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INDEX TO "THE ELECTRICIAN."

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SPECIAL INDEXES.

	PAGE
*COMMERCIAL AND INDUSTRIAL SUPPLEMENT	10
*Municipal, Foreign and General Notes	8
Companies' Meetings, Reports, Dividends, Statutory Returns, &c.	9
Companies (New Electrical, &c.) Registered	10

* *Entries in these Indexes are* not *included in the* GENERAL INDEX.

SUB-HEADINGS IN GENERAL INDEX.

	PAGE
Accounts	3
Institution of Electrical Engineers	4
Legal Intelligence	5
Obituary	5
Parliamentary Intelligence ..	6
Personal	6
Railways, Electric	6
Reviews of Books	6
Telegraphy	7
Telephony	7
Wireless Telegraphy and Telephony	7

Names of Authors of Articles and Papers are indexed alphabetically in the GENERAL INDEX, *and not under the sub-headings.*

General Alphabetical Index.

Heavy figures **denote that the subject matter is a "Leading Article" or in the "Editorial Notes." When the letter (C) is placed after a title it signifies that the article in question appeared in the Correspondence columns.**

A

Accident, Fatal, at Eastbourne, 672

ACCOUNTS—
Aberdeen, 36
Alloa, 73
Ayr, 147
Barrow-in-Furness, 219
Birkenhead, 219
Bournemouth, 147
Bradford, 135
Cardiff, 332
Cheltenham, 73
Derby, 73
East Ham, 73
Edinburgh, 219
Exeter, 332
Glasgow, 287
Gravesend, 442
Keighley, 74
L.C.C. Trams, 828, 839
Leeds, 442
Liverpool, 788
Maidstone, 74, 148
Manchester, 287
Marylebone (London), 219, 385
Middleton, 260
Newcastle-on-Tyne, 74
Pontypridd, 74
Poplar (London), 583
Shoreditch (London), 74
Southwark (London), 583
Stepney (London), 36
Stockport, 74
Tonbridge, 148
Willesden, 788
York, 260

Accounts, Analysis of, [Bradford] 135, [Manchester] 287, [St. Marylebone] 385, [London County Council Tramways] **828**, 839
Accumulators, The Use of, in Alternate-Current Stations [Schroeder], **77**, 98
Adelaide, Elec. Railway Signals, 795
Administrator, The Engineer as, 658
A.E.G., The, 186
Aeronautical Institution, 42
Agencies at Home and Abroad, 251
Agriculture, Power in, 397
Air. Flow, through Nozzles, 828
Alien Enemy Members, The Institution and, [Styles] (C) 358,
Allies' Economic Conference, 885
Alternators, Method of Constructing, to Obtain a Pure Sine Wave, [Seeman] **114**, 137, (Drysdale) (C) 172
Aluminium, Manufacture of, in the United States, 225
AMBERG, E. J.: Overhead Contact Systems, Construction and Costs, 663
American Cities, North, Use of Electricity, 707
American Elec. Industry, 543
American Electro-Chemical Society, 794
American Foreign Trade, 437
A.M.I.E.E. (C), I.E.E. and Enemy Members, 916
Ammeters, Alternate-current and Voltmeters, 120
Ampere-turns for Teeth, Calculation of, 336
Antennæ, Compound, Oscillation Frequency, 761
Arc, Electric, Consumption of Carbon in the, 371
Arc, Elec., in Vapours and Gases at Reduced Pressures, [Darrah] 415
Arc, Use of the Flame, in Paint and Dye Testing, 153
Arc, Welding, Applications of, 484
Arc Lamp, New York Discards the, 623
Arc Phenomena, [Collis] 806
Arcs, Poulsen, 552
ARMAGNAT, H.: Magnetos for Elec. Ignition, **861**, 865, 899
Armatures, Continuous Current, Methods of Chord Winding for, [Leyerer] 771
ARMSTRONG, E. H.:
The Audion Amplifier, (C) 61, 264
Some Recent Developments in the Audion Receiver, 798
ARMSTRONG, Prof. H. E.: Problems of Coal, 876
Artisans' Dwellings, Elec. Light in, [Cleary] 313, **318**, **410**, (C) 540
Artists' Rifles, O.T.C., 411, 693
ARTOM, A.: The Direction Finder (C), 210
Assessment, Electricity Supply Works, **302**
Association, A Commercial Electrical, 327
Association of Engineers-in-Charge, 42
Association of Mining Elec. Engineers, W. of Scotland Branch, 4, 42
Association of Supervising Electricians, Presidential Address by Mr. A. H. Dykes, 8, 20
AUEL, C. B.: Elec. Welding, 45, **57**, 84
Australasia, Electricity Supply in, 397
Australasia, Enemy Trading, 885
Australasian Market, 177
Australia, Elec. Winding in, 897
Australia, Enemy Trade Marks, 683
Australian Companies, Enemy Shareholders in, 750
Auxiliaries, Separate Unit for Elec., 40

B

Baekeland, Dr., Perkin Medal Award, 447
BAILY, T. F.: Electric Furnace for Re-heating, Heat Treating and Annealing, 159, **168**
BAIRSTO, G. E.: On the Relation between the Alternating-current Conductivity of a Dielectric and its Change of Capacity with Frequency, 53
Bakelite, 760
Bakery Installations, 31
Bascule Bridge, Trolley Wire on Double Leaf, [Foster] 393
Batteries, Storage, Installation and Working of, 175
Battery, Elec. Trucks, Efficient Use, 613
Battery Locomotives, 749
Battleship, "California," Electrically Propelled, [Emmett] **446**, 458
BAUER, B.: Tests on Oil Switches, 767
BAUM, F. G.: The Effect of Hydro-Electric Power Transmission Upon Economic and Social Conditions, with Special Reference to the United States, 15
B.E.A.M.A., 266, (*Annual Meeting*) 646
"Beama Journal," 586
BEARD, J. R.: Design of High-pressure Distribution Systems, 375, (*Discussions*) 420, 538, 576
BEATTIE, R.: Permeameter for Straight Bars, (C) 781
Beit Scholarships for Scientific Research, 623
BELLINI, E.: (C) The Direction Finder, 27, 62, (Artom) (C) 210
Bells, Signalling Battery, 586
BENISCHKE, Dr. G.: Variations in the Wave-shape in High-tension Testing Installations, **385**, 389
BIEDERMANN, E. A.:
Estimation of the Dispersion Coefficient of Three-phase Induction Motors and its Application to their Design, **39**, 48, 132, 204, 276, 346, 453, **483**, 493
Some Problems of Electromagnetic Induction, (C) 208, 356
BISHOP, F. L.: Application of Electricity to the Heating of Metals, 158, **168**, 189
Blading, Turbine, Alloys for, 726
Boiler of 1915, [Pratt] 695, **708**
Boiler Fuels, 795
Books, Appeals for, 485
Bradford Electricity Supply, **113**, 135
BREISIG, Dr. F.: Standardisation of Loaded Telephone Lines, 468
British Association, 80, 303
British Cable Makers in 1915, 919
British Industries after the War, 919
British Industries Fair, 471, 749
British Manufacturing, Collective Power for, 431
British Ores, 692
British Patents, **586**
British Science Guild, 712
British Trade After the War, **674**
Business and Engineering, 587, (C) [Garrard] 681
Business (?) as Usual, 211
Business Policy, New National, 411

C

Cable Messages, Enemy, 66
Cables at the Golden Gate, 623
Cables, Underground, Testing with Continuous Current, [Record] 661, **692**, [*Discussion*] 698
Calorising Metals, 726
CAMPBELL, A., and DYE, D. W.: Magnetic Testing of Bars of Straight or Curved Form, 642
CAMPBELL, E. D.: On the Influence of Heat Treatment on the Specific Resistance and Chemical Constitution of Carbon Steels, 27
Canada, Hydro-Electric Works in, 2, 105
Canada's Coal, 896
Canadian Hydro-Electrics, 361
Canadian Industry, Electric Power in, [Mitchell] 192, **201**
Canadian Trade Manufacturers, 919
Canal, New York State Barge, 659
Candle-power, Nominal, of Incandescent Lamps, **725**, [Salomon] 744, [Willcox] (C) 814
Capital and Labour, Relations Between, 783
Car Bogies, Removing by their Own Power, 79
Car, New York Municipal, 379
Carbon, Consumption of, in the Electric Arc, 371
CARLIER, J.: Solution of the Traction Equation of a Vehicle in Motion by the Power Meter, 308
Cars, Ford, Electric Equipment for, 225
Cars, One-Man, 658
CARTER, F. W.:
Elec. Locomotive, 540, [Wiel] (C) 574
Eddy Current Loss in Dynamo Teeth, 569; (Press) (C) 849
CARTER, T.: Direct-current Motor Speed Regulation by Resistance in the Armature Method, with Special Reference to the Diverter Method (*contd. from* Vol. LXXV.), 22
Cast Iron, 623
Cells, Dry, [Cooper] 906
Cells, Selenium, [Cooper], 676, 705, 735
"Central, The," 726
Charges, Elec. Supply, 177
Chemical Intelligence Branch of Board of Trade, The Proposed, 186
Chicago, Milwaukee & St. Paul Railroad, 693
Chimney Design, 795
China and Japan, 139
China, Electrical Progress in, 65
Chisels, 897
CHREE, C.: Lord Kelvin and Terrestrial Magnetism, **725**, 740
Circle of Scientific, Technical and Trade Journalists, 797
City and Guilds of London Institute, Report on the Work of Technology Dept., **483**, 492
CLAYTON, A. E.: Wave-shapes Obtaining with Alternating-current Generators Working under Steady Short-circuit Conditions, 729, 763
CLEARY, J.: Electric Light in Artisans' Dwellings, 313, **318**, **410**, (C) 540
CLINKER, R. C.: Transformer Core Loss as Affected by Triple Harmonics, (C) 102
Coal, Bituminous, 658
Coal Cutting, Electrical, 760
Coal-cutting Machinery in 1914, 637
Coal Delivered, Costs of, 484
Coal-loading Plant, Mechanical, 264
Coal, Output in the United Kingdom in 1914, 658
Coal, Problems of, [Armstrong] 876
Coal Supplies for Electricity Works, **389**
Coal Supply, 361
Coal Supply for Municipal Elec. Works, 577
Coal and Coke Supplies, **794**, 795
Coaling Plant, Christobal, 726
COHEN, L.: Long-distance Radio Transmission, 743
Colleges, Engineering, and the War, [Walmsley and Larard] **426**, 428
Colliery Electric Plant Breakdowns, 911
COLLIS, A. G.: Arc Phenomena, 806
Colonies, Electricity Supply in the, **776**
Colour of Illuminants, 587
Commissions, Royal Engineer, 114
Commonwealth Institute of Science and Industry 829
Commutating Machinery, Physical Limitations in Direct-current, 303
Companies, Elec. Supply in 1915, 749, 851
Companies, New Electrical, in 1915, 499
Companies, Public, Wound-up, Dissolved, &c., in 1915, 508
Compressed Air, Motors Replace, 586
Concreting Electric Car Heaters for Cold Weather, 224
Conduction of Electricity Through Metals, [Thomson] 13
Conductors, Skin Effect in, 692
Control and Protection of Electric Systems, [Steinmetz] 155
Controlled Works, Central Station as a, **657**
Controllers, Hoisting, for Large Elec. Revolving Cantilever Cranes, **862**, 870
Cooking, Elec., at Euston Station, 498
Coolidge Rontgen Ray Tube, 114
Co-operation, Scientific, **896**, 898
COOPER, W. R.:
Dry Cells, 906
Selenium Cells, 676, 705, 735
Copper, Electrolytic, the Production and Properties of, [Welbourn] **224**, 235
Copper, Price of, 543
Corona and Other Forms of Electrical Discharge, 795
Corona in Air at Continuous Potentials and Pressures Lower than Atmospheric, [Mackenzie] 247
Cost of Elec. Energy, Effect of Power Factor on, [Stöppler] 704
COURSEY, P. R. Uniformity in Drawing Elec. Diagrams, (C) 882
COURSEY, P. R., and FLEMING, J. A.: Effect of Elec. Oscillations on the Magnetic Properties of Iron, Investigated by the Campograph, 738
COX, H.: Industrial Development, 812, 844
CRANE, H. G., and DAWES, C. L.: Construction of Lecture-room Oscillograph, 904
Cranes, Cantilever, Hoisting of Controllers for Large Elec. Revolving, **862**, 870
Croydon Wireless Society, 660, 830
"Crystallisation Doubtful," 658
Crystallography, The New, 623
Curves, Comparing Load and Water Rate, 586
Cylinders, Cooling of, 841

D

Damping Factor in Highly Damped D'Arsonval Galvanometers, 587
DARRAH, W. A.: Elec. Arc in Vapours and Gases at Reduced Pressures, 415
DAWES, C. L., and CRANE, H. G.: Construction of Lecture-room Oscillograph, 904
"Dead Man's Hand," **794**
Decrement, Measurement of, 447
DENTON, F. M.:
(C) Double Dynamometer Wattmeter, 714
(C) Rapid Reckoning Chart, 815
Depreciation of War Plant, **39**

Derrick, 20-ton, With Roller-bearing Mast, 552
Design, Some Difficulties of High-speed Generators, [Field] 272,, 321, (*Discussion*) **483**, 488
Diagrams, Electrical, Uniformity in Drawing, [Kapp] 802, **810**, [Garrard] (C) 849, 862, [Coursey] (C) 882
Dielectric, On the Relation Between the Alternating-current Conductivity of a, and Charge of Capacity with Frequency, [Bairsto] 53
Dielectrics, Flow of Electricity through, [Richardson] 646
Diesel Engine Users' Assoc., 43, 116, 304, 448, 588, 808
Diesel Engines for Generator Drive, [Legrand] 452
Discussions and Early Closing, **657**
Dispersion Coefficient of Three-phase Induction Motors, The Estimation of, and its Application to their Design, [Biedermann] **39**, 48, 132, 204, 276, 346, 453, **483**, 493
Distribution Systems, Design of High-pressure, [Beard] 375, (*Discussion*) 420, 538, 576
Distributors, Non-electrical, 105
Dow, J. S.: Some Principles in Industrial Lighting, 574
Drawings, Line, **336**
Dreadnought, Progress of the Elec., 26
Dredger, Turbo-Electric, 264
Drilling Machine, Midget Electric, 518
Drills, Percussion Rock, Elec., 265
DRYSDALE, C. V.:
Sine Wave Alternators, (C) 172
Double Dynamometer Wattmeter, **518**, 523, 558, 593, (C) [Denton] 714
Dublin, Position at, **691**
DURTNALL, W. P.: Passing of the Small Turbine, (C) 247
DYE, D. W., and CAMPBELL, A.: Magnetic Testing of Bars of Straight or Curved Form, 642
Dynamo Starters, 105
Dynamo Teeth, Eddy Current Loss in, [Carter] 569, (Press) (C), 849
Dynamometer Wattmeter, Double, [Drysdale] **518**, 523, 558, 593, (C) [Denton] 714

E

Earth Resistance, [Murdoch] (C) 62, [Marchant] (C) 394, [Peters] (C) 466
Earth Resistance and Electrolysis, 727
Earth Resistivity, A Method for Measuring, [Wenner] 103
Earthing, [Rhodes] (C) 746
Eastbourne Fatal Accident, 672
E.C.A. Activities, 211
ECCLES, W.: An Abac for the Calculation of Wave-lengths, 388
ECCLES, W. H., and MAKOWER, A. J.: Simple Thermal Instruments for the Measurement of Current, 233
Edge Effect of Plate Condensers, [Watson] (C) 883
Edison's Birthday, 794
Education After the War, 518
Education Estimates, 884
Education, Higher Technical, Committees, **517**
Education, Technical, The War and After, 518
Education and Labour, 828
"Electric Locomotive," 586
Electric-Resistor Material, New, 828
Electric Supply Undertaking, Modernising, 863
Electrical Assoc. of Australia, 660
Electrical Trades' Benevolent Institution, 916
Electricians and the Motor Trade, 683
Electricians, Women, 327
Electricity through Metals, Conduction of, [Thomson] 13
Electrochemistry and Lighting, 371
Electrolysis, Effects of, on Engineering Structures, [Ganz] 185, 199
Electrolysis, Mitigating, 518
Electrolytic Iron, 225
Electromotive Forces, 828
Electrons, Escaping, Work Done by, 862
ELLERD-STYLES, W.: City Guilds' Subject, "Electric Wiremen's Work" (C) 782
EMMETT, W. L. R.: Electrically-propelled Battleship "California," **446**, 458
Employés Serving with the Colours, Allowances, 361
Enemy, Trading with the, **585**, 717
Engineer, Commercial, A Plea for, 289
Engineer, "Status" of the, 351
Engineer? What is an, 795
Engineering, **586**
Engineering and Business, 587
Engineering, British, 683
Engineering Industry, Organising British, 278, **280**
Engineering Institutions' Volunteer Training Corps, 4
Engineers, Cranks and Business, **621**
Engineers, Mobilise, **827**
Engineers, Mobilising of, **1**
Engineers, Royal (Wireless Section), 336
Engines, Aviation, 251
Enlistment of Clerical and Commercial Employés, 187
Equation, Personal, 897
Europe, Water Powers, 795
Euston Station Elec. Cooking, 498
Events, Electrical, of 1915, **462**
Examination, City and Guilds, in "Wiremen's Work," (C) [Lundberg & Sons] **726**, 746, (Ellerd-Styles) (C) 782
Examinations, I.E.E., 484
Exports, Maintenance of, 327
Exports, Prohibition of, 885

F

Factories and Workshops, Lighting in, Some Notes on First Report of Departmental Home Office Committee, **301**, 312, **409**, 423
Factories, Annual Report of the Elec. Inspector of, **302**, 316
Factory Construction, Director of, 153
Fan, Experimental, Value of, in Mining Laboratory, 586
Faraday House "Journal," 2, 692
Faraday Society, 4, 42, 266, 486
Ferry, Electric, 336
Fibres, Electrification of, 862
FIELD, Prof. A. B.: Some Difficulties of Design of High-speed Generators, 272, 321 (*Discussion*) **483**, 488
Filament Industry, 484
Filaments, Lamp, Preparation of Tungsten for, 370
Filaments, Lamp, Zirconium-Iron Alloy for, 370
Finance, Municipal Elec. Supply, **585**
Fires, Electric, 211
FISCHER, K.: Construction of Insulators out of "Hard Paper" or "Pertinax," **185**, 197
Fog Dispelling, Electrical, 153
Fools and Fool-proof Starters, **657**
FOREST, LEE DE: Development in Radiotelegraphy and Telephony During 1915, (C) 466
FOSTER, S. L.: Trolley Wire on Double-leaf Bascule Bridge, 393
Foundations for Transmission Line Towers and Tower Erection, 230
FLEMING, J. A.: Organisation of Scientific Research, **691**, 710, **727**
FLEMING, J. A., and COURSEY, P. R.: Effect of Elec. Oscillations on the Magnetic Properties of Iron Investigated by the Campograph, 739
Flying Machines, Electric, 78
Flywheel, Two, Breakdowns, 519
Freezing, Preventing, 518
Freight Rates, 410
Frequency Changers, Parallel Operation of, [Rettew] 5
Fuel and Motive Power, The World's Sources of, 153
Fuel, Low-grade, Use of, 748
Fuel, Saving of, 519
Fund, "The Times," for Sick and Wounded, 336
Furnace, Elec., Development, 3
Furnace, Elec., for Copper Ore Smelting, 40
Furnace, Experimental Electrics, for High Temperatures, 727
Furnace, The Electric, for Re-heating, Heat Treating and Annealing, [Baily] 159, **168**
Furnaces, Elec., 809
Furnaces, Elec. Steel, Heat Losses, 897
Furnaces, Elec., Value of, 410
Future, Plans for the, **301**

G

Galvanometer, Portable, 774
Galvanometers, D'Arsonval, Damping Factor in Highly-damped, 587
GANZ, A. F.: Effects of Electrolysis on Engineering Structures, **185**, 199
GARRARD, C. C.:
Business and Engineering, (C) 681
Apparatus for Protecting Elec. Machinery against Abnormal Elec. Conditions (*cont'd. from* Vol. LXXV.), 11
Apparatus for Starting and Controlling Electrical Running Machinery, 772, 837, 873
Diagrams, Electrical, Uniformity in, (C) 849
Gas and Hygiene, 587
Gas and the War, 31
Gas Mixtures, Explosive, Ignition by Elec. Sparks, [Morgan] 536
"Gas, Necessity of," 783
Gas, Natural, 897
Gas Opposition to Electricity Supply, 577
Gases, Ignition by Impulse Electrical Discharge, 863
GASTER, L.: Recent Progress in Industrial Lighting, 809
GATI, B.: Submarine Cable Rapid Telegraphy, Ocean and Intercontinental Telephony, 305, **301**, [Squier, Harrison] (C) 357
Generator, 10,000-volt Continuous-current, 411
Generator, Direct-Current for 10,000 volts, [Linke] 842
Generator, Steam, Development, **552**, 553
Generators, High-speed, Some Difficulties of Design, [Field] 272, 320, **483**, (*Discussion*) 488
Generators, Three-phase, for the Rjukanfos Power Station, 343
German Business Methods, **240**, 245
German Catalogues, Exhibition in London, 885
German Colliery Mixed Turbine Plant, 693
German Elec. Manufacturers and the War, 3
GIMINGHAM, E. A., and MULLARD, S. R.: A New High Efficiency Incandescent Lamp, **369**, 390
Giovi Line, Elec. Traction on the, 449, 487
Golden Gate, Cables at the, 623
Goods, Manufactured, Export of, 397
Government and Technical and Business Training, 919
Granary, Electrical Machinery at the Meadowside, 392
Gravitational Constant, 410
Greenock Electrical Society, 42, 80
Gun, An Electric, 153
GUREWITCH, P.: Water-power in Russia, 505

H

Halfpenny Postage, 65, 105
Hamilton Elec. Incline Railway, 552
Hammer Drill, A New Electric, 40
Harmonic Analysis Schedules, 760
Harmonics in Transformer Magnetising Currents, [Peters] 24, 43
Harmonics, Triple, Transformer Core Loss as Affected by, [Clinker] (C) 102, [Lacey and Stubbings] (C) 285
HARRISON, H. H.:
Submarine Cable Rapid Telegraphy, (C) 358
Principles of Modern Printing Telegraphy, 602, 634, 669, (*Discussion*) 731, [Raymond-Barker] (C) 745
HARRISON, H. T.: Efficiency of Projectors and Reflectors, 842
Haulage and Winding, Elec., in Mines, 761
Heat Loss, Rate of, 411
Heat Treatment, On the Influence of, on the Specific Resistance and Chemical Constitution of Carbon Steels, [Campbell] 27
Heating, Elec. Charges for, 437
Heating, Elec.: Its Present Position and Future Development, [Wilkinson] 421
Heating of Metals, Application of Electricity to the, [Bishop] 159, **168**, 189
Heating Steel Tyres Electrically, 225
Hefner Lamp, Dependence of the Light on Atmospheric Conditions, More Especially Atmospheric Pressure [Ott], **224**, 227
Hele-Shaw Transmission Gear, 829
High-Voltage Measurement, Notes on, [Work] 835
HIRSCH H. H.: Hirsch Portable Elec. Lamp, 877
HOBART, H. M.: Elec. Railways, **446**, 457, 501, 521
HOGAN, J. L.: Signalling Range in Radiotelegraphy, 699
Hoist, Large Electric, 761
Hong Kong, Trade with, 577
Hong Kong, University of, 761
Honours, New Year's, 485
HORNOR, H. A.: Standard Marine Elec. Installations, 373, 413
Hospitals and Nursing Homes, Elec. Lighting in, 852
HOWE, Prof. G. W. O.:
Some Problems of Electromagnetic Induction, 169, (C) 210, 323, 355, 431, [Biedermann, Maccall] (C) 209, 356, [Wilson] (C) 285
Distributed Capacity of Solenoids, (C) 173
Calculation of Effective Resistance of Earth Plates, 353
Hydro-Electric Developments in Norway, 137
Hydro-Electric Plant, 5,000 H.P. Chain-drive for a, 239
Hydro-Electric Plant at Lake Margaret, Tasmania, 225
Hydro-Electric Plant, Largest in Montana, 484
Hydro-Electric Power Transmission, The Effect of, upon Economic and Social Conditions, with Special Reference to the United States, [Baum] 15
Hydro-Electric Works in Canada, 2, 105
Hydro-Electrics, Canadian, 361
Hygiene, Gas and, 587
HUBBARD, J. C.: On the Distributed Capacity of Single-layer Solenoids, 138, [Howe] (C) 173
HUGHES, E.: Alternating-current Work, (C) 358

I

Ignition, Elec. Magnetos for, [Armagnat] **861**, 865, 899
Illuminants, Artificial, for Use in Practical Photography, [Mees] 167
Illuminants, Colour of, 587
Illuminants, Elec., 877
Illumination, Measuring, Future Possibilities in the Design of Instruments, 746
Illumination, Nomenclature of Elec., 210
Illumination of Streets, The Effective, [Millar] 81, 96
Illumination Tests with a Camera, 371
Import, Machine Tools, 327
Imports, Prohibition of, 885
Impulse Currents, Theory, 693
India, Elec. Vehicles in, 577
India Office Appointment, 153
Indian, Elec. Enterprise in, 324, 327
Indian Government Finances, 817
Indian Shareholders and Income Tax, 437
Induction, Electromagnetic, Some Problems of, [Howe] 169, (C) 210, 323, 355, 431, [Biedermann, Maccall] (C) 209, 356, [Wilson] (C) 285
Induction Motor under Cyclical Operation, 336
Industrial Development, [Cox] 812, **844**
Industrial Districts, Elec. Power in, 211
Industry, A Growing Tyneside, 518
Industry, Electrical, Before and After the War, 834
Injustice, A Monstrous, **410**
Inland Steel Co., Rolling Mill Equipment, 658
Installation Costs, Comparative, 519
Institute of Chemistry, 588, 728, 797

INSTITUTION OF ELECTRICAL ENGINEERS—
Alien Enemies and the I.E.E., **760**, **793**, 801, 815, [Swinton, Tilney] (C) 848, 883, [A.M.I.E.E.] (C) 916
Birmingham Section, 80, Col. J. F. Lister's Address, **152**, 173, Meetings, 154
Cables, Underground, Testing with Continuous Current, [Record] 661, **692**, (*Discussion*) 698, 779
Continuous-Current Railway Motors, [Pannell] 831, (*Discussion*) 869
Continuous Current for Terminal and Trunk Line Electrification, [Grover] 846, 880, (*Discussion*) 902, **912**
Copper, Electrolytic, Production and Properties of, [Welbourn] **224**, 235
Council Nominations, **895**
Distribution Systems, Design of High-Pressure, [Beard] 375, (*Discussions*) 420, 538, 576
Dublin Section, 830
Examinations, 484
Expulsion of Enemy Members, 660
Generators, High Speed: Some Difficulties of Design, [Field] 272, 320, (*Discussion*) **483**, 488
Heating, Elec.: Its Present Position and Future Development, [Wilkinson] 421
Institution of Elec. Engineers, 4, 42, 553
Lamp, Incandescent, New High Efficiency, [Gimmingham & Mullard] **369**, 390
Machinery, Dynamo-Electric, Predetermination of the Performance, [Walker] 531, 570, (*Discussion*) 607
Presentation of Faraday Books, &c., 265
Presidential Address, **263**, 282
Roll of Honour, 372
Scottish Local Section, 188, 728, 864
Special General Meeting, **692**, 694
Students' Section, 372
Telegraphy, Printing, Principles of Modern, [Harrison] 602, 634, 669, (*Discussion*) 731, (C), (Raymond-Barker) 745
Terrestrial Magnetism, [Lord Kelvin and Chree] **725**, 740
The Forces and the Institution, 693
Wiring Rules, 829
Yorkshire Section, Chairman's Address, 238

Institute of Industry, 519, 726, 830
Institute of Metals, 226
Institute of Metals "Journal," 693
Institute of Post Office Electrical Engineers, 728
Institute of Radio Engineers, 694, 8?4
Institution of Civil Engineers, 116, 762
Institution of Elec. Engineers, [Maycock] (C) 644
Instruments, Simple Thermal, for the Measurement of Current, [Eccles and Makower] 233
Insulating Compounds in Telephony, 64
Insulating Materials, Artificial, **621**, 627, 679
Insulating Materials, Elec. Strength of, Under Mechanical Pressure, [Kock] **1**, 16
Insulation, Mica Armature Coil, Experimental Data Concerning the Safe Operating Temperature, [Newbury] **263**, 267, 381
Insulation, Mica, Temperature Limits for, 381
Insulator Impregnated Stockingette, (C) 173
Insulators, Construction of, out of "Hard Paper" or "Pertinax," [Fischer] **185**, 197
Insulators, Dielectric Losses in Various, 239
Insurance Companies, A Word to, 31
Interned Aliens, Legal Status of, 31
Iron Alloys, Characteristics of, 186
Iron Alloys, Thermo-E.M.F. of, 726
Iron Alloys, The Magnetic Properties of Some, Melted in Vacuo, [Yensen] 114, 339, **352**
Iron-Cobalt Alloy, Fe_2Co, and its Magnetic Properties [Yensen], **40**, 52
Iron, Electrolytic, 225
Iron Losses in Direct-Current Machines, 862
Iron Permeability in, Production of High, [Wilson] 596
Italian Industry and Germany, 851

J

Jarrow, Train Disaster, 411
Johannesburg Elec. Supply System, 519
JONES, C. H.: Top Contact Unprotected Conductor Rail for 600-volt Traction Systems, 733
Journal, New Electrical, 40
Junior Institution of Engineers, 412, 694 796

K

Kananaskis Falls, Alberta, Plant, 795
KAPP, G.: Uniformity in Drawing Elec. Diagrams, 802, **810**, [Garrard] (C) 849, 862, [Coursey] (C) 882
Kingstown Provisional Order, **760**
KNIGHT, C. D.: Principles and Systems of Elec. Motor Control, **551**, 555, [Maycock] (C) 849
KOCK, F.: Electric Strength of Insulating Materials under Mechanical Pressure, **1**, 6
Kyoto Imperia University, 828

L

Labour-Saving Devices and the War, 717
LACEY, H. M., and STUBBINGS, C. H.: Transformer Core Loss as Affected by Triple Harmonics, (C) 285
LACH, Dr.: Elec. Heating and Schoop's Metal-squirting Process, **336**, 342
Lamp, Hirsch Portable Elec., [Hirsch] 877
Lamp, Incandescent, A New High-Efficiency, [Gimingham and Mullard] **369**, 390
Lamp, Safety, Centenary of the, 518
Lamps, Electric, Recent Developments in Relation to Illuminating Engineering, **370**, 394
Lamps, Incandescent, Nominal Candle-power of, [Salomon] **725**, 744, [Wilcox] (C) 814
Lamps, Metal Filament, Efficiency Progress, 814
Lamps, Miners' Cap, Upkeep of, 829
Lamps, Tungsten, Gas-Filled, [Pirani and Meyer] **335**, 350
Lancs. & Yorks. Railway, Electrification of Manchester to Bury Section, 526, 561, **585**, 597, 629
LANGMUIR, I.: The Melting-Point of Tungsten, 424
LARARD, C. E., and WALMSLEY, R. M.: Engineering Colleges and the War, **426**, 428
Latin-America, How to Sell to, 371
LEBENBAUM, P.: Contact System of the Southern Pacific Company, Portland Division, 713

LEGAL INTELLIGENCE—

Adnil Elec. Co., 104
Albion Electrical Co. *v.* L. K. W. Synd., 472
Alien Enemy Patents, 310, 395, 541, 612
Alien (Interned), Right to Sue, 30
Alien Shareholders in British Companies, 66
Allen West & Co. *v.* British Westinghouse Co., 714
American Wireless Patents, 293
Articles Lost on Tramways, Liability for, 293
Attewell *v.* W. Ham Corpn., 782
Baldcok's Telegraph Instruments Co. *v.* British Telegraph Instruments Co., 104
Beattie *v.* Barton-Wright, 140
Blatch *v.* Port of London Authority, 647
British Elec. Traction Co., 292, 396, 852
British Thomson-Houston *v.* Stonebridge Electrical Co., 917
Brown *v.* Lambeth (London) Borough Council, 253
Budgett, T. W. G. *v.* Stratford Co-Operative Society, 917
Re Cedes Elec. Traction, 576
Colliery Regulations, Breaches of, 715
Consolidated Diesel Engineers Mnfrs., 612
Consumption of Electricity, Fraudulent, 541
Contracts, Effect of War on, 434, 852
Re County of Durham Elec. Power Distribution Co., 254
Davis (J.) & Co. (Southampton); Hands *v.* Company, 818
Devonport Tramways Arbitration, 648
Dexter *v.* Aldershot U.D.C., 292
Diamond Coal Cutter Co. *v.* Mining Appliances Co., 140
Electric Current, Alleged Fraudulent Use of, 396
Elec. Lighting Plant, 682
Elec. Railway Co. of London *v.* Inland Revenue Commissioners, 326
Elec. Supply Undertakers' Obligations, 434
Electrical Engineers' Slander Action, 647
Electricity Works Assessment, 291
Electricity Works Valuation Appeals, 104
Export of Prohibited Goods, 293
Farrell *v.* Bloxam, 748, 918
Re Float Elec. Co., 748
German Companies, Agreement with, 918
Grocott *v.* Lovatt & Another, 748
Heeman *v.* Edwards Bros., 918
Hodges (C.) & Co. *v.* Ellis & Ward, 612
Hurt *v.* Mayor, &c., of Sheffield, 541, 917
Irish Elec. Lighting Contract, 648
Kingstown Provisional Order Arbitration, 435, 782
Leiston Gas Co. *v.* Leiston-cum-Sizewell Urban Council, 648
Liability of Local Authorities, 292
Light Elec. Motor Co. *v.* M. Rosen, 254
Lowe, H. W. *v.* Blundell, C. J. Weld, 818
Mayor and Corporation of W. Ham *v.* Hart Accumulator Co., 396
Meters Destroyed by Fire, Liability for, 435
Mining Regulations, Breach of, 782, 818
Morris (Herbert) *v.* Saxelby, 682
Morshead (L. R.) *v.* Quasi Arc Welding Co., 818
Motor Purchase Dispute, 714
Munitions Case, 715
Muntz *v.* W. Bromwich Corporation, 682
Napier Kimber *v.* Davis & Smith, 612
Newhouse and Others *v.* Northern Light, Power & Coal Co., 140
Osram Lamp Works *v.* Merryweather & Sons, 291
Osram Lamp Works *v.* Pope's Elec. Lamp Co., 104, 252, 291, 396, 433
Pembroke Urban Council *v.* Diesel Engine Co., 254
Planing Machine, Damaging Elec., 576
Plymouth Tramways Arbitration, 253, 290, 473
Price (E.) *v.* Hammersmith Borough Council, 715
Prize Court Cases, 360

Legal Intelligence—*continued.*

Secret Process for Making Filaments, 140
Segar (S.) *v.* Isaacs (G.), 435
Shrimpton *v.* Northern Power, Light & Coal Co., 435
Tampering with Elec. Wires in a Colliery, 473
Taylor & Farley *v.* W. Bromwich Corpn., 576
Telegraphist's Cramp, 682
Tramway Conductors' Holidays, 541, 911
Tramway Undertakings, Liability of, 326
Valuation Appeal, 541
Vandervell *v.* A. P. Lundberg & Sons, 325, 395
W. Sunderland *v.* Economisers, 104
Wireless Apparatus in Territorial Waters, 253
Workmen's Compensation Cases, 66, 212, 254, 293, 435, 918
Wynstanley *v.* Macartney, McElroy & Co., 612
"Z" Elec. Lamp Mfg., Co., 254
Zinc Corporation *v.* A. Hirsch & Sohn, 472
Zinc, Electrolytic, Patent for Getting, 510

Legal Record of 1915, **604**
LEGRAND, C.: Diesel Engines for Generator Drive, 452
Length, Measures, Origin of, 485
LEYERER, F.: Methods of Chord Winding for Continuous-current Armatures, 771
Lifts, Electric, [Marryat], 432
Lifts, Semi-Automatic, on the Underground, 459
Lifting Appliances and Chains, 485
Light by Recombination of Ions, 862
Light, Elec. in Artisans' Dwellings, [Cleary] 313, **318**
Light Source, A New Standard, 587
Lighting and Electro-chemistry, 371
Lighting Contracts, Public, 783
Lighting, Elec., Telegraphy and other Applications of Electricity in 1915, **534**
Lighting, Industrial, Recent Progress, [Gaster] 809
Lighting, Industrial, Some Principles in, [Dow] 574
Lighting in Factories and Workshops, Some Notes on the First Report of the Departmental Home Office Committee, **301**, 312, **409**, 423
Lighting, Train, 224
Lighting, Train, and Uncorroborated Evidence, **828**
Lightning, Protection of Life and Property against, [Peters] 246
Lightning, Protection against, 658
LINKE, W.:
Direct-Current Generator for 10,000 volts, 842
The Starting of Rotary Converters, 243
Linking-up, A Time for, **621**
Liverpool Overhead Railway, 447
Load, Factor High, 518
Locomotive, Electric, [Carter] 540, [Weil] (C) 574
Locomotive Weights, 897
Locomotives, Battery, 749
Locomotives, Petrol-Electric, 337
London - Birmingham - Liverpool Telephone Cable, 862
London County Council Tramway Accounts, **828**, 839
London Elec. Engineers (T.F.), 2, **370**
London Electricity Supply Companies, **827**
London Electricity Supply Loans, 613
London, Trams and 'Buses in, 265
LUNDBERG & SONS: City and Guilds' Examination in "Wiremen's Work." (C) **726**, 746, (Ellerd-Styles] (C) 782

M

MACCALL, W. T.:
Some Problems of Electromagnetic Induction, (C) 208, 357
The Design of Transformers, (C) 102
Machine Tools Import, 327
Machine Tools, Influence of the Electric Motor on, **2**
Machinery, Dynamo-electric, Predetermination of the Performance, [Walker] 531, 570, (*Discussion*) 607
Machinery, Elec. Running, Apparatus for Starting and Controlling, [Garrard] 772, 837
Machinery, Gt. Western Railway's Electrical, 86
MACKENZIE, D.: Corona in Air at Continuous Potentials and Pressures Lower than Atmospheric, 247
McLACHLAN, N. W.:
Mathematical Investigation of Voltage Waves Obtained in Testing Iron, 242
Resistance of Moist Sandstone to High and Low Frequency Alternating Currents, 875, 896
Magnetic Force, Horizontal and Vertical, 623
Magnetic Properties of Iron Cobalt Alloy Fe_2Co [Yensen], **40**, 52
Magnetic Properties of Iron, Effect of Elec. Oscillations on the, Investigated by the Campograph, [Fleming and Coursey] 738
Magnetic Properties of Some Iron Alloys Melted in Vacuo, [Yensen] 114, 339, **352**
Magnetic Testing of Bars of Straight or Curved Forms, [Campbell and Dye] 642
Magnetos for Electric Ignition [Armagnat] **861**, 865, 899
Magnets, Lifting, 552
MAKOWER, A. J., and ECCLES, W. H.: Simple Thermal Instruments for the Measurement of Current, 233
Manchester Assoc. of Engineers, 266
Manchester! Ave, 289
Manchester Municipal School of Technology, 552
Manufacturing, British Collective Power for, 431
MARCHANT, E. W.: Earth Resistance, (C) 394, 574
Marine Engines, Remote Control of, 264
Marine, Standard, Elec. Installations, [Hornor] 373, 413
MARRYAT, H.: Electric Lifts, 432
Mathematical Printing, 659
MAYCOCK, W. P.:
Institution of Elec. Engineers, (C) 644
Frequency, Freq. or Curl, (C) 286, 324, [Reviewer] (C) 324, [Hughes] (C) 358
Motor Control, Elec. Principles and Systems of, (C) 849
MEBS, C. E. K.: Artificial Illuminations for Use in Practical Photography, 167
Merchant Shipping Convention Act (1914), 336
Mersey Railway, 447
Metals, Radiography of, 153
Metals, Speculation in, 817
Meter Testing [Williams], (C) 916
Metric System, 885
Metropolitan Assoc. of Elec. Tramways Managers, 80, 553
Metropolitan Company, **895**
Metropolitan Railway and Tramway Companies in 1915, 885
Mexico, Mining Machinery, 649
MEYER, A. R. and PIRANI M.: Gas-filled Tungsten Lamps, **335**, 350
Mica Armature Coil Insulation, Experimental Data Concerning the Safe Operating Temperature, [Newbury] **263**, 267, 381
Mica Insulation, Temperature Limits for, 381
Michigan Railway, Steel Cars for, 778
Microphones and Microphonic Contacts, [Pedersen] 589, 625
Military Service and Indispensable Workers, 225
MILLAR, P. S.: Effective Illumination of Streets, 81, **96**
Mine Electrification, 2
Mine Rescue Signalling Device, 153
Mines and Quarries, Divisional Report on, 26
Mines, Elec. Winding and Haulage in, 761
Mines, Safety in, 817
Mining, Application of Elec. Power, 898
Mining Institute of Scotland, 694, 864
Minnesota Steel Co. Elec, Plant, 552
Mirrors, Electrolytic, Coating of, 19
MITCHELL, C. H.: Elec. Power in Canadian Industry, 192, **201**
Mobilisation, Commercial, 610
Molecular Physics, 265
Mollier Diagram, 623
Molybdenum in Steel, 484
Montana, Largest Hydro-elec. Plant, 484
MORGAN, J. D.: Notes on the Ignition of Explosive Gas Mixtures by Electric Sparks, 536
MOSSAY, P. A.: Battery Vehicles, (C) 207
Motive Power, The World's Sources of Fuel and, 153
Motor Control, 447
Motor, Elec. Control, Principles and Systems of, [Knight] 555, [Maycock] (C) 849
Motor, Elevator, 586
Motor Induction, under Cyclical Operation, 336
Motor Speed Regulation, Direct Current, by Resistance in the Armature Circuit, with Special Reference to the Diverter Method, [Carter] (*contd. from* p. 955, Vol. LXXV.) 22
Motor Trade and the Electricians, 683
Motors, Mining, 411
Motors, Replace Compressed Air, 586
MULLARD, S. R., and GIMINGHAM, E. A.: A New High-efficiency Incandescent Lamp, **369**, 390
Municipal Councils and Alien Enemy Goods, 717
Municipal Elec. Supply Finance, **585**
Munition Workers, Training of, **445**
Munitions of War, Employment of Women, 693
Munitions, Voluntary Help for, 896
MURDOCH, W. H. F.: (C) Earth Resistance, 62
Myth and a Moral, **638**

N

NAGAOKA, Prof. H.: Propagation of Elec. Waves at Surface of the Earth and the Ionised Layer of the Atmosphere, 741
National Assoc. of Colliery Managers, 797
National Illumination Committee of Great Britain, 116
Navy's Need for Skilled Engineers, 115
NEWBURY, F. D.: Experimental Data Concerning the Safe Operation Temperature for Mica Armature Coil Insulation, **263**, 267, 381
News for Neutrals, 78
New York City, Census of Gas Producer Plants, 410
New York Discards the Arc Lamp, 623
New York, Electricity and Gas Consumption, 749
New York Municipal Car, 379
New York State Barge Canal, 659
New Zealand, Elec. Power in, 411
New Zealand, Elec. Supply, 509
Nitrate Industry, 658
Nitrates, U.S.A. Govt. Production of, 519
Nitrogen, Atmospheric, Fixation of, 795
Nobel Prizes, 153, 186, 225
Norway Hydro-Electric Developments in, 137
Norway, Water Power in, 336
Norwegian Water Power, 518
Numerals, Proposed Standard, 727

O

OBITUARY—
Bailey, Pte. I., 3
Barrell, Prof. F. R., 337
Bastian, Dr. H. C., 265
Batty, Sergt. J. D., 728
Beazley, H., 587
Cameron, Cpl. D. J., 520
Cartwright, Capt. G. C., 80
Cassels, W. R., 520
Casson, Capt. Wm., 41
Clay, John, 864
Courtis, Capt. I. H., 303
Cripps, Prof. H. L., 226
Crompton, Lieut. N. G., 188
Cross, Wm., 448
Currie, Lieut. C. A., 486
Dann, 2nd-Lieut. T. V., 116
Davies, Major J. L., 303
Dawbarn, R. A., 796
Donovan, H. C., 303, 337
Duesbury, T., 898
Duncan, Louis, 830
Eden, Augustus, 553
Fairweather, C. W., 830
Fawcett, Cpl., 41
Forbes, 2nd-Lieut. J., 412
Fulton, Col. J. D. B., 226
Garrett, 2nd-Lieut. W. O., 448
Gibbs, Capt. J. R., 41
Goodfellow, 2nd-Lieut. E. A. F., 762
Gwynne, 2nd-Lieut. O. P., 624
Harris, 2nd-Lieut. H. L., 372
Hicks, Lieut. B. E., 3, 116
Hollingsworth, Lieut. J. G., 79
Horne, Pte. J. L., 486
Huber-Werdmüller, Col. P. E., 79
Hughes, 2nd-Lieut. O., 338
Hunter, 2nd-Lieut. W. C., 520
Hyam, T., 587
Iago, F., 371
Inchley, Lieut. W., 486
Jacob, Lieut. A. L. H., 41
James, Capt. Baron T., 188
Jones, F. J., 624
Kelvin, Lady, 864
Kingsford, H., 693, 762
Lacey, F. W., 898
Lane, J. H., 371
Levinstein, Ivan, 864
Lewes, Prof. V. B., 115
Llewellyn, J., 898
Long, Lieut. F. S., 265
Luntley, W. A., 115
Maclean, F. G., 412
Marsh, Major H. H. S., 412
Meldola, Prof. R., 226
Minter, Pte. H., 3
Mitchell, C. F., 624
Moor, 2nd-Lieut. C., 154
Morley, Arnold, 553
Morley, Pte. E. G., 154, 303
Munro, A. H., 187
Noble, Sir Andrew, 115
O'Kelly, H. M., 486
Parker, T., 337, 410
Peek, Pte. G. W. R., 154, 303
Porter, H. F., 187
Potts, L., 115
Reeves, R., 587
Rivers-Wilson, Sir C., 693
Roscoe, Right Hon. Sir Henry E., 412
Ross, 2nd-Lieut. J. A., 154
Rucker, Sir Arthur W., 154
Sabine, A. L., 728
Salomons, Capt. D. R., 187
Sankey, Capt. S. J., 115
Saxon, Pte. H., 41
Scholey, Lieut. C. H. N., 3
Schultz, 2nd-Lieut. L. E., 79
Shea, Wm., 371
Slater, W. P., 412
Smith, Prof. R. H., 728
Somerville, Lieut. R. N., 79
Stevenson, E. A., 762
Taylor, H. A., 447
Thornton, R. E., Lieut. J. McL., 624
Tucker, G. N. G., **551**, 554
Venner, R. F. S., 587
Vickers, Col. T. E., 79
West, Rifleman T., 3
Whitaker, Capt. A. C., 520
Whitwham, A. E., 412
Wollaston, C. J., 303
Wood, John, 694
Wood, Cpl. S. A., 154, 303
Woodward, Lce.-Cpl. A., 3
Wooster, Pte. J. C., 41, 303

Obstacle, The Eternal, 105
Oil Switches, Tests on, [Bauer] **759**, 767
Omnibus and Tube Facilities, 613
Omnibuses, Trolley versus Motor Omnibuses, 371
"On Earth Peace, Good Will Toward Men," **409**
Operators, Protection of X-ray, 336
Optical Appliances in Warfare, 898
Orders, Elec. Lighting Provisional, 460
Ores, British, 692

Organisation, Professional, 519
Oscillations, Effect of Electric, on the Magnetic Properties of Iron Investigated by the Campograph, [Fleming and Coursey] 738
Oscillograph for High-tension Work, 672
Oscillograph, Lecture-room Construction of, 904
OTT, Dr. E.: Dependence of the Light of Hefner Lamp on Atmospheric Conditions—More Especially Atmospheric Pressure, **224**, 227
Oven, Elec., for Testing Shrapnel, 264

P

Pacific Cable Board, 424
Panama Canal, Elec. Work, 484
Panama Pacific Exposition, Energy Required, 794
Panama, Pumping Work, 518
Pan-American Scientific Congress, 649
PANNELL, E. V.: Continuous-Current Railway Motors, 830, (*Discussion*) 869
"Paper, Hard," or "Pertinax," Construction of Insulators out of, [Fischer] **185**, 197
Parker, the Late Thomas, 410

PARLIAMENTARY INTELLIGENCE—
Celluloid Regulations, 212
Commercial Policy after the War, 542
Elec. Power Station Employees, 293
Electricity Supply Charges, 254
Ericht Water & Electric Power (Extension of Time) Order, 176
Excess Profits Tax, **151**, 176
Finance Bill, 212, 293, 359
Firms Bill, Registration of, 916
Import Duties on Motor Cars, 30
L.C.C. (Tramways & Improvements) Bill, 29
London, Public Lighting of, 542
Manchester Electricity Supply, 396
Re Mexican Light & Power Co., 67
Military Inventions, 254
Munitions Act, Amendment of, 293, 396
Patents and Designs (Partial Suspension) Bill, 254, 293
Post & Telegraph Rates, 66
Railway Carriages, 473
Royal Assent, 176
Trading with the Enemy (Amendment) (No. 2) Bill, 611
Trading with the Enemy (Extension) Bill, 396, 436
Trains, Elec. Lighting of, 576

Parliamentary Record for 1915, **622**, 647
Parliamentary Schemes, New, 361
PARSHALL, J. F.: Economics of Elec. Power Station Design, **264**, 269
Patents, Alien Enemy, 114, **152**, 181, **551**
Patents, British, **586**
Patents Expiring in 1916, **447**, 461
Patents in 1915, 543
Peace Hath its Mourning No Less than War, 31
Peat, Utilisation of, 658
PEDERSEN, Prof. P. O.: On Microphones and Microphonic Contacts, 589, 625
Perkin Medal Award to Dr. Baekeland, 447
Permeameter for Straight Bars, [Beattie] (C) 781
Permeability, High, in Iron, Production of, [Wilson] 596

PERSONAL—
Balsillie, J. G., 694
Baynes, S. W., 3
Bright, C., 830
Bryan, F.R.S., Prof. G. H., 188
Callender, T. O., 188
Courtenay, 2nd-Lieut. A. R., 553
Cox, S. B., 372
Dugdale, J. W., 830
Gadstone, N. F., 588
Garnett, Dr. Wm., 338
Gifkins, A. V., 80, 265
Gilling, A. C., 4
Gladdy, T., 796
Greenhill, F.R.S., Sir George, 830
Hipwood, C., 830
Hopkinson, Prof. B., 694
Howell, F. H., 587
Hoyle, Cpl. B., 3
Kershaw, L. J., 412
Knight, S. A., 588
Lamme, B. G., 188
Laurie, Principal, 694
Leblanc, Maurice, 372
Leigh, A., 588
Lincon, P. M., 372
Marriott, H., 338
Marwood, W. F., 830
Masters, Major F. H., 796
Meares, J. W., 303
Meldola, Prof. R., 265
Moggridge, E. G., 830
Moncrieff, H. A., 587
Murray, J. W., 412
Parshall, H. F., 486, 659
Parsons, Sir Charles A., 694
Pearson, J. B., 154
Pease, J. A., 553
Perkins, A., 80
Prangnell, N. W., 303
Pupin, Dr. M. J., 80
Read, Dr. J., 412
Richardson, T. K., 154, 659
Riley, E. S., 338

Personal—*continued.*
Rolling, Major B. I., 226
Royal Engineers (T.F.), 4, 41, 80, 116, 188, 265, 372, 412, 520, 553, 588, 624, 694, 728, 762, 796, 864, 898
Scott, C. E., 588
Scott, W. A., 830
Shepherd, C. W., 520
Sillar, A. M., 303
Smith, C. H., 694
Sparks, Lieut. A. C., 830
Taylor, Temporary Lieut. H. M., 116
Taylor, W. T., 226
Turner, H. C., 624
Vines, A., 486
Whitney, Dr. W. R., 265
Wickham, W. G., 338
Wilson, G., 80
Wolfe-Barry, 2nd-Lieut. B. J., 486

PETERS, J. F.: Harmonics in Transformer Magnetising Currents, 24, 43
PETERS, O. S.:
Protection of Life and Property Against Lightning, 246
Earth Resistance, (C) 466
Petrol-Electric Locomotives, 337
Petrol Electric Sets, 623
Petroleum Production in 1915, 692
Philadelphia Electric Co., New Generating Station, 645
Physical Society, [Barratt, Griffiths] 234, [Fleming, Whipple] 286, [Guild, Griffiths' Dickson, Griffiths, Ravenshear] 359, [Lees' Sand] 747, [Skinner, Willows], 883
Physical Society, 728
PIRANI, M., and MEYER, A. R.: Gas-filled Tungsten Lamps, **335**, 350
Plans for the Future, **301**
Platinum Supplies, 543
Plugs, Wall, British Standard Specification for, and Sockets, and for charging Plug, and Socket, 485, 509, 543
Portland Cement, 623
Postage, Halfpenny, 65, 105, 139
Post and Telegraphs Bill, New, 106
Postmaster-General's Annual Report, **896**, 914
Poulsen Arcs, 552
Power, Electric, as a Factor in Capturing Trade 717
Power, Elec., in New Zealand, 411
Power, Natural Sources, Development of, 289
Power, Norwegian Water, 518
Power Project, Sold, 371
Power Station Design, Economics of Elec., [Parshall] **264**, 269
Power Station, Founding a Large, on Soft Marsh, 775
Power Supply, Maintenance of, **335**, 364
PRATT, A. D.: Boiler of 1915, 695, **708**
PRESS, A.: Eddy Current Loss in Dynamo Teeth, (C) 849
Primary Capacity, Best, for Tesla Coils, 552
Private *versus* Municipal Enterprise, 613
Producer Plants, Gas, Census of, in New York City, 410
Profits, Castner-Kellner Alkali, 289
Profits, Excess, of Municipalities, **224**, 258
Profits, Taxation of Excess, **151**, 176, **223**
Projectors and Reflectors, Efficiency, [Harrison 842
Propulsion, Elec., of Battleships, 411
Protecting Elec. Machinery, against Abnormal Elec. Conditions, Apparatus for, [Garrard] (*contd. from* p. 918 Vol. LXXV.), 11
Protection and Control of Electric Systems, [Steinmetz] 155
Provisional Elec. Lighting Orders, 460
Prussia, Water-power in, 40
Pumping Plant, Variable-speed, for a Drainage District, 469
Pumping Work at Panama, 518
Pumps, Automatic Elec. "Boosting," 40
Pupin, Prof. M. I., Hébert Prize for, 760
Pyrometers, Radiation, 322

Q

Quebec Bridge, Erection Plant for the, 381, 417, 659

R

Radiation, Sir J. J. Thomson on, from Atoms and Electrons, 910
Radiography of Metals, 153
Railway, Elec. Signalling on New South Wales, 3
Railway, Elec., Signals at Adelaide, 795
Railway Rates, Increased, 65
Railway's Elec. Machinery, Gt. Western, 86

RAILWAYS, ELECTRIC.
Alsatian Elec. Railway, An Interesting, 18
Chicago, Milwaukee & St. Paul Railroad, 693
Contact, Overhead, Systems, Construction and Costs, [Amberg] 663
Contact System of the Southern Pacific Co., Portland Division, [Lebenbaum] 713
Contact Systems, Overhead, Construction, Maintenance and Cost of, [Zogbaum] 469
Contact, Top, Unprotected Conductor Rail for 600-volt Traction Systems, [Jones] 733
Continuous Current for Terminal and Trunk-line Electrification, [Storer], 846, 880 (*Discussion*) 902

Railways, Electric—*continued.*
Continuous-Current 5,000-volt Railway, 78
Development, Elec. Railway, 114
Economy in Elec. Railway Working, 761
Giovi Line, Elec. Traction on, 449, 487
Hamilton Elec. Incline Railway, 552
Lancs & Yorks Rly., Electrification of Manchester to Bury Section, 153, 526, 561, **585**, 597, 629
Liverpool Overhead Railway, 447
Locomotive, Battery, 749
Locomotive, Elec., [Carter] 540, [Weill] (C) 574
Locomotives, Petrol-Elec., 337
London & S. Western Railway Electrification (*continued from* p. 965, Vol. LXXV.), 59, 78, 87, 124, 163, 186, 303
Mersey Railway, 447
Motors, Rly., Continuous-Current, [Pannell] 830, (*Discussion*) 869
Railways, Electrical, [Hobart] **446**, 457, 501, 521
St. Paul Railway, Successful Tests, 485
Steel Cars for Michigan Rly., 778
Sweden, Elec. Railways in, 78
Termini, Railway, Electrification of, 485
Traction, Elec., in 1915, 500
Traction Equation, Solution of, [Carlier] 308
U.S.A. Progress in Elec. Railways, 659
United States & Canada Elec. Railways, 303

Rating, Thermal Characteristics and Intermittent, 62, **77**, 93
RAYMOND-BARKER, E.: Principles of Modern Printing Telegraphy, (C) 745
Reactance, Laboratory Built, of Large Capacity, 337
Receptivity, **409**
RECORD, O. L.: Testing of Underground Cables with Continuous Current, 661, **692**, (*Discussion*) 698, 779
Recruiting and Common Sense, **185**
Red Tape, The Passing of, **152**
Reflecting Power Standards, 659
Reflectors and Projectors, Efficiency of, [Harrison] 842
Registration of Firms, 683
Report Writing for Engineering Students, 519
Research, 371
Research, Grants for, 692
Research Laboratory, An Elec. Engineering 115
Research, Scientific, Beit Scholarships for, 623
Research, Scientific and Industrial, 186, 863
Research, Scientific Organisation of, 622 [Fleming] **691**, 710, 727, **742**, [Tinsley] (C) 745
Research, State-aided, 78
Resistance, Earth, [Marchant] (C) 394, 574
Resistance Grids, Elec. Locomotive, Repairing, 761
Resistance of Networks of Conductors, 896
Resistor, Elec., New Material, 828
Resonator, Ideal, 761
RETTEW, G. H.: Parallel Operation of Frequency Changers, 5

REVIEWS OF BOOKS—

Aircraft in the Great War, [Grahame-White and Harper] 58
Alignment Charts, [Andrews] 388
Alternating-Current Work, [Maycock] 281, (C) 286, 324, [Reviewer] (C) 324, [Hughes] (C) 358
Alternating Currents, Arithmetic of, [Crapper] 242
Alternating Currents, Examples in, [Austin] 607
Analysis, Modern, A Course of, [Whittaker] 777
Annuaire pour l'An, 1916, 914
Arc Phenomena, Elec., [Rasch] 845
Callendar Steam Tables, [Callendar] 427
Commutation, Recherches sur la, [Rezelman] 242
Conductivity, Electrical, and Ionization Constants of Organic Compounds, [Scudder] 21
Constants and Numerical Data, Annual Tables of, Chemical, Physical and Technological, 21
Constant Voltage Transmission, [Dwight] 710
Continuous and Alternating-Current Machinery Problems, [Ryan] 428
Continuous Current Elec. Engineering, [Maccall] 241, [Maycock] (C) 286
Diesel Engines for Land and Marine Work, [Chalkley] 879
Dynamo Elec. Machinery, Specification and Design of, [Walker] 131
Edinburgh Citizen, Life Jottings of [Macdonald] 880
Electricity and Magnetism, Elementary Lessons in, [Thompson] 640
Electrochemistry, A Laboratory Course in, [Watts] 319
Engineering Science, A First Course in, [Haler & Stuart] 428
Experiments, [Edelman] 22
Experimental Harmonic Motion, [Searle] 639
Graphics and Structural Design, [Hess] 880
Grinding Machinery, [Guest] 282
Handbook, Standard, for Elec. Engineers, [Fowle] 97
Imports to Exports, Relation of, [Peddie] 913,
Lettering, Hand, A Treatise on, for Engineers Architects, Surveyors and Students of Mechanical Drawing, [Lineham] 203
Light, Treatise on, [Houston] 639
Machine Tools, Testing of, [Burley] 778

Reviews of Books—*continued.*
Mechanical World Electrical Pocket Book, 710
Mechanical World Pocket Diary and Year Book, 710
Mechanics, Applied, An Introduction to, [Andrews] 387
Micrometers, Slide Gauges & Calipers: Their Construction and Use, [Marshall & Gentry] 282
Patent Law, Handbook of, [Thompson] 387
Penrose's Annual, 710
Practical Electrician's Pocket Book and Diary, 1916, 710
"Practical Engineer" Electrical Pocket-Book and Diary, 914
Proctor's Useful Tables, 880
Production, First Principles of, [Peddie] 58
Radiotelegraphy and Radiotelephony, Elementary Manual of, [Fleming] 811
Railway., Elec., Handbook, [Richey] 98
Rapid Reckoning Chart, [D'Albe] 778, [Denton] (C), 815
Smoke Abatement, Modern Boiler Room Practice and, [Hodgson] 319
Spon's Architects' and Builders' Pocket Price Book, 1916, [Young & Brooks] 778
Technical Instructions, Handbook of, for Wireless Telegraphists, [Dowsett] 811
Technology, Mechanical, [Charnock] 778
Telegraphy and Telephony (Final Examinations), Questions and Solutions in, 846
Telephone and Telephone Exchanges: Their Invention and Development, [Kingsbury] 606
Tramway Track Construction and Maintenance, [Holt] 57
Transformers, High Pressure, Directions for Designing, Making and Operating, [Austin] 607
Transformers, Low Pressure, How to Make, [Austin] 607
Wireless Telegraphist's Pocket Book of Notes, Formulæ and Calculations [Fleming] 709
Wireless Telegraphy, [Rolfe-Martin] 97
Wireless Telegraphy, [Zenneck] 913
Wireless Time Signals, 22
Wirtschaftlich Die Günstigste Spannung für Fernubertragungen Mittelst Freileitungen, [Eimer] 204

RHODES, S. C.: (C) Earthing, 746
RITTERSHAUSEN, A.: Losses in Electrical Water Heaters, 591
Rjukanfos Power Station, Three-phase Generators for, 343
Rolling Mill Equipment of the Inland Steel Co., 658
Röntgen Ray Tube, The Coolidge, 114
Röntgen Society, 154
ROSENBAUM, M.: Characteristics of Three-phase Induction Motors or Single-phase Circuits, 701
Rotary Converters, Starting of, [Linke] 243
Royal Engineers (Wireless Section), 897
Royal Institution, 154, 338, 624, 660
Royal Society, 154, 226, 588, 660, 728, 762, 795, 796, 883
Royal Society and Scientific Co-operation, **896**, 898
Royal Society of Arts, 266, 588
RUDENBERG, R.: A Study of the Surges Caused on Switching off Asynchronous Motors, 455
Rugby Engineering Society, 412
Russia, British Elec. Enterprise in, 471
Russia, Contemplated Taxation of Electricity, 760
Russia, Water-power in, [Gurewitch] 505
Russian Central Station Statistics, 794
Russian, Elec. Companies' Results for 1914, 29
Russian Market, 211

S

St. Paul Railway, Successful Tests, 485
SALOMON, Dr. E.: Nominal Candle-power of Incandescent Lamps, 744, [Willcox] (C) 814
Sandstone, Moist, Resistance to High and Low Frequency Alternating Currents, [McLachlan] 875, 896
Schoop's Metal Squirting Process, Elec. Heating and, [Lach] **336**, 342
SCHROEDER, L.: The Use of Accumulators in Alternate-current Stations, **77**, 98
Science in the War and After the War, 3, 207
Science, Organisation of, 623
Science, The Relation of, to Practice in Engineering, 172
Science and Technology, Advanced Students of **369**
Scientific and Technical Press, The Sphere of, in Relation to Technical Education and Research, 875
Screw Gauges, 863
Searchlight, Mobile, 518
SEEMAN, W.: Method of Constructing Alternators to Obtain a Pure Sine Wave E.M.F., **114**, 137, [Drysdale] (C) 172
Selenium Cells, [Cooper] 676, 705, 735
Sheffield Power Load, 543
Ship, The Turbo-electric, "Mjolner," 41
Shipping Reform, 683
Showrooms, Utility of, 437
Signalling Bells, Battery, 586
Signalling Device, Mine Rescue, 153
Signalling, Elec., on the New South Wales Rly., 3

"Simpson" Light, 518
Skin Effect in Conductors, 692
SKRITZKY, N.: Some Considerations on the Marconi High-power Transmitting Plant, 348
Slip, Chattering Wheel, 761
Smoke Abatement and Elec. Supply, 471
Society of Engineers, 4
Soldiers and Sailors, Land Settlement for, 717
Solenoids, On the Distributed Capacity of Single-layer, [Hubbard] 138, [Howe] (C) 173
Sound Carrying, 518
S. Africa, Elec. Progress in, 509
South Shields Progress, 577
Southern Pacific Company, Portland Division, Contact System, [Lebenbaum] 713
Spain, Business with, 817
Spark-Gap, On an Adjustable Prism-shaped Multiple, [Thieme] 162
Sparkless Break, Means for Producing, of an Inductive Circuit, [Wall] 640
Spheres and Cylinders, Approximate, Electrical Capacity of, 828
Sprinklers, Electric, 623
SQUIER, G. O.: Submarine Rapid Cable Telegraphy, (C) 357
Stabiliser, The Sperry, 484
Standard Specifications, British, for Wall Plugs and Sockets and for Charging Plug and Socket, 485, 509, 543
Standardisation Rules, British, for Elec. Machinery, 186, **878**
Starred Trades Scandal, **861**
Stars and Lesser Fry, **827**
Starters, Dynamo, 105
Starting and Controlling Elec. Running Machinery Apparatus for, [Garrard] 772
Steam Generator Development, **552**, 553
Steam Turbine, Largest in the World, 78
Steam Turbine, Relation Between, Rating and Water Rate, **78**, 103
Steel, Elec., Industry of U.S.A., 692
Steels, Non-rusting, 411
STEINMETZ, C. P.: Control and Protection of Electric Systems, 155
Stepney, Inauguration of New Plant at, 79
STIGANT, S. A., and THOMPSON, J. L.: Equipment and Protection of Outdoor H.T. Substations, 665
Stockingette, Impregnated (Insulator), (C) 173
STÖPPLER, R.: Effect of the Power-factor on the Cost of Electric Energy, 704
STORER, N. W.:
5,000-volt Continuous-current Traction, **186**, 190
Continuous Current for Terminal and Trunk Line Electrification, 846, 880, (*Discussion*) 902, **912**
STUBBINGS, C. H., and LACEY, H. M.: Transformer Core Loss as Affected by Triple Harmonics, (C) 285
Students, Engineering, and the War, **113**, 138
STYLES, W. ELLERD-: The Institution and Alien Enemy Members, (C) 358
Sub-stations, Outdoor H.T., Equipment and Protection of, [Thompson and Stigant] 665
Supply, Electricity, Reliability in, **551**
Supply System, Johannesburg Elec., 519
Surges, A Study of, Caused on Switching off Asynchronous Motors, [Rudenberg] 455
Sweden, Water-power, 587
Swedish General Electric, (C) 505
SWINTON, A. A. C.: (C) "Stranger that is Within Thy Gates," 848
Switch Boxes, Street, **517**
Sydney Elec. Supply, Sub-stations of the, 129
Synthesiser, Thirty-two Element, 726

T

Tables, Electricity Supply, **691**
Tariffs as Affected by Power Factor, **692**
Tasmania, Hydro-electric Plant at Lake Margaret, 225
Taxation of Electricity, Contemplated, in Russia, 760
Taxation of Excess Profits, **151**, 176, **223**
Technical Education, Higher, Committees, **517**
Technical Education, The War and After, 518
Technical Education and Research, The Sphere of the Scientific and Technical Press in Relation to, 875
Technical Man, **223**
Technically-trained Men, Supply of, **151**
Technology Dept., Report on the Work of City and Guilds of London Institute, **483**, 492
Technology and Science, Advanced Students of, **359**
Teeth, Ampere Turns for, Calculation, 336
Teeth, Dynamo, Eddy Current Loss in, [Carter] 569, [Press] (C) 849
Telautograph, New, 336

TELEGRAPHY—
British Telegraphy, 518
Cable, New Submarine Telegraph, 34, 69
Cablegrams, Deferred and Week-end, 686
Chinese Telegraphs, 475
Codes, Telegraph, 616
Lodge, Telegraph Cable (No. 2,470), 187
Messages, Week-end, 616
Post and Telegraphs Bill, New, 106
Post Office and Boy Labour, 143

Telegraphy—*continued.*
Printing Telegraphy, Modern, Principles of, [Harrison] 602, 634, 669, (*Discussion*) 731, (C) [Raymond-Barker], 745
Rates, Telegraph and Postal, 69
Roumania, Telegraph Service with, 580
Russia, Telegraph Service with, 513
Submarine Cable Rapid Telegraphy: Ocean & Intercontinental Telephony [Gati], 305, **301**, [Squier, Harrison] (C), 357
Submarine Telegraph Service, 251
Telegrams, Deferred, 580

TELEPHONY—
Abuse of the Telephone, 177
Aeroplane Telephone, A Practical, 40
Automatic Telephony at Los Angeles, 114
Brighton, 143
Cable, London-Birmingham Loaded, 128
Cables, Telephone, Drying of, 370
Charges, Increased Telephone, 686
Guernsey Telephone Service, 652
Hull Telephone System, 580
Insulating Compounds in Telephony, 64
Intercommunication Telephones, 817
Jamaica Telephone Service, 576
Latin America, The Telephone in, 370
Loaded Telephone Lines, Standardisation of [Breisig], 468
London-Birmingham-Liverpool Telephone Cable, 862
Long Distance Telephony Record, 692
Municipal Telephony, 215, 256, 296
Nevada, Long Distance Telephones in, 385
New York, Telephones in, 370
Norway, Automatic Telephony in, 105
Rates, Telephone, 256
Recent Developments in Telephony, 623
Regulations, New Telephone, 34
Shanghai Telephone Service, 475
Superimposed or "Phantom" Telephone Circuits, 99, 117
Telephone Development, 795
Transmission, Tentative Standards of, 464
Warfare, Telephones in, 484

Temperature and Young's Modulus, 761
Terrestrial Magnetism, Lord Kelvin and, [Chree] **725**, 740
Tesla Coils, Best Primary Capacity, 552
Tests, Alternating Stress, 897
Thames, Power Plant in, 613
Thanks, We Return, **585**
Thermophone, The, 317
THIEME, B.: On an Adjustable Prism-shaped Multiple Spark-gap, 162
THOMPSON, J. L., and STIGANT, S. A.: Equipment and Protection of Outdoor H.T. Substations.
THOMSON, Sir J. J.:
Conduction of Electricity Through Metals, 13
On Radiation from Atoms and Electrons, 910
Three-phase Induction Motors, Characteristics of, on Single-phase Circuits, [Rosenbaum] 701
TILNEY, M. J. E.: (C) "The Stranger that is Within Thy Gates," 848, 883
TINSLEY, H.: Organisation of Research, (C) 745
"Tower was Called Babel," **568**
Traction, A 5,000-volt Continuous-current, [Storer] **186**, 190
Trade After the War, 613, 649, 717, 783, 851, 884
Trade, British, After the War, **674**
Trade and Business after the War, 543
Trade Literature, Current, 819
Trade, Overseas, 289
Trade in War Time, 649
Trade-marks, Enemy in Australia, 683
Trades, Scheduled, **263**
Trading With the Enemy Act, 749
Train Delays, Electrification and, 484
Train, Julian, Control and Automatic Stop, 807
Trains, Gas Lighting, 509
Training, Technical and Business, and Our Government, 919
Tram Conductors, Women, 139
Trams and 'Buses in London, 265
Tramways, Trailer Cars on the L.C.C., 265
Transformer, 1,000,000-volt, 337
Transformer Core Loss as Affected by Triple Harmonics, [Clinker] (C) 102, [Lacey & Stubbings] (C) 285
Transformer Magnetising Currents, Harmonics in, [Peters] 24, 43
Transformers, Abnormal Voltages in, **78**
Transformers, Design of [Maccall] (C) 102
Transmission Gear, Hele-Shaw, 829
Transmission Gear, Variable Speed, **760**, 764
Transmission Line Towers, Foundations for and Tower Erection, 230
Transmission, Tentative Standards of, 464
Trolley Systems, 1,200 versus 600-volt, 499
Trucks at Cristobal, Electric, 153
Tube and Omnibus Facilities, 613
Tungsten, Melting-point of, [Langmuir] 423
Tungsten, Preparation of, for Lamp Filaments, 370
Tungsten Wire, Drawn, Manufacture of, 633
Turbine Blading, Alloys for, 726
Turbine, Low-pressure, 761
Turbine, Passing of the Small, **130**, [Durtnall] (C) 247
Turbine Plant, Mixed, at a German Colliery, 693
Turbine's 32 months' Non-stop Run, 417
Turbo-Alternator, 60,000 kw. Unit for, 696
Turbo-Alternator Development, 123
Turbo Unit, 70,000 kw., 760
Tyneside Industry, A Growing, 518
Tyres, Heating Steel, Electrically, 225

U

United States, Water-power in, 410
U.S.A. Elec. Railway Progress, 659
U.S.A. Elec. Steel Industry, 692
U.S.A. Export Trade, 398
U.S.A. Govt. Production of Nitrates, 519

V

Van, Light Elec. Delivery, 105
Variable-speed Transmission Gear, **760**, 764
Variometer, Portable, for Magnetic Surveying, 704
Vehicle Charging, Battery, Minimum Rates, 251
Vehicle, Commercial Battery, Progress, 471
Vehicle Committee, Elec., 42, 304
Vehicle, Elec., Committee, 796
Vehicle, Elec., Development, 411
Vehicle (Elec.) Progress, Oct. 22, Nov. 19, Dec. 31, Jan. 28, Feb. 25, March 31
Vehicles, Elec., 518
Vehicles, Elec. v. Horses, 251
Vehicles, Elec., in India, 577
Verband Deutscher Elektrotechniker, 303
Visiting Day, 65
Voltage Waves, Obtained in Testing Iron, Mathematical Investigation of, [McLachlan] 242
Voltmeters, Alternate-current Ammeters and, 120

W

WALKER, Prof. MILES: Predetermination of Performance of Dynamo-Electric Machinery, 531, 570, (*Discussion*) 607
WALL, T. F.: Means for Producing a Sparkless Break of an Inductive Circuit, 640
WALMSLEY, R. M., and LARARD, C. E.: Engineering Colleges and the War, **426**, 428
War, After the, **151**
War Allowances, Municipal, 139
War Plant, Depreciation of, **39**
War, Science in, and After, 207
Water-Heaters, Elec., Losses in, [Rittershausen] 591
Water-power Development, 622
Water-power in Norway, 336
Water-power in Russia, [Gurewitch] 505
Water-power in Sweden, 587
Water-power in the United States, 410
Water-powers of Europe, 795
WATSON, C. J.: Edge Effect of Plate Condensers, (C) 883
Wattmeter, Double Dynamometer, [Drysdale] **518**, 523, 558, 593
Wave-length for Thin Straight Conductor, 829
Wave-shapes, Obtaining with Alternating-current Generators Working under Steady Short-circuit Conditions, [Clayton] 729, 763
Wave Shape, Variations in, High-tension Testing Installations, [Benischke] **385**, 389
Waves, Analysing Electric, 2
Waves, Elec., Propagation of, at Surface of the Earth and the Ionised Layer of the Atmosphere, [Nagaoka] 741
Waves, Elec., in Transmission Lines, 447
Waves, Voltage, Obtained in Testing Iron, Mathematical Investigation, [McLachlan] 242
WEIL, P.: Elec. Locomotive, (C) 574
WELBOURN, B.: Production and Properties of Electrolytic Copper, **224**, 235
Welding, Elec., [Auel] 45, **57**, 84, 410
WENNER, F.: A Method for Measuring Earth Resistivity, 103
WHITE, G. W.: "Discharge Tube," Used as a Wireless Valve, 103
WILKINSON, G.: Electric Heating: Its Present Position and Future Development, 421
WILLCOX, F. W.: Rating of Incandescent Lamps, (C) 814
WILLIAMS, J.: Meter Testing, (C) 916
WILSON, J. C.: Some Problems of Electromagnetic Induction, (C) 285
WILSON, Prof. E.: On the Production of High Permeability in Iron, 596
Winder, Mechanics of the Elec., 303
Winding, Chord, Methods of, for Continuous-current Armatures, [Leyerer] 771

WIRELESS TELEGRAPHY AND TELEPHONY—
Arcs, Poulsen, 552
Brazil, Radiotelegraphy in, 331
Kite-Supported Aerials for Radiotelegraphy, 40
Neutrals, News for, 78
Oscillating Currents, 225
Radiotelegraphy, Signalling [Hogan] 699
Radiotelephony, Long Distance, 79, 187, 392
Radio Transmission, Long-Distance, [Coker] 743
Telephony, Wireless, 2
"Wiremen's Work," City and Guilds' Examination, **726**
[Ellerd-Styles] (C) 782
Wiring Improvements, 437
Wood, Electricity in, 264
WORK, W. R.: Notes on the Measurement of High Voltage, 835
"Workman," Definition of the Term, 65

X

X-Ray Operators, Protection of, 336
X-Ray Tube, Ionisation Potential of an, 41
X-Rays, Hard, 225

Y

YAGI, H.: Production of Undamped Electric Oscillations by Quenched Spark Discharge, 195
YENSEN, T. D.:
Iron Cobalt Alloy, Fe_2Co, and its Magnetic Properties, **40**, 52
Magnetic Properties of Some Iron Alloys Melted in Vacuo, 114, 334, **352**
Yorkshire Association of Mining Elec. Engineers, 338
Young's Modulus, Temperature and, 761

Z

Zirconium-Iron Alloy for Lamp Filaments, 370
ZIPERNOWSKY, F.: Construction, Maintenance and Cost of Overhead Contact Systems, 469

Municipal, Foreign, and General Notes.

ELEC. SUPPLY—

Extensions.

Aberdeen, 254, 294, 362, 398, 718
Accrington, 718, 819, 920
Alloa, 254
Aylesbury, 886
Ayr, 213
Bacup, 254, 614
Barking, 32
Barnes, 886
Barnsley, 254
Barrow, 718
Bath, 363, 614, 853
Belfast, 178, 363
Bermondsey (London), 614
Birkenhead, 684
Birmingham, 178, 474, 511, 544
Bolton, 328, 578, 784
Bo'ness, 107, 213, 294, 544, 684, 819
Bradford, 178, 255, 511, 853, 886
Bridlington, 784
Burton-on-Trent, 363, 398, 819
Chesterfield, 67, 107
Coventry, 141, 213
Darlington, 255, 363
Darwen, 32, 578
Derby, 67, 438
Dover 886
Dundee, 294
Dunfermline, 255
Durham, 294
Eccles, 32
Edinburgh, 67, 255
Finchley, 213, 511
Fulham (London), 853
Glasgow, 650
Gravesend, 141, 255
Greenock, 511
Hackney (London), 255, 819, 886
Halifax, 544
Hammersmith (London), 438
Hastings, 399
Heston and Isleworth, 784
Hornsey, 363
Huddersfield, 438
Ipswich, 179, 784, 920
Kettering, 107
Kilmarnock, 474
Kingston-on-Thames, 399, 439
Leicester, 141, 511
Leigh (Lancs.), 784
Lincoln, 718
London County Council, 107, 141, 294, 363, 439, 684, 819
Luton, 107, 213, 544, 718, 784
Manchester, 107, 255, 474, 718
Middlesbrough, 474
Newport (Mon.), 718
Nuneaton, 107, 363, 399, 578
Pembroke (Dublin), 328, 399, 578
Plymouth, 141, 920
Poplar (London), 294, 886
Pwllheli, 67
Redditch, 439
Rotherham, 32, 853
St. Helens, 718
[illegible] 759
Salford, 511, 718
Sheffield, 141, 544, 718, 819, 853
Shipley, 684
Shoreditch (London), 179
Southend-on-Sea, 439
Stafford, 439, 718, 886
Stalybridge, 578
Sterling, 784
Stockton-on-Tees, 545
Stoke-on-Trent, 179, 363, 650
Sunderland, 328
Sutton Coldfield, 399
Swindon, 614
[illegible]
Walsall, [illegible]
[illegible]
W. Bromwich, 32, 213, 511
W. Ham, 141, 399, 614, 751, 920
Weymouth, 328
[illegible]
[illegible]
Wimbledon, 32
[illegible]
Woolwich, 328, 784, 920
[illegible]

General.

[illegible]
Amble, 213
[illegible]
[illegible]
[illegible]

[illegible] 179
Barnes, 255, 439, 718
Barnet, 751
Barnsley, 474
Bath, 32, 67
Battersea (London), 213, 399
B.E.A.M.A., 439
Beckenham, 213
Bedford, 615
Belfast, 32, 141, 213, 328, 684
Berehaven (Cork), 33
Berkhamsted, 545
Bermondsey (London), 107, 179, 439
Bethnal Green, 328, 511
Bexhill, 67, 615
Bidford-on-Avon, 141
Bingley, 784
Birmingham, 68, 650, 684, 751, 819, 921
Birtley, 545
Blackburn, 214, 255, 684, 751, 819
Blackpool, 784
Bolton, 179
Bradford, 718
Bray, 886
Bredbury and Romiley, 853
Bridlington, 33
Brighton, 179, 399, 439, 578, 615, 719, 751
Bristol, 399
Bungay, 363
Burnley, 363, 545, 819
Burton, 615
Buxton, 294
Cahiravien (Co. Kerry), 294
Cardiff, 294
Carlisle, 294, 329
Carmarthen, 294
Castlewellan (Co. Down), 511
Cheadle & Gatley, 214
Chelmsford, 511, 921
Cheltenham, 214
Chester, 179, 474
Chippenham, 615
Chislehurst, 615
Church Stretton, 921
City of London, 886
Coal Contracts, 474
Coal Supplies, 615
Colchester, 68
Collieries, Electricity in, 921
Coventry, 474
Croydon, 68
Dartford, 853, 921
Darwen, 141, 399
Derby, 363
Dewsbury, 545
Doncaster, 294
Dover, 68, 474, 651, 851, 921
Downham, 214
Dublin, 33, 294, 719
Dublin Electricians' Strike, 329
Dungannon, 685
Eastbourne, 363, 685
East Ham, 33
[illegible]
Edinburgh, 886, 887
Electrical Engineering Apprentices, 33
Elland, 545, 685
Ellon, 68
Epsom, 819
[illegible]
[illegible]
[illegible] 483 [illegible]
[illegible]
[illegible]
[illegible] 33
[illegible] Electrical Show-[illegible]
Gloucester, 651
[illegible]
[illegible] 651
[illegible]
[illegible]
[illegible]
[illegible] 74 651, 921
[illegible]
[illegible]
[illegible]

Municipal, Foreign and General Notes.—*Continued.*

Goods of Enemy Origin, 403
Holland, Exports to, 366
Immingham and Grimsby Tide Tables, 547
Imports, 71, 258, 441, 581, 753, 856
Inquests, 145, 181, 258, 296, 331, 403, 440, 478, 513, 547, 581, 617, 652, 687, 720, 855
Insurance, Unemployment, 721
Licences, War Trade, and Exports, 721
Loans, Temporary, 488
Manslaughter Charge Against Tramcar Conductor, 687
Military Exemption Applications, 888
Military Tribunal Cases, 855, 922
Motor Transport Year Book and Directory, 1916, 889
Municipal War Allowances, 146
Munition Case, 441
Munition Workers, Trade Unions and Strike Pay, 478
Munition Workers, Who Are? 403
Munition Works, 217, 513
Munitions Act Charges, 35, 109
Munitions Establishments, 922
Munitions Plant, Private, 440
Munitions Tribunal Cases, 71, 687
Museums, Closing of, 617
Naval Wiremen, 258
Netherlands, Exports to, 71
Parcels for the Troops, 258
Parliamentary Notices, 366
Patent Agents and Alien Enemy Patents, 297
Patent [illegible] Fees, 331
Patent Specifications, 513
Patents, Alien Enemy, 152, 181
Patents in Enemy Countries, [403
Plant for Sale, 258
Port of Havre, 821
Presentation, 855
Rifle Clubs, 331
Royal Assent, 652
Russia, Telegraph Service, 513
Safety Lamps, Elec., Miners', 855
Shareholders, Enemy, in British Companies, 403
Technical Education, Legacy for, 922

Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.

Aberdeen Suburban Tramways, 858
Adams (L.), 333
Adelaide Elec. Supply, 74, 406
Agar, Cross, 367
Aldershot Gas, Water & District Lighting, 689
Altrincham Elec. Supply, 928
Amalgamated Wireless (Australasia), 74
Amazon Telegraph, 220, 260, 619
Anglo-American Telegraph, 111, 549
Anglo-Portuguese Telephone, 299
Apparatus & Accessories, 443
Ardee Electrical, 443, 481
Armstrong (Sir W. G.), Whitworth, 619
Arrol-Johnston, 926
Auckland Elec. Tramways, 220
Auto-electric Transmission, 37
Automatic Telephone, 926
Automatic Telephone Mfg., 367, 791, 892
Babcock & Wilcox, 75
Bank für Elektrische Unternehmungen (Zurich), 149, 333
Barbados Elec. Supply Corpn., 148, 655
Barraclough Bros., 407
Baughan & Co., 927
Beauly Elec. Supply, 892
Birmingham District Power & Traction, 75
Blackburn, Starling, 149
Blackpool & Fleetwood Tramroad, 654
Blackpool & Garstang Elec. Light Rly., 655
Blackpool, St. Anne's & Lytham Tramways, 407, 480
Bombay Elec. Supply & Tramways, 894
Bournemouth & Poole Electricity, 757, 824, 892
Bourton-on-the-Water Elec. Light & Power, 893
Bray, Markham & Reiss, 299
Brazilian Traction, Light & Power, 111, 367, 583, 894
Brimsdown Lamp Works, 299
Brisbane Elec. Trams Investment, 149
British Aluminium, 892
British Arc Welding, 149
British Columbia Elec. Rly., 480, 515
British Columbia Telephone, 928
British Elec. Automatic Machines, 221
British Elec. Traction, 221
British Elec. Transformer, 858, 892
British Engine, Boiler & Elec. Insurance, 892
British Insulated & Helsby Cables, 583, 825, 892, 925
British L. M. Ericsson Mfg., 789, 858
British Tramways & Carriage, 789
British Westinghouse Elec. & Mfg., 894, 926
Bromley (Kent) Elec. Light & Power, 926
Brompton & Kensington Elec. Supply, 892, 926
Brooker (T. H.), 37
Brunner, Mond, 221
Buenos Ayres Lacroze Tramways, 548
Buenos Ayres Port & City Tramways, 261
Bullers, 367
Burmah Elec. Tramways & Lighting, 481
Burt, Escaré & Dennelle, 549
Calcutta Elec. Supply Corpn., 37, 261, 407, 583
Calcutta Tramways, 111
Callender's Cable & Construction, 111
Cambridge Elec. Supply, 722
Canadian General Elec., 407, 894
Cape Electric Tramways, 182
Castner-Kellner Alkali, 261, 333
Cedes " Elec. Traction, 619
Central Argentine Rly., 221
Central Elec. Supply, 221, 688
Central London Rly, 723, 755, 791
Central Wireless, 261
Chadburn's (Ship) Telegraph, 481
Charing Cross, West-End & City Elec. Supply, 619, 789, 856
Chatham & District Light Rlys., 688
Chelsea Electricity Supply, 723, 789, 824
Chepstow Elec. Lighting & Power, 407
Chili Telephone, 149, 481
Chilian Elec. Tramway & Light, 37
Christy Bros., 149
Cia de Electricidad de la Provincia de Buenos Aires, 583, 654, 859
City & S. London Rly., 724, 789
City of Buenos Ayres Tramways (1904), 183, 688
City of Las Palmas Water & Power, 789
City of London Elec. Lighting, 407, 791, 825, 858, 890
City of Oxford Elec. Tramways, 655
City of Santos Improvements, 75
Cleveland & Durham Elec. Power, 926
Clyde Valley Elec. Power, 892, 926
Clontarf & Hill of Howth Tramroad, 791
Colne Valley Elec. Supply, 407
Colston Elec. Works, 689, 757
Companies Struck Off the Register, 75, 149, 443, 481, 655
Consolidated Diesel Engine Mnfrs., 333
Consolidated Signal, 183, 299, 333
Cordoba Central Rly., 182
Cordoba Light, Power & Traction, 367, 480, 791
Costa Rica Elec. Light & Traction, 406
County of Durham Elec. Power Distribution, 183, 859
County of London Elec. Supply, 792, 824, 858
Creedon (W. A.), 481
Crompton, 149
Crossley Bros., 757
Cryselco, 299
Cuba Submarine Telegraph, 37
Davenport (G.), 299
Davis (John) & Son (Derby), 75
Davis & Timmins, 757
Delabole Elec. Lighting & Supply, 37, 183
Delagoa Bay Development Corpn., 220
Devonport & District Tramways, 654
Dick, Kerr, 74, 148, 655, 859
Direct Spanish Telegraph, 859, 892, 924
Direct United States Cable, 37, 549
Direct West India Cable, 758
Douglas Southern Elec. Tramways, 515
Doulton & Co., 859
D.P. Battery, 299
Drake & Gorham, 182, 260
Dublin & Lucan Elec. Rly., 825
Dublin United Tramways (1896), 549, 654
Dynamic Electrical, 37
East London Railway, 583, 618
Eastern Extension, Australasia & China Telegraph, 367, 515
Eastern Telegraph, 111, 407
Edison & Swan United Elec. Light, 220, 261, 298
Edmundson's Elec. Corpn., 299
Elec. Construction, 299
Elec. Furnaces & Smelters, 927
Elec. & General Investment, 407
Elec. Light & Power, of Cochabama, 367
Elec. Reduction, 655
Electrical Distribution of Yorkshire, 723, 824
Electrical & Industrial Investment, 723
Electrical Oil Refining, 221
Electrical Securities Trust, 333
Electro-Bleach & Bye-Products, 789
Electro-Flex Steel, 111, 221, 619
Electro-Mechanical Brake, 407
Electrolytic Copper, 549
Ellis & Ward, 791
Enfield Elec. Cable Mfg., 111, 619, 757
Evered & Co., 927
Evershed & Vignoles, 480
Faringdon Elec. Light & Power, 893
Ferranti, 37, 111
Fife Tramway, Light & Power, 790
" Float " Elec., 893
Folkestone Elec. Supply, 927
Foote & Milne, 689
Fraser & Chalmers, 111, 183
Fuller Accumulator, 443
Gateshead & District Tramways, 927
German Electrical, 619
Globe Elec., 655
Globe Telegraph & Trust, 367, 792, 894
Glover (W. T.) & Co., 860
Goodwin (Stanley), 221
Greenwood & Batley, 548
Guernsey Railway, 758
Hacking (C. W.) & Co., 928
Hadfields, Ltd., 860
Halifax & Bermudas Cable, 480, 758
Hamilton (Claud), 183
Harrow Elec. Light & Power, 790
Hastings & District Elec. Tramway, 894
Healing (L. J.), 299
Heath (T. W.), 893
Henley's (S. Africa) Telegraph Works, 299
Henley's (W. T.) Telegraph Works, 825, 892, 925
Hexham & District Elec. Supply, 791
Holophane (Ltd. & Reduced), 111
Hong Kong Tramway, 149
Huelva Gas & Electricity, 149
Hurst, Nelson, 75
Hydro-Elec. Power & Public Service Trust, 481
India-Rubber, Gutta Percha & Telegraph Works, 406, 442, 826
Indian Elec. Supply & Traction, 75
Indo-European Telegraph, 75
International Dowsing Elec. Heating & Appliances, 481
International Lighting Assoc., 148
International Light & Power, 261, 407
Isle of Thanet Elec. Tramways & Lighting, 480
Jackson (P. R.) & Co., 893
Jacobs, W. A. & R. J., 221
Jarrow & District Elec. Traction, 790, 826
Johnson-Billington Elec. Meters, 221
Kaministiquia Power, 149, 549
Kensington & Knightsbridge Elec. Lighting, 756, 823
Keynsham Elec. Light & Power, 655
Lamplough & Son, 655
Lanarkshire Tramways, 689
Lancashire Dynamo & Motor, 792
Lancashire United Tramways, 756, 824
Larne Elec. Light Works, 791
Launceston & District Elec. Supply, 860
Linathode, 481
Liverpool Elec. Cable, 481
Liverpool Overhead Rly., 723, 790
Lisbon Elec. Tramways, 149
Llandudno & Colwyn Bay Elec. Rly., 689
Llanelly & District Elec. Lighting & Traction, 927
Llangollen & District Elec. Light & Power, 481
London & Suburban Traction, 655, 858, 893
London Elec. Rly., 724, 756, 790
London Elec. Supply Corpn., 756, 788
London Elec. Trading, 261
London Elec. Wire & Smith's, 724
London United Tramways, 893
M. & G. Truck & Engineering, 655
Mackay, 333, 723, 758
Madras Elec. Tramways, 893
Malaga Electricity, 481
Manaos Tramways & Light, 481
Manila Elec. Railroad & Lighting Corpn., 826
Mansfield & District Tramways, 792
Manx Elec. Rly., 367, 480
Marconi International Marine Communication, 481
Marconi's Wireless Telegraph, 443
Marconi's Wireless Telegraph of Canada, 443
Masham & District Elec. Supply, 757
Mather & Platt, 724, 756, 790
Maxim Lamp Works, 221
Melbourne Elec. Supply, 406
Melton Mowbray Elec. Light, 893
Memoranda, 37, 75, 111, 149, 183, 221, 261, 299, 333, 367, 407, 443, 481, 515, 549, 583, 619, 655, 689, 723, 757, 791, 825, 859, 894, 928
Mersey Rly., 724, 893
Metallic Seamless Tube, 261
Metropolitan District Rly., 724, 756, 790
Metropolitan Elec. Supply, 792, 824, 858, 891
Metropolitan Elec. Tramways, 825, 858
Metropolitan Rly., 655, 689, 723
Mexico Elec. Tramways, 481
Mexico Tramways & Power, 299
Midland Elec. Corpn. for Power Distribution, 826
Mirrlees-Watson, 826
Montevideo Telephone, 111, 148, 655
Montreal Light, Heat & Power, 183, 619
Montreal Tramways, 689
Muirhead, 655
Nairobi Elec. Power & Lighting, 860
National Conduit & Cable, 481
National Elec. Supply, 689
Naylorgraph, 407, 515
New British Ever-Ready, 221
Newcastle & District Elec. Lighting, 756, 791
Newcastle-on-Tyne Elec. Supply, 367, 758, 859
Newmarket Electric Light, 927
New St. Helens & District Tramways, 149, 481
Newtons, 481, 655
Northampton Elec. Light & Power, 825
North-Eastern Elec. Smelting, 221
Northern General Transport, 893
North Melbourne Elec. Tramways & Lighting, 481
North Metropolitan Elec. Power Supply, 826, 893
[illegible]
Oxford Elec., 758, 859
Pacific & European Telegraph, 481
Paisley District Tramways, 723
[illegible]
Paraguay Central Rly., 927
Peebles (Bruce), 824, 892
Pintsch's Elec. Mfg., 75
Pirelli, 655
Power Gas Corpn., 333
Provincial Tramways, 298
Railless Elec. Traction, 791
Ransomes, Sims & Jefferies, 860
Rawlings Bros., 407
Renew Elec. Lamp, 333
Reside, 407
Resisto Elec. Mfg., 549
Rio de Janeiro Tramway, Light & Power, 583
Robey & Co., 894
Rushden & District Elec. Supply, 825
Russell Bros., (Wolverhampton) 928
Ruthin Elec. Supply, 480, 655
St. James' & Pall Mall Elec. Light, 619, 655, 689, 722
Salford Elec. Instruments, 299
Sanders (W.), 443
Sao Paulo Tramway, Light & Power, 75
Scarborough Elec. Supply, 860, 927
Scottish Tube, 894
[illegible]
Elec. Power, 221
Siemens & Halske, A. G. (Berlin), 481
Simplex Conduits, 928
Slough & Datchet Elec. Supply, 927
Smith (S.) & Sons (Motor Accessories), 37
Smithfield Markets Elec. Supply, 689, 723, 757
South Brazilian Rlys., 37, 149
S. London Elec. Supply Corpn., 655, 791, 822
S. Metropolitan Elec. Light & Power, 757, 825, 859
Southern Brazil Elec., 261, 299
Sterling Telephone & Elec., 407
Stewarts & Lloyds, 893
Stirling & Bridge-of-Allan Tramways, 261
Submarine Cables Trust, 37
Sunderland District Elec. Tramways, 689
Sykes (W. R.) Interlocking Signal, 299
Telegraph Construction & Maintenance, 724, 757, 822
Tottenham District Light, Heat & Power, 655, 757
Traction & Power Securities, 655
Tramways, Light & Power, 791, 825
Tucuman Tramways, Light & Power, 37
Tyneside Elec. Development, [illegible]
Tyneside Tramways & Tramroad, [illegible]
Underground Elec. Rlys. of London, [illegible]
Underground Rlys. Pooling Scheme, 515
United Alkali, 826
United Elec. Tramways, of Caracas, 220
United River Plate Telephone, 75
United Rlys. of Havana & Regla Warehouses, 261
United Rlys. Investment, 220
Venezuela Telephone & Electrical Appliances, 443
Vera Cruz Elec. Light, Power & Traction, 220
Vickers, 928
Victoria Falls & Transvaal Power, 333, 481, 894
Vulcan Boiler & General Properties, [illegible]
Wadebridge & Dist. Elec. Supply, [illegible]
Waste Heat & Gas Elec. Construction, [illegible]
825, 859
Weiss & Biheller (Canada), 149
Wemyss District Tramway, 893
West India & Panama Telegraph, [illegible]
Western Canada Power, 549
Western Telegraph, 183, 219, 367, 481, 860
Western Union Telegraph, 406, 583
Westminster Elec. Supply Corpn., 619, 723, 755
Whitstable Elec., 481
Windsor Elec. Installation, 927
Yorkshire Elec. Power, 654, 757
Yorkshire (W. Riding) Elec. Tramways, 407, 549, 619
[illegible]

Companies, Joint-Stock (New Electrical, &c.), Registered.

Actose Mfg., 37
Adams (L.), Ltd., 261
Addison (W. J.), Ltd., 221
Amp Welding, 407
Anglo-American Metals Synd., 149
Anglo-Russian Engineering, 443
Arcorundum Abrasives, 407
Army & Navy Mfg. Aircraft, 221
Atkinson, Lloyd, 619
Ball (Albert A.), 261
Barton (R.), Adamson, 893
Baughan, 791
Bladon (T. E.) & Son, 619
Brown's Motor Accessories, 689
Bruce (C.), 791
Burroughes (W. J.) & Sons, 654
Butt (F. R.), 407
Caton Elec. Supply, 893
C. E. C. (Ltd.), 37
Charnley Mfg., 927
Coates (Sheffield), 757
Comely & Morton, 893
Copper Depositing & General Engineering, 443
Croft & Perkins, 689
[illegible], 791
Edouard Dubied, 221
Electrical Manufacturers, of Gt. Britain, 480
Feltham & District Elec. Lighting, 75
General Engineering (King's Cross), 619
Glaze (T. W.), 261
Hadars, Ltd., 221
Hampton's Heating, 515
Hanson (A. & B.), 515
Howlett (M.), 221
H. S. M. Patent Belt Fastening, 75
Ilford Dry Battery, 37
Institution of Locomotive Engineers, 480
Jackson, H. E., 619
Jacobs, W. A. & R. J., 75
Lea (H. & E.), 655
Leach (S. G.), 111
Lester (J. E.) & Folwell, 757
Levick (John), 549
Lidgett Engineering, 757
London & Burmese Wolfram, 221 [757
Lower Thames Land Development & Power,
Luby-Lowe Engineering, 791
Magnesium Metal, 37
Makin, 757
Marshall & Plumtree, 927
[illegible], 149
Minns (S.), 75
Motor Engineering (Nottingham), 221
New Era Signs (U.S.A.) (1916), 927
Newtons (Camborne), Ltd., 407
Noble Engineering, 111
Nottingham Engineering, 893
O'Neil's Recorder Synd., 407
Owen, King, 549
Oxygen Producers, 791
Parson's & Hodges, 619
Productive Engineers, 549
Quasi-Arc (France), 333
Regulus Metal & Plumbing, 757
Reliance Lubricating Oil, 619
Republic Rubber, 407
Sanders (W.), 261
[illegible], 619
Scott Electrical 757
Scott, Kirk, 791
[illegible], 299
Shepherd's Parging Block, 655
Smith (Folkestone), Ltd., 75
S. Wales & West of England Wireless Training College, 549
Swindon Engineering Works, 515
Tees Benzol Synd., 75
Telephone Mfg., 221
Temple Bros., 515
[illegible], 791
Tredelect Engineering, 333
Truman (J.), 333
Turner (Croydon), 480
Underground Elec. Rlys. of London, 791
[illegible], 593
United Tube Corpn., 149
Vandervell (C. A.), 549
[illegible], 655
[illegible], 549
Westminster Glass & [illegible], 791

"The Electrician"

COMMERCIAL & INDUSTRIAL SUPPLEMENT.

OCTOBER 8TH, 1915, TO MARCH 31ST, 1916.

INDEX TO CONTENTS.

A

Accessories, Elec. Light Fittings, 28
Anti-Aircraft, "Diffusa," Light Screen, 151
Automobiles, Tumbler Switch Controls for, 40

B

Belting, Whittle, 92
Blue Printing Machine, Elec., Wickes' Continuous, 103
Booklet, An Attractive Free, 58

C

Cable Capacity Gauge, 111
Cableway, Temporary Travelling, 50
Cables, Railway Electrification, 140
Calendars, Diaries, Novelties, &c., 97, 110, 161
Catalogue, Ferranti, Complete, 88
Catalogue, Storage Battery, 176
Catalogues, New, 126
Catalogues, New Dowsing, 74
China, G.E.C. Electrical Plant for, 156
[illegible], 43
Cooker, Elec., A Nursery, 76
Co-operative Stores, Lighting of, 162

D

Detector, The "Migas," 70
[illegible], Automatic Air Starting Device for, 124
Diesel Engine, Cross Head Type, 131
Doping Rooms, Fume Removal in, 116
Drawing Offices, Lighting of, 144
Dynamos and Motors, D.C., 130

E

"E.A.C." Notes, 84
[illegible], 4
Electro-Harmonic Concert, First, 16
[illegible]
[illegible], 180

F

[illegible], 174
Fire, "Angelus," Elec., 121
Fire, Elec., The "Veriott," 50
Fires, "Belling" New Season, 25
Fires, Carron, 36, 41
Fires, Elec., "Arora," 146
Fires, "Ensign," 110
Fires, "Jackson," 32
Fires, "Magnet" Elec., 43
Fires, "Revo" Elec., 2
Fish Fryers, 22
Fittings Catalogue, "Ediswan," 14
Fittings, Elec. and Glassware, 96
France, 118
Furnace, Tinning, Monometer, 56
Furnaces, Elec. Laboratory, 24
Furnaces, Monometer, 19, 107

G

Generating Set, Paraffin Elec., Self-contained, 176
Glasgow Showrooms, New, 16, 85
Glassware, Holophane Elec., Fittings for, 169
Gyratory Foundry Riddle, 151

H

Half-Watt Projectors for Theatre, 126
Heating, Factory, Steam Heater and Elec. Fan System for, 62
Heating, Industrial Elec., 77
[illegible], 169
Holophane Handbook, New, 15

I

Illumination, Interior, Holophane, 132
Insulator Clip, A New, 8
[illegible]

K

[illegible], 128
[illegible], 146

L

[illegible]
[illegible]
Lamp, Simplex Inspection, for Shells, 61
[illegible], 160
[illegible], 111
Lamps, "Axial," Use of, 180
Lamps, B.T.H. Incandescent Elec., 152
Lamps, Carbon, "Pope," 60
Lamps, Ediswan Radiator, 30
Lamps, Inspection, Ediswan Shell, 144
Lamps, Photographic, 114
Lamps, "Ruby" and "White Star," 83
Lantern Slides, Westinghouse, 64
Light and Munition Work, 46
Lighting Efficiency, 61
Lighting Efficiency in the Office, 6
Lighting, Industrial, 168
Lighting, Picture, 64
Lighting Set, Paraffin, 22
Lighting, Shop, 60
Lists, "Benjamin Elec.," 86
Lists, Lundberg's New No. 1, 98
Lists, New, 72

M

Machine Tool Control, Automatic, 33
Machine Tools, Control Equipments for, 122
"Magnet of Commerce," 62
Magnets, Lifting, 47
[illegible], 83
[illegible], 114
Motor Drive, Elec. Advantages of the, 18
Motor Starters, "Witton" and Controllers, 94
Motors, Leasing, on Trial Service, 112
Motors, Zepp.-Proof, 72

O

[illegible] A.C. and D.C., 10

P

Pad, A New Desk, 43
[illegible], 20
[illegible], 84
[illegible], 120
[illegible], 20
[illegible], 30
[illegible], 38
[illegible], 114
[illegible], 10
[illegible], 128

R

Radiators, New, 109
[illegible], 11
[illegible], 126
[illegible], 166

S

[illegible], 11
[illegible], 42
Shells, Inspection Lamp for, 41
[illegible], 164
Stamps, Mazda "Poster," 36
[illegible], 134
"Sun" A[illegible], 18
[illegible], 77
[illegible], 22
Switchboards, "Firimine," for Mines, 158
Switchboards, "Ironsafe," 142
Switches, China Cover, 19
[illegible], 164
[illegible], 76
[illegible], 76
[illegible], 104

T

[illegible], 108
Testing Set, Portable D.C., 2
[illegible], 34
Tramway Controller, "Run-Back Preventer," 170
Tumbler Switches, Single-Way, with Quadruple Break, 4

V

[illegible], 134

W

[illegible], 10
[illegible], 113
Wiring and Heating Contract Equipment for, 168
[illegible], 166
[illegible], 19
[illegible], 80

X

X-Ray [illegible], 117

Table Supplements to Volume LXXVI.

February 18, 1916 — [illegible]

March 3, 1916 — [illegible] Railways and Tramways of the World.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 1
Arrangements for the Week .. 4
Parallel Operation of Frequency Changers. By G. H. Rettew. Illustrated 5
Electric Strength of Insulating Materials Under Mechanical Pressure. By F. Kock. Illustrated 6
Presidential Address by Mr. A. H. Dykes to the Association of Supervising Electricians 8
Apparatus for Protecting Electrical Machinery Against Abnormal Electrical Conditions. By C. C. Garrard. Illustrated. *Continued* 11
Conduction of Electricity Through Metals. By Sir J. J. Thomson, O.M., F.R.S. Illus. 13
The Effect of Hydro-Electric Power Transmission Upon Economic and Social Conditions, with Special Reference to the United States of America. By Frank G. Baum 15
An Interesting Alsatian Electric Railway 18
The Electrolytic Coating of Mirrors. Illustrated 19
THE PROBLEM OF THE CONTINUATION SCHOOL 20
REVIEWS 21
Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological.
REVIEWS—*Continued.*
The Electrical Conductivity and Ionization Constants of Organic Compounds [Scudder].
Experiments [Edelman].
Wireless Time Signals.
Direct-Current Motor Speed Regulation by Resistance in the Armature Circuit, with Special Reference to the Diverter Method. By Thomas Carter. Illustrated *Concluded* 22
Harmonics in Transformer Magnetising Currents. By J. F. Peters. Illustrated 24
Divisional Reports on Mines and Quarries 26
CORRESPONDENCE 27
The Direction Finder (E. Bellini).
On the Influence of Heat Treatment on the Specific Resistance and Chemical Constitution of Carbon Steels. By Edward D. Campbell. Illustrated 27
Russian Electrical Companies' Results for 1914 29
PARLIAMENTARY INTELLIGENCE 29
LEGAL INTELLIGENCE .....
Educational Notes 30
The "Electrician" Commercial and Industrial Section 31–38

NOTES.

The Mobilising of Engineers.

IN our last issue we urged the engineering and scientific institutions to claim the right to guide the State in all things of an engineering and scientific character. We wish to make it clear that we are not referring merely to the present time of stress, nor are we referring to any particular committee. The engineering institutions ought to be responsible for the proper conduct of all engineering matters at all times. The appointment of a Board to advise the Secretary of the United States Navy was noted in these columns some time ago, and the personnel of the Board has recently been announced. Mr. EDISON is the only man appointed directly by Mr. DANIELS, the Secretary of the Navy Department, the others having been nominated, at the suggestion of Mr. F. J. SPRAGUE, with the approval of Mr. DANIELS and Mr. EDISON, by the leading engineering and scientific societies of the United States. Each of eleven societies selected two members to represent it on the Board, and the nominees were all acceptable to Mr. DANIELS. It is interesting to note that the majority of the Board are identified with the electrical industry. The following societies are represented: Institutions of Electrical Engineers and Mining Engineers, Societies of Mechanical Engineers, Civil Engineers, Automobile Engineers, Aeronautic Engineers, the Electrochemical, Chemical, Mathematical and Aeronautical Societies, and the Inventors' Guild.

London & South-Western Electrification.

WE have taken the unusual step this week of interrupting our account of the electrification of the London & South Western Railway. This is due to the circumstances in which manufacturing firms find themselves at the present moment. There is so much to be done in the way of urgent Government work that they cannot afford time to supply information promptly on other matters. We have, therefore, been unable to secure all the particulars that we wish to include in this particular article, and thus we think it better to postpone further publication for a week. It would have been easy for us to give a short description of general interest, but in view of the importance of the work we are inclined to think that our readers would prefer to wait till such time as particulars of engineering interest can be given. Although we regret the delay, we certainly would not have the circumstances otherwise, for it becomes clear that the resources of this country are being placed more and more seriously at the disposal of the Government to bring the struggle in which we are at present engaged to a successful conclusion. This must be our one national object at the present time

Electric Strength of Materials under Pressure.

AN article which we give elsewhere by Mr. F. KOCK deals with the interesting subject of the dependence of electric strength of insulating materials upon the mechanical pressure to which they are subjected. It is not an easy matter to carry out experiments of this kind where pressures up to 70 atmospheres are employed, and the author is to be congratulated on carrying through such an investigation. The results obtained show, as might be expected by analogy, that the dielectric strength increases with the pressure, but that this increase tends to fall off after a time. This is particularly shown in the case of castor oil, where the effect diminishes after about 20 atmospheres, and eventually becomes very small. It would seem as though the increase in pressure, although it has a strengthening effect in one direction, has a weakening effect in another. What the weakening effect may be it is difficult to say, but it looks as if, by carrying the pressure sufficiently high, the weakening effect might ultimately become the more prominent of the two. In experiments of this kind there must always be some danger in the effects being masked by impurities. For example, as was first pointed out by Mr. C. E. SKINNER, the presence of moisture makes an enormous difference, and for this reason it was found that an oil sometimes seemed to improve after several discharges, due, probably, to a certain drying effect. Experiments on frequency showed that a lower frequency was more severe in its effect than a higher

frequency, which corresponds with the effect noticed with gases, that there is a lower breakdown value with continuous current than with alternating. Undoubtedly the ultimate effects near the breakdown point are complicated, and probably depend to some extent upon the heating, which is inevitable. Although it must be allowed that the working of dielectrics at pressures of 20 atmospheres is not of much practical importance, the results are interesting and add to our knowledge.

Influence of the Electric Motor on Machine Tools.

On account of the practically simultaneous introduction of high-speed steel it is not an easy matter to trace the effect of the electric motor on the design and performance of machine tools. At the recent meeting of the International Engineering Congress in San Francisco Mr. A. L. De Leeuw presented a Paper in which attention was directed to this difficulty. Of itself the introduction of high-speed steel would have had the effect of modifying more or less completely the established practice in machine tool design and construction, but the effect of the two together, the electric motor and high-speed steel, has been little short of revolutionary. As Mr. De Leeuw rightly points out, the probability is that less attention would have been paid to the requirements of machine tools had it not been for the introduction of high-speed steel, which made a demand on machine tools much in excess of their power. Trying to fit the machines to their new duties led to the making of tests, and the motor drive made these tests possible. It may be said that all the existing knowledge, so far as powers, pressures and speeds are concerned, is due to the electric motor as driving power. In the Paper referred to, the author states that the electric motor has had a fourfold influence on the machine tool. First, it has improved our knowledge of the data governing the design of machine tools; secondly, it has enhanced the possibilities in regard to power; thirdly, it has afforded closer control in regard to speeds, to stopping and starting, and in the making of necessary adjustments; and, fourthly, it has made the use of machine tools more flexible, by making such tools portable and a better shop construction possible.

Mr. De Leeuw refers to Mr. Taylor's very important work on the "Art of Cutting Metals"—a work with which many of our readers will be familiar. He is of the opinion that the work of studying the subject has been left almost entirely to the individual makers or users of machine tools, though here and there universities and colleges have taken up this line of investigation and have helped it along. We think that the author is inclined to underrate the work done on this subject by the universities, particularly in this country. To our knowledge, many makers of machine tools, of high standing, were led to re-design their tools on the lines laid down by Dr. Nicolson in his deservedly famous Manchester experiments, and in this work the Manchester Association of Engineers played no mean part. Although Nicolson's experiments were confined to the study of the lathe, they are of much wider application. In course of time Dr. Ripper's Sheffield experiments will have the same beneficial effect on every branch of the machine tool trade. We heartily agree with the author that the study of machine tools should be taken up in universities and technical colleges with the same amount of earnestness and thoroughness which has been devoted to the study of prime movers or of the electric motor itself. We believe that such a study would lead to results of a surprising character.

Wireless Telephony. According to a report, the Navy Department of the United States has experimented successfully with a wireless telephone communicating between Arlington (Va.) and Mare Island (Cal.), a distance of approximately 2,500 miles. It is also stated that wireless communication was established at the end of last month between the Atlantic seaboard and Honolulu, a distance of 4,600 miles.

Mine Electrification.—The electrification of mines, ore concentrating plants and smelting plants is, according to the "Mining and Engineering World," proceeding at a rapid pace in America. The mining work now exceeds anything known for the last eight or ten years; so mining companies are having to install a great deal of new equipment to meet the demands made upon them. In this, electrical machinery figures largely especially for hoists, compressors, pumps, and mill machinery. Existing plant is also being extensively changed over to electric power. Automatic and remote control characterises many of the new installations.

London Electrical Engineers (Territorial Force.)—Owing to the expansion of the Corps, the opportunity now exists for additional men of suitable age and training to enlist in the unit. Men of the following professions and trades are specially required: Electricians, mechanical and electrical engineers, engine drivers, engine erectors, instrument repairers, metal turners, fitters, telephonists and telegraphists. There are a limited number of vacancies for carpenters, cabinet makers, pattern makers, draughtsmen, joiners and wood turners. Forms of particulars can be obtained from the Officer Commanding at 46, Regency-street, Westminster, S.W.

"Faraday House Journal."—The Michælmas term number of this Journal has just been issued. Two interesting articles are contributed by the Principal, Dr. Alexander Russell, on "The Cooling of Hot Bodies," and "The Electrical Transmission of Energy." There is also an appreciative discussion of the Standardisation Rules of the American Institute of Electrical Engineers. Besides a sketch of the life and work of the late Mr. Robert Hammond, there are obituary notices of several former students of Faraday House who have laid down their lives on the battlefield. A further list of students and members of the staff serving with the Allied Forces supplements the previous lists. Altogether there are now 179 past and present students, and 12 past and present members of the staff serving with the Colours.

Analysing Electric Waves.—An ingenious method for the separation of the voltage wave into its component harmonics was described recently by Mr. C. W. Ricker in the "Electrical World." It is pointed out that an artificial transmission line, when divided into different fractions of a wave-length, can be employed to magnify any particular harmonic in the current, thus showing the presence of the corresponding harmonic in the voltage wave. The order of the harmonic can be computed from the length and electrical characteristics of the line used to magnify each particular harmonic, while the form of the voltage wave can be determined by applying certain corrective factors. It is further explained that a short-circuited line will magnify even harmonics more than odd harmonics, thus affording a convenient method of observing the former.

Hydro-Electric Works in Canada.—The "Electrical News" gives some interesting statistics (prepared by the Dominion Water-power Branch) relating to the development of Canadian water powers.

Within the provinces of the Dominion and excluding the North-West Territories, practically all of the Yukon and the northern and eastern portions of Quebec, it is estimated that 17,764,000 H.P. are available, this amount being inclusive, in the case of Niagara Falls, Fort Frances and the St. Mary's River at Sault Ste. Marie, of only the development permitted by international treaties, and, further, does not contemplate the full possibilities of storage for the improvement of capacities. The developed powers, which are inclusive of all water powers, whether for electrical production, pulp grinders, for milling or for the numbers of other uses, aggregate 1,712,193 H.P. as developed by turbines. This amount is distributed over the provinces as shown in the following table:

Province.	H.P. developed.	Province.	H.P. developed.
Nova Scotia	21,412	Manitoba	56,730
New Brunswick	13,300	Saskatchewan	45
Prince Edward Island	500	Alberta	33,305
Quebec	520,000	British Columbia	265,345
Ontario	789,406	Yukon	12,000

German Electrical Manufacturers and the War.—We learn from the "Elektrotechnische Zeitschrift" that the Ministry of War has added to its manufacturing department a branch for the supply and distribution of electrical machinery. The Verband Deutscher Elektrotechniker has been entrusted with the execution of the work, and the general secretary of the Verband (Herr Geo. Dettmar) has been made an assistant at the Ministry.

Electric Signalling on the New South Wales Railway.—In a Paper read recently before the Electrical Association of Australia, Mr. W. F. Barton described the system of power signalling employed on the New South Wales railways. This is on the track circuit principle, some sections of the line being completely automatic and others semi-automatic. The all-electric system is employed from Ashfield to Homebush, and is operated at 60 volts; but in the busy parts round Sydney the signals are electro-pneumatic, compressed air at 65 lb. to 75 lb. per square inch being used, with current for the signal relays taken from accumulators at 17 volts. Track circuits are worked from 4 to 6 volt batteries. Edison cells have given good results in this work. Manual block working has now been entirely dispensed with in this area, which comprises the whole of the four main lines between Sydney and Homebush and Sydney and Sydenham; but at various places signal boxes are retained, at which certain sections may be either automatically-operated or by hand, the last method being at times required for shunting.

Science in the War and After the War.—Last Wednesday afternoon Dr. J. A. Fleming, F.R.S., gave an interesting public lecture, at University College, on "Science in the War and After the War."

Some account was given of range finders, more particularly that of Barr & Stroud, and the general principles were explained on which the range may be determined by means of the angle subtended by an object, by the amount of detail that is apparent and by other methods which had been receiving the attention of Dr. Fleming during the last few months. With regard to the use of radiotelegraphy on aerial craft, the difficulty with aeroplanes was to obtain a sufficient balancing capacity, the smallness of which limited the aerial current and consequently the range. A good deal of attention had been given to the use of visual signals instead of audible signals, which were not easily heard under conditions of flight, but so far not much progress had been made in this direction owing to the small amount of power available. In the case of airships other difficulties were found. The earth was negative with regard to the atmosphere above it and an airship, therefore, tended to become positively charged, more particularly owing to the products of combustions and water vapour, which were constantly being discharged from it and which brought the ship to the potential of the atmosphere. Consequently, it might happen that a spark would pass from the framework if it came near an earthed object, such as a tree, and the hydrogen might thus be ignited. There was also danger from sparks induced by the radiotelegraphic apparatus. Returning to the question of the various committees that had been formed for dealing with war inventions and similar matters, Dr. Fleming insisted on the importance of the members possessing a practical knowledge as well as theoretical. Turning to the position of affairs after the war, Dr. Fleming called attention to the great importance of proper organisation of invention, research and commerce. He was of opinion that one of the most important matters was to obtain energy more efficiently from our coal and to produce nitrates from atmospheric nitrogen by means of coal. Manufacturers also should be less reticent about their results and should be willing to pool their knowledge, as they did in Germany, if that enabled them as a whole to gain trade.

Electric Furnace Development.—Particulars have been published by "Iron Age" and by "Iron and Coal Trades Review" regarding the location, type, product and capacity of all the electric steel furnaces operating or building in the world. From these it appears that on January 1, 1915, the total number of furnaces was 213. This is an increase of nearly 100 per cent. since early in 1910 and of 50 per cent. since early in 1913. The table given below is based on data furnished by the technical department of the United States Steel Corpn., and is regarded as authoritative. The number of miscellaneous electric furnaces other than Héroult, Girod or induction, building or operating in Europe at the beginning of the year, as shown by literature on the subject, was 62, comprising the following types: Stassano, 15; Keller, 6; Chapelet, 5; Electrometals, 4; Gröndal, 2; Hiorth 1; Nathusius, 2; Stobie (building), 4; Anderson, 4; Soderberg (building), 1; Rennerfeldt, 18. It will be seen that the Héroult furnace leads all types in number of installations, with 75 in the world, the induction furnaces as a class coming next with a total of 36. Of the total of the 213 furnaces in the world, active or building, on January 1, 1915, 174 are of the arc type, 37 are of the induction type, and two are of the combined arc and induction type. Development in the United States and Canada in the last two years has been distinguished by the entrance into the field of three types of furnaces not operating in Europe, the Snyder, the Hering and the special furnace of the Moffat-Irving Steel Works, of Toronto, in which castings are made direct from the ore.

Country.	Type of furnace.												
	Héroult.	Girod.	Induction.	Stassano.	Keller.	Chaplet.	Electro-metals.	Hiorth.	Nathusius.	Renner-feldt.	Gröndal.	Special.	Total, Jan. 1, 1915.
Germany	19	6	16	2	1	...	...	...	2	...	...	...	46
Austria-Hungary	10	3	3	2	...	...	...	...	...	...	...	...	18
Switzerland	1	2	...	...	...	...	...	...	...	...	...	...	3
Italy	4	1	2	5	5	5	...	...	...	...	...	...	22
France	8	7	2	...	...	...	...	...	...	...	...	...	17
England	7	1	1	4	...	...	...	...	...	3	...	...	16
Belgium	2	1	...	...	...	...	...	...	...	...	...	...	3
Russia	3	1	1	2	...	...	...	...	...	2	...	...	9
Sweden	2	...	1	...	...	...	2	...	...	13	...	...	18
Norway	...	...	1	...	...	...	1	...	...	...	...	...	2
Spain	...	...	1	...	...	...	...	...	...	...	...	...	1
Japan	...	...	1	...	...	...	...	...	...	...	...	...	1
Mexico	...	...	1	...	...	...	...	...	...	...	...	...	1
Brazil	...	...	...	...	...	...	1	...	...	...	...	...	1
Location not given	...	...	...	...	...	...	...	1	...	...	2	9	12
United States	18	6	6	4	...	...	...	...	...	...	...	7*	41
Canada	1	...	...	...	...	...	...	...	...	...	...	1	2
World's total	75	28	36	19	6	5	4	1	2	18	2	17	213

* Includes five Snyder furnaces.

OBITUARY.

KILLED IN ACTION.—We regret to record the death of Lieut. Charles Harry Norman Scholey, of the 9th Battalion Rifle Brigade (son of Mr. H. Scholey, of 56, Victoria-street, London, S.W.), who was killed in action on the Western front on Sept. 26. Lieut. Scholey, who was only 23 years of age, was educated at Uppingham, and was at Cambridge University when war broke out.

We regret to announce that Lieut. Basil Erin Hicks, 8th Royal Berkshire Regiment, is reported as missing and believed to be dead. He is the son of Dr. William Mitchinson Hicks, F.R.S., Professor of Physics at Sheffield University.

The following have also been reported as killed in action:—

Rifleman T. West, King's Royal Rifles, an employé of Rochdale Corporation Electricity Works.

Lance-Corporal A. Woodward, who was employed at the Rugby works of the British Thomson-Houston Co.

Private Henry Minter, electrical engineer, of Toowoomba (Queensland).

Private John Bailey, an employé of Warrington Corporation electricity works.

PERSONAL.

Readers of THE ELECTRICIAN will join us in sympathising with Mr. Sydney W. Baynes, borough electrical engineer of St. Pancras, upon the death of his wife, which occurred at Haverstock-hill, London, N.W., on Sunday last.

Corporal Bertram Hoyle, R.E., who is serving in France as a motor cycle despatch rider, has been granted by the Admiralty a temporary commission as lieutenant, Royal Naval Volunteer Reserve. Mr. Hoyle is an A.M.I.E.E., and an assistant lecturer and demonstrator in electrical engineering at the Municipal School of Technology, Manchester.

Mr. A. C. Gilling, electrical engineer to Epsom Urban Council, who has been on active service for nine months, has returned from the Front with a shrapnel wound in the head, which fortunately is not serious. Mr. Gilling has now been given a commission in the Royal Flying Corps.

Royal Engineers (T.F.)—The following appointments have been made :—

Tyne Electrical Engineers: H. G. White and Corporal Alex. G. Dickson (from Northumbrian Div. Engineers) to be Second Lieutenants.

APPOINTMENTS VACANT AND FILLED.

The Governors of the Borough Polytechnic Institute invite applications for the post of chief assistant in the electrotechnics departmen. Commencing salary £180, rising to £250. Applications by Oct. 14 to the Principal, Mr. C. T. Millis, Borough-road, London, S.E. *See also an avdertisement.*

Holmfirth Urban District Council require an electrical engineer to take charge of their electrical undertaking, one having had experience with suction gas plant and overhead wiring preferred. Commencing salary £2. 5s. per week. Applications to the clerk of the Council, Mr. A. Percy Ruscoe, Council Offices, Holmfirth, by Wednesday, Oct. 20. *See advertisement.*

Belfast Tramways and Electricity Committee invite applications for the positions of senior engineer-in-charge and junior engineer-in-charge in their electric generating station. Wages £4 and £3 per week, respectively. Application to the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast, by Oct. 15.

A professor of organic chemistry (pure and applied) is required for the University of Sydney. Salary £900. Particulars from the Agent-General for New South Wales, 123, Cannon-street, London, E.C., to whom applications must be sent by Oct. 13.

West Ham Corporation have made the following appointments to the tramway staff: Mr. J. W. B. Carruthers, civil engineering assistant, at £250 per annum ; Mr. E. Ainsworth, surveying assistant and draughtsman, at £120 per annum ; Mr. W. G. Smith, general foreman, at £3. 5s. per week ; and Mr. G. Bourne, foreman platelayer, £2. 5s. per week.

Mr. A. W. Bull and Mr. Whitworth have been appointed shift engineers at Barnes electricity works to fill the vacancies caused by Mr. Bullpitt having joined the Colours, and the resignation of Mr. Keiffer.

Mr. Thos. McD. Mundell has been appointed electrical engineer at the Commonwealth Naval Dockyard, Cockatoo Island (N.S.W.), at £400 per annum.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—Our readers will be glad to hear that the lighting of the Institution is now being supplied by the Metropolitan Electric Supply Co. We do not doubt that the illumination will be improved by this step.

Association of Mining Electrical Engineers, West of Scotland Branch. On Saturday, Sept. 25, the members of the West of Scotland branch of the Association of Mining Electrical Engineers visited Auchincruive Colliery, Prestwick, belonging to Messrs. Wm. Baird & Co. (Ltd.). Chief interest centres in the electrical installation, which is believed to be one of the most extensive and complete in Scotland. The installation, which is on the "Thury" principle, was begun in 1908, under the direction of Messrs. Selby, Bigge & Co., and completed about four years ago. The visitors were shown over the plant, which included the following interesting features: Separate colliery centre operated entirely by electric power from a central generating station, with two main winding equipments, fitted with motors of the "Thury" variable voltage constant-current series type; mixed-pressure turbo alternators; exhaust steam accumulator; "Thury" automatic voltage regulator; motor equipment on large ventilating fan; and motor generator of the flywheel storage type, with automatic slip regulator, having high vertical alternating current. After the inspection of the colliery the company were entertained to luncheon in the Red Lion Hotel, Prestwick. Mr. A. B. Muirhead, the president of the branch, who occupied the chair, said he supposed the majority of the members would have been surprised and pleased to see that a Scottish colliery was able to show such a wide range of up to date plant, and such modern methods in the application of machinery. The colliery afforded, to his mind, a most interesting example of what could be achieved by a judicious combination of electricity and exhaust steam. The electrical system at the colliery was a development of what Mr. Thury had done in Switzerland. For winding purposes they would see that it was probably better adapted than any other system, because of the fact that the "Thury" motor was the only electrical motor which had exactly the same characteristics as the steam engine.

Society of Engineers.—At the meeting of this society on Oct. 4 Mr. Sydney G. Turner, A.M.Inst.C.E., Barrister-at-Law, read a Paper on "Law and Engineering—Some Points of Contact." The author pointed out that in almost every branch of engineering practice the provinces of the engineer and the lawyer overlap, and advocated the establishment of some periodical meeting, open to the members of both professions, at which subjects of common interest could be discussed. The Paper contained a brief survey of the principal branches of engineering, and in regard to each illustrations were given of such subjects by way of suggestion. Commencing with the subject of expert evidence, the author went on to deal with the duties of the engineer when acting as arbitrator, and in connection with the preparation of contracts and certificates. In connection with municipal engineering, it was pointed out how closely municipal engineers are interested in law, inasmuch as their work consists almost entirely in the administration of Acts of Parliament. The problems created by modern traffic conditions and highway construction, and gas, water and electrical engineering were in turn dealt with. Some of the more important judicial decisions in each branch of engineering were quoted, and in conclusion, the author expressed the hope that in the course of the discussion opinions might be offered as to the desirability of establishing some such meeting as was advocated in the Paper.

The Faraday Society.—The Faraday Society will hold a general discussion on "The Transformations of Pure Iron," on Tuesday, Oct. 19, 1915, at 8 p.m., at the Institution of Electrical Engineers. The president, Sir Robert Hadfield, F.R.S., will preside over the discussion, which will be opened by Dr. A. E. Oxley, of Sheffield. Tickets may be obtained from the Secretary of the Faraday Society, 82, Victoria-street, S.W.

Engineering Institutions' Volunteer Training Corps.—The work in connection with the new headquarters at Chester House, Eccleston-place, S.W., has been commenced, and it is proposed that drills shall start there on Monday, Oct. 18. Mr. C. G. Spiers has been appointed acting company sergeant-major, vice H. N. Fullarton, resigned.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 8th (to-day).

Electro-Harmonic Society.

p.m. Smoking Concert in the King's Hall, Holborn Restaurant.

Junior Institution of Engineers.

8 *p.m.* Meeting at 39, Victoria-street, Westminster. Paper by Mr. A. J. Simson on "A Grinding Problem."

MONDAY, Oct. 11th.

Junior Institution of Engineers.

8 *p.m.* Monthly meeting at 39, Victoria-street, Westminster. Paper by Mr. W. Rawlinson on "Modern Foundry Practice."

WEDNESDAY, Oct. 13th

The Association of Engineers in Charge.

8 *p.m.* Meeting at St. Bride Institute, Bride lane, Fleet-street, E.C. Presidential Address by Mr. Frank Bailey, M.Inst.C.E.

FRIDAY, Oct. 15th

Institution of Mechanical Engineers.

8 *p.m.* General Meeting at the Institution of Civil Engineers, Great George-street, S.W. Paper on "The Theory of Grinding with reference to the Selection of Speeds in Plain and Internal Work," by Mr. J. J. Guest.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing October 11, 1915.

Drills, 6.30 to 7.30 ; 7.30 to 8.30 p.m.

Saturday, October 9th.—Company Parade, 2.30 p.m. Route March.
Monday, October 11th.—Section 1, technical; Section 3, squad, signalling class.
Tuesday, October 12th.—Section 2, technical; Section 4, shooting.
Thursday, October 14th.—Section 3, technical; Section 1, shooting.
Friday, October 15th.—Section 4, technical; Section 2, squad, Signalling class.

In consequence of the great Recruiting March Out on Saturday, October 2nd, the Route March arranged for that day was postponed until Saturday, October 9th, when it will take place at 2.30 p.m.

PARALLEL OPERATION OF FREQUENCY CHANGERS.*

BY G. H. RETTEW.

Summary.—The author describes the difficulties sometimes met with in synchronising frequency changer sets, especially when they are located in different stations. He describes a concrete example of a system where continuous synchronous operation of two stations is only necessary over certain periods, the load being carried during the greater part of the time by a main sub-station.

This article deals only with that form of frequency changer consisting of synchronous motor direct connected to a revolving field alternator, that being the type generally employed on the larger systems.

In the operation of frequency changers in parallel, difficulties arise which, while not impossible to overcome, are not generally well known except to those who have such apparatus in charge. These difficulties are brought about partly by reason of the fact that the motor is of the synchronous type and hence does not have the drooping speed characteristic which is desirable in driving alternators which are to be paralleled, and further by the fact that both the motor and generator must be paralleled. An additional trouble is that the division of load on the generators cannot be accomplished by regulating the power supplied by the driving motor.

The last-mentioned difficulty is overcome in modern machines by mounting the stator of either motor or generator in a cradle, thus enabling the operator to give the various units to be paralleled, such relation to their respective revolving fields, and to each other, as will secure the desired division of load. With units of similar characteristics, even though there is considerable difference in capacity, the load may be satisfactorily divided in proportion to the respective capacities.

The paralleling of a unit of this description on the motor end is readily accomplished by starting up through a compensator, but after reaching synchronous speed the generator end may or may not bear the proper relation to synchronise with another unit which is already carrying load, hence it is necessary to slip poles by reversing the motor field. One or more reversals may be necessary before the proper relation is found.

The synchronising of the generators without a synchroscope is almost sure to lead to trouble, hence synchroscopes are almost universally used in connection with frequency changers. It must be borne in mind that, as the load increases on a unit such as we are here dealing with, there will be a corresponding angular displacement of the revolving fields, so that if one machine is carrying a full load and a second one is started, the synchroscope will not show true synchronism, even though the proper relation of the two machines has been established. However, there is usually no serious disturbance when two machines are thus thrown together, provided they are in the same station; where the resistances of the leads is small, and where automatic feeder voltage regulators are used, such disturbances as there are will usually not be manifest to the consumer.

Where machines are located in different stations, and where it is desirable to parallel over a tie line, additional complications arise due to the fact that the resistance of the tie line tends to lower the synchronising power of the machines, and due further to the fact that there is a drop in voltage in the tie line. Of course, the same conditions are also in evidence as obtain where the machines are in the same station, such as the angular displacement due to load on one or more machines in one station with an incoming machine in another station having no load. These conditions are so difficult to meet that where more than one station has frequency changers, at least one machine in each station is usually kept in service, the tie line only coming into use for transmitting part load from one station to the other in order to hold a high machine load factor, although in event of one machine "kicking off," the tie line would prevent a complete shut down.

A concrete example will serve to illustrate some of the difficulties referred to, and also to demonstrate a method whereby, with relatively small and inexpensive tie lines, the machine load factor is held quite high, and satisfactory synchronising is secured. The system employed does not contemplate continuous synchronous operation of two stations, but rather enabling one main station to carry the load, except during the peak, and thus hold a high machine loading factor, and allowing the transfer of load without appreciable effect on the voltage regulation.

Referring to the diagram the two sub-stations containing frequency changers are fed from a common generator bus some miles away; hence by starting the frequency changers on the motor side through compensators, they must necessarily be properly paralleled on that side. During the hours from midnight to approximately 5:30 p.m. the load on the smaller of the two stations is about 100 k.v.a. and is carried by the larger of the two sub-stations over the tie line, the single unit in the second station being idle. As the evening load starts to come on, this single unit is started, synchronised, and the tie line then cut out. About midnight the tie line is cut in, and the single unit shut down.

With a 1,000 kw. unit in operation at the larger station, with nearly full load on it, and with approximately 100 k.v.a. passing over the tie line, there was formerly quite a nasty "bump" at the instant when the unit was paralleled with the tie line at the smaller station. As previously explained, the synchroscope would never stand at the true synchronous position due to the fact that the machine or machines at the larger station were loaded while the new machine was unloaded, but would stand at an angle of from 30 deg. to 60 deg. fast, indicating that the incoming machine was fast, or ahead, hence when the machine was thrown in there was not only a "bump," but surges, the character and extent of which depended on many circumstances, one of which was whether the switch was closed on the peak of the wave or on the increasing side of the wave, or whether on the decreasing side, or at zero.

A very noticeable improvement in the conditions has been made by installing a resistance and suitable control switches, in the station containing the single unit. Referring to the diagram, the disconnecting switches are left closed except when repairs are necessary. The cycle of operations is as follows: Assume the tie line to be carrying the load and it is desired to put the frequency changer on load. Oil switches Nos. 1, 2, 3 and 4 and the generator oil switch must be open. Start the machine and synchronise. Close oil switch No. 4, then No. 1, then No. 2, then generator. Open No. 4, close No. 3, open the tie line switch, and No. 2, open No. 1, open No. 3. Assume the machine to be carrying the load and it is desired to put the load on the tie line. The tie line switch and Nos. 1, 2, 3 and 4 must be open. Close switch No. 3, then No. 1, then No. 2, then the tie line switch. Open switch No. 3, close No. 4, open the generator switch, then open No. 2, then No. 1, then No. 4.

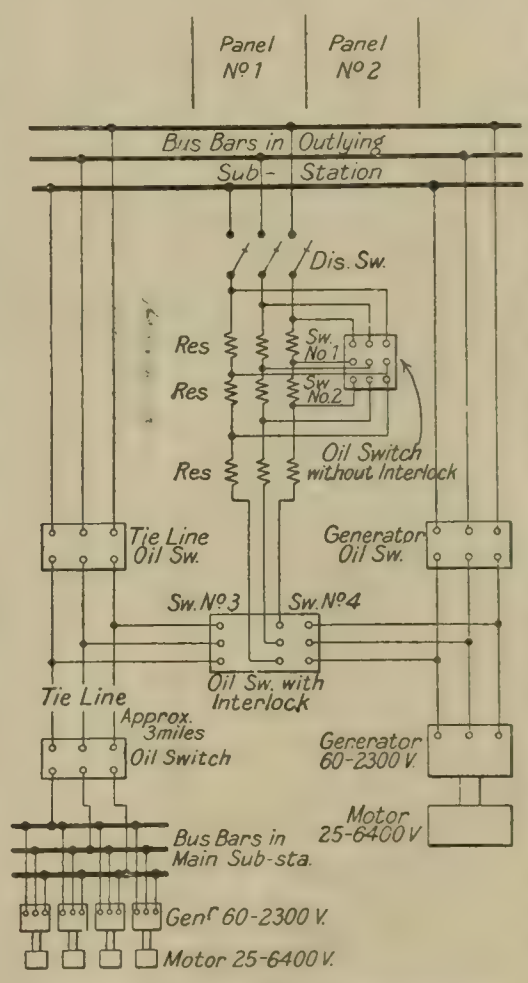


DIAGRAM SHOWING ARRANGEMENT FOR PARALLELING FREQUENCY CHANGERS IN SEPARATE SUB-STATIONS.

The effect of these operations is to permit the load to be shifted from the tie line to the machine, or vice versa, in steps having a low enough value to practically eliminate the trouble previously experienced. Assuming that the tie line is carrying the load and that the machine is synchronised, the synchroscope may stand at, say, eight minutes after 12, showing that the incoming machine is approximately 48 deg. ahead. As the resistance is thrown in circuit the incoming machine picks up part of the load and the synchroscope will fall back to, say, five minutes after 12 position, or 30 deg. Cutting out another step of resistance will further reduce the angular displacement, and on the last step the synchroscope will be near enough to the true synchronising position to enable paralleling with little or no "bump."

Practically the same result could be accomplished by putting an artificial load on the incoming machine thus causing a mechanical displacement in it which would bring it back to the correct synchronising position, and this is virtually what is accomplished by the method described.

The number of operations involved in putting the machine on load, or taking it off, is considerable, but as the switches are mounted on adjacent panels it does not cause the operator a great amount of work, and the time involved can be as little as 10 seconds. This method of operation has proved reliable and satisfactory and may be of service to others in developing their sub-stations along the same lines.

* Article in the "General Electric Review," slightly abbreviated.

ELECTRIC STRENGTH OF INSULATING MATERIALS UNDER MECHANICAL PRESSURE.*

BY F. KOCK.

This Paper refers to fluid, viscous and solid insulators, and the effect produced on the value of the voltage which is sufficient to break them down if the materials are themselves submitted to pressure. The main part of the work was done on the ordinary oils used in electrical work. The apparatus that was used may be described as follows. It consists, as shown in Fig. 1, of a hollow cylinder within which is placed a second co-axial cylinder, the space between the two being that through which the discharge is intended to pass. In this gap there is a definite field-strength, which can be calculated, when the two cylinders are connected to a source of excitation. The two cylinders can be exchanged for others of different dimensions, so that it is possible in this way to get gaps of differing thicknesses. In order to avoid heavy charges at the ends of the cylinders, these ends are carefully rounded. The surfaces of the cylinders are also very carefully smoothed. The discharge takes place in a steel cylinder, fitted with covers which can be screwed on. The hollow cylinder is not insulated from the steel cylinder; the axis of the inner cylinder is mounted on a bush of vulcanite cemented into the lower cover. This arrangement was designed for a pressure of 80,000 volts, and was tested at this pressure under oil before the real tests were begun. Each time that a discharge passed, the upper cover had to be removed in order to clean the surfaces between which the discharge passed. The pressures were produced partly by a hydraulic pump, which acted on a vessel containing mercury, this being separated from the pressure vessel by another which contained a fluid similar to that under test. Pressure was also partly produced by compressed air or carbonic acid gas in cylinders. The surface of the fluids in the cylinder was covered with a paper disc, in order to prevent eddies in the air let in under pressure, which might cause air bubbles. The high pressure is connected to the inner cylinder under oil in order to prevent discharges over the surface of the vulcanite or the formation of corona. For this purpose, carefully dried transformer oil is contained in a glass receiver, in which the under portion of the pressure cylinder dips. The well-known formulæ, giving the electric stress on the surfaces of the cylinders, show that the greatest stress is on the surface of the inner cylinder and it is there that the breakdown eventually takes place. The author proceeds to describe certain preliminaries that were undertaken for the purpose of the electrical measurements, for information concerning which the original Paper should be consulted. The ordinary transformer oils, i.e., light mineral oils, were examined, as well as oils used in the making of cables, such as resin oil, paraffin, petroleum, vaseline, solid paraffin, together with toluol and benzol. Vulcanite was the only solid body examined.

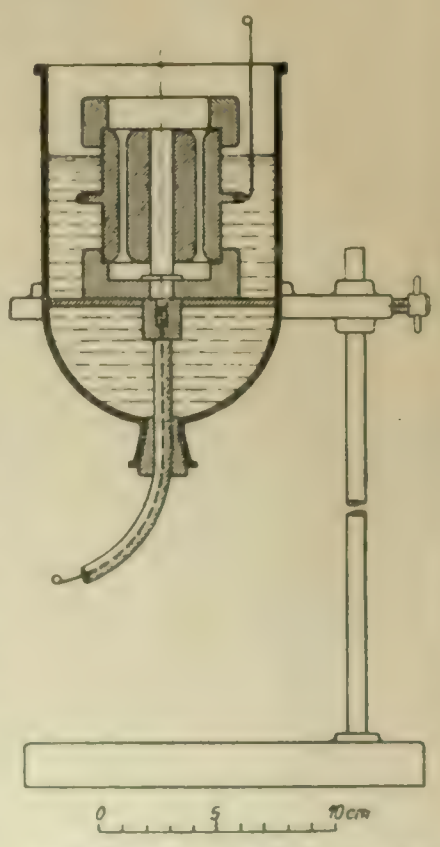


FIG. 1.—APPARATUS USED FOR TESTING THE VARIOUS INSULATING MATERIALS UNDER PRESSURE.

The breakdown voltage of oils depends very much on the amount of water they contain; the smallest traces are very important. If an oil breaks down, say, at 10,000 volts when perfectly free from water, it will break down at 1,000 volts if it contains 0·04 per cent., and the breakdown voltage falls gradually, but slower if there is more water present. Some of the oils that were tested were heated under a vacuum at 100°C. in order to separate the water; but this is not suitable with toluol and benzol, the samples of which were guaranteed by the makers to be free from water. Another oil was heated with calcium chloride and then filtered; but many methods are known to be effective. The dried samples were preserved under phosphorus pentoxide out of contact with the air. Kinzbrunner has pointed out that the value of the breakdown voltage depends to some extent on the time which the testing voltage is applied; constant values can only be obtained if the voltage is slowly raised; in other words, the voltage must be applied for some time before it is further raised. It was thought well to take this into account, and in the present experiments, the voltage was very slowly raised, in spite of the fact that the raising of the voltage quickly or slowly did not seem in the present case largely to affect the results. An approximate value of the breakdown voltage was quickly ascertained. Then half this voltage was applied, and i was then slowly and steadily raised till breakdown took place. Two minutes were generally allowed for any given voltage to act. The breakdown voltage was taken to be that at which continuous discharges took place. A characteristic noise, correpsonding in pitch to the periodicity of the alternate current, accompanies this breakdown. If the oil is not under pressure, the noise sounds dull; if there is pressure on the oil, the noise is sharp and buzzing. The voltmeter falls permanently at this instant. No notice was taken of momentary falls of the voltmeter, which indicated only occasional and not steady discharges.

Some preliminary experiments to test the effect of radius and of spark-gap length were made at atmospheric pressure, and at a temperature of 17·3°C., with Gargoyle transformer oil, A, made by the Vacuum Oil Co., having a specific gravity of 0·884, a viscosity of 4·24 at 20°C., and a specific heat of 0·469. The results of these tests are as follows:—

Diameters of cylindrical surfaces in mm. $=d_2/d_1$.	Thickness of layer of oil in mm. $=d$.	Pressure in kV. (R.M.S.)	Electric strength in kV./cm.
36/15	10·5	66·75	101·9
26·5/15	5·75	43·05	101·5
19/15	2·0	17·74	99·6

There is here slight difference in the values of the breakdown voltage; it seems to fall slightly when the gap was reduced to 2 mm., but this may be due to the fact that the oil may have contained some particles of dust, which it is practically impossible to remove. Therefore, in the following tests, when the spark-gap is as small as 1·5 mm., the breakdown voltage may be slightly too low.

Experiments were also made with the same oil to determine the effect of varying the radius of the inner cylinder.

Diameters of cylindrical surfaces in mm. $=d_2/d_1$.	Thickness of layer of oil in mm. $=d$.	Pressure in kV. (R.M.S.) $=kV.$	Electric strength in kV./cm. $=\delta$.
19/15	2	17·76	99·8
36/32	2	18·95	99·2

The effect of variation in the radius of curvature of the electrodes with oil is thus almost negligible as compared with air, in which a similar variation in the radius of curvature causes the electric strength to vary 11·32 per cent. Similar results were obtained at a temperature of 20·4°C. with paraffin oil, viz.:—

d_2/d_1.	d.	kV.	δ
36/32	2	13·65	71·5
36/16·5	9·75	46·4	72·4

The rest of the Paper refers to the tests under pressure, and contains a considerable number of curves which give a graphical representation of the results. It is not possible to reproduce all these curves, and we must, therefore, content ourselves for the most part with a general description. The first oil to be tested was the transformer oil of the A.E.G., which is dried with calcium chloride and filtered. Its specific gravity is 0·882, its specific heat 0·476; the temperature of the oil during the tests—i.e., the mean between the temperatures at the beginning and end—was 18° C.; the diameters of the cylinders were 19 mm. and 16 mm. respectively. The breakdown voltage rises according to a straight-line law for pressures up to 40 atmospheres, after which it rises more slowly (Fig. 2). At ordinary pressures it is about 95 kv. per centimetre; at a pressure of 40 atmospheres it is 350 kv. per centimetre.

A further experiment was made to see whether the magnitude of the diameter of the inner cylinder affected the result, but though the diameter was doubled it was impossible to find any measurable difference, which only amounted to 1·01 per cent., and is well within the limits of experimental errors.

Experiments were made at 20° C. with the *Gargoyle transformer oil*, A (specific gravity of 0·853 at 23·5° C., specific heat of 0·469 at 15° C., and viscosity of 4·24 at 20° C.), with and without a series resistance

* Abstract of Paper in the "Elektrotechnische Zeitschrift," Vol. XXXVI., pp. 85–88 and 99–102.

in the primary of the transformer, the results with the resistance (80 ohms) being given in curve I., and without in curve II., Fig. 3. For *castor oil* of specific gravity of 0·965 at 23·5°C., specific heat of 0·559 at 22·5°C., tested at 17°C., the results were as in the curves, of which (I.) is with 80 ohms series resistance in transformer primary, and (II.) without (Fig. 4).

With *resin oil* of specific gravity 0·965 the breakdown voltage rises from 95 kv. per centimetre at the pressure of the atmosphere to 300 kv. at 20 atmospheres, after which point the curve bends.

For *paraffin oil*, measured at a temperature of 20·3°C., of a specific gravity of 0·881 at 23°C., a specific heat of 0·482 at 22°C., and using a cylinder ratio $d_2/d_1=36/32$ mm., the results are given in the accompanying curves for unboiled and unfiltered oil (Fig. 5), and for boiled and filtered oil (Fig. 6), a series resistance of 80 ohms being used in the transformer primary in each case. The filtration was to remove traces of water, but this was too slight to be estimated.

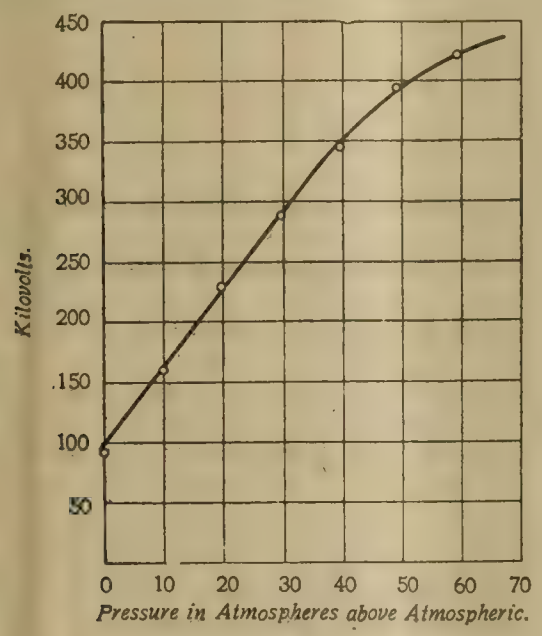


Fig. 2.—A.E.G. Oil.

The author made a series of tests, with and without resistance in the primary of the transformer, on petroleum at a temperature of 17·8°C., of a specific gravity of 0·846 at 23·5°C., and a specific heat of 0·467 at 20°C., and using a cylinder ratio $d_2/d_1=19/16$ mm. The results were represented by two curves.

Curves are also given for benzole and toluol. They exhibit the same peculiarities as the others, starting according to a straight-line law and then bending over.

The next experiments related to viscous substances. For the purposes of these tests, cylinders were used that could be taken apart, of which a photograph is given. The viscous substances were made fluid, and then the spark-gap was filled as carefully as possible with this heated fluid, with a view to the prevention of bubbles. The whole apparatus was then cooled down to the temperature of the room under the application of the draught from a fan. Ordinary commercial yellow vaseline was tested. The straight-line law held for atmospheric pressure when the breakdown voltage was 100 kv. per centimetre up to 15 atmospheres, when it was about 230 kv.; after this the breakdown voltage increased still further, but at a slower rate. With Kahlbaum's paraffin, the straight-line law held nearly throughout the tests, with a very slight falling off at the topmost limit. Thus, the breakdown voltage at atmospheric pressure was 100 kv. per centimetre and 530 kv. at 60 atmospheres.

With solid bodies, the only substance that was tested was vulcanite. The apparatus is described and illustrated. Very carefully made tubes were used, which were intended for insulation purposes. In order to avoid air bubbles the tubes were filled with mercury, which formed the inner electrode. The outer cylinder consisted of a brass tube with rounded ends, which fitted very exactly over the outer sides of the tube. Glow discharges are in this way avoided. On account of the known high time constants of the substance, the pressure was always applied for four minutes before it was further raised. As might be expected, the effects of pressure on the results were not very great. The breakdown voltage rises very slowly and fairly steadily from 600 kv. per centimetre at atmospheric pressure to 620 kv. at a pressure of 70 atmospheres.

If we compare the curves that are obtained for breakdown pressure with an arc, we find, exactly as with gases, there are certain maximum end values which are different for different substances. As for fluids that have once been broken down, it seems that after a time they regain their insulating capacity. However, with some of the thicker oils, such as resin oil and sometimes with paraffin oil, a definite short-circuit seems to be formed in the spark-gap. Thus, the insulating capacity of the substance was definitely destroyed by the discharge. The different values of the breakdown voltage after several discharges showed sometimes that they tended to increase and sometimes to decrease. Sometimes an oil seemed to improve after several discharges, as with paraffin oil that had not been completely dried. Petroleum showed a marked falling off in the value of the breakdown voltage after discharge. With toluol and benzol there was a black deposit on the walls of the spark-gap after a discharge. This tended to make the values of the breakdown voltage rather irregular, but on the whole decidedly increased them. The increase of the value of the breakdown voltage takes place at different rates with different substances, if the pressure to which they are submitted is increased. In this respect, paraffin oil and solid paraffin increase proportionately to the pressure for a longer time than the other substances. Vulcanite differs a great deal from the other substances, and shows very slight effects due to pressure. The slight increase that was noticed in this case may probably be due to the increased pressure of the very thin layer of air in the path of the spark-gap. The discharges through the oil in some cases caused a slight decomposition of the substance; this was clearly seen in the case of paraffin—this decomposition showed itself in the cloudiness of the fluid.

The effects of frequency were then noted in a series of tests on Gargoyle transfomer oil, where the breakdown voltage increased from 75 kv. per centimetre at atmospheric pressure to 310 kv. per centimetre at 40 atmospheres with a periodicity of 60, while it increased from 70 kv. per centimetre at atmospheric pressure to 270 kv. per centimetre at 40 atmospheres with a frequency of 20. (All the preceding tests, already noticed, were carried out with a frequency of 50.) As a result of these experiments, it seems as though there were a question of sluggishness or inertia or lag connected with the problem of breakdown. The effect of the wave-form was also investigated.

Finally some tests were made with direct current, for which purpose an old form of Holtz machine of the influence type was used. It had two discs and was driven by a motor. The curves, generally speaking, were similar in outline to those already noticed. With petroleum, the breakdown voltage rose from 65 kilovolts per centimetre at atmospheric pressure to 160 kilovolts per centimetre at 30

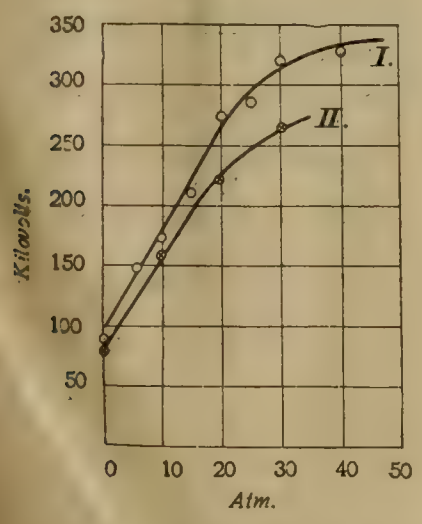


Fig. 3.—Gargoyle Oil.

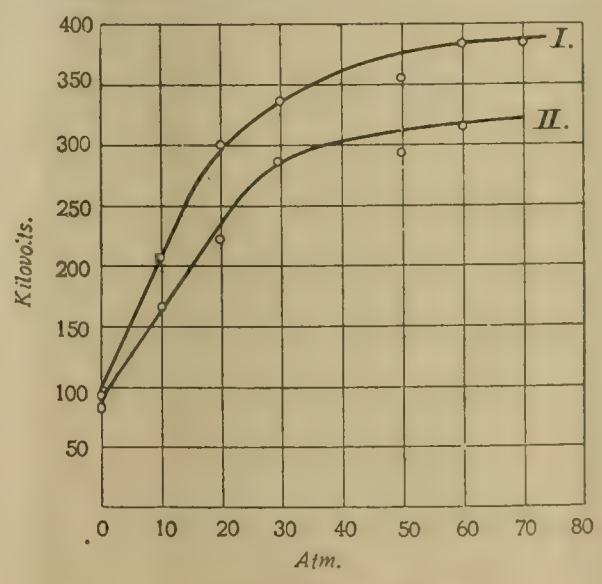


Fig. 4.—Castor Oil.

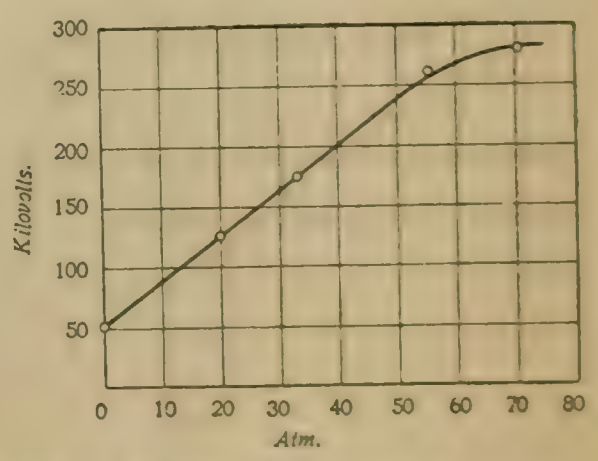


Fig. 5.—Paraffin Oil (Paraffinum Liquidum of Kahlbaum), Unboiled and Unfiltered.

atmospheres according to a straight-line law, and then the rise took place at a very much slower rate. With paraffin oil the straight-line law held up to about 40 atmospheres. It may here be remarked that the upper limits were always a little uncertain owing to causes that can readily be understood. The tests show that with direct current, the breakdown voltage, in so far as this is dependent on the pressure on the oil or other substance, rises much more slowly than with alternate current. With gases the same effect has been noticed by Wien; with direct current there is a much lower value of the breakdown voltage in the case of gases than there is with alternate current. Further attempts to find whether the insulation resistance of the oil depends on the pressure were undertaken. There were the two methods of the discharge of a condenser and the method of directly determining the current that passes. The substances under examination were placed between two cylinders, as before, and the whole was enclosed in the pressure cylinder. For the first method, a Leyden jar was used as a condenser, and voltages between 3,000 and 1,000 were used. The second method required the use of a high-tension battery, giving 1,000 volts. It was found that the conductivity was quite independent of the pressure. The results were as follows :—

Substance.	Conductivity in cgs.
Castor oil	$1{\cdot}18 \times 10^{-12}$
Transformer oil, A	$4{\cdot}96 \times 10^{-14}$
Petroleum	$1{\cdot}81 \times 10^{-13}$
Toluol	$7{\cdot}8 \times 10^{-13}$
Benzol	$1{\cdot}11 \times 10^{-10}$
Vaseline	$2{\cdot}12 \times 10^{-16}$

It may be assumed that with alternate current the phenomena preceding the breakdown represent so many losses in the dielectric; these are quite independent of the conductivity measured with direct

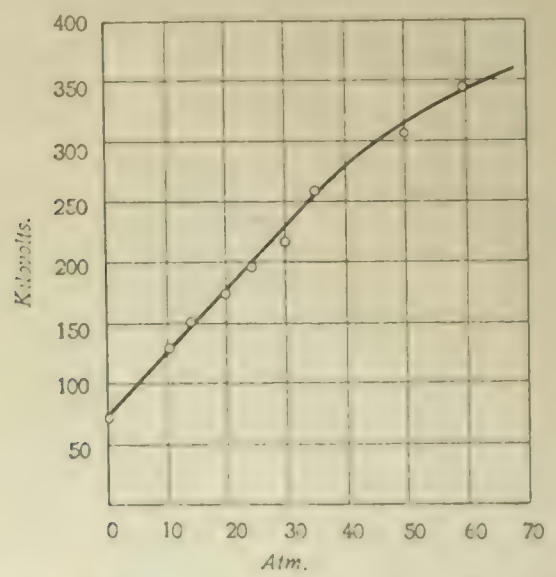


Fig. 6.—Paraffin Oil. Boiled and Filtered.

current, *i.e.*, the conductivity, measured with direct current, has nothing to do with the breakdown voltage. It may be supposed that under the influence of ionising effects a glow discharge takes place in the fluid, starting from the electrodes; this causes a decomposition or volatilisation of the oil either at the moment of the spark-discharge or in the instants which precede it. The spark then passes along a path of water vapour. This is similar to what takes place in gases, and might explain some of the phenomena we have been discussing. The slow increase in the value of the breakdown voltage at higher pressures might perhaps be explained, as in gases, by the supposition that electrons pass from the metal to the fluid; the curves show that this takes place sooner than in the case of air, in which the critical stress is known to be that due to 800 kilovolts per centimetre. The supposition that a vapour path is formed at the moment of discharge is, however, opposed to the fact that with fluids it was impossible to find any connection between the breakdown voltage and the diameter of the inner cylinder. There may, in fact, be differences between the effects produced by ionisation in fluids and in gases under these conditions; in which case, it is impossible to argue by analogy from the one to the other. The arrangement of the apparatus used by the author was such that it was not possible to observe the electrodes during the instant of breakdown or to note anything which took place within the pressure vessel. A good many points must, therefore, stand over till it is possible to go into the matter with a slightly different arrangement of the apparatus and to investigate points which are of considerable theoretical interest.

PRESIDENTIAL ADDRESS BY MR. A. H. DYKES TO THE ASSOCIATION OF SUPERVISING ELECTRICIANS.

When, as we hope, we and our Allies shall have concluded a victorious peace few things in our national life will be left unaffected, and it will be necessary to consider from a new point of view all our social and economic conditions. At the present time so great is the demand for skilled and also unskilled labour, that there is practically no unemployment, and wages generally are at a higher rate than ever before in the history of our country. The position is, however, an artificial one, and on the conclusion of the war, when we have to bear the full burden of the taxes necessary to cover the vast expenditure which has been incurred, we shall have to face difficulties and problems which in some respects will be even greater than those with which we have to deal to-day.

To begin with, not only this country, but the greater part of Europe will be impoverished—poorer both in men and in wealth. The wealth of a nation depends on the productive labour of its citizens, and on those who initiate and control its enterprises. All these elements which this country has possessed in ample measure are now working together, and the same unselfish co-operation will be even more needed in the economic struggle which will begin directly military operations have come to an end.

In the unprecedented circumstances in which we shall then find ourselves it will be necessary to utilise to the fullest extent all our resources. Everyone will, I think, admit that our social and economic position at the commencement of the war left much to be desired. In many trades there were symptoms of general unrest, and our means of production were not being utilised to their fullest extent.

Why is it that so many men do not take more interest in their work, and why do some organisations apparently exist for the purpose of seeing that a man shall earn, not the full amount that his individual skill and industry would enable him to do, but a certain maximum fixed to suit his less skilled or less industrious fellow workman? Doctors, lawyers, architects, all have their Trade Unions, but what would the members say if they were told they were not to do more than a certain amount of work a day? These unions try, and rightly, to set up a certain minimum standard of remuneration, but each man is free to give of his best, and so secure for himself, and thus indirectly for the nation, the maximum reward which his individual skill and energy enables him to obtain. The happiest man is he who takes a pride and interest in the work by which he earns his daily bread, and the happiness of our citizens, the future of our industries, and the prosperity of our country depend very largely on the extent to which we can succeed in inducing men to take an increased pride in their work.

If we can succeed in solving this problem many of our industrial evils and difficulties will soon disappear. In the old days the craftsman made an article, a whole article. It was the product of his skill and labour from start to finish. He had thoroughly learned his trade and took pleasure in comparing his productions with those of his fellow workmen, and he took a keen interest in his work quite apart from the fact that it brought him in so much money per week. Now that the world has become more complex, it is no longer possible, in most cases, for a man to make one article throughout; he has to do one process, he is only one of a team engaged in carrying out that particular job.

We must start with the young boys just beginning their industrial life, and see that their education is continued after they have left the elementary school. We must subject them both at home and in the schools to firm but kind discipline and teach them as much as possible of the history and principles underlying their trade, and to try to induce in them a pride and interest in the work of the firm of which they form a unit, so that they will scorn to scamp their work and will take a pride in helping to make the products of their firm second to none.

Most of us here have arrived at that stage when we feel that we can set a limit to our own possible development, and our thoughts our hopes, and our anxieties are for our sons, to see that they are properly equipped for the fight. I feel that there are many present more conversant with the problems involved in the proper training of the boys who are to be the future electrical workmen than I can claim to be, but the outsider sometimes sees most of the game, and my experience may possibly help me to put a few considerations before you and thus initiate a useful discussion.

In the old days a boy wishing to learn a trade was bound apprenticed to a master craftsman who undertook generally to feed and clothe him and teach him his trade. The period of apprenticeship was normally seven years, it being considered that this term was

none too long for a boy properly to learn his trade and to reimburse his master by service for the training he had received. The boy was bound to serve his master, to keep his secrets, not to waste his goods and to obey all his lawful commands, and fairly drastic powers of correction were given to the master in the event of the apprentice proving idle or disobedient. On completion of his apprenticeship the boy became a journeyman and was eligible to join the guild and in time to take apprentices of his own.

In the time of Queen Elizabeth it was enacted that no person should exercise any trade or mystery without having served a seven-years' apprenticeship, and it should be borne in mind that this applied not to craftsmen alone, but to lawyers, doctors and other learned professions.

Various abuses, however, crept in, such as the restriction of the number of apprentices in order to keep all the trade in as few hands as possible, and in 1814 the act of Queen Elizabeth was repealed in so far as it enacted that no person should engage in trade without having served a seven-years' apprenticeship. Apprenticeship was made, therefore, optional instead of compulsory, and any person was free to exercise any occupation of a mechanical or trading kind for which he deemed himself qualified. Apprenticeship still continued but with the substitution of trading companies for the individual master, and the general change in the whole industrial world brought about by the introduction of power-driven machinery, the system became greatly weakened. To the older, longer established trades it still remains the generally accepted channel of entrance, but in many trades the greater proportion of the men now engaged have drifted into the work without any proper training at all.

The need for something to take the place of the old apprenticeship has led to the institution of technical schools, which in England were first established toward the latter half of the last century under the direction of a Government Department known as the Science and Art Department and of the City and Guilds of London Institute. With the exception of a few higher trade schools and institutes designed for the education of those destined to fill the upper ranks in the industrial army, the technical schools have necessarily been restricted to evening classes, and splendid as has been the work which they have done and are doing, it must be confessed, I fear, that they do not meet all requirements, more particularly for the rank and file of the industrial army. The average boy of this class leaves school at the age of about 14, an age when he is only just beginning to be in a position to take advantage of educational facilities, and only too frequently is put to that employment which offers the greatest immediate salary, without any consideration being given to his future prospects.

A boy finds that by becoming an errand boy, a van boy or a newspaper boy, he can earn at once more money than if he attempts to learn a trade, and at the same time he is under less disciplined control. As it is not compulsory for him to attend any continuation school, he perhaps naturally decides that he has finished his education. The result is that after a few years when he wants a man's job and a man's wage, he can get neither and joins the army of unemployed. Even if he be apprenticed to a trade he finds that by the time the evening comes he is too tired properly to profit by the evening classes at the technical school, and every technical teacher knows how the numbers attending the classes fall off as the session wears on.

The standard of discipline, both at home and at school has fallen very greatly of late years, and in the absence of any compulsion it is only the exceptional boy who steadily attends the evening school and profits by what it has to offer. Quite apart from this, however, the average course in, say, electrical work tries to cover so much ground and to meet the needs of lads in so many different branches of electrical work that the boy often gets out of his depth, becomes discouraged with the difficulty and remoteness from his trade life of the class work and gives up before the end of the session. The net result is that only a very small percentage of those entering your trade ever receive any systematised training in it. What is the remedy? My own belief is that we shall in time have to make attendance compulsory for about eight hours a week, at a trade continuation school up to the age of at least 18, this attendance being made in working hours.

I should like every one here to-night to read a little book by Mr. R. H. Best, chairman of Best & Lloyd, and Mr. C. K. Ogden, of Magdalene College, Cambridge, entitled "The Problem of the Continuation School." The authors point out very clearly the problem and show how it has been successfully solved elsewhere. There is an old Latin tag which tells of the wisdom of learning from one's enemies, and much as we loathe and detest some of their methods there is no doubt that as regards their technical education there is much that we can with great advantage learn from the Germans.

In the town of Munich (population 600,000) every boy between the ages of 14 and 18 must attend in the day time the special trade school instituted for members of his trade alone. There are schools for every trade capable of providing more than 20 pupils. These schools are entirely free and are each managed by a committee representing the trade, the municipality and the school, the expense being shared equally by the municipality and the trades concerned. The boys attend for an average of eight hours weekly, between 7 a.m. and 7 p.m., either one whole day or two halves, to suit the convenience of the employers, who are obliged in every case to allow the time and see that their young employees or apprentices attend. Every boy, whatever his trade, devotes one hour weekly to trade arithmetic and bookkeeping, one hour to composition, business letters and reading, and one to citizenship, good behaviour, and hygiene, the remaining time being directed to drawing and information about his special trade, goods and tools. During the first two years he does no practical work as he is supposed to be learning that in his master's shop. But the last two years they get practical work of a higher grade than they are likely to get in their shop. There are now 10 school buildings distributed throughout the town providing for no less than 56 different trade schools, employing entirely 150 teachers with another 300 who give lessons there in addition to their ordinary work. The teachers comprise school teachers, master-workmen, journeymen and artisans. There are special schools for bakers, butchers, cooks, chimney sweeps, tool makers, gunsmiths, waiters, coachmen, in fact for every trade, each taught not only by trained educationalists but by practical men actually engaged in the trade, and under the direct supervision of the trade.

The results of these schools have been most excellent, over 90 per cent. of the boys leaving the elementary school at the age of 14 going straight to definite taught trades. We have not in this country gone as far as this, we have attacked the problem in our own individualistic way, but there are signs that the principles underlying the Munich system have found acceptance also amongst many of our leading educationalists and business men.

As you are more immediately concerned with the welfare of men in the electrical contracting trade perhaps I cannot do better than refer to the system which has recently been worked out by the Gas Light & Coke Company for training your friendly rivals, the gas fitters. Realising the need for a better system of training boys wishing to become gas fitters they approached the London County Council and a joint scheme of practical training and general educational classwork has been evolved.

Boys are indentured for a term of four years commencing between the age of 14 and 16. For the first six months the boys are engaged in a special workshop which the company have erected for the purpose, where they learn the use of tools and receive brief simple lectures from the company's foreman, dealing with the practical part of their work. The next six months they go out on the district with the fitters. In the second year the same routine is followed, first six months in the shops at more advanced work, and the next out with the fitters. During the whole of these two years they spend 9 to 10 hours per week, during working hours (generally three afternoons), at the Westminster Technical Institute, where the L.C.C. have arranged a special continuation school for them in mechanical drawing, workshop arithmetic, spelling, punctuation, English composition and letter writing. After the end of the second year the educational classes are held in the evening, every boy being required to attend two evenings a week (4½ hours) at classes in gas supply and English, and after the apprenticeship is over, they are still expected to attend at least two evenings a week. By a system of weekly, monthly and terminal reports, the company is kept in close touch with the educational work and can ensure punctual and regular attendance.

The results have, I understand, been most satisfactory. In summing up the results, the manager of the company in a Paper he read on the scheme, some time ago, said :—

"Compare the boy trained as I have described—one who has pride in his work and a real knowledge of his craft—with one who has been allowed to pick up information anyhow. The one can go all over the world and earn a good wage, the other is, as a rule, amongst those who are only tolerated by an employer and who are discharged first when work is slack."

Did time permit I should much like to go more into detail as to the training given in these and similar cases, but I think, perhaps, enough has been said to show the lines on which experience has shown that we can best proceed. I would urge the employers in the London district to make a commencement by agreeing on a uniform system of apprenticeship. There should, I think, be no premium asked, or at any rate only a nominal one. The term should be for at least four years, terminable by the master at any time in the event of

laziness, disobedience, or improper behaviour on the part of the apprentice. This may at first seem unfair, but it must be remembered that the master can no longer exercise those old-fashioned and somewhat drastic methods of upholding discipline which were in fashion in Queen Elizabeth's time, and experience has unfortunately shown that frequently if an apprentice has paid a premium and his articles cannot be broken, he presumes on the situation and cannot be made to work properly.

It is not likely to lead to hardship, because if the boy does not behave properly to begin with, it is no hardship to get rid of him, and later on when he has begun to learn his trade, the master is not likely to dismiss him and thus lose his services without very good and sufficient reason. It should be one of the conditions of the indenture that the master allows the necessary time and that the boy attends the trade school of his particular trade for at least eight hours per week, during the whole term of his apprenticeship, the classes being, at any rate for the first two years, held during working hours.

I have reason to believe that there would be no difficulty in arranging with the County Council and Board of Education a scheme of combined practical and theoretical education, the masters undertaking the practical work including instruction by foremen and practical men, and the County Council providing special continuation classes at, say, two convenient centres. These classes could be held in some existing institutes which are principally used for evening classes and are frequently not fully occupied during the day. Both employers and employees would be represented on the board of management, and I am sure that there must be many members of your Association who would be able and willing to give practical instruction. Both masters and men would thus be interested in the training of the lads belonging to their firm and the boys would be encouraged to do their best. A healthy rivalry might be created between the lads of different firms, which would be continued as they grew older, with the result that they would take a pleasure in working to make their shop superior to all rivals. In this way they would acquire the habit of taking a pride in their work to their own contentment and happiness and to the great profit of the nation. Employers also must remember that the good will of a firm consists not in its past history or in its list of customers, but in the possession amongst its staff and workmen of that love of good work and of pride in themselves and their shop which will not allow them to let a piece of careless work leave their hands.

I know that a number of objections can be raised on points of detail, but I venture to think that on the broad lines laid down, there can be worked out a practical scheme of the greatest benefit to your industry, and indirectly to the nation at large.

We are all of us to-day working together in order that we may continue to carry on our British institutions and civilisation in our own way; let us see to it that after the war the lesson in co-operation and mutual assistance is not thrown away. We have given, and are giving, of our best blood in this fight for our country; let us so act that when the war is over Britain is more efficient, better organised and happier than ever before, so that those who have laid down their lives for her sake shall, as they look down on us, feel that their sacrifice has not been in vain.

DISCUSSION.

Mr. Rashleigh Phipps, in opening the discussion, thought that some such scheme as that outlined by the President was very necessary, but there certainly was the great difficulty that at the present time boys with practically no education or tuition were able to earn as much as 20s. per week in blind-alley trades. For some years past his firm had taken the boys of their workmen, and in many cases they had done extremely well. They were not indentured. Mr. Dykes' suggestion was undoubtedly a solution of the problem, provided they could be assured that the boys would stay with them, and not go somewhere else for an extra 2s. per week.

Mr. J. M. Crowdy thought that the point which stood out prominently was the difficulty of getting such things arranged without some form of compulsion. Some kind of indenture should be drawn up, and something definite done, instead of going on in the haphazard manner in which we were going at the present moment. In his opinion, one of the great effects of this war would be that it would open people's eyes to the fact that the Germans could teach us a great deal in the way of organisation. They ought to have some agreement between their association and the Electrical Masters' Association for making arrangements in connection with the boys in their employ at the present time. The Electrical Masters' Association had been talking about the matter for a long time, but so far had done nothing. It was for the Association of Supervising Electricians to find some way of making progress.

Mr. C. J. Banister thought that the difficulty of the afternoon classes was to spare the boys from their practical work in order to attend them. The Electrical Contractors' Association (Incorporated) Liverpool Branch had adopted a form of model indenture for apprenticeship, which would give them some idea of what the masters in that district considered to be a fair and adequate wage for boys learning the electrical trade. This was as follows:—

1st year	2s. 6d.	per week and overtime at the rate of		1½d.	per hour.
2nd ,,	5s. 0d.	,,	,,	3d.	,,
3rd ,,	7s. 6d.	,,	,,	4½d.	,,
4th ,,	10s. 0d.	,,	,,	6d.	,,
5th ,,	12s. 6d.	,,	,,	7½d.	,,

That, in his opinion, was certainly not an adequate wage for London. The electrical employers of London could not control the home life of a boy, but by giving him an adequate wage they would assist him and tend to show him that by sticking to his trade there was a big future before him. He had had practical experience of teaching in night schools, and could assure them that the boys were far too tired and unfit to learn anything in the evening. Afternoon classes were undoubtedly necessary.

Mr. R. Rankin thought that the great difficulty in getting on with indentures was to get a move on the working man. Anyone who had anything to do with workmen knew that they did not turn out anything like what they could do, and it was up to the Association to get at the boys and put different ideas into their heads in their early life. There seemed to be no such thing in the workman nowadays as pride.

Mr. J. M. Crowdy doubted whether anything could be done by merely convincing the boys. In most cases the only thing to do was to force them. Some binding agreement ought to be made between the electrical employers and their Association. Pride was undoubtedly a thing that was lacking.

Mr. R. W. Whitley considered that there should be some rule among employers that no boy should be taken on unless he had gone through a certain amount of training. It seemed to him that as the cost of the whole matter would fall upon the employer, it was up to that gentleman to settle the business.

Mr. C. R. Bates thought that a good solution of the picture palace problem was to make such places educational. He admired the boy who left his employment in order to get 2s. more a week. If the apprenticeship system advocated by the President was adopted, he would like to know what was to happen to boys who were discharged for some reason or other. It had been suggested that the masters should form a committee, and take a number of apprentices themselves. That was all right, but it was not on broad enough lines. It should be a national programme rather than a local effort. The lack of practical instruction in Board Schools was no doubt at the bottom of all the trouble. If the electrical trade did the same thing as the gas fitters it would simply be working on the lines of setting up a model, so that one could put it forward as the result of experience as the lines on which the national system should be based.

Mr. H. Marryat had had some experience in his own business with apprentices. He gave the boys no wages the first year, then 5s., 10s., 15s. and 20s. per week for the next four years respectively, and although some of the boys had been earning 14s. per week before starting with him he had found no lack of parents willing to apprentice their boys on those terms. It was a condition in the indenture that the firm should pay for the evening classes, and that the boy should attend, but he was sorry to say that the attendance fell off terribly. He strongly suspected that the nature of the education given was the reason for it. He considered that every contractor should be allowed to choose his own rate of wages.

Mr. J. R. Lauder thought that the lads should be encouraged a little more, and that the masters should offer a bonus in some shape or form to those lads making the best progress. Afternoon classes were no doubt difficult to arrange, but by splitting the boys into batches something might be done.

Mr. G. Gorringe did not care for the binding of boys, on account of the danger of some of them, knowing that they could not be discharged, becoming a nuisance to the firm employing them. There should be some arrangement whereby a boy placed under a certain man should be allowed to remain with that man for a given time, so that there might be personal interest.

Mr. F. C. Heritage thought there was a lamentable lack of co-operation between night schools and masters of apprentices. Teaching in night schools was very slip-shod, and most of the time seemed to be wasted. He knew of a firm in Philadelphia having a system of apprenticeship and afternoon classes, which, on account of splitting the boys up into three classes, worked very well.

Mr. C. R. Bates said that the discussion would undoubtedly do good, but they had unfortunately got no further in the matter. It was a question which really rested with the electrical masters. One thing which would no doubt stand in the way was the cost. They must, however, have a working model to start with, and if the Electrical Manufacturers' Association could be induced to start the thing right away something could be done.

Mr. Rashleigh Phipps suggested that the Association of Supervising Electricians should form a committee to meet the Electrical Contractors' Association for the purpose of discussing the matter. He would undertake to put the views expressed during the discussion before the Electrical Contractors' Association. That, at any rate, would set the ball rolling.

Mr. A. H. Dykes said that what he wanted was to see that the ordinary education of the boy was continued. They did not want a man to be a workman and nothing else. They were out to train citizens, and, therefore, they wanted to widen the boy's mind. It would no doubt mean a good deal of self-sacrifice, and while a boy was learning his trade he must stick to the firm which was teaching him. He thought that the afternoon classes could be so arranged that the same matter was taught for a whole week, which would enable the boy to attend at the most convenient time. The Board of Education and the London County Council would give assistance in the matter if the masters were willing to undertake it.

APPARATUS FOR PROTECTING ELECTRICAL MACHINERY AGAINST ABNORMAL ELECTRICAL CONDITIONS.*

BY C. C. GARRARD.

(*Continued from p.* 918, *Vol. LXXV.*)

Summary.—The author deals first with the conditions which give rise to abnormal electrical conditions of a transient type, such as those due to switching, arcs and sparks. Methods of suppressing arcs to earth are described. The author then passes on to pressure rises between the turns of electrical windings, and those due to causes exterior to the system, such as lightning. Various protective devices are described, such as water jet earthing resistances, the Moscicki and other condensers, Giles' valve and the more ordinary lightning arresters. In conclusion the question of earth plates is considered.

LIGHTNING ARRESTERS FOR CONTINUOUS CURRENT.

Aluminium Electrolytic Lightning Arrester for Continuous Currents.—There is no doubt that the best form of lightning arrester for continuous current is the aluminium electrolytic cell.

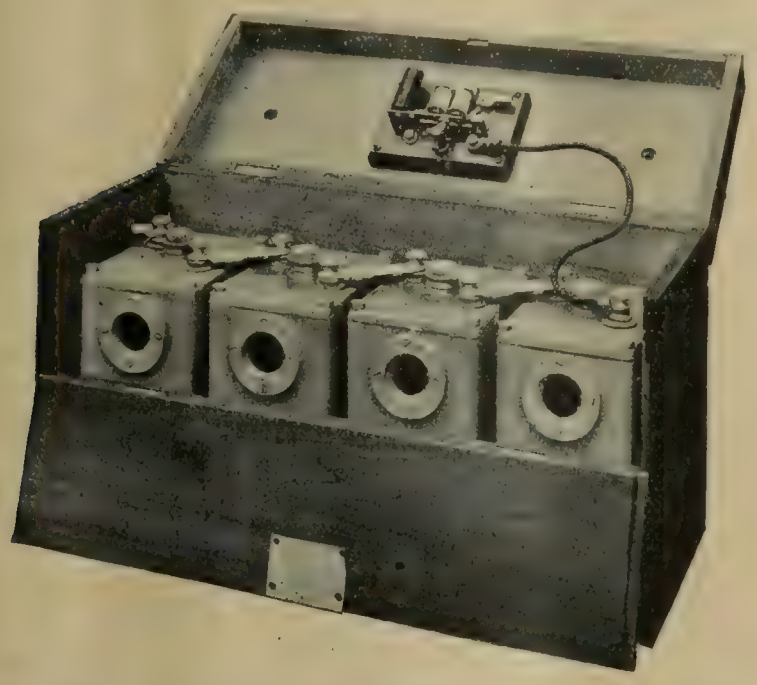


FIG. 40.—ALUMINIUM ELECTROLYTIC LIGHTNING ARRESTER WITH CHARGING RELAY.

On continuous-current circuits the aluminium cell can be connected directly between the lines and earth without including any spark-gap in circuit. The disadvantages inherent to the spark-gap in series with a condenser are thus done away with. The continuous-current voltage keeps the aluminium plates always formed. Both high and low frequency discharges pass readily through the cell; thus such arresters safeguard the machinery also against voltage rises due to breaking inductive loads (extra currents). On some installations such voltage

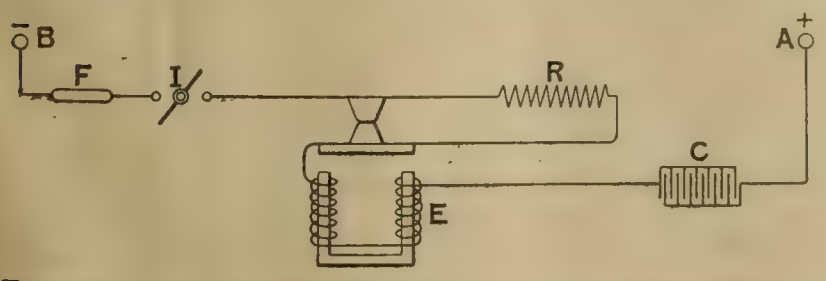


FIG. 41.—DIAGRAM OF CONNECTIONS OF ALUMINIUM ELECTROLYTIC LIGHTNING ARRESTER FOR C.C. CIRCUITS WITH CHARGING RELAY.

rises are very troublesome. Cases have come before the present writer where every time a circuit breaker operated, or a short circuit occurred, a breakdown in insulation somewhere in the station took place due to inductive rises. In the first instance, the installation was a direct-current colliery in which a single core armoured cable was used, the return being via the armour. The second case was an electrochemical works where the positive and negative were separated through the entire installation by a distance of several feet. Thus the network had a large self-induction. In such cases it is good practice to connect aluminium cells across the terminals of dynamos or where dangerous rises may be expected. Fig. 40 illustrates a continuous-current aluminium arrester for 500 volts. In the lid will be noticed the charging relay. The object of this is to insert a resistance in series at the moment

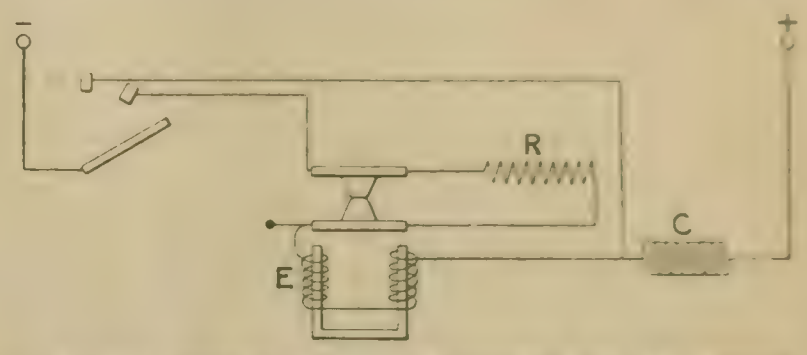


FIG. 42.—ALUMINIUM LIGHTNING ARRESTER FOR C.C. CIRCUITS (arrangement to cut out E when in normal running condition).

of connecting up. After the very short time required for forming the plates the resistance is automatically cut out of circuit. In Fig. 41, C represents the condenser, and it will be seen that directly the current falls to the normal small leakage value the resistance R is short-circuited. F is a fuse and I a switch. The induction of the coil E is, of course, small, but is always in circuit when the diagram of connections shown is

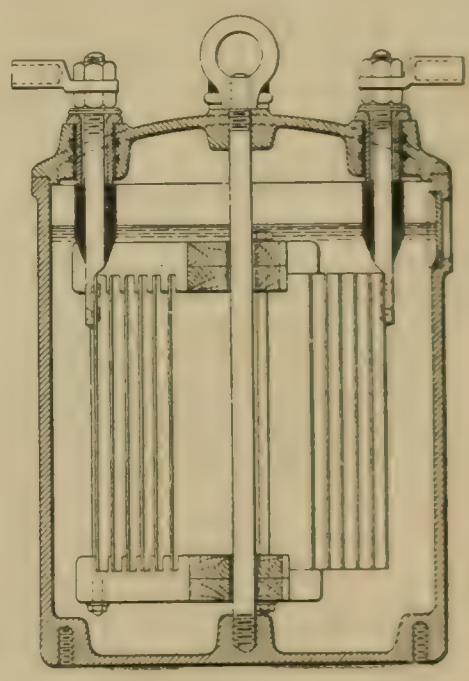




FIG. 43.—INTERNAL CONSTRUCTION OF ALUMINIUM ELECTROLYTIC LIGHTNING ARRESTER FOR CONTINUOUS CURRENT.

used. If possible, therefore, it is better practice to have another switch to cut E entirely out of circuit when C is charged. This switch can be combined with I if desired to make a fool-proof arrangement (*see* Fig. 42).

The internal construction of such an aluminium cell is shown in Fig. 43. Fig. 44 illustrates a convenient form of electrolytic cell combined with a choke coil, the whole being mounted on a bracket for ease of erection.

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Magnetic Blow-out Lightning Arresters for Continuous Current.—Arresters in which the magnetic blow-out effect of the dynamo current which follows the discharge has been used to extinguish the arc across the spark gap have been considerably used, especially on traction circuits. The first principle of construction of such arresters is that the discharge should not have to pass through the inductive winding of the blow-out electromagnet. Such an arrester is illustrated in Fig. 45. It will be seen that it consists of two gaps, A and B,



Fig. 44.—Aluminium Electrolytic Lightning Arrester Combined with Self-contained Choking Coil. (Isenthal & Co.)

in series between the line and earth. The second gap B is shunted by the resistance rod (100 ohms) C. The discharge will, therefore, pass across A and through C to earth, or, if heavy enough, across both the gaps, and will thus have an unimpeded passage to earth. Even if both the gaps discharge a certain amount of the following dynamo current will be shunted through the resistance C. About half-way across the resistance C a tapping is taken off to energise the magnetic blow-out coil D. The core of D has two extended pole-pieces,

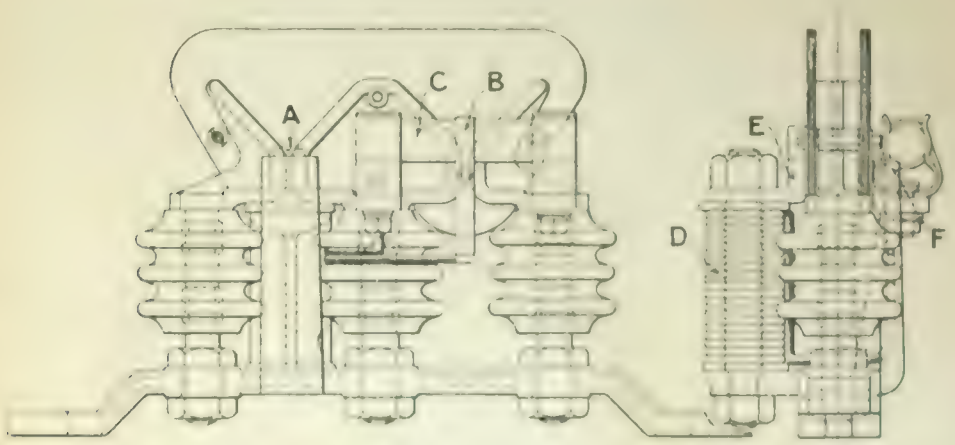


Fig. 45.—Magnetic Blow-out Lightning Arrester for continuous-current (500 volt) circuits. (General Electric Co.)

E and F, which embrace the spark gap A. Directly the blow-out coil is energised, therefore, a magnetic field is created across the gap A which extinguishes the arc. It will be seen that the arrester illustrated in Fig. 45 has no series resistance. This is an advantage.

A simpler form of magnetic blow-out arrester can be made by using a single gap in series with a resistance. The blow-out coil is then energised from a tapping across part of this resistance. Such an arrester has, of course, a smaller discharge capacity by virtue of the series resistance than the one illustrated in Fig. 45.

LOCATION OF LIGHTNING ARRESTERS.

The location of lightning arresters relative to the incoming connections is a matter for considerable care. Obviously, if the arrester is to protect the station from incoming trouble from the line, it should be placed immediately at the entrance point of the line. The choke-coil should be between the arrester and the apparatus to be protected. The earth connection of the arrester is of great importance. If the earth wire make many turns and twistings it will possess considerable inductance and prevent high-frequency discharges passing quickly to earth. In Fig. 46 are represented the two extreme cases. The line comes into the building from the left. Diagram A is the worse arrangement, and diagram B, with the short straight earth connection, is the better. It may not always, for constructional reasons, be possible to instal the best arrangement, but in any case great attention must be paid to providing a good earth connection as free as ever possible from induction.

EARTH PLATES AND CONNECTIONS.

The proper action of all lightning arrester apparatus depends upon obtaining a good connection to earth by means of earth plates. These are sometimes made of iron well galvanised, say, 6 ft. by 3 ft. in size and $\frac{1}{8}$ in. thick. Generally, however, it is better to use copper plates, in which case somewhat smaller ones—viz., 4 ft. by 4 ft. by $\frac{1}{16}$ in. thick—may usually be used. Where the subsoil is liable to corrode the copper, the plate may

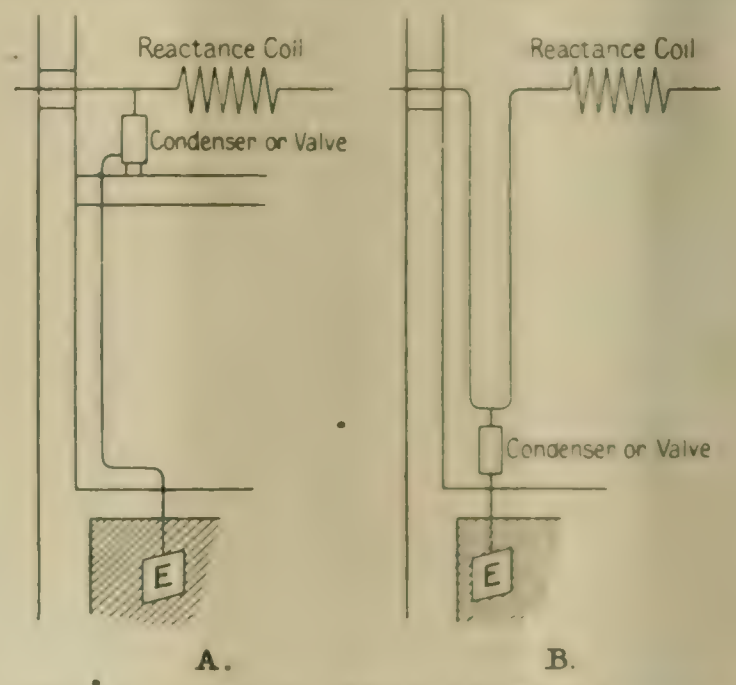


Fig. 46.—Diagram illustrating Extreme Cases of Location of Lightning Arresters.

be tinned. In some instances local conditions demand special and more complex arrangements to secure a good earth. These take the form of cages and metallic frameworks buried in the earth. It is essential that the soil surrounding the earth plate should always remain moist. To this end it is sometimes necessary to insert a pipe into the ground in the immediate neighbourhood of the earth plate down which water can be poured in dry weather.

A large installation will naturally have a number of earth plates. In fact, each important piece of apparatus requiring an earth connection should, as far as practicable, have its own earth plate installed as near as possible to the apparatus in question. A link should always be included in the earth wire, so that the resistance to earth of the earth plate may be measured. All earth plates in a station should be connected together by means of a stout copper wire or strip (arranged on the apparatus side of the testing link, so that each individual plate can be isolated for testing purposes). This wire should be connected to all earthed metal work in the station, such as constructional ironwork, water pipes, &c. On no account must water pipes and the like be relied upon alone for the earth connection. The earthed frames of all machinery will, as a matter of course, be connected to this earthing wire.

As regards the periodical testing of the resistance of earth plates, the British Board of Trade specifies in its Regulations as to electric power on tramways and light railways that two

earth plates (*i.e.*, in systems having an un-insulated return) should be used at a distance apart not under 20 yds. These plates shall be such that an E.M.F. not exceeding 4 volts shall cause a current not under 2 amperes to flow from one plate to the other through the earth. It will therefore be seen that the resistance of each earth plate to earth must not exceed 1 ohm. This provides a criterion as to the goodness of an earth connection.

Conical Form of Earth Plate.—A convenient form of earth plate which avoids the necessity of digging a large hole in the ground is illustrated in Fig. 47. It is constructed of perforated copper sheet tipped with a solid copper point. The cone is filled with pea-size charcoal or coke. A braided hollow copper cable is soldered to the copper tip, and the earth wire is soldered to the cable. A copper cap is placed over the top of the cone. To instal it, a hole is bored in the ground with a post-hole auger, and filled up with coke with the cone in the centre. The coke absorbs moisture by capillary attraction, and keeps the earth around it moist. The hole is filled up above the cone with earth.

Earth Plates on Colliery Installations.—The provision of a good earth connection is of special importance in colliery installations, having regard to the necessity of avoiding danger of shock. If a single earth plate having 1 ohm resistance be

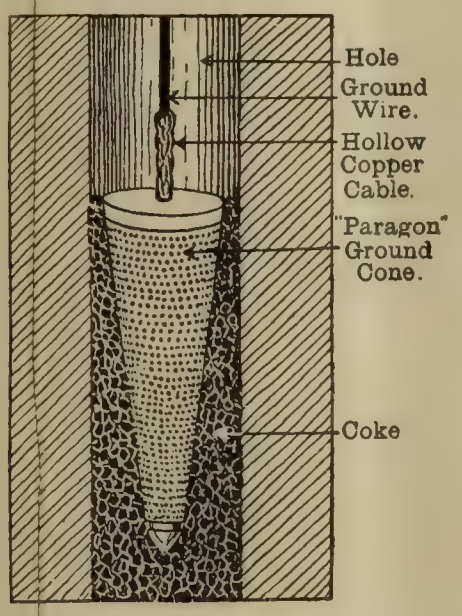


Fig. 47—Conical Form of Earth Plate.

used should this be called upon to carry momentarily a current of 500 amperes, such as may be necessary for a circuit-breaker to operate the earth plate would be raised to a voltage of 500 volts above earth, which would be very dangerous. In the memorandum on the Electricity Regulations [Coal Mines Act, 1911 (General Regulations, July 10, 1913)], issued by the British Home Office, the following suggestions as regards earth plates appear :—

"Earth plates may be of copper, cast-iron or galvanised-iron

"A cast-iron plate with projecting forks to give a large contact surface forms a good earth connection. Earth plates should be not less than 4 ft. square, placed preferably in an upright position in the ground, packed hard on each side with about 12 in. of broken coke free from sulphur. The depth at which they are buried must depend upon the condition of the ground in regard to moisture. The place selected should be permanently wet or at least damp."

C. P. Sparks ("Proceedings" I.E.E., Vol. 53, p. 389, 1915) has shown that earth plates installed under favourable conditions on the lines here recommended may have a resistance of 2 ohms or more to earth. Even two such earth plates connected together, therefore, would be useless to secure safety. Great attention must, therefore, be given to this point on the part of all engineers in charge of such installations. It may be added that station earths (as described on page 12), made by using a number of plates and interconnecting with all pipework, &c., may be obtained as low as 0·01 to 0·03 ohms (C. P. Sparks, *loc. cit*).

CONDUCTION OF ELECTRICITY THROUGH METALS.*

BY SIR J. J. THOMSON, O.M., F.R.S.

The investigations of Kamerlingh Onnes on the resistance of metals at the temperature of liquid helium have led to results which are of vital importance in the theory of metallic conduction; they have shown, for example, that some metals can exist in a state where their specific resistance is less than the one hundred thousand millionth part of that at 0°C. The transition from the state in which the resistance is diminishing normally with the temperature to the one where they possess this super-conductivity takes place abruptly at a definite temperature, and the difference in the electrical properties of the metal above and below this temperature are as well marked as the difference in elastic properties when a solid melts or in the magnetic ones when a piece of iron passes through the temperature of recalescence. One of the most remarkable effects discovered by Kamerlingh Onnes is that when a current was started in a small ring of lead at a temperature of about 4 deg. absolute, by bringing a magnet close to it, the current, instead of dying away as it would have done at 0°C. as soon as the magnet was stopped, went on with practically undiminished intensity, its rate of decay being so slow that Kamerlingh Onnes estimated that it would take four days to fall to half its initial value. This power of transmitting a current for long periods when no external E.M.F. acts on the metal is one that has to be accounted for by any theory of metallic conduction; any such theory must indicate that in certain metals a change of electrical state takes place at a definite temperature, that above this temperature the current dies away almost instantaneously after the E.M.F. is removed, while below it the current may persist for days without undergoing any considerable diminution. It seems to me that this is another and fatal objection to the theory that metallic conduction is due to the presence in the metal of free electrons which drift under the electric force, for no permissible increase in the number of free electrons or in the mean free path would explain the difference between the ordinary and super-conducting state. In the case of the lead ring the maximum free path (equal to the longest chord that can be drawn in the ring) cannot be more than a few millimetres.

It is the object of this Paper to show that the effects discovered by Kamerlingh Onnes are in accordance with the theory of metallic conduction which I gave in "The Corpuscular Theory of Matter," page 86, and which, with the substitution of an electron for a charged atom is substantially the same as that given in my "Applications of Dynamics to Physics and Chemistry," 1888.

On this theory the atoms of some substances, including the metals, contain electrical doublets—*i.e.*, pairs of equal and opposite electrical charges at a small distance apart. In the normal state of a body the axes of the large number of doublets occurring in even a small volume are uniformly distributed in all directions; when, however an electrical force acts on the body, the axes of the doublets tend to point in the direction of the force, and the moments of the doublets have a finite resultant in this direction. If the axes of the doublets were quite free to set in any direction, the smallest electrical force would be able to pull the axes of all the doublets into line and thus produce the maximum polarisation. There are, however, several influences at work which limit the number of doublets which point in the direction of the electric force.

In the case of gases, for example, there are collisions between the various molecules which tend to knock the axes of the doublets out of line as fast as they are brought into it by the electric force. Langevin has calculated from the principles of the "Kinetic Theory of Gases" the magnitude of this effect, and has shown that if M is the moment of each doublet, N the number of doublets in unit volume, I the resultant of these moments parallel to x and X the force on a doublet in this direction,

$$I = NM\left(\frac{\epsilon^x + \epsilon^{-x}}{\epsilon^x - \epsilon^{-x}} - \frac{1}{x}\right),$$

where $x = MX/R\theta$.

θ being the absolute temperature and $R\theta$ the mean kinetic energy of a molecule at this temperature; when x is very small $I = \frac{1}{3}NMx$, when it is very large $I = NM$.

In the case of solids and liquids, though there may not be collisions between the molecules, the rotation of the molecules endows them with a quasi rigidity, making each molecule behave very much as if its axis of rotation were acted on by a restoring couple proportional to the angle through which the axis is displaced and proportional also to the kinetic energy possessed by the body in virtue of its rotation, it behaves, in fact, very much like a spring whose stiffness is proportional to its kinetic energy. The value of I will be a function of the ratio of XM, the deflecting couple acting on the doublet, to the

* Extract from a Paper read before the Physical Society.

restoring couple brought into play when the axis is deflected through unit angle. As this couple is proportional to the average kinetic energy of the molecules, we have

$$I = NMF(XM/w).$$

Thus we see that for solids and liquids, as well ac for gases, I is a function of MX/w.

We need not here go into the question whether the form of the function depends on whether the body is in the solid, liquid or gaseous state. It is sufficient to notice that whatever the state, when $x=0$, $F(x)=0$, and when $x = \infty$, $F(x) = 1$.

Thus $F(x)$ will be represented by a curve of the type shown in Fig. 1. The force X which occurs in the expression for x is not merely the external electric force acting on the system; the polarised doublets will themselves give rise to strong electric forces, and X is the resultant of such forces and the external electric force. We shall

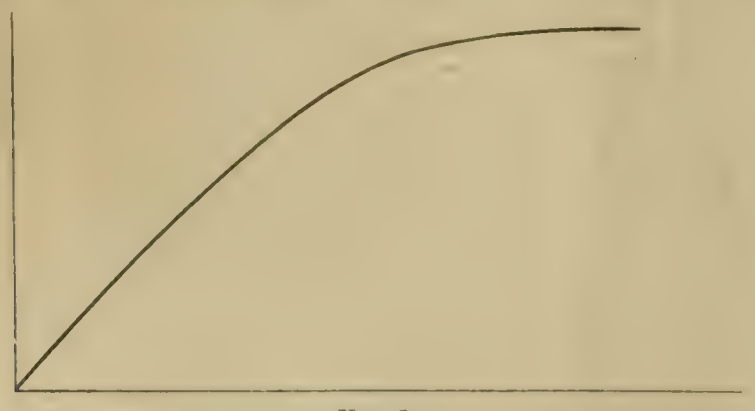


Fig. 1.

take the force due to the polarisation of the doublets as proportional to I and put it equal to kI. Thus if X_0 is the external electric force,

$$X = X_0 + kI.$$

and

$$x = \frac{M(X_0 + kI)}{w},$$

or

$$I = \frac{w}{Mk}x - \frac{X_0}{k}.$$

This relation between I and x is represented graphically by a straight line and the value of I corresponding to any value of X_0 can be determined by finding where this line intersects the curve

$$I = NMF(x).$$

The effects corresponding to any finite value of I will be the same as if I doublets per unit volume pointed in the direction of the electric force, while the axes of the rest were uniformly distributed in all directions; and we may picture the substance as containing a number of chains of polarised atoms whose doublets all point in the direction of the electric force as in Fig. 2.

So far as we have gone there has been nothing to differentiate between insulators and metals; in each of these the doublets set under the electric field and give to the substance specific inductive capacity, the value of which is proportional to the value of I when X_0 is unity.

It will be noticed that the electrons in the atoms of the substance will be under the influence of forces excited by neighbouring polarised atoms. Thus in the case represented in the figure these forces tend

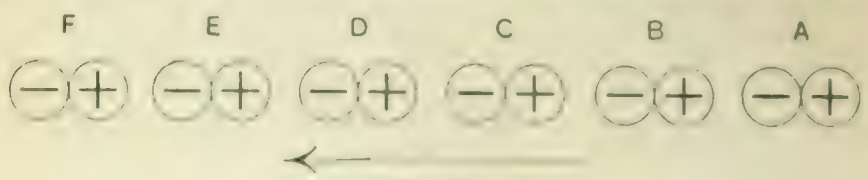


Fig. 2.

to make the electrons in A move towards B and those in B to C, and so on. On this theory the peculiarity of metals is that electrons, not necessarily nor probably those in doublets, are very easily abstracted by these forces from the atoms when these are crowded together. Thus we may suppose that under these forces an electron is torn from A and goes to B, another from B going to C, and so on along the line, the electrons passing along the chain of atoms like a company in single file passing over a series of stepping stones. Let us suppose that p electrons pass along each of these chains per second, then if there are n of these chains passing through unit area at right angles to the electric force, the current i through unit area will be epn, e being the charge on an electron. If d is the distance between adjacent atoms in the chain, there will be $1/d$ atoms per unit length of chain, and I, the number of doublets per unit volume pointing in the direction of the electric force, will be equal to n/d; thus $p = Id$, and therefore

$$i = epId.$$

The specific conductivity of the metal c is equal to i/X_0, so that

$$c = epd\Pi/X_0.$$

The force exerted by the polarised atoms on the nearest electron in a neighbouring atom will be very large compared with that exerted by the external electric force, so that p will be determined by these inter-atomic forces and will not to an appreciable extent depend on the external electric force. The ratio of the current to this force will, therefore, follow the same laws as the ratio of I to the force.

We have seen that the value of I is determined by the intersection of the line,

$$I = \frac{wx}{Mk} - \frac{X_0}{k}. \quad \ldots\ldots\ldots (1)$$

with the curve

$$I = NMF(x), \quad \ldots\ldots\ldots (2)$$

where w is the kinetic energy of a molecule; unless the temperature is very low $w = R\theta$, where θ is the absolute temperature and R the gas constant. When the temperature falls to the stage where the specific heat diminishes with the temperature w will be smaller than the value given by this equation.

When w/MK is considerable the line (1) will be steep and will intersect the curve near the origin, where it approximates to the straight line,

$$I = NMxF'(0). \quad \ldots\ldots\ldots (3)$$

The intersection of (1) and (3) is given by

$$I = \frac{NM^2F'(0)X_0}{w - kNM^2F'(0)},$$

and i the current by

$$i = \frac{epdNM^2F'(0)X_0}{w - kNM^2F'(0)}.$$

Thus the current is proportional to X_0 and Ohm's law holds. The specific resistance σ is given by the equation

$$\sigma = \frac{w - kNM^2F'(0)}{epdNM^2F'(0)}.$$

Now, except at very low temperatures, w is equal to $R\theta$, so that σ is expressed by an equation of the form,

$$\sigma = A(\theta - b).$$

It is thus a linear function of the temperature, which is very approximately true for pure metals.

Super Conductivity.—Let us now consider what happens when the temperature is diminished. The slope of the line (1) continually decreases and the intersection of this line with he curve gets farther

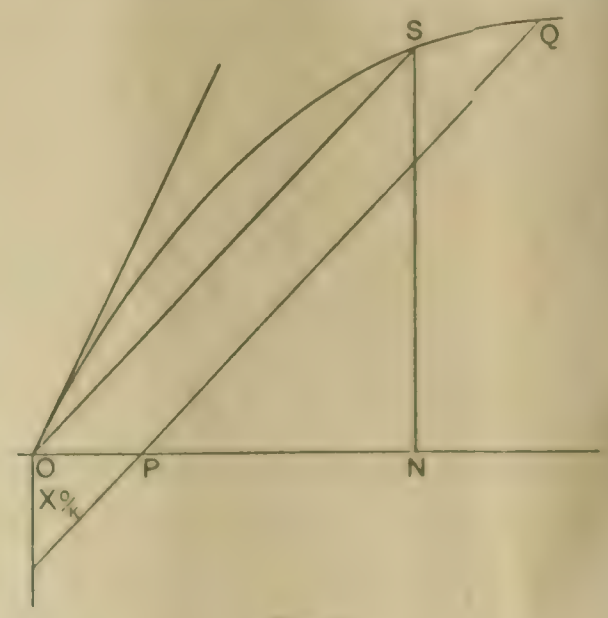


Fig. 3.

and farther away from the origin. When the intersection comes on a part of the curve at an appreciable distance from the tangent at the origin, Ohm's law will no longer hold. Suppose that the slope of the line (1) has fallen so that, as in Fig. 3, it is less than that of the tangent at the origin to the curve $I = NMF(x)$; and after the application of a force X_0, suppose the force is gradually removed, the value of I corresponding to the diminished force will be got by drawing parallels to PQ, continually getting nearer to the origin, and its value when the force has been entirely removed, by drawing a parallel through the origin itself. We see from the figure that in this case the line through the origin will intersect the curve again at S, showing that I retains the finite value SN after the electric force has disappeared. From the point of view of this Paper, however, the part played by the electric force in metallic conduction is to polarise the metal—*i.e.*, to form chains. When once these are formed, the electricity is transmitted along them by the forces exerted by the atoms on the electrons in their neighbours. Thus, if the polarisation

remains after the electric force is removed, the current will remain, too, just as it did in Kamerlingh Onnes' experiment with the lead ring. We see that we shall have the current remaining after the removal of the electric force—*i.e.*, the metal will be in the super-conducting state as soon as the slope of the line is less than that of the tangent at the origin to the curve—*i.e.*, when

$$\frac{w}{kM} \text{ is less than } NMF'(0),$$

or

$$w \text{ less than } NM^2kF'(0).$$

Thus, the temperature at which the metal passes into the super-conducting state is such that

$$w = NM^2kF'(0), \quad \ldots\ldots\ldots \quad (4)$$

kNM is the electric force exerted by the doublets when they all point in one direction ; if we denote this force by P, then w_0, the value of w at the critical temperature, is given by

$$w_0 = MPF'(0).$$

If the specific heat of the metal had not commenced to diminish at this temperature, θ_0, the temperature of transition into this state would be given by the equation,

$$R\theta_0 = NM^2kF'(0) = MPF'(0).$$

As, however, the transition takes place at very low temperatures, when the specific heats are variable and w no longer equal to $R\theta$, we must use a more general expression for w in terms of θ to determine the critical temperature. The persistence of the chains after the removal of the electric force is due to the disturbance due to thermal agitation being too weak to break up the chains when once they are formed. The chains are held together by the electric force due to the doublets in the chain itself as well as by the external electric force, and when we approach the critical temperature the force due to the doublets is much greater than that due to the external field. We see this from the expression,

$$I = \frac{NM^2F'(0)}{w - NM^2kF'(0)} X_0.$$

This may be written as $I = \frac{1}{k} \frac{w_0}{w - w_0} X_0$,

or

$$\frac{kI}{X_0} = \frac{w_0}{w - w_0}.$$

Now, kI is the part of the force on a doublet due to the other doublets, and we see from this expression that when w is nearly equal to w_0, kI is very large compared to X_0, so that the removal of X_0 will not appreciably weaken the coherence of the chains. On the other hand, at temperatures considerably above the critical, kI is small compared with X_0, so that the external force is essential for the coherence of the chains.

If the disturbing effect on the chains is entirely due to the thermal energy, and if this energy vanishes at the zero of temperature, it will always be possible to find a value of w which satisfies equation (4), and there will always be a critical temperature—*i.e.*, the metal will be able to pass into the super-conducting state. It is possible, however, that the action of adjacent atoms may, independently of thermal agitation, tend to make the axes of the doublet take up a definite distribution of orientation giving a kind of crystalline arrangement to the metal, and that the doublets when disturbed from this alignment come under the action of couples tending to restore them to their original positions. We can easily take this into account. All that we have to do is to replace w in the preceding equation by $w+D$ where D is proportional to the restoring couple for unit angular displacement, due to the mutually directive action of the atoms.

THE EFFECT OF HYDRO-ELECTRIC POWER TRANSMISSION UPON ECONOMIC AND SOCIAL CONDITIONS, WITH SPECIAL REFERENCE TO THE UNITED STATES OF AMERICA.*

BY FRANK G. BAUM.

To determine in any exact way the result of any particular industry on any period of progress is difficult, because many influences contribute to the results. We can, however, in a way see the effect of hydro-electric power as a progressive influence by examining the general growth of the country as related to the growth of the electrical industry.

In order not to take a narrow view of the progress, as resulting from the hydro-electric industry alone, it is thought advisable to survey briefly the entire development and the use of mechanical and other power as an aid to man. It will be seen from this view that the aid that man is receiving from hydro-electric power is the result of a long period of development and preparation, from the time when practically all energy was supplied by man's own efforts to the present day, when by far the larger part of the energy required by modern civilisation is being received from water-power or from the energy stored in past ages in the form of gas, oil, coal and wood ; and, in my opinion, the final and ultimate stage of this development is the use of water-power, which is perennial, and not subject to exhaustion ; and the use of electric transmission to transmit the energy over wide areas I believe to be as permanent as is the present system of distribution of water under pressure to municipalities. This hydro-electric development had its beginning about 1891, and assumed real headway about 1895, so that the industry may be said to be about 20 years old.

The remarkable results shown would, if understood, make an optimist out of the normal pessimist ; and it is believed a general understanding of the reasons for the remarkable developments of the past 50 years, by the nations that were ready for the change, will be of great service in the further work along the new line of general electric transmission and distribution systems.

It is scarcely necessary to point out that transportation or transmission in one form or another has always been the greatest problem of the world, and that no great progress was made by the human races until they began to classify and organise the labour used in production, and to organise the means of distributing the products of mind and of labour. And, as a matter of fact, no real lasting progress by the races was made until man began to use other forces than his own muscles to produce the results he wanted. The first aid man used to relieve his own labour was the energy of animals. This relieved his burden to some extent, allowing more time and energy for other work ; but even with this aid there was not the systematic and large development as we know it to-day. Some races developed well for a time, and then decayed. The decay cannot always be attributed to lack of brains, for Marcus Aurelius and Confucius and many others, who lived centuries ago, were as sound in their philosophy as we are do-day, yet Rome decayed and China sleeps with fatigue. Had Rome had modern systems of telephones and telegraph and used modern transportation and mechanical power, she probably would dominate the world to-day. And if China had done the work she put on the backs of her people by mechanical power and had used the energy stored by previous ages instead of the energy of her people, she would not have gome to sleep from sheer fatigue.

The very rapid growth of the wealth of the world in the past 50 years is not then due, altogether, to our superior brains, but due to the fact that we now do our work largely by energy other than human energy, and the fact that we can now, through a single head, organise and direct energies which in times past would have meant the organisation and control of millions of men. The difference in results obtained is due to the fact that we do not need to support these additional workers, but the equivalent energy is taken from Nature's stores or from water-power ; and also, due to the fact that the mechanical, electrical and chemical operations can now be predicted and realised ; but no man in times past could direct the energies of several million men and obtain consistent and efficient results. And, further, many of the results actually obtained by controlling the energies—mechanical, electrical and chemical—could not be obtained at all by human energy.

From a table published by the National Electric Light Association it appears that (neglecting animal power) there are 120,000,000 mechanical horse-power in the United States. To exert 1 H.P. would require the work of 10 men, and for 24 hours it would require at least 30 men, allowing three eight-hour shifts.

The 120,000,000 mechanical horse-power is, therefore, equivalent to the work of 1,200,000,000 strong men, assuming only 10 men to produce the results of one average horse-power. That means an enormous increase in the capacities of the people and a corresponding reduction in the load carried by the people. In other words, although we, in the United States, have only 100,000,000 population, we have the equivalent in human workers of twice the combined population of China and India. The actual net results obtained are really greater than the figures shown by the illustration. And *here* lies, of course, the fundamental reason for the enormous growth of wealth of the United States and other countries using electrical, mechanical and chemical means of production and making use of modern methods of supplying energy, in one form or another, to do the work formerly required to be done by men. And here lies largely the reason why we can purchase so many comforts and luxuries, and it is the underlying reason for the large fortunes accumulated in the past 50 years.

As long as man depended on his own energy and the seasonal products of his labour to supply his wants he could not get more

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

than his necessities. And often in countries like China, India and Egypt, where there is a large population and all products are produced by human labour, without much aid from mechanical energy or appliances, and means of transportation are not available, we have, and must continue to have, repeated famines. Any race which lives merely on the local products of the seasons is liable and almost certain to decay. These people make use of only a small part of what they are "heir to from all the ages." The American Indian had enormous forests, which merely produced for him food and shelter in a limited way, and it took all of his time to provide the necessities for existence. The modern American who displaced him is collecting "the inheritance of all the ages" by means of modern appliances for utilising the energy stored by past ages.

Some 50,000,000 H.P. in motive power is used for transportation by steam railways in the United States. To accomplish this work by men, if it could be accomplished at all, would require about 500,000,000 men. As a matter of fact, we cannot conceive any way of organising human or animal forces to do this work. In China, India, Egypt, &c., they use human labour largely to do what is done in this country by the railways, the power systems, the automobiles, and by the countless mechanical appliances. The modern nations are using the energy stored in past ages—that is, oil, gas, coal and wood—to produce this energy. We are, therefore, "collecting our inheritance."

A man, to-day, controlling and directing wisely the output of 1,000 H.P. of mechanical power for eight hours per day is directing the work equivalent of about 10,000 men. Is there any wonder, when viewed from this standpoint, that many fortunes have been produced in this age of the use of mechanical power? That some have been able to produce larger fortunes than others is largely due to the fact that men have different capacities for seeing new ideas and their probable effect. These differences of appreciation and knowledge of conditions are greatest, naturally, during the development stages of any large movement, as the use of mechanically applied energy has been in the past 50 years. Hence, the greatest discrepancies in fortunes are liable to result during the development period. But all the people indirectly gain as a result of the general increase in wealth. For a wealthy man can use little of his wealth, except to use it to build up other industries, which again supply employment for other labour. We could not pay the high wages prevalent in the United States were it not for the fact that the development of industries has become possible by using what has been stored by past ages. That is, it is the energies of past ages that is buying our comforts and luxuries, and making us all well off, relatively, to what our condition would be if we did not use this stored energy. There is no reason to believe that we would be any "better off" than some of the other nations except for our uses of energies of past ages, made possible by the genius of a few great men.

Naturally, as we are taking out of the storehouse of Nature, we must expect the store's stocks to become exhausted at some time. Where the stores are very large, or the probability of finding new sources of supply is likely, or other means of supplying the same requirement are possible, we need have no fear for the immediate future. But where we draw from Nature's savings bank, we must consider what is left for posterity. The fertility of our soil we know we can maintain by the use of energy to manufacture fertilisers to replace what is taken from the soil; and by the use of energy we can supply the need for the larger part of our work. As long as a nation can produce energy in a useable form cheaply I have no fear for its decay. Hence, conversely, the best assurance against decay is a continuous supply of energy that can be produced cheaply. The use of mechanical appliances to replace human and animal energy will largely multiply the capacity of our farms and insure our permanence. Energies in sufficient quantities to be considered can now be produced by using the energy of gas, oil, coal or water. (We need not consider air or the sun, as these cannot be collected in large enough units to be of any value.) The largest amount of mechanical power is now produced by coal or oil. Energy produced by water power is at this time only about 4 per cent. of the total generated in the United States, and the power transmitted electrically is less than 10 per cent. of the total.

With the development of electrical transmission of power from the point of production to the point of consumption a new influence was introduced, which assures our power supply for a very long period, if not indefinitely. By the means of electrical transmission we can produce the required power at favourable points and transmit the same many miles—and do it efficiently. This water power, and otherwise useless coal beds, may be used to produce the power of the present and future. Electric generation and transmission of power, be it understood, is merely a medium for conveniently converting mechanical power into electric power and transmitting it from the point of production to the point of use; the original power being divisible into an infinite number of parts, each part performing its function at its proper place in a perfectly pre-determined and efficient manner. That is, electric power is a medium of exchange of mechanical power, similar to money, which is a medium of exchange of property. Starting with mechanical power produced by oil, coal or water-power, and converted into the electrical form, we can go on producing for ever any mechanical operation. The great problem of all the ages has been to connect the producer and the consumer, and the greatest loss in efficiency is in this step between the producer and consumer. If we could produce, distribute and consume all other products as efficiently and as simply as we can electricity this great loss between producer and consumer would largely disappear. For this reason the electrical method of doing a thing will always be the ideal, and some time in the future a nation's civilisation will be measured largely in terms of kilowatt-hours consumed per capita, just as the measure of civilisation to-day is to be largely measured by the amount of mechanical power used. For as the mechanical power is large so the inefficient labour is small; and a large burden is taken from the people by electric and mechanical power. As the permanence of water-power and modern electric transmission is assured and the sources of production of power by means of oil or coal are assured for a long time, we may inquire into the growth of the electrical industry and what has been the effect of this industry on the economic and social conditions of the people.

Electric generators having a combined output of about 12,000,000 H.P. are used in the United States for central stations and electric railways; this is equivalent to the work of 120,000,000 men, and this is only about 10 per cent. of the total mechanical power used in the United States. The electrical generator capacity in the United States in 1912 was nearly four times as great as that in 1902, showing the high rate at which this form of power is growing. Table I. shows the summary for all central stations for the United States, and Table II. shows the corresponding growth for California hydro-electric plants. Table III., showing the available water-power in the United States, is extremely interesting. California, Washington, and Oregon have possible water-power of over 10,000,000 H.P., which at 50 per cent. load factor can do the equivalent work of more than 150,000,000 men. Niagara has a possible 6,000,000 H.P., or at 50 per cent. load factor, the equivalent of more than 90,000,000 workers. Future generations will not toil while this power is kept idle mainly for a few tourists. At least the water should be put to work six days in the week, and the sight of the increasing and decreasing quantity as it changed on Sunday would give a very wonderful effect. California is variously estimated to have water-power resources of between 3,500,000 H.P. to

Table I.—*Summary for all Central Electric Stations and Hydro-electric Station Reporting Water-power of* 1,000 H.P. *or More*; 1912.
(U.S. Census, p. 21, "Bulletin" 124.)

	Total for central electric stations.	Stations reporting water-power of 1,000 H.P. or more.	Per cent. of total.
Number of stations	5,221	225	4·3
Cost of construction and equipment	£435,135,653	£184,590,870	42·4
Total income	£60,423,120	£14,543,516	24·1
Light, heat and power, including free service	£57,396,171	£13,370,526	23·3
All other	£3,026,950	£1,172,990	38·8
Total expenses, including salaries and wages	£46,883,896	£11,268,413	24·0
Total No. of persons employed	79,335	17,160	21·6
Total horse power	7,528,648	3,179,244	42·2
Steam engines and steam turbines :—			
Number	7,844	520	6·6
Horse power	4,946,532	885,162	17·9
Water-wheels :—			
Number	2,933	1,552	52·9
Horse power	2,471,081	2,288,396	92·6
Gas and oil engines :—			
Number	1,116	19	1·7
Horse power	111,035	5,686	5·1
Kw. capacity of dynamos	5,134,089	1,951,397	38·0
Output of stations, kw. hours	11,532,963,006	5,859,397,943	50·8
Estimated No. of lamps wired for service :—			
Arc	505,395	62,624	12·4
Incand. & other varieties	76,507,142	13,403,893	17·5
Stationary motors served :—			
Number	435,473	73,645	16·9
Horse power capacity	4,130,619	1,283,769	31·1

Table II.—*Horse-power in Hydro-electric Plants in California.*

1892	1 plant	480 kw.	equal	643	H.P.
1893	2 plants	1,230	,,	1,649	,,
1894	2 ,,	1,230	,,	1,649	,,
1895	4 ,,	5,730	,,	7,681	,,
1896	7 ,,	8,190	,,	10,978	,,
1897	9 ,,	12,440	,,	16,676	,,
1898	15 ,,	20,715	,,	27,768	,,
1899	19 ,,	27,175	,,	36,427	,,
1900	20 ,,	28,695	,,	38,478	,,
1901	23 ,,	38,015	,,	50,958	,,
1902	27 ,,	51,565	,,	69,122	,,
1903	33 ,,	65,075	,,	86,232	,,
1904	41 ,,	88,465	,,	118,586	,,
1905	50 ,,	100,115	,,	134,216	,,
1906	54 ,,	122,265	,,	163,894	,,
1907	58 ,,	161,465	,,	216,441	,,
1908	67 ,,	238,985	,,	320,355	,,
1909	69 ,,	248,285	,,	332,808	,,
1910	71 ,,	293,095	,,	392,889	,,
1911	71 ,,	293,095	,,	392,889	,,
1912	72 ,,	308,295	,,	413,264	,,
1913	78 ,,	420,045	,,	563,063	,,
1914	79 ,,	436,045	,,	584,511	,,

Table III.—*Potential Water-power in the United States.*

As computed by the United States Geological Survey and as revised by the Bureau of Corporations (p. 55).

	Potential horse-power on basis of 90 p.c. efficiency.		Potential horse-power on basis of 75 p.c. efficiency.	
	Minimum.	Assumed maximum.	Minimum.	Assumed maximum.
United States	32,083,000	61,678,000	26,736,000	51,398,000
Summary—				
North Atlantic States	2,670,000	4,910,000	2,223,000	4,092,000
South Atlantic States	2,813,000	5,107,000	2,344,000	4,256,000
North Central States	2,079,000	4,270,000	1,733,000	3,558,000
South Central States	1,726,000	3,342,000	1,438,000	2,785,000
Western States	22,795,000	44,049,000	18,996,000	36,707,000

"A notable fact disclosed by the table is the remarkable natural centralisation of water-power in the United States. Approximately 11,500,000 H.P. (on the 75 per cent. efficiency basis), or 43 per cent. of the total estimated minimum power of the country, is found in the states of California, Oregon and Washington alone. If we add to this total the power of the three states of Montana, Idaho and Wyoming, we have in the six states 60 per cent. of the total power, and by including the three states of Colorado, Arizona and Utah we find in the nine states mentioned 70 per cent. of the estimated minimum power in the United States. About 8 per cent. of the minimum total is found in the territory in the north-eastern section of the country, including Pennsylvania and the states to the north and east. In the area east of the Mississippi river and south of the Ohio river there is about 12 per cent. These three group of states contain about 90 per cent. of the estimated minimum water-power of the country, and more than one-third of the remainder is in the four states of Michigan, Wisconsin, Minnesota and Illinois, bordering on the Great Lakes." (Extract from the Commissioner's report.)

6,000,000 H.P., and now has developed about 600,000 H.P. The amount developed is equivalent to 9,000,000 workers, or two workers for each inhabitant, assuming 50 per cent. load factor. But, as this was derived from 600,000 H.P. in California and there is a possible use of over 100,000,000 H.P. in the United States, we see that electrical power is truly in its infancy.

It is noted that the United States consumed 175·8 kw.-hours per capita, which may be increased to 200 kw.-hours per capita on account of isolated plants. The kilowatt-hours output for California was practically 10 per cent. of the above total for the United States; and as the population is less than 3 per cent. of the total for the United States, it is seen at once that the kilowatt-hours consumed in California is over 600 kw.-hours per capita. And we know that in California saturation has not been reached. It is also noted that the kilowatt-hours output for the United States has increased about four times from 1902 to 1912, but has increased in California nearly 12 times during the same period. As California has been the leader in electric transmission, the hydro-electric growth in California for the past 22 years, as given in Table II. will be of interest. This shows an increase from 643 H.P. in 1892 to 584,511 H.P. in 1914, surely a remarkable result.

We are certain that at the time when all coal, oil and wood has been consumed, the only form of power available will be water-power. Water-power is the only permanent useful power which will ultimately be available to us, and as electricity is the ideal system

Table IV. —*Per cent. of Horse-power Used for [illegible] California.*

Agricultural	[illegible] per cent.
Industrial	[illegible]
Domestic	[illegible]
Railroad	[illegible]
Miscellaneous	[illegible]

The above shows the possibilities of the application of power to pumping for irrigation. Much larger areas have been reclaimed by pumping surplus water off the lands, in other sections of the state.

It is estimated that 90,300 H.P. in motors are sold yearly in California, of which 55 per cent. are for agricultural development.

of distributing this power, we see that ultimately all transportation systems will be merely electrically operated mechanical devices for moving those things that can be so moved. That time is close at hand in some localities and further away in others. Just as the reciprocating engine men fought in vain against the supremacy of the steam turbine, so the railway men will fight in vain against the replacement of the steam locomotives by electric traction. The end of the reciprocating engine came in a period of a little over 10 years, and when electric traction really begins to be applied to railways I expect to see the end come, not as rapidly perhaps, but as surely as in the case of the reciprocating engine, so far as main trunk lines are concerned where traffic is heavy.

We will now apply our attention to analysing some more local California results in order to lead us to understand the cause and probable effect of hydro-electric and other power. As the available arable lands in California have been estimated at 20,000,000 acres, a large part of which must be irrigated by water-power, we see here what enormous values will be produced. Assuming one-half of the above lands irrigated by power and using 1 H.P. to 10 acres, we see that a total of 1,000,000 H.P. will be ultimately required.

The production of cement in California has increased from 9,500 bbls. in 1896, valued at £5,650, to 6,167,806 bbls. in 1913, valued at £1,549,000. Electric power was used in the manufacture of all the cement produced in the latter year. The production of gold in California amounted to £4,081,390 in 1913. Of this amount, gold to the value of £1,618,060 was produced by the dredging operations, and the remainder, £2,463,330, came from the mines. All the dredges and most of the mines used electric power in their operations. In California one system has grown to have an average load of over 100,000 average horse-power since 1897, serving more than 1,000,000 people in 30 out of the 58 counties of the State, covering an area of nearly 40,000 square miles.

I am quite sure that the 300,000 average horse-power now being supplied in California is making a profit for the consumers of more than £10 per horse-power, or £3,000,000 per year. This *profit* to the consumer is as large as the *gross* revenue derived from the power plants proper by all the companies. The cost of power to the consumers has been reduced in California to about one-half the cost of 20 years ago. Further than this, the capital saved by the consumers, assuming 600,000 H.P. in motors installed (instead of having to instal engine plants), has been at least £6,000,000. This much capital is then available by the power users of California for the development of the industries of the consumers.

Statistics might be quoted almost indefinitely, but enough has been shown to indicate the value of electricity in this new era of development. Cost of electric lighting has been reduced about 75 per cent. in the past 20 years, as a result of a reduction of power production due to water-power and steam turbine improvements and increase of lamp efficiency. In the same time cost of living and farm labour increased about 50 per cent. It has been shown by these statistics that these large electric power systems are to the advantage of the community as a whole, and a few simple considerations have shown that electricity is one of the greatest influences for the stability of a country; for, as is well known, to be stable a country must be efficient, and it is now being more and more recognised that to be efficient it must use electric power. Also, it is now becoming recognised that the most stable country is one in which the industries are diversified and widely distributed, and, especially, one having a prosperous and stable farming interest. To bring about this diversification and distribution of interests and population the influence of the electric-power systems (and especially the water-power systems) is probably as great as that of the railways. The stability of any civilisation depends, also, on the fact that it consumes less than it produces; and as it is necessary, with an increasing population (the natural resources of a country being fixed and limited and its population increasing), to operate more and more efficiently in order to produce more than is consumed, the most efficient methods must be

employed for all operations. Nature's naturally replenished sources of power must be used instead of consuming wood, coal, oil, &c.; and the most natural source of power is falling water, which Nature is annually producing.

Let us repeat, the great problem of all ages has been to connect the producer and the consumer, and the greatest loss in efficiency has been in this step between the producer and the consumer. If we could produce, distribute, and consume all other products as efficiently and as simply as we can electricity, this great loss between production and consumption would be largely reduced. For the reason of the high inherent efficiency, the electrical method of doing a thing will always be the ideal; and some time in the future, a nation's civilisation, as has been said, will be measured largely in terms of kilowatt-hours consumed per human being per year, because as the kilowatt-hours are large so the non-productive inefficient labour will be small. Therefore, a nation having large natural water-power need never fear decay. Hence we see the general benefits accruing to all the people—an unearned increment, so to speak—as a result of the electric transmission systems. The electrical transmission systems will ultimately form a network all over the country, just as the railways have gridironed the States in the past, and electric service will be a necessity.

The result of a general electric-power system will be that the same service, in electric power, will be available at the mining camps in the mountains, at the small towns, and to the industries in the larger cities. Aside from the economies mentioned of such a system, resulting from the concentration of the facilities, the power conditions throughout the country will tend to become equalised, resulting in a distribution of population and industries not otherwise possible; and resulting, also, in adding to the general stability of the country and in great saving in capital and operating expenditure for the industries and cities served. Very often it will enable the establishment of an industry, for example, a small factory, a stone quarry, a cement plant, or a farm, at a point otherwise prohibited, thus adding to the economic value of the district. The tendency will also be to equalise rates for light and power and to reduce rates to the lowest level, as is evidenced by the fact that in small Californian cities the consumer of electric light or power gets a much lower rate than is ordinarily obtained in Eastern cities having local power stations.

In consequence of this electrical development, industries will be established in many of the smaller towns and outlying districts where the employés can live more advantageously; and the natural effective result is a healthy growth of all parts of the State and country, a large saving in operating expenses, capital and resources, a general equalising of opportunities, and, on the whole, a tremendous economic gain for the communities, increasing in geometric ratio. It is naturally to the interest of the people that the power systems be extended as rapidly as conditions warrant, as the resultant economies from the extension of the business will of necessity redound to their benefit. Also a nation using science and mechanical power to solve its problems tends to become exact, and to draw conclusions as to probable results; and if anything will teach a man that action is necessary to get results, it should be obtained from mechanical and electrical power appliances.

The transmission and distributing systems are gradually covering the entire State, and will ultimately form an electrical, metallic screen over the entire country. This will be a screen of equal and constant potential, under which service, opportunities, and rates tend to become equal. By building the transmission systems across and through valleys of California, there was formed a system which makes for the uniform and stable development of the State as a whole; the same will occur in other sections of the United States. Not only this, but the hydro-electric companies, and those using waste coal, use a waste to reduce a want, and in using this waste energy to lift the burdens of humanity they make a net gain for civilisation, and do not merely transfer a burden from one set of shoulders to another. That is, electric power tends to make masters of men and to eliminate slavery. This gives us assurance for the future, for an increasing population requires progress, progress requires profits, profits require efficiency—and we may claim, in all modesty, that modern business could not be carried on efficiently without electric power. The statistics given, with a backward look over the road which has been travelled in the past 50 years, make one hesitate to predict the ultimate effect of a general electric power transmission on future civilisation. We have, however, summed up the general benefits to be desired.

The great benefits derived by the people as a result of the electric railways in making it possible for people to live in suburbs instead of in the tenement houses in cities, is only comparable to the general benefits derived by all in the use of electricity in the house as well as in the factory and farm. The further extension of the electric railways depends largely on the establishment of the large central stations and transmission systems. I expect to see central stations of 100,000 kw. with 25,000 kw. units become common, and I expect to see trunk transmission lines constructed to connect a large number of these stations throughout the country, with branch sub-stations and lines extending practically over the entire country. The prime movers for the generators will be so large as to exclude reciprocating engines of every kind, limiting the prime movers to water-wheels located at favourable water-power sites and steam turbines located at sources of cheap fuel, coal, oil or gas.

When this is accomplished and the energy we require comes from water-power and waste fuel sources, we will have reached the age of the wise, of "our inheritance." The curve of human efficiency must become flattened and become asymptotic to the line representing 100 per cent., and as this 100 per cent. line is known, and we are approaching it with the electric system, I believe the electrical age to be the ideal end of the remarkable series of steps of human progress that has taken place in the past 100 years.

AN INTERESTING ALSATIAN ELECTRIC RAILWAY.

In an article in "La Lumière Electrique," Mr. J. Reyval has recently described the electric railway in Alsace, running from Münster to the Schlucht Pass in the Vosges. It was ostensibly constructed to give access to these heights to the people living in the country round Colmar, but may have had a strategic object as well. Should the French recapture this district they could turn this railway to good account, provided it is left in workable condition.

The most interesting feature of the line is the fact that some of the gradients are worked on the ordinary adhesion principle and some by means of a rack-rail. The rack portion is about $1\frac{3}{4}$ miles long and the gradient here varies from 18 to 22 per cent., while the curves have a minimum radius of 80 metres. Gradients as great as 6 per cent. are, however, encountered on the other parts of the line.

The running rails for $3\frac{3}{4}$ miles from Münster are of the tramway type, after which on the heavy gradients they are of Vignole's section and rest on steel sole-pieces on the sleepers, spikes and coach-screws being used to hold down the rail flange. The rack rail is of much the same section as the others in its lower portion, but is held to the sleepers by gripping rail chairs. Massive concrete anchorages at intervals also keep the rack from slipping. The passage of the coaches on to the rack portions is accomplished easily and without shock.

The power house is situated at Münster. It contains two boilers with superheaters and Green's economisers and two horizontal compound steam engines of 250 H.P., turning at 124 revs. per min. The generators are three-phase alternators of 200 k.v.a., belt-driven at 500 revs. per min., giving current at 7,000 volts and 50 periods.

There is a sub-station $3\frac{3}{4}$ miles down the line, containing two converter sets, each consisting of a three-phase induction motor, driving through a flexible insulating coupling a continuous-current dynamo. The three-phase motors give 150 H.P. at 6,500 volts, 50 cycles, and 485 revs. per min. The dynamos give 100 kw. at 750 to 1,000 volts; they are shunt-wound, four-pole machines. There is also a storage battery with a capacity of 247 ampere hours at the one-hour rate. The current is delivered by means of a trolley wire of 9 mm. diameter, supported on brackets or cross wires with double insulators.

The novelty of the line is in the equipment of the motor coaches. These sometimes run alone and sometimes draw a trailer; they carry 40 passengers and the trailers 32. The speed is at least 10·5 miles per hour on the adhesion sections and 4·7 on the rack rail. The motor coaches are supported on two four-wheeled bogies, each of which has a motor driving one pair of wheels through single reduction gearing and another driving a spur wheel for the rack through double gearing. The bogie wheel base is 1·7 metres, but the central pivot is only 0·375 metre from the axle of the adhesion drive so as to get as much adhesion weight as possible. There is a band brake on the axle of the rack driving motor and also block brakes on the four wheels acting at the same time. Another brake is automatically brought to act on the rack driving mechanism when the speed exceeds the safe limit, and provision is further made for electric braking by short-circuiting the motors. Each motor is of 85 H.P. continuous rating or 100 H.P. maximum capacity. On the rack rail sections all four motors are in action and on the other parts, of course, only the two driving the ordinary wheels. The four motors are operated from one controller, by which series-parallel arrangements can be made as well as reversing and braking.

The current is collected by flexible bows from the trolley wire. Lightning arresters are fitted on the roof of the car.

THE ELECTROLYTIC COATING OF MIRRORS.

Large mirrors which are coated with silver by the usual methods require a protecting coating at the back, and instead of a varnish, such as was at one time in common use for this purpose, a copper plating has been used as being more efficacious in protecting the silver against oxidation. Such a coating of silver is easily attacked by moisture or gases present in the air, and it has been something of a problem to secure a suitable covering. Theoretically the copper-plating method was excellent as regards protection, but it was difficult to apply evenly all over the surface. In previous methods the glass was laid in a flat plating bath and contacts were simply put on at the edges of the silver surface, but it will be readily seen that such a method was defective from the fact that it gave rise to a deposit of copper which diminished rapidly in thickness from the edges to the centre of the surface on account of the high electric resistance which the very thin silver layer possesses, and thus the glass had a heavy coating at the edges and a very thin one at the middle, which was unsatisfactory as regards protection besides being uneconomical. The problem in a plating method lies in multiplying the number of contacts at the surface so as to have an even distribution of current, care being taken not to damage the very delicate silver layer which is almost infinitesimal (about 0·0005 mm.)

The drawbacks which we have just mentioned are avoided in the new copper plating method by multiple points which is the invention of Messrs. Declère, Grésy & Pascaliz, and is now being applied with success at Paris and elsewhere. By the present method, the flat glass mirror to be copper plated, shown at G in the diagram, is placed in a large flat plating bath, the object being to deposit copper upon the silvered surface of the mirror by the use of numerous points or electrodes which bear all over the surface of the silver and thus secure a uniform distribution of the current. The silvered mirror is laid flat upon a set of wood cleats which run across the tank. Above the mirror are placed anodes formed of copper bar *a*, each bar being mounted on the under side of a wood strip (Fig. 1). The number of anodes used depends naturally on the size of the mirror; in the diagram six anodes are shown. Current is brought to the surface of the silver or cathode by the use of a number of contact combs, which form the original feature of the process. Three of these combs, are shown. Each of these is made up of a great number of metal teeth, each formed of a brass rod which can slide vertically in a support and tipped with a soft metal such as tin so as not to injure the silver coating. A mechanical device worked by a hand wheel serves to bring down the comb upon the surface of the mirror, and the teeth all make contact with the surface, sliding up in their supports at the same time, the adjustment being properly made so that all the teeth make contact on the silver.

Except at the lower end, the teeth carry an insulating coating, usually of paraffin, to protect them from the action of the bath. Current is brought to each of the combs by flexible cables. The copper comb can be lifted out of the bath by the use of overhead cables and pulleys. Current is supplied at about 5 volts, and a density of 30 amperes per square metre of working surface, and under these conditions the operation is carried out in about 20 minutes. The combs are changed over to a second position after 10 minutes' running, in order to make a copper deposit upon the points which have been touched by the teeth and which would otherwise be left unplated.

A continuous circulation of the plating bath, which is an ammoniacal solution of copper, is kept up by a turbine pump PE. This pump is coupled to the electric motor, and serves to handle the liquid between the large containing tank BB and the electrolyzing vat, by means of the end pipes TT′, so that the liquid enters the plating vat at the left, passes along horizontally, and descends at the right-hand side to the tank in the basement. After the plating operation, the vat is quickly emptied through the large pipe T″ into the containing tank below, by operating a valve V′, and at the same time the liquid is filtered by the compact canvas filter bag F which surrounds the mouth of the pipe. A general view of the plant is seen in Fig. 2.

After the plating, the vat is emptied and the glass is washed with water which is introduced into the vat by a suitable device; this avoids manipulating the glass for the operation of washing and saves space needed for a separate tank for this purpose. The active circulation of the plating solution in the vat during the process is found to give a considerable advantage in preventing any impurities from settling upon the surface of the glass which would leave traces on the plated deposit.

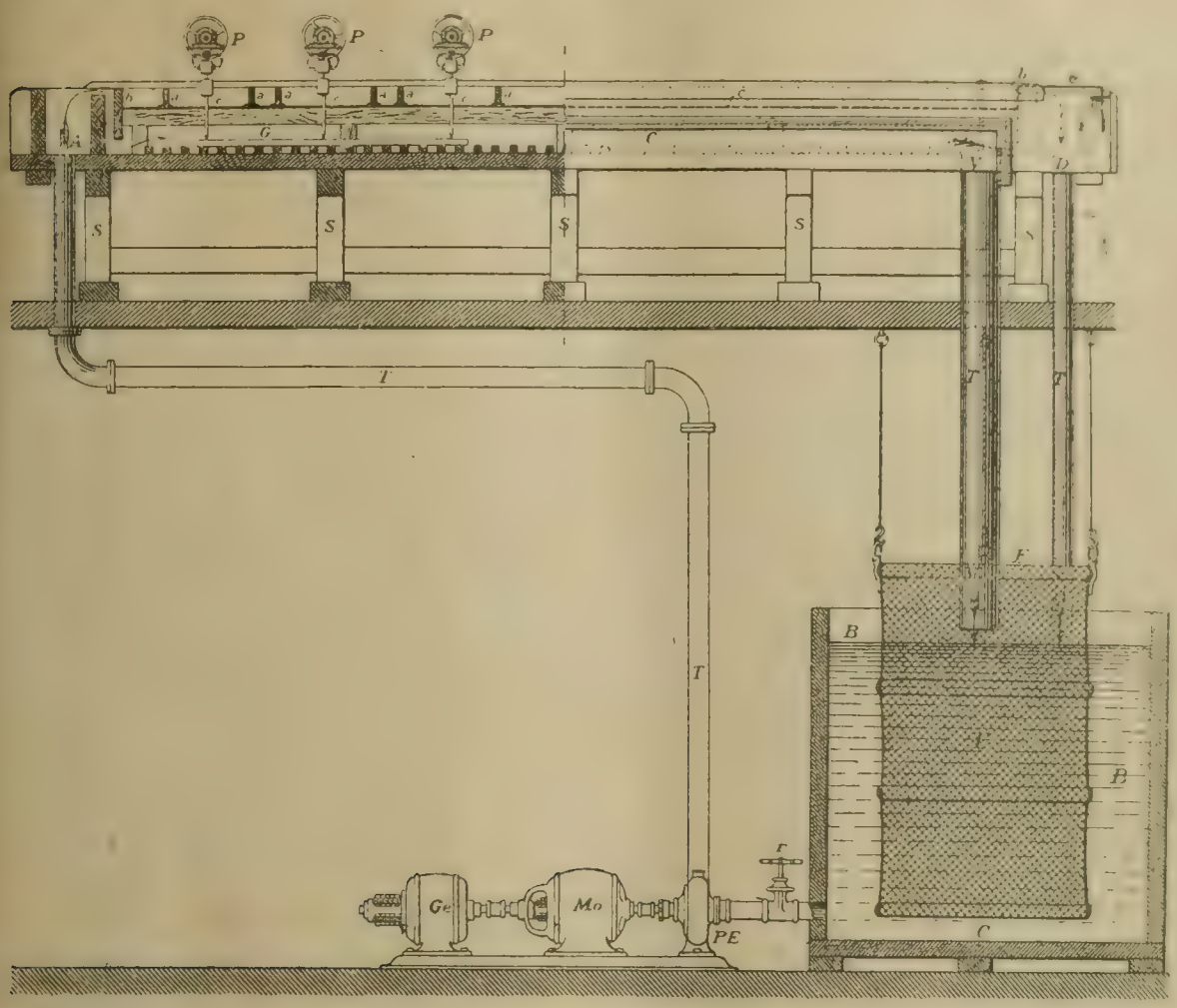


Fig 1.—Sectional Elevation of Plant.

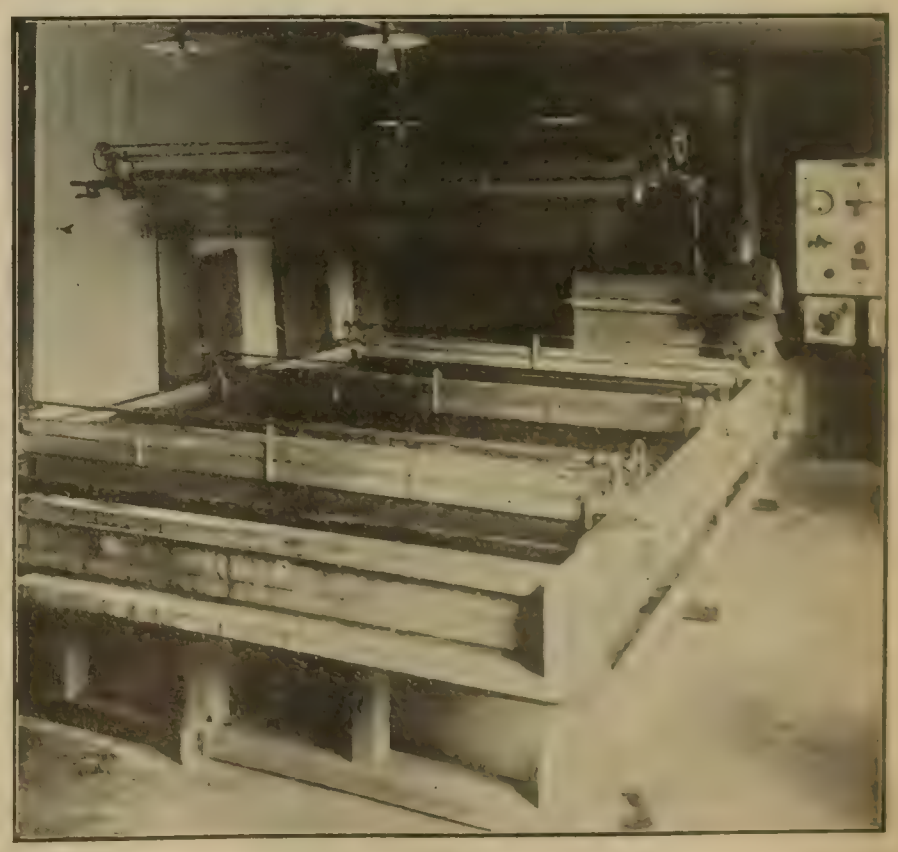


Fig. 2.—View of Plant.

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THE PROBLEM OF THE CONTINUATION SCHOOL.

From time to time discussions arise on the subject of technical education, but such discussions have generally been concerned with the education of engineers. Recently, however, more attention has been given to the question of technical education for the artisan, and for the moment we must confess that we feel this part of the subject to be more important than any other. In order that the artisan may be able to carry out his work intelligently, it is necessary that he should know something of the principles underlying his work, rather than that he should rely merely upon rule-of-thumb methods picked up in actual practice. The subject was again brought forward last week by Mr. A. H. DYKES in his Presidential Address to the Association of Supervising Electricians. Mr. DYKES rightly points out that the workman of to-day is unable to handle the whole of a process or a job for himself, as used to be the case years ago. He becomes more of a unit in a team of workers; but that is no reason why he should not take a pride and interest in his particular work and in a job as a whole if he is able to appreciate it. Mr. DYKES refers more particularly to electrical installation work, but the same principles apply more or less to other branches of engineering.

The desirability of technical instruction for the artisan is no doubt unquestioned: the only difficulty is to get a suitable system into operation. Hitherto, evening classes have been in existence and have no doubt done a certain amount of useful work; but it is obvious to those who, in their time, have put in a full day of manual work that the average boy cannot be expected to take an intelligent interest in evening classes, or to derive full benefit from them, when he arrives fatigued in body and mind. Employers must take the matter in hand themselves, and be prepared to make some sacrifices, for which they will certainly see a good return in due time, and which will benefit the country as well as themselves. In other words, the

employers must be prepared to sacrifice a certain amount of the boy's working time, so that he can attend technical classes systematically at hours when he is in a frame of mind to benefit thoroughly by the instruction that is given.

The other side of the problem is the question of inducing boys to take advantage of the facilities that are given. This is a more difficult matter, because effective educational schemes, of an extensive character, cannot easily be carried through except by some form of compulsion. Mr. DYKES points out that the problem is tackled in compulsory fashion by the city of Munich, and that the results obtained are very satisfactory. This system is described in a book entitled "The Problem of the Continuation School," by Messrs. R. H. BEST and C. K. OGDEN. It appears that in Munich every boy between the ages of 14 and 18 must attend in the daytime a special trade school instituted for members of his trade alone. There is a school for every trade capable of providing more than 20 pupils, and the expenses of the schools are shared equally by the municipality and the trades concerned, the tuition being entirely free. The average attendance is eight hours per week between the hours of 7 a.m. and 7 p.m., and may be given as one whole day a week or two half-days a week, to suit the convenience of the employers. Three hours per week are devoted to arithmetic, bookkeeping, composition, business letters, reading, citizenship, good behaviour and hygiene; and the remaining five hours to drawing and to information about a special trade. During the last two years the boys are given practical work of a higher grade than they are likely to get in their shop.

In this country we have a certain fondness for voluntary systems, but this partiality may be carried too far. The attendance at Board schools is no longer a voluntary matter, and there is no reason, in our opinion, why the attendance at continuation schools should be voluntary either, up to a certain age. If, however, the voluntary system is to be maintained, there seems to us to be only one way of reaching the desired end, and that is for all the best firms to agree between themselves to allow a certain amount of time for the technical instruction of boys in continuation schools. If this course were followed sufficiently widely, the parents would probably see the advantage of it, and would not allow their boys to go to the smaller works where such facilities were not given. Some firms are already setting a good example, and are themselves providing classes which give excellent results. This is so at the British Westinghouse and at the Gas Light & Coke Co.

Apart from the actual technical instruction, we should like to see something done so that the boys would take a certain pride in the work they carry out. It is noticeable that at Munich one hour per week is given to the subjects of citizenship, good behaviour and hygiene. There are many people in this country, no doubt, who would scoff at the idea of giving time to subjects of this kind, but we do not doubt that the seeds thus sown have a great deal to do with the cohesion shown by the German nation at the present moment. In this country, on the other hand, one of the first ideas that seems to be implanted in the mind of the young artisan is that he should restrict his work. This would not so much matter if the manufacturers of this country had merely to compete among themselves for home trade, without foreign competition. If, however, we have restrictions of this kind on the part of the workman it makes it extremely difficult to compete against foreign labour where such restrictions do not exist. This handicap will certainly be felt much more acutely after the war. Surely it is a vicious system which stops a man from earning as much as he can, and from exerting his skill for his own benefit.

REVIEWS.

Copies of the undermentioned works can be had from The E[illegible] free, on receipt of published price [illegible] 10 per cent. for abroad or for foreign [illegible].

Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological. [illegible] Pp. lii.–595. 28s. 6d. net. Also in Parts as follows: (A) Spectroscopie, 10 fr.; (B) Electricité, etc., 10 fr.; activité, 2·50 fr.; (D) Cristallographie, 4 fr.; [illegible] (F) Art de l'Ingenieur et Métallurgie, 10 fr.

The third volume of this monumental work has come to hand somewhat late, which is only natural under the present international conditions. In the number of pages that volume is rather smaller than its immediate predecessor (595 pages as compared with 759), but this reduction appears to be rather in bulk than in matter, owing to the use of smaller type. This is a change which, in our opinion, is desirable, for a work of this kind is not required for continuous perusal; moreover, shelf accommodation is often limited, and therefore the saving in bulk is a convenience.

The only innovation we notice is a table of contents under headings of technical materials. This will, no doubt, give useful assistance to the inquirer.

In regard to engineering, the data given have always been restricted to building materials, such as tests on cement, refractory materials and similar information. It seems a pity that electrotechnical data are largely untouched. True, there are the sections dealing with electricity and magnetism, but these are on pure science lines, and do not go far enough. We think that some extension in this direction would be appreciated.

We are glad to note that the tables are now being issued in six parts (according to subjects), as above detailed, as well as in a single volume. This will render them more accessible to the man of limited means and limited interest.

The Electrical Conductivity and Ionization Constants of Organic Compounds. By HEYWARD SCUDDER, B.A., B.S., M.D. (London: Constable & Co.) Pp. 568. 12s. 6d. net.

Assuredly the scientific worker owes a debt of gratitude to those patient and painstaking authors who are willing to go through numberless publications, extracting constants and numerical results so as to present them in a convenient form for reference. The volume before us is an example of this kind of work. The number of organic compounds has increased enormously during the last 30 or 40 years, and much work has been done upon their electrolytic properties. The author has dealt with the periodical literature from 1889 to 1910, and has also included the more important work, which is of small extent, before that time. From 1910 onwards the corresponding information is to be found in the "Annual Tables of Constants and Numerical Data" issued by the Committee appointed by the Seventh Congress of Applied Chemistry, to which we have referred above.

The amount of work involved in producing the present volume must have been enormous and tedious in the extreme. Seventy-eight journals and about 5,000 dissertations were examined page by page, apart from other journals which were examined where information was probable. Apart from the search, there is often some difficulty in clearing up the information that is found. We sympathise with the author when he remarks that, in general, the obscurity varies with the chief occupation of the author. At one extreme is the pure chemist, chiefly engaged in organic work, who describes his compound accurately, but leaves his physical measurement in ambiguous terms. At the other extreme is the physical chemist, who gives his measurement quite definitely, but leaves doubt as to the actual compound with which he is dealing and its state of purity.

The volume consists chiefly of tables, arranged alphabetically, giving ionisation constants, data of conductivity and bibliographical references. These tables are followed by a formula index, a list of authors, and a subject index. The work will not appeal to a large circle of readers, but will certainly be appreciated by those working in this particular field,

Experiments. By P. E. Edelman. (Minneapolis: Philip E. Edelman.) Pp. 256. $1.50.

This book is of an unusual type, in that it gives directions for carrying out a number of experiments, not as purely scientific exercises, but rather to arouse interest. We presume that it is intended primarily for young people having an experimental turn of mind, and for those so inclined it should be distinctly worth having, as the experiments are described so that they can be carried out without any complicated apparatus. They are, indeed, of the rough-and-ready kind, which are, nevertheless, more instructive, because those who carry them out will undoubtedly make up their own apparatus. The experiments cover a wide range, starting with chemistry and electrochemistry and passing on to electrical experiments of one kind and another, and finally ending with wireless telegraphy, aeronautics and microscopy. The end of the book deals with invention and the conducting of original researches, but these seem to be somewhat out of place. The parts of the book which may be most criticised are the illustrations, which are very poor; but, notwithstanding this defect, we think the book is excellent for the young mind having a taste for experimental work, preferably with a little supervision to avoid risk and to explain difficulties.

Wireless Time Signals. Issued by the Paris Bureau of Longitudes. (London: E. & F. N. Spon.) Pp. ix.+133. 3s. 6d. net.

This little book is a translation of the pamphlet to which we referred in The Electrician of April 25, 1913, and which is of great utility to all those who wish to avail themselves fully of the signals sent out by the Eiffel Tower. We need not, therefore, deal at any great length with the contents, but may content ourselves with saying that the translation will certainly be welcomed by radiotelegraphic observers not having a good knowledge of French. The translators have added three appendixes to their translation. The first deals with the weather reports, and includes a useful wireless time table for amateurs. The second gives a list of international signals, the international Morse code and a short French vocabulary; whilst the third refers to recent changes of British weather reports, such as the expression of results in dynes, and gives some conversion tables.

DIRECT-CURRENT MOTOR SPEED REGULATION BY RESISTANCE IN THE ARMATURE CIRCUIT, WITH SPECIAL REFERENCE TO THE DIVERTER METHOD.

BY THOMAS CARTER.

(*Concluded from page* 955, *Vol. LXXV.*)

Summary.—This article, after indicating the conditions of speed regulation under which the use of resistance in the armature circuit of a motor may be considered advisable, and pointing out the accompanying disadvantages as regards low efficiency and instability of speed when regulation is obtained by this device, proceeds to consider the conditions under which diverter resistance may be usefully employed in addition to ordinary series resistance. On the assumption of a certain sequence of operations in causing the speed of the motor to increase from zero to normal, mathematical expressions are obtained showing the corresponding changes in the various parts of the circuit in regard to current, resistance, &c., and the relations are also shown graphically. Some special cases are then considered, including that of the effect of varying stiffness in starting a driven machine, and finally there is an investigation of the changes in speed which result from changes in load while the regulating resistances remain unchanged, showing that, especially at very slow speeds, the change is much less when a diverter is employed than when only resistance is in circuit. The change is shown to be a rectilinear one.

VI.

A full analysis of the inferences to be drawn is impossible here, owing to considerations of space, but one or two cases may be considered.

(i.) In the case already treated when $r=0$, $R_s=\frac{E}{C_A}(1-l)$, as above stated, and R_D has the same general expression as before, which, by a slight rearrangement, may be put into the form

$$R_D=\frac{E}{C_A}\cdot\frac{(1-l)\left(\frac{1}{r}+1\right)+\left(\frac{l}{r}-\frac{l}{p}\right)}{r-(1+r)(1-l)}\cdot\frac{1}{p}.$$

Now if $r=0$, $1/p=0$ also at the "runaway" condition, *i.e.*, the motor runs infinitely slowly, or, say, just creeps round. If $r=0$, and $1/p=0$, it is clear that $R_D=\infty$, a conclusion already hinted at above, and now deduced from the mathematical expression. That is to say, the diverter never comes into action at all if $r=0$.

(ii.) If the load be less than C_A, but r be the same as before, the diverter is practically the same in ohms as before also for a given value of $1/p$. Suppose C'_A, the new current, is $0{\cdot}50C_A$, and r is still 1·0. Then l becomes 0·025 since it is proportional to the armature current. Then, since

$$R_s=\frac{E}{C_A}\left\{\frac{1}{1+r}-l\right\},$$

the new value of R_s is about twice the old value, so long, that is to say, as l is small compared with $1/(1+r)$, which is usually the case. An inspection of the expression for q shows that it does not change much if r is unchanged, and the same is true of R_D.

(iii.) Should the load be very much less than C_A, it may not be possible to increase R_s sufficiently to obtain the standard condition for starting laid down at the outset. In this case

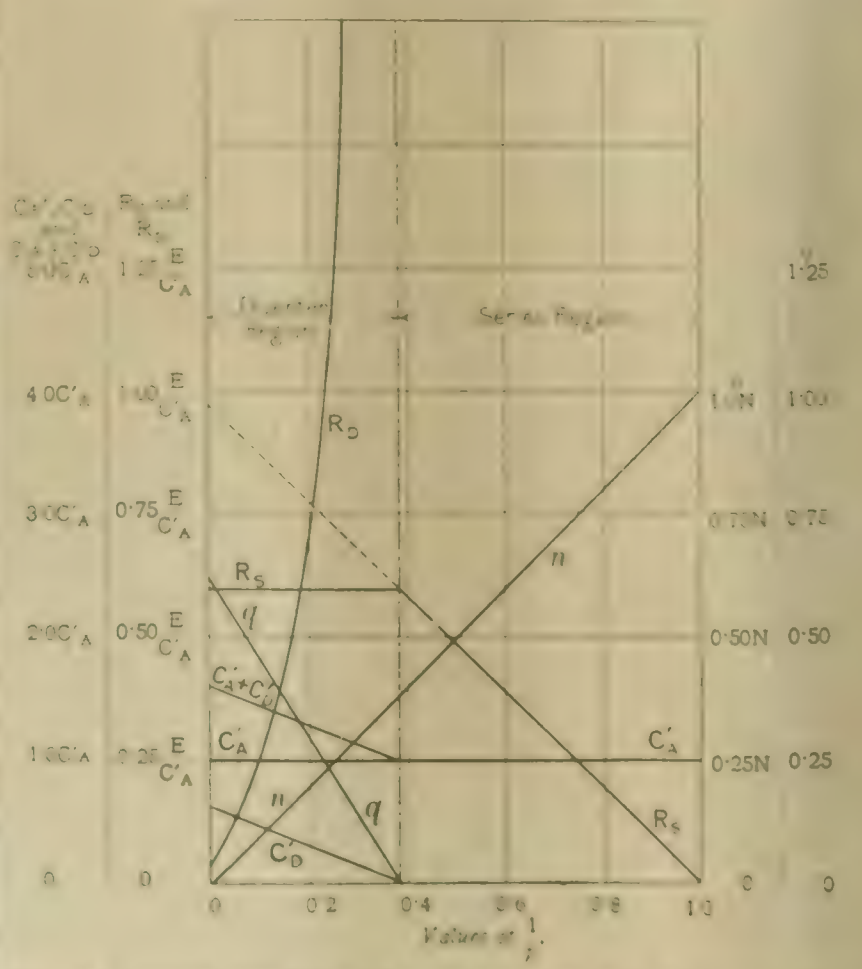


Fig. 3.—Curves for Speed Regulation by the Diverter Method ($r=0{\cdot}6$: $l=0{\cdot}025$).

the practical effect is to increase the value of r beyond what is really required for starting alone. By working back from the available R_s the effective value of r can be obtained, and the expression for q and that for R_D can be deduced, using the equivalent value of r so determined. It will then be found that R_D has an appreciably different value for a given value of $1/p$ from what it had before.

(iv.) A particularly interesting case is that referred to in Fig. 3, in which the same machine as in Fig. 2 is considered, but working at a lighter load, and with a different value of r. Let $C'_A=0{\cdot}50C_A$, and let $r=0{\cdot}6$, *i.e.*, assume that the starting conditions are relatively easier than at full load. The initial value of R_s is $0{\cdot}60E/C_A$, and the "runaway" speed is only $0{\cdot}585N$, owing to the reduction in r resulting in a narrower diverter region. A similar set of tabulated values can be obtained to those obtained for Fig. 2, and these values are plotted in Fig. 3. Note that the scales are chosen so that the ordinates of resistance are to the same scale measured in ohms, *e.g.*, the height $1{\cdot}5E/C_A$ in Fig. 2 is the same as the height $0{\cdot}75E/C'_A$ in Fig. 3, and these have the same numerical value, since $C_A=2C'_A$. Hence it is at once clear from the two sets of curves that for a

given value of $1/p$ the value in ohms of R_D is very considerably greater in Fig. 3 than in Fig. 2. Exactly the opposite effect would have been produced if r had increased instead of diminishing, *i.e.*, if the machine had been relatively stiffer to start, say, at the reduced load. These two diagrams, Figs. 2 and 3, will repay careful study in comparison with each other, as only by such study can the general effect of changes in the conditions be realised.

VII.

Fig. 4 refers to a case where $l=0{\cdot}05$, and retains this value unchanged. Some of the other possible variables are shown so as to illustrate the way in which they depend on r. The values from which the curves are drawn can be easily tabulated from the general expressions already deduced for the various parts of the circuit. The curve marked R_s gives the initial value of R_s, which remains constant during the diverter region. The curve marked $1/p$ gives "runaway" speed values of $1/p$, and bears out the statement already made, that diverter resistance is more and more useful the greater r is. The curve marked q shows initial values of q, *i.e.*, indicates the current in R_D for the condition of just enough of R_D being switched in to

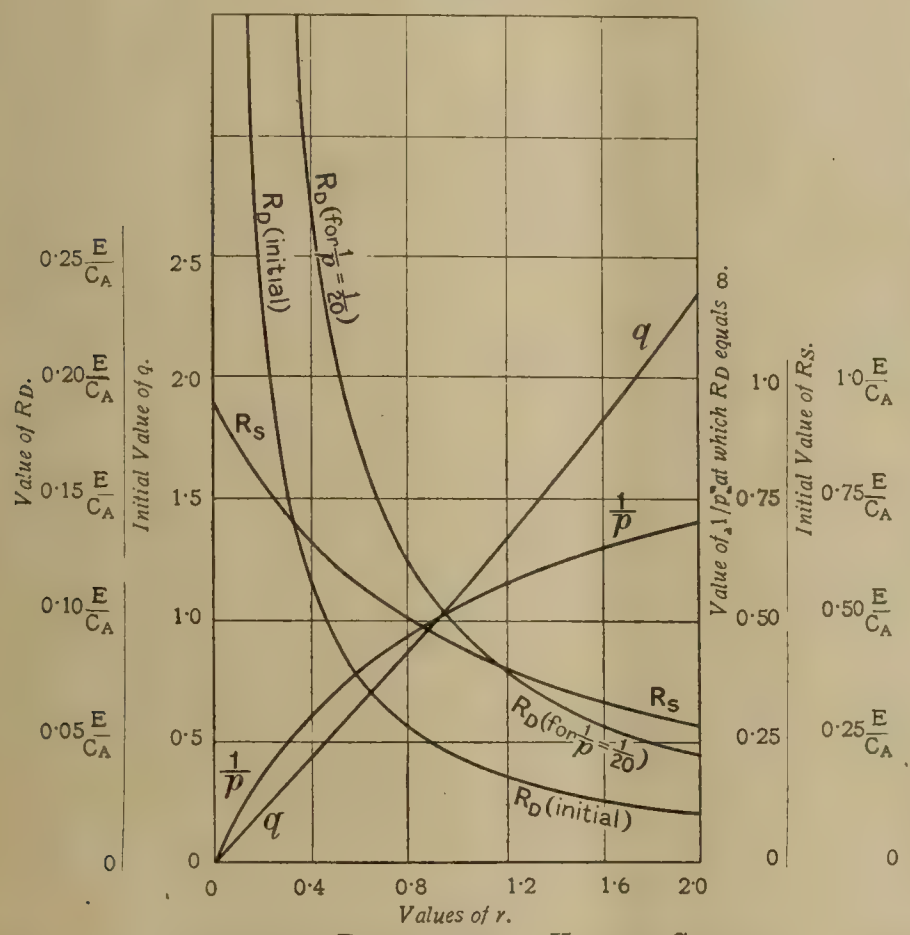


Fig. 4.—Curves showing Dependence of Various Constants upon r ($l=0{\cdot}05$)

make the motor creep round at a very slow (theoretically infinitely slow) speed. The value of R_D to produce this effect is shown in the curve marked R_D (initial), and the other curve of diverter resistance, marked R_D (for $1/p=1/20$) shows the relative increase necessary in R_D to raise the speed from zero to one-twentieth of the maximum. The scales to which the various curves are drawn are clearly indicated, and for the assumed condition that $l=0{\cdot}05$, the chart gives an excellent summary of the conditions obtaining under various degrees of stiffness in starting.

VIII.

The final point to be investigated here is the effect on the speed of the motor of a change in C_A, R_s and R_D remaining meantime unchanged. Let C_A represent normal load, and C'_A any other load. For any value of $1/p$, the value of e (which is here assumed to be the back E.M.F. corresponding to the condition requiring C_A amperes in the armature) is $E(1-l)/p$. Let e' be the back E.M.F. corresponding to any C'_A. The minimum value of C'_A is, numerically, zero, although this extreme value is not, of course, reached in practice. It is, however, possible to reach practical conclusions from the assumption of the condition $C'_A=0$, and this will now be done.

If $C'_A=0$, e' must be exactly equal to the volts lost in R_s through which, in this case, the whole of the line current will pass. Thus e', when $C'_A=0$, is equal to $R_s \times E/(R_s+R_D)$. It should be clearly borne in mind that the values of $1/p$ are always those which give the speed corresponding to C_A. It is then obvious that the speed at any other current C'_A, less than C_A, is greater than N/p in the proportion of e' to e. The value of e' for $C'_A=0$ is the greatest it can have for a given value of $1/p$ as above defined, and hence e' for $C'_A=0$ may be called $e'_{max.}$

$$\frac{e'_{max.}}{e} = \frac{ER_D}{R_s+R_D}\cdot\frac{p}{E(1-l)} = \frac{pR_s}{(R_s+R_D)(1-l)} = \frac{p}{1-l}\cdot\frac{1}{\frac{R_s}{R_D}+1}$$

From previously ascertained values of R_s and R_D this becomes, when simplified,

$$\frac{e'_{max.}}{e} = \frac{p}{1-l}\cdot\frac{(1+r)\{1-l(p-1)\}}{\{pr+(1+r)lp\}},$$

which, since $E=\dfrac{ep}{1-l}$, may be modified into

$$e'_{max.} = E\cdot\frac{1+l(p-1)}{p\left(\dfrac{r}{1-r}+l\right)}.$$

In Fig. 5 the relation is shown between $1/p$, $e'_{max.}$, e, and $e'_{max.}/e$. The practical meaning of $e'_{max.}/e$ is that it forms a measure of the amount by which the speed will change when the load changes from full to light load for any value of $1/p$. The fact that C'_A for light load has been assumed to be zero instead of,

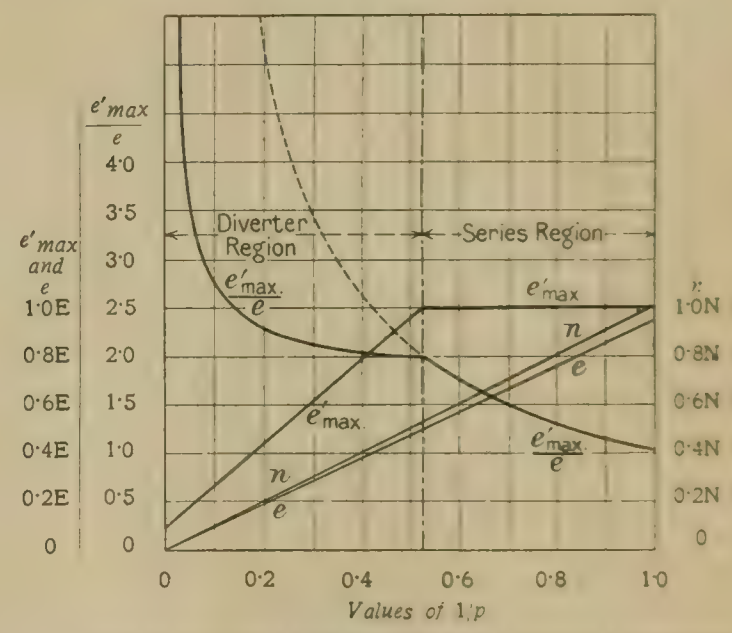


Fig. 5.—Curves showing Dependence of Various Constants upon C_A ($r=1{\cdot}0$: $l=0{\cdot}05$).

as would actually be the case, something slightly greater than zero, simply means that the value of $e'_{max.}$ above deduced is slightly too high, and that, therefore, the speed will actually not change quite as much as is indicated by the ratio $e'_{max.}/e$. This ratio represents, therefore, an outside limit for the change in question. The line marked n in Fig. 5 is the curve of full load speeds, corresponding to C_A and to $1/p$ as above defined.

The above expression for $e'_{max.}$ holds good for the diverter region, up to the value

$$1/p = r/\{(1+r)(1-l)\}.$$

At this point R_D is infinite, and since, as has already been stated, $e'_{max.} = \dfrac{E}{R_s+R_D}\cdot R_D = E\cdot\dfrac{1}{\dfrac{R_s}{R_D}+1}$ it is clear that e' has now become equal to E. This continues also throughout the series region, since when $C'_A=0$ there is no lost voltage at all. Hence, remembering that $e=E\,.\,(1-l)/p$, it is clear that, for the series region,

$$e'_{max.}/e = p/(1-l),$$

and, further, that, when $1/p=1{\cdot}0$,

$$e'_{max.}/e = 1/(1-l),$$

which denotes the obvious fact that, for this particular condition, the motor runs at its natural light-load speed. The curves in Fig. 5, therefore, show the various relations right across the whole range of diverter and series regions, and one very interesting fact emerges. The dotted curve shows the continuation backwards of the $e'_{max.}/e$ curve for the series region and indicates what would have happened in regard to speed variation had no diverter been used. Clearly, then, the diverter ensures steadier running than would be obtained without it on a varying load, and at low speeds the advantage thus gained is very marked indeed.

It only remains to show how the change from the e line to the $e'_{max.}$ line proceeds, as C'_A changes gradually from C_A to zero. Let C'_A have some intermediate value, say, $C'_A = tC_A$, where t may vary from 1·0 to zero. First consider the diverter region. When C_A changes to tC_A, the speed changes until $e' + tC_AR_M = (tC_A + C'_D)R_S = E$. *i.e.*, until $e' + tC_AR_M = E - tC_AR_S \cdot R_D/(R_S+R_D)$, C'_D being eliminated by using the expression $C'_D = (e' + tC_AR_M)/R_D$, and simplifying.

Thus
$$e' = \frac{E - tC_AR_S}{R_S + R_D} \cdot R_D - tC_AR_M, \text{ and similarly}$$
$$e = \frac{E - C_AR_S}{R_S + R_D} \cdot R_D - C_AR_M.$$

Hence
$$\frac{e'}{e} = \frac{(E - tC_AR_S)R_D - tC_AR_M(R_S+R_D)}{(E - C_AR_S)R_D - C_AR_M(R_S+R_D)}.$$

With the help of the relation $R_M = \frac{E}{C_A} l$, this becomes finally

$$\frac{e'}{e} = \frac{1 - t\left(l + R_S + \frac{R_S l}{R_D}\right)}{1 - \left(l + R_S + \frac{R_S l}{R_D}\right)}.$$

This is of the general form $\frac{e'}{e} = \frac{(1-At)}{(1-A)} = \frac{1}{(1-A)} - \frac{At}{1-A}$

where A is some constant. This means that e changes to e' by way of a straight line as t changes from 1·0 to zero, and hence the speed changes in the same way. So much for the diverter region. In the series region the same thing can be shown. For, when C_A becomes tC_A, $E - tC_AR_S = e' + tC_AR_M$, or

$$e' = E - tC_AR_S - tC_AR_M = E\left(1 - tl - t\frac{C_AR_S}{E}\right).$$

Similarly
$$e = E\left(1 - l - \frac{C_AR_S}{E}\right).$$

Hence it follows that

$$\frac{e'}{e} = \frac{1 - t\left(l + \frac{C_AR_S}{E}\right)}{1 - \left(l + \frac{C_AR_S}{E}\right)}.$$

This is of the general form $\frac{e'}{e} = \frac{1-Bt}{1-B} = \frac{1}{1-B} - \frac{Bt}{1-B}$

where B is some constant. This again indicates that here also the change from e to e', and hence the change in the speed is by way of a straight line, as t changes from 1·0 to zero.

Thus the change just investigated is similar in character for the whole range of values of $1-p$ from 1·0 to zero, and is a rectilinear change.

IX.

The above investigation is, as a whole, doubtless more elaborate than would be required for any single given case. But the present writer has found it exceedingly useful as a means of obtaining a comprehensive view of the interdependence of the various parts of the circuit on each other under all sorts of possible conditions. It seems clear that only by means of some such general consideration can the study of particular instances be intelligently carried out with a view to designing the proportions of the various parts so as to suit best the specified conditions of each case.

It is with the hope that the general line of treatment here developed may be useful in the way just indicated that the results arising out of it are now published.

HARMONICS IN TRANSFORMER MAGNETISING CURRENTS.*

BY J. F. PETERS.

Summary.—The purpose of this Paper is to show in a concise manner the cause and effects of higher harmonic currents in magnetising currents of transformers. A hypothetical case is analysed to show the cause of the harmonics; then the schemes of connecting transformers that are commonly used for polyphase transformation are taken up and the effects of the harmonics on each case pointed out. The author also shows the reason why third harmonic voltages are not developed in the three-phase "core type" transformer when connected star-star.

It is well known that the higher harmonics in the magnetising currents of transformers under certain conditions of operation produce badly distorted voltage waves. In general, the methods used to show the causes of these higher harmonics and the distortions which they produce have been rendered obscure by rather complex mathematics. The object of this Paper is to present the problem in a more simple form without any complex mathematics so that the general principles involved may be understood with a minimum of effort on the part of the reader.

The permeability of sheet steel used in the construction of electrical apparatus changes as the magnetic flux density increases, so that the rate of variation of the latter is less than that of the magnetising current producing it. The induced voltage in the secondary and also the counter E.M.F. in the primary of a transformer are proportional to the rate of change of the magnetic flux enclosing these windings. The rate of change of a sine function

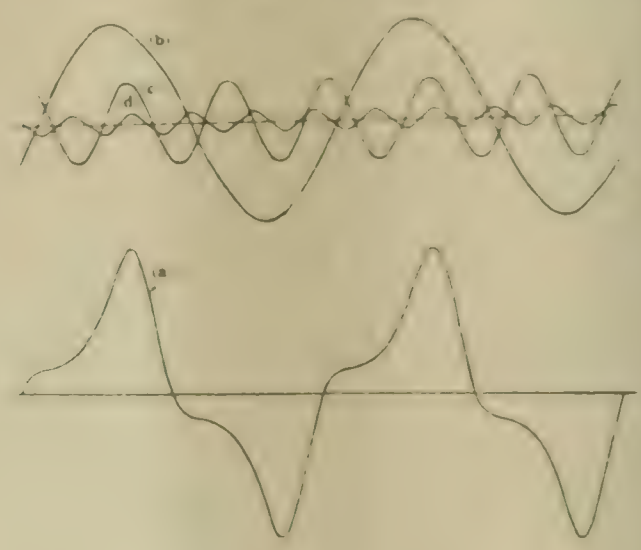


Fig. 1.

90 deg. later in time phase. Therefore, to produce a voltage having a sine wave, the rate of change in the magnetic flux also must be a sine wave.

On account of the change in permeability of the iron at different flux densities, the magnetising current producing a sine wave of magnetic flux cannot itself be a sine wave. It has been found by analysis that the magnetising current of a transformer producing a **sine wave of voltage has a considerable third harmonic component.** It also contains the higher odd harmonics (5th, 7th, 9th, &c.), but to a much less degree.

That the magnetising current must contain a comparatively large third harmonic component is shown by the following: A comparatively small current is required for the first part of the magnetic flux cycle, the density being low, while as the maximum flux density is approached a much larger current in proportion is required. Therefore, the current wave necessary to produce a sine wave of flux will be peaked. There will be only one peak per half cycle corresponding to the maximum flux density, and this peak must be made up largely of a harmonic that has but one maximum value, in the proper direction, per half cycle of the fundamental. The third harmonic has one and one-half cycles per half cycle of the fundamental, and it is so located that its one maximum occurs a little later than the fundamental maximum. The other two maxima of the third suppress the fundamental in the first and last part of the half cycle. If some harmonic higher than the third had a considerable magnitude, the result would be that two maxima per half cycle would be produced in the magnetising current. This could not produce a sine wave of voltage.

* Paper presented at the Panama-Pacific Convention of the American I.E.E., slightly abbreviated.

In Fig. 1, *a* represents the magnetising current of a transformer. It is the resultant of a component at fundamental frequency *b*, a third harmonic component *c*, and a fifth harmonic component *d*. The magnitude of *c* is 40 per cent. of the fundamental, and *d* is 10 per cent. of the fundamental. The harmonics higher than the fifth were neglected for simplicity.

The magnetising current of a transformer does not contain any even harmonics. This is obvious from the fact that the plus and minus half waves of a complete cycle of magnetising current are the same. That is, it takes the same value of current to magnetise the core in one direction as it does in the other. Therefore, all the harmonics as well as the fundamental must at the beginning of the second half cycle be of the same value, but in the direction opposite to that at the beginning of the first half. Only odd harmonics will satisfy this condition.

While the fundamental passes through $\frac{1}{2}$ cycle, the third harmonic passes through $1\frac{1}{2}$ cycles, and the fifth harmonic through $2\frac{1}{2}$ cycles, &c. All odd harmonics end with an odd number of $\frac{1}{2}$ cycles, and are therefore in the same relative position, but in the direction opposite to that at the beginning of the first half cycle. If the magnetising current does not contain all of the harmonics necessary to produce a sine wave of voltage, then the voltage will contain those harmonics which the magnetising current lacks, and possibly more. For example, when the magnetising current does not contain the necessary third-harmonic component, the induced voltage contains a third-harmonic component.

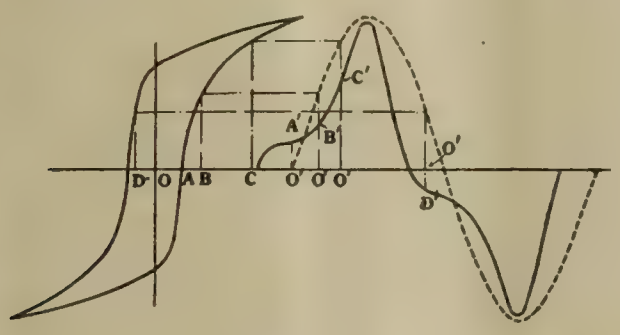


FIG. 2.

A convenient means of showing the effect of changes in the shape of a magnetising current wave is to plot the hysteresis loop, and from this and the modified wave of magnetising current construct the magnetic flux wave. The hysteresis loop corresponding to the magnetising current wave shown in Fig. 1 (*a*), is plotted in Fig. 2. The abscissas OA, OB, OC, &c., in the hysteresis loop equal the corresponding ordinates O′A′, O′B′, O′C , in the magnetising current wave. The wave shown in dotted line is the resultant magnetic flux wave. The method of construction is obvious from a brief scrutiny of this figure.

By following the same methods in Fig.3, it is shown that when the magnetising current is a sine wave, the magnetic flux is not a sine wave but is of the shape indicated by the dotted line. The magnetic

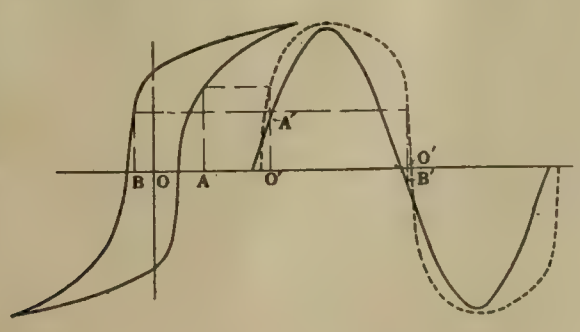


FIG. 3.

flux wave for this figure was constructed from a sine wave magnetising current and the hysteresis loop.

The analysis of this flux wave gives a fundamental component of 17·62 sin (θ—0·8 deg.), a third harmonic component of 3·9 sin (3θ—5 deg.), and a fifth harmonic component of 2·2 sin (5θ—24·3 deg.) where θ is the time angle in degrees and 0·8 deg., 5 deg. and 24·3 deg., are the angles at which the fundamental, third and fifth respectively lag behind the composite wave. This composite wave also contains odd harmonics higher than the fifth, but they are not taken into consideration here as previously stated.

The voltage produced by the magnetic flux shown in Fig. 3 is proportional to the rate of change, that is, the differential of the composite magnetic flux wave. The differential of this wave gives for the fundamental 17·62 cos (θ—0·8 deg.), for the third harmonic component 11·7 cos (3θ—5 deg.), and for the fifth harmonic 11 cos (5θ—24·3 deg.). It will be noted that the third-harmonic component of voltage for the above case with a sine wave of exciting current is 65 per cent. as great as the fundamental, and that the fifth-harmonic component of voltage is 62·5 per cent. as great as the fundamental.

In practically all schemes of connecting transformers for transmission purposes, the proper composite exciting current is supplied, in which case large higher harmonic voltages are not developed in the windings. In a comparatively few cases, however, it is not possible to draw the proper magnetising current and consequently in these cases the higher harmonic voltages do exist. An effort will be made in the following to show how the magnetising currents are supplied for the different schemes of connections and types of transformers, and where harmonic voltages will appear.

The most frequent scheme of connecting transformers is three single-phase units connected into a three-phase bank in delta on the low-voltage side, and in star on the high-voltage side. Assume that a bank so connected is used to step-down the voltage, and that the magnetising currents for each of the three units are as indicated by

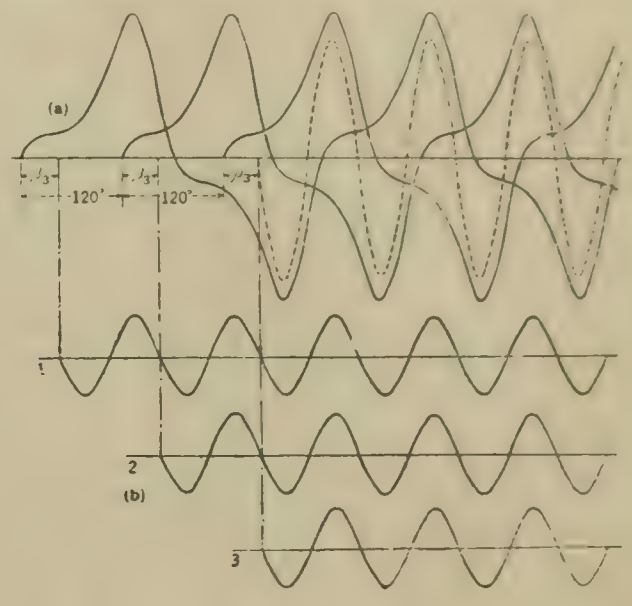


FIG. 4.

Fig. 1 (*a*). The magnetising currents then for each phase contain, in addition to the fundamental, a third and a fifth-harmonic component. Since the transformers are connected in three-phase relationship their voltages are 120 deg. apart and, therefore, their magnetising currents are 120 deg. apart. The magnetising currents for the three units are shown in their proper phase position in Fig. 4 (*a*). The three leads feeding the bank carry the current both to and from the transformers and, therefore, the resultant of the current in the leads must at all times be zero. But the resultant of the magnetising currents for all three units in this case is shown by the author to be 1·2 sin (3θ—β_3), where β_3 is the angle at which the third harmonic component lags behind the composite wave. This resultant is not zero; therefore it will be seen that not all of the magnetising current for this connection can be supplied through the three leads. The resultant current is shown dotted in Fig. 4 (*a*) which is obtained by combining the three waves.

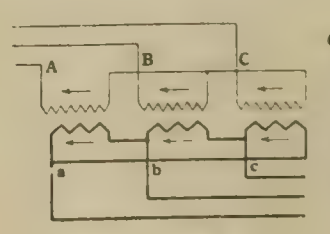


FIG. 5.

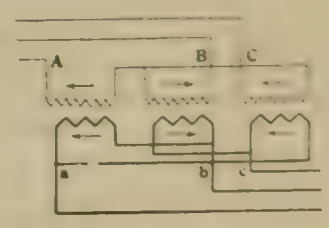


FIG. 5A.

It will be noted that this resultant current is at triple the fundamental frequency, and that its magnitude is three times as great as the third harmonic component of magnetising current for each phase. If the other higher harmonics of the magnetising current had been taken into account (7th, 9th, 11th, &c.) in the above analysis it would be found that they all would be drawn from the line except the third and odd multiples of the third (9th, 15th, &c.). Therefore, the necessary third-harmonic component and its multiples to produce a sine wave of voltage must be supplied in some other manner for this scheme of connections, since they cannot be drawn from the line.

In Fig. 4 (*b*) at 1, 2 and 3 are plotted the third harmonic components of the magnetising currents for the three phases in their proper phase position with respect to the composite waves shown in the same figure at (*a*). It will be seen that these third-harmonic currents are all in the same direction at corresponding points. In Fig. 5, which is the star-delta scheme of connection, the arrows

indicate the instantaneous directions in which the third harmonic currents should flow in the primary or star side. Since the third harmonic currents of all three phases are in phase with each other they have no return path in a star-connected circuit, therefore they cannot flow. Consequently third-harmonic voltages will be generated due to the absence of the third-harmonic currents. These voltages are all in the same direction since their components of the magnetising currents are all in the same direction.

The generated or induced third-harmonic voltages appear in both the primary and secondary windings, but the delta-connected secondary forms a closed local circuit for its third-harmonic voltage. Consequently, a third-harmonic current will circulate around this circuit and produce a third-harmonic magnetic flux which will cut both the primary and secondary windings. This flux will generate in both windings a counter third-harmonic voltage approximately equal and opposite to the one caused by the absence of the third-harmonic current in the primary. This results in cancelling all of the third-harmonic voltages, except that due to the reactance of the transformer which is generally so small that it is of no consequence.

It is evident from the foregoing that the third-harmonic component of the magnetising current for a bank of transformers connected star-delta is supplied by a circulating current in the closed delta. If the units forming the bank require different values of third-harmonic currents, then, since the circulating current is the same in all three phases, one or two phases will be over supplied with this component of current while the other phases will be under supplied. This will result in inducing a third-harmonic voltage of small value in all three phases

It would be found by a similar analysis that the 9th and 15th harmonic currents and all odd multiples of the third are supplied by a circulating current in the secondary, while all other odd harmonic currents are drawn from the line. The magnitude of this circulating current is such that when it is multiplied by the secondary turns the product is equal to that of the required harmonic current in the primary multiplied by the primary turns. That is, the magneto-

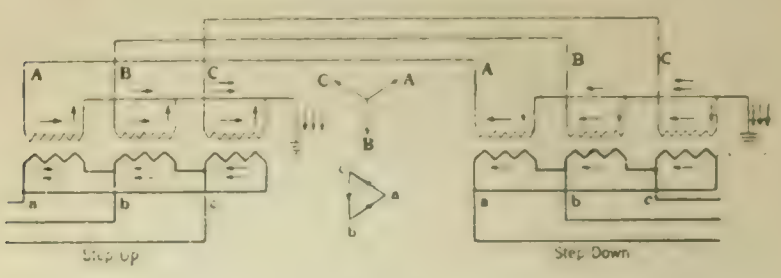


Fig. 6.

motive force is the same whether supplied by the primary or by the secondary, therefore the star-delta connection relieves the primary of a part of the magnetising current and adds it to the secondary.

If this bank be fed by another bank of transformers connected in star on the secondary side with its neutral grounded, then grounding the neutral of the step-down transformer bank, as shown in Fig. 6, produces closed circuits in the star-connected side through which the third harmonic component of the magnetising current can flow. These circuits for each phase consist of one line, the windings in each bank connected to this line, and the earth. The third-harmonic current carried by the ground connection is the sum of the third harmonic currents in the three star-connected phases. With this connection a part of the third harmonic component of the magnetising current will circulate around the closed circuit in the delta connected secondary and a part will be drawn from the line using the earth as a return. The division of current between these two circuits depends upon their relative impedances. The difference in the magnitude of the third harmonic currents required for the different phases of the bank, so connected, will be supplied through the grounded neutral. If the neutral of the secondary of the step-up transformer bank is not grounded then grounding the neutral of the step-down bank will have no effect on the distribution of the third harmonic component of the magnetising current.

(To be concluded.)

Progress of the Electric Dreadnought. It is announced that the keel of the electrically-propelled dreadnought, "California," of the United States Navy, will be laid on October 14th. This is the first ship of this class to be fitted with electric propulsion, and will take two or three years to complete. It is stated that the cost will be over £3,000,000.

DIVISIONAL REPORTS ON MINES AND QUARRIES.

All of the Divisional Inspectors' Reports on Mines and Quarries for the year 1914 have now been issued. As will be observed in the statistics of output quoted below, there is in all the reports a drop in output of coal from the preceding year, this being, of course, due to the war. The effect on the number of persons employed is best shown in the general report on divisional statistics, of which the main points were given in our issue of September 10th, among them being the accidents due to electricity, and the output of minerals other than coal. Below we reproduce the divisional outputs of coal only, as electric cutting is practically entirely confined to coal. The amounts cut by electric and compressed-air cutters are given, as well as the extent of the electrification of mining machinery generally.

Lancashire, North Wales and Ireland Division.—In this district 26,200,447 tons of coal were raised, which, however, is less by 1,942,422 tons than the quantity for 1913. Of this amount, 2,089,572 tons were machine cut. The number of electric coal-cutting machines has fallen from 36 in 1913 to 34 in 1914, though there has been an increase in compressed-air cutters from 354 to 365. During the year 355,650 tons of coal were cut by means of electricity and 1,733,922 by compressed air. In the preceding year the figures were 393,940 and 1,773,351 respectively. With regard to visual signals for winding plant, the Inspector states that their installation progresses very slowly, and the majority in use are far from satisfactory. The electrical types are, however, generally better than the mechanical, though sometimes more expensive. In the 137 mines under the Coal Mines Act there is electrical machinery aggregating 13,117¾ H.P. on the surface and 22,502¼ H.P. underground, a total of 35,620 H.P. The underground power consists chiefly of that used for pumping and haulage. In the surface machinery, winding, haulage, ventilation and coal washing and screening are large items.

Midland and Southern Division.—The output of coal in this district was 27,430,992 tons, or 853,395 (3·02 per cent.) less than in 1913 There were in 1914 84 coal-cutting machines operated by electricity and 139 by compressed air. Figures for the preceding year are not given. Electricity was the means of cutting 770,654 tons of coal and 161,192 tons of ironstone. The amounts for compressed-air cutters are less than these namely, 678,298 tons of coal and 36,883 of ironstone. The amount of electric power used in the coal mines is 12,164½ H.P. on the surface and 41,105⅝ underground, a total of 53,270$\frac{1}{16}$ H.P This power is applied to its different uses in much the same proportions as in the above division, except that the bulk of that used on the surface of metalliferous mines is put down as "miscellaneous," and hardly any electric power is used in these mines for ventilation or haulage above or below ground.

Yorkshire and North Midland Division.—The figures given for this division show that it has developed into the most important of the kingdom, the total output of coal being 66,807,623 tons, though in 1913 it was 72,951,841. Electric coal cutters here are almost as extensively used as compressed-air cutters, there being 350 electrical machines and 375 worked by compressed air. The numbers in 1913 were 331 and 342 respectively. The coal cut by electricity was 3,556,410 tons and that by compressed air 3,576,729, in each case a slight decrease on the amount of the previous year. In the coal mines of this district the electric power totalled 123,648$\frac{3}{16}$ H.P., consisting of 65,857$\frac{1}{2}\frac{3}{8}$ H.P. on the surface and 57,790½ H.P. used underground. About a third of the power used on the surface is used for coal washing or screening, and about half the power underground for haulage Pumping is also a large item, absorbing 16,366¼ H.P.

Scotland Division.—The output of this division was 38,847,362 tons in 1914 and 42,456,516 in 1913. Here as many as 747 electric coal cutters are employed, while the number of compressed-air machines is only 166 The tons of coal cut by electricity were 7,808,984 and of ironstone 56,496, while 1,313,593 tons of coal and 16,572 tons of ironstone were cut by compressed air. The electrical machinery in coal mines totals 119,639¼ H.P., 26,278½ H.P. of this being used on the surface and 93,361¾ H.P. underground. Of the various uses of this electric power, pumping consumes the most energy (43,393 H.P.).

South Wales Division.—The coal raised in this division amounted to 63,879,728 tons, whereas the output in 1913 was 56,830,072 tons. The machine-cut coal shows a decrease of 4,898 tons, though 16 more cutters were at work than in 1913 Altogether there were 44 electric cutters and 87 worked by compressed air, the former cutting 242,742 tons of coal and the latter 392,079 tons. The electrical surface machinery totals 93,832½ H.P., chiefly for winding, ventilation and haulage, and that underground amounts to 100,443½ H.P., mostly for pumping and haulage.

Northern Division.—Here the output of coal has decreased from 58,675,687 tons in 1913 to 52,384,478 tons in 1914. Of this amount 1,256,433 tons were machine cut by electricity, and 2,317,879 tons by compressed air. The number of coal cutters has increased, the electrical from 134 to 156 and the compressed air from 531 to 546. The use of electricity has grown during the year by over 11,000 H.P., and there is now 78,936¼ H.P. installed above ground, and 90,875½ H.P. below. Ventilation absorbs 18,644½ H.P. of the surface power, while winding, hauling and coal washing and screening also consume large amounts of energy. Underground practically all the electricity is employed in haulage or pumping, which account for 40,681 H.P. and 42,657¼ H.P. respectively.

CORRESPONDENCE.

THE DIRECTION FINDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Prof. Artom's letter published under the above title in the issue of THE ELECTRICIAN dated September 17th. As usual, Prof. Artom tends to create confusion to his advantage. He cites two Italian patents, namely, Patent No. 88,765 and Patent No. 88,766. The object of the first patent is a certain kind of single directive aerial, and the object of the second is the radiogoniometer. I can admit that Prof. Artom's affirmations, if they refer to the patent in regard to directive aerials, are possibly right. I say "possibly," as I do not know the judgments to which Prof. Artom alludes. But, as to the second, his statements are incorrect. I have an official copy of the Notary Act dated April 5, 1912, cited by Prof. Artom, and as it is a private document which readers cannot get I am disposed to send it in turn to the readers who care to ask me for it, in order that they can ascertain *de visu* that not a word of Prof. Artom's affirmations regarding the radiogoniometer is to be found therein.

My ideas upon the invention of the aerials described in the first patent have changed since I read Prof. Blondel's communication to the Congress at Angers of the Association française pour l'avancement des Sciences, held in 1903. I invite Prof. Artom to read this, and he will be convinced that his claims to the invention of these aerials have no foundation.

I will not repel for the hundredth time Prof. Artom's claims to the invention of the radiogoniometer. I will only call to mind three circumstances: (1) The British and North American patents, for which the patentees must swear that they are the sole and true inventors, bear the names of Bellini and Tosi; (2) that an Italian patent can be obtained in the name of anybody, be he the inventor or not; (3) that the reasons for which the Italian patent was taken in the name of Prof. Artom were of a special character.

The Notarial Act alluded to is the Act by which Prof. Artom accepted the retrocession of his old patents and returned the money he had received for them. My signature was required as warrantor.

Difficulties having subsequently arisen as to the interpretation of this Act, Messrs. Agnelli and Scarfiotti, the purchasers, sued Prof. Artom before the Courts. These having decided in favour of Messrs. Agnelli and Scarfiotti, Prof. Artom appealed himself before the Court of Appeal and asked me to be present because I had signed the Notarial Act. But my presence was utterly useless, as is proved by the fact that I have learned only from the letter of Prof. Artom that a decision had been given and that one of the parties had subsequently sued in the Court of Cassation. And this is natural, as these cases did not concern me, but were only a matter of money between Agnelli, Scarfiotti and Artom. In any case, I have written to have a copy of these judgments, and as soon as I receive them, I will write you further on the subject. But what is clear at present is that, as the object of these cases was not the radiogoniometer, no judgment on it could have been given.—I am, &c.,

Enghien-les-Bains, Sept. 22. E. BELLINI.

ON THE INFLUENCE OF HEAT TREATMENT ON THE SPECIFIC RESISTANCE AND CHEMICAL CONSTITUTION OF CARBON STEELS.*

BY EDWARD D. CAMPBELL.

Summary.—The purpose of the present Paper is to add a little to the knowledge we have of the specific resistance of steels of varying carbon content, when these steels have been subjected to different heat treatments, and to attempt to point out the relation existing between specific resistance and chemical constitution, with a view to throwing a little more light on the underlying causes of hardness in steel.

The solution theory so clearly pointed out more than 50 years ago by A. Mathiessen is now almost universally accepted, so that the problem of the constitution of steel has to a large extent been reduced to a study of the solubilities of elements or compounds in iron as a solvent, and the relation between the chemical constitution and physical properties of such solutions.

In 1902 C. Benedicks,† in discussing the work of Barrett, Brown and Hadfield, laid down the following law: "Equi-atomic solutions of iron possess equal resistances," and at the same time established the formula:—

$$\rho = 7{\cdot}6 + 26{\cdot}8\Sigma C \text{ microhms cm.}^3,$$

where ρ is the electrical resistance of the steel, 7·6 the electrical resistance of pure iron, and ΣC is the sum of the values, in terms of carbon, of the elements dissolved in the iron. The carbon "value" is obtained by dividing the percentage found on chemical analysis by the atomic weight of the element and multiplying the result by 12, the atomic weight of the carbon.

A conception such as that laid down by Benedicks would require that all elements in solid solution in iron exist in a monatomic condition, or at least that all compounds in solid solution possess equal numbers of atoms to the molecule.

In an exhaustive treatise entitled the "General Considerations Regarding the Electrical Resistance of Steels,"‡ A. M. Portevin pointed out that Benedicks' formula is a limitational one, approachable only in dilute solutions, but is inapplicable if the carbon equivalent of all elements, other than iron, exceeds 2 or 3 per cent.

In general, with a given heat treatment, changes in the microstructure of steels, due to the addition of one or more elements other than iron and carbon may be taken to indicate changes in the chemical constitution either of the solutes or of the solvent, which changes would lead to differences in solubilities, hence to changes in specific resistance.

In an article by the present author on the "Constitution of the Carbon Steels,"§ not only was the general parallelism between solid solutions in iron and ordinary solutions in water recognised, but a further assumption of the essential identity of mechanism of solutions, even to recognition of ionic dissociation of solutes in solid solution, was made.

In a recent article on the theory of hardening,‖ A. McCance has shown that if the carbon concentration in solid solution is sufficient to give an increase in the specific resistance of not less than about 13 microhms in excess of the specific resistance of the same metal annealed, the hardened metal will attain the maximum hardness, if by hardness is in reality meant viscosity, as measured by a Brinell testing-machine. McCance assumes that this hardness is due to a certain portion of the iron existing in what has at various times been termed as a state of internal tension, internal strain, or, by McCance, interstrain; this state of interstrain resulting from the trapping of a certain portion of the γ-iron during the time the metal is passing through the critical range. If the carbon concentration is too low to give an increase in specific resistance of much less than 13 microhms, then no matter how rapidly the metal may be quenched the maximum hardness cannot be attained, since not enough of the iron will be trapped during the transformation. On the other hand, if the carbon concentration is high enough to give an increase of specific resistance of more than 13 microhms, the velocity of cooling through the critical range may be reduced without reduction of the proportion of iron trapped during the transformation, hence without reducing the hardness. Thus, while the hardness or high viscosity is apparently due to a certain portion of the metal existing in a state of strain, since the extent of this interstrain itself is dependent upon the concentration of the carbides in solid solution at the instant of quenching, and the velocity of cooling it would seem that the control,

* Abstract of a Paper read before the Iron and Steel Institute.

† "Zeitschrift für Physikalische Chemie," 1902, Vol. XL., p. 545.

‡ Iron and Steel Institute, "Carnegie Scholarship Memoirs," 1909, Vol. I., pp. 283-364.

§ "Journal of the Iron and Steel Institute," 1908, No. III., p. 318.

‖ Ibid., 1914, No. I., p. 192.

at least of the hardness, can be best effected by control of the chemical constitution of the metal at the instant of quenching.

Experimental Work.

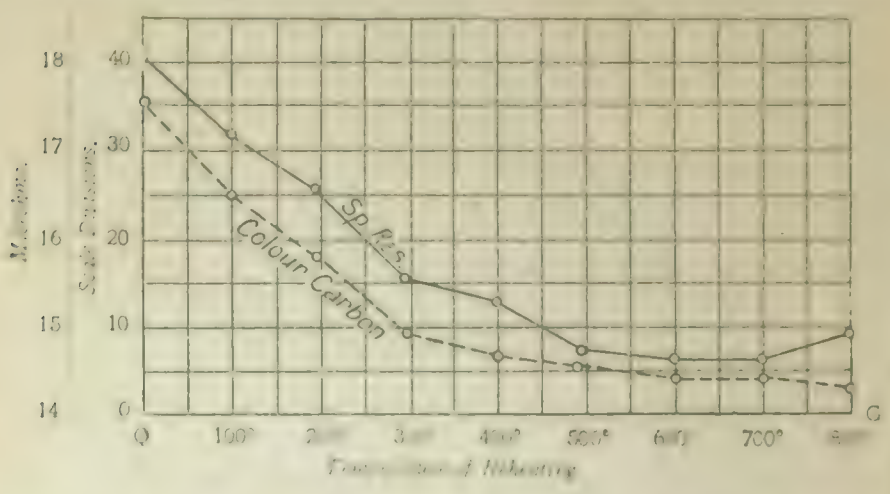
The steels used in the experimental work, which was carried on by Robert Atkinson, M.Sc., have the compositions shown in Table I.

Table I.

Steel.	Carbon.	Manganese.	Phosphorus.	Sulphur.	Silicon.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
C 04	0·04	0·10	0·007	0·029	...
M 16	0·30	0·204	0·012	0·013	0·033
H 35	0·35	0·08	0·009	0·024	0·18
H 41	0·41	0·08	0·012	0·016	0·19
H 57	0·57	0·11	0·010	0·020	0·17
C 5	0·88	0·27	0·018	0·020	...
MPO	1·04	0·214	0·019	0·023	0·191
HGM	2·71	0·08	0·012	0·014	0·09

Bars of the different steels, about 15 cm. long, and a little more than 6 mm. square, were suspended in an electrically heated furnace which had been previously brought to the temperature from which it was desired to quench. When the bars had come to constant temperature, they were withdrawn from the furnace and quickly cooled in a large volume of iced water.

One set of bars was quenched from 892°C., and another from 1,103°C. After quenching the bars were polished, the cross-section accurately measured and the specific resistance determined. The specific resistances were determined by measuring the fall in potential between knife-edges, clamped to the bar 10 cm. apart. The bars during the measurements were immersed in a bath of refined paraffin oil, so that the temperature of the bars could be taken and



the results reduced to a standard temperature of 20°C. Measurements could be easily duplicated to within less than 0·05 microhm, and it is thought that the values given do not differ more than 0·2 of a microhm from their absolute value.

After measuring the specific resistance and taking sufficient drillings from one of the H 35 bars for making colorimetric determinations, the quenched bars from 892°C. were placed in a steam drying oven at 100°C.-105°C. for two days, after which they were removed, the specific resistance measured, and drillings again made for colorimetric work. In the subsequent heat treatments the bars, quenched from 892°C. were packed in a steel tube to avoid oxidation together with a tube for the insertion of a thermocouple, and the whole placed in an electric furnace, which was then gradually raised to various temperatures, Table II. When the desired temperature, as indicated by the thermocouple, was reached, it was held as nearly as possible for from one to two hours, after which the furnace was allowed to cool overnight. After each heat treatment the specific resistance was again measured and drillings taken for colorimetric comparison. An examination of the results reveals two points in addition to the lowering of the specific resistance of hardened steel by tempering. First, a comparison of the specific resistances of the samples quenched from 1,103°C. with those of the same steels quenched from 892°C. clearly shows, as was shown by Maurer, that the specific resistance increases with the temperature of quenching. This would be expected if the molecular weight of the dissolved carbides was lowered by progressive dissociation, as was suggested by the author some 16 years ago.* The second point to which attention might be directed is the increase in specific resistance of hypo-eutectoid steel when reheated to 800°C. and slowly cooled, when compared with the results on the same samples reheated to 600°C. or 700°C.

In order to bring out the relation existing between the specific resistance and the chemical constitution of steel which has been subjected to different heat treatments, a bar of steel, H 35, was selected. This bar was of the same dimensions as the ones used in the determinations of specific resistance, and was subjected to the same heat treatment. After each heat treatment enough drillings were taken from the bar to enable colour carbon tests to be made.

The results are shown graphically in the accompanying figure, in which the abscissæ represent the temperatures of reheating, while the ordinates show the specific resistance in microhms and the colour of the dinitro derivatives due to carbides soluble in cold nitric acid, in scale divisions. A glance at these curves reveals clearly the close relationship existing between the concentration of the carbides in solid solution and the specific resistance.

However, it will be noted that in the sample reheated to 800°C. there is an increase in specific resistance accompanied by a decrease in the dinitro derivatives. Metal cooled very slowly from 800°C. would have the carbides distinctly segregated into relatively large masses, and although the precipitation would be most nearly complete, the separated cementite would consist of carbides saturated with iron in solid solution, hence the increase in specific resistance.

The question may properly be asked, To what may this relationship probably be due? If a metal such as iron be regarded as a solvent, differing, it is true, in viscosity from ordinary liquids, but in which the atomic relations existing between solutes in true solid solution and the solvent are essentially the same as the relations existing in ordinary solution, we may find the reasonable explanation for the co-relation between the concentration of the carbides in solid solution and the specific resistance of steel.

While in most research work in physical chemistry attention is focussed on the solutes and the influence of concentration, temperature, &c., on these, in most work in metallurgy attention is, perhaps unconsciously, focussed on the properties of the solvent, and the influence of temperature and concentration of solutes on the properties of this latter is what is most carefully studied. It is seldom that ordinary chemistry is regarded as a study of the influence of solutes on the properties of water, and yet this is the habitual viewpoint taken in the study of the influence of impurities on the properties of metals. If steel is regarded from the same view-point as ordinary solutions, we may calculate the molecular concentration of solutes in solid solution in a manner exactly similar to that employed in such calculations in ordinary solutions. If the assumption is made that 1 litre of steel weighs 7,800 grammes, the molecular concentration of solutes in solid solution in iron would be represented by the following formulæ given in the table below, in which the symbol of the element stands for the number of "points" (0·01 per cent.) of that element, and N the number of atoms of the element in each molecule of the solute :—

Table II.—*Showing Formulæ and Molecular Concentration of Steel*, H 35.

Element.	Formula.	Molecular Concentration.
Carbon	C	2·27
	15·4N	N
Phosphorus	P	0·02
	39·8N	N
Sulphur	S	0·06
	41·1N	N
Silicon	Si	0·49
	36·3N	N

Manganese is not included in the above table, since in steel it functions as a metal, entering partly into combination with carbon and sulphur, and partly into the constitution of the solvent, iron, the law of mass action determining its distribution. The same law applies to the distribution of nickel, chromium, and some other elements frequently found in steel.

In the article on "The Constitution of Steel,"* to which reference has already been made, it was shown that N of the above table in the case of carbides is a function of the carbon content and heat treatment of the steel. In the case of a slowly cooled low-carbon steel, N is more than 4, while in high-carbon steel it averages less than this figure. In a metal suddenly cooled from above the critical point, the value of N is distinctly lower than when the same metal is in the annealed condition.

In the dissociation theory as applied to aqueous solutions, when solutes dissolve, a certain proportion of the molecules are assumed to be separated into parts termed ions. When a solute is dissolved in water, it dissociates to a large extent, and the chemical or internal energy is decreased, with the appearance of equivalent positive and negative charges on the respective ions. It is because the solvent in the case of an aqueous solution is a dielectric that the ions are able to acquire and retain their charges, and thus conduct the electric

* "Journal" of the Iron and Steel Institute, 1899, No. II., p. 223.

current by transporting these charges between the electrodes. It is assumed that the ions only are electrically active, since the electrolytic conductance is used as a measure of the ionic concentration. On account of the high electrical resistance of the solvent in the case of aqueous solutions, an almost negligible proportion of the total current carried is carried by the solvent. If ions resulting from the dissociation of the molecules in aqueous solution are capable of acquiring energy in the form of electric charges, but in these solutions retain and transport this electrical energy only because of the di-electric property of the solvent, one might properly ask, What should we expect if solutes were dissolved and dissociated in a solvent which was in itself a conductor possessed of very low specific resistance? In such a case there seems to be no inherent reason why the mechanism of solution and dissociation of the molecules of the solute into constituent parts, bearing precisely the same atomic relation to the solvent, should differ essentially from that which holds when a solute is dissolved in a dielectric solvent. In case the solvent were a metal, it would be obviously impossible for the products of ionic dissociation to retain electric charges; hence it would be clearly out of the question to call these products ions, so that we have suggested the term "ionoids" to indicate the products of ionic dissociation in solutions in which the solvent is a metal. The "ionoids" in the metallic solutions, like the ions in aqueous solutions, constitute that portion of the solute which has undergone dissociation and which is electrolytically active. The result of this electrolytic activity of "ionoids," however, will manifest itself in a manner directly the reverse of that manifested in the behaviour of ions, not because of any fundamental difference in the atomic relations existing between the "ionoids" or ions and the solvent, but because of the reverse of the electrical properties of the solvents. In a metallic solution practically the whole of the conductance is through the solvent and undissociated solutes, while the "ionoids" which are electrolytically active tend, like ions, to acquire energy in the form of electric charges, but on account of the nature of the solvent retention of this energy is impossible, and it is in consequence transformed and dissipated in the form of heat. Thus the electrical energy transformed into heat by the "ionoids" may be expressed in terms of specific resistance, and consequently the ionic concentration in solid solution in metals may be determined by deducting from the total specific resistance that due to the solvent and undissociated solutes. Under the above conceptions the dissociation theory of solution would be just as applicable to solid solutions in metals as to aqueous solutions, although the phenomena, when the two solutions were subject to a difference of potential at two points, would manifest themselves in opposite directions. The differences, however, in electrical behaviour of the two solutions are due, not to any fundamental difference in the atomic relations existing between solutes and solvent, but to the differences in the electrical properties of the solvents.

RUSSIAN ELECTRICAL COMPANIES' RESULTS FOR 1914.

[COMMUNICATED.]

In spite of the war, most Russian enterprises for electrical branches have achieved favourable results. The Russian General Electric Co. (capital 12,000,000 roubles), an offshoot of the German A.E.G., made a net profit of 2,051,651 r., against 1,751,474 r. in 1913. The shareholders received 10 per cent. as dividend (25 r. per share, against 23·50 r. in 1913 and 22·50 r. in 1912). The orders received by the company were fewer in number in 1914 than in 1913, but the year's results were satisfactory, as the company received important orders for the Russian army and navy. In order to deliver Russian Government orders more promptly, the company organised a special department for artillery, and erected a new building for the purpose, and as a number of the required articles could not be produced in their Russian factories they entered into an arrangement with the American General Electric Co. and with the British Thomson Houston Co.

The Russian Siemens and Schuckert Co. (capital 15,000,000 r.) distributed a dividend of 5 per cent. for 1914, the Russian Siemens & Halske Co. (capital 5,600,000 r.) 6 per cent. (against 5 per cent. in 1913). All three companies are now under Russian State supervision, the capital being mostly in German hands.

The Russian electrical machine factory "Volta," (capital 2,000,000 r.), in Reval, declared a dividend of 6 per cent.; the Russian Electrical Co. "Dynamo," of Moscow (capital 4,000,000 r.), 4 per cent.; the Russian telephone factory, N. K. Heissler & Co. (capital 1,000,000 r.), of Petrograd, 12 per cent.; the Russian accumulator factory, "Tudor" (capital 2,400,000 r.), of Petrograd, 6 per cent.; and the Electric Power Company of Baku (which owns the electrical works in Baku), 9 per cent. on the preference shares and 6 per cent. on the stock. The capital of this last-named company is 9,000,000 r. The electro-mechanical company, formerly Dyckoff, Constantinowitch & Co., of Petrograd (capital 1,500,000 r.), which received important orders for the Russian army and navy, declared a dividend of 10 per cent. The capital of this company is mostly in French hands.

The Russian cable factories achieved still better results. The largest Russian cable works, the United, at Petrograd, which belongs to the Russian General Electric and the Russian Siemens and Schuckert companies, divided 15 per cent. on the capital of 6,000,000 r. The net profits of this concern amounted to 3,337,361 r., or over 50 per cent. of the capital. 1,243,467 r. was placed to reserve and 900,000 r. divided. Explanation of these large profits is found in the enormous reserves of copper and other materials in hand at the outbreak of the war, bought at low prices. After the outbreak of war prices rose nearly 50 per cent.

The Russian cable factory, Coltchugin, Moscow, in consequence of their increased output, raised their capital from 6,000,000 r. to 10,000,000 r.

The Russian Company for Wireless Telegraphy & Telephony (capital 3,000,000 r.) distributed a dividend of 15 per cent.; the Russian Company "for Long-Distance Station," Petrograd (capital 4,000,000 r.), 4 per cent.; the Company for Electric Lighting, Petrograd, (capital 50,000,000 r.), 11 per cent. on the preference shares and 8 per cent. on the original shares; the Company for Electric Plant, Petrograd (capital 11,600,000 r.), 10·2 per cent.; only one company, that for Transmission of Electrical Power, Moscow ("Electroperedacha"), announced a loss (216,318 r. on a capital of 6,000,000 r.).

Owing to the lack of Russian electrochemical factories, the company "Bertol" was founded in Rostow, on the Don, with a capital of 1,200,000 r., for the purpose of trading in electrochemical products.

According to information in the Russian newspapers, the British Aluminium Co. purpose erecting a factory in Russia, and seeks information regarding suitable raw material deposits for the manufacture of aluminium. The high protective duties render it probable that an aluminium factory in Russia would be profitable, as Russia imported in 1913 from Germany, according to German statistics, aluminium value 967,000 marks and aluminium goods value 1,754,000 m. The total import of aluminium into Russia in 1912 was valued at 1,600,000 r.

PARLIAMENTARY INTELLIGENCE.

L.C.C. (TRAMWAYS AND IMPROVEMENTS) BILL.

This Bill came before a Select Committee of the House of Lords on the 30th ult.

Mr. VESEY KNOX, K.C. (for the London County Council) said the Bill had been recommitted for further consideration because of the capricious action of the Home Office, whose opposition to the proposals of the Bill had been regarded as a matter of mere criticism on details. When the Bill was previously considered by the Committee the Council did not think it necessary to call evidence to meet the allegations put forward by the police. The tramway proposals were the construction of a tramway (half a mile long) in Hackney, and the reconstruction of a tramway which had been worked by horses in Bermondsey. When the matter came before the Lord Chairman of Committees the Home Office objected to the proposals, root and branch, unless the Council would undertake to carry out street widenings which would enable a double tramway to be laid throughout—widenings which would cost £150,000. The London County Council could not at the present time consent to come under the obligation to spend that very large sum to secure what was considered by local authorities to be absolutely unnecessary. With regard to one of the schemes, it was merely proposed to electrify a line which had existed for 30 years and had been worked by horses, and to construct a small tramway which would give a connection between West India Docks and the north of London. The connecting line was only half a mile in length, and would cost about £20,000. The Home Office proposal was that the scheme should be suspended until arrangements had been made to secure a double track, with a space of 9 ft. 6 in. between the edge of the pavement and the tramline, without reducing the width of the pavement.

Superintendent BASSOM, of the Carriage Department of Scotland Yard, gave evidence in support of the Home Office report on the schemes. He expressed the view of the Chief Commissioner that because of the increasing difficulty of regulating the traffic in the metropolis, especially in cases where tramways were improperly allowed to be laid, the public interest would not be served by the proposals in the Bill. The Commissioner was the more anxious because of the increasing number of accidents in the streets. The difficulty of regulating the traffic was great, as in such places as Plumstead, Croydon and Kingston, where there was not room between the pavement and tramlines for a vehicle to pass. He stated that there would be danger at the junction of Mare-street and Well-

street of the cross-traffic being obstructed, and that a proposal to reduce the width of the pavement was open to serious objection. The increase of fatalities at present time was not attributable to the darkening of the streets, because the percentage of fatalities was practically the same as it was before the present conditions of lighting.

Mr. J. K. Bruce, deputy chief officer of the London County Council tramways, stated that the tramway proposed ended in a junction with existing tramways and would do away with a dead end. He could not see any hope that that line would become a great arterial thoroughfare. It was impossible that there could be four cars together delaying the traffic at the junction of Well-street and Mare-street, Hackney; the greatest stretch of single line was 72 yds., and with a four-minute service there could not be more than one car at a time on the proposed connecting line.

The Committee decided that the Bill should proceed, both the Hackney and Bermondsey tramways proposals being sanctioned.

IMPORT DUTIES ON MOTOR CARS.

It was announced in the House of Commons on Thursday last that the import duty under the Budget upon motor cars will not apply to motor lorries and vans used exclusively for commercial purposes.

LEGAL INTELLIGENCE.

Right of Interned Alien to Sue.

Last week Mr. Justice Younger delivered his reserved judgment in the case of Schaffenius v. Goldberg, which raised the question of the right of an interned German to maintain an action. His lordship said the action was brought to enforce an agreement between plaintiff and defendant, and defendant's preliminary answer to the whole proceeding was that plaintiff, a German, had been interned as a civilian prisoner of war since the execution of the agreement, and that as long as he remained interned all access to the Courts was denied to him. It was said that he had become ex lege during his internment. Without expressing any opinion as to the extent of the relief to which plaintiff was entitled, he was of opinion that he was at liberty to maintain the action free from any disability attributable to his enemy character. He arrived at that conclusion on the ground that defendant being entitled under the Royal Proclamation to enter into the agreement with plaintiff, and no change having since taken place in plaintiff's condition affecting the propriety of defendant's entering into an identical agreement with him even now, plaintiff must be entitled to enforce in the Courts any rights which the agreement gave him. Plaintiff had never been, and was not now, an enemy within the meaning of any Proclamation relating to Trading with the Enemy. The internment of plaintiff had in no way affected any right which defendant otherwise had to contract with plaintiff, although it might have restricted his opportunities for so doing. Internment had not made plaintiff an enemy. After quoting Coke's view of the position of aliens and referring to the Royal Proclamation and cases decided thereunder, his Lordship said he was of opinion that plaintiff was entitled to maintain the action. Having regard to the number of enemy aliens now interned in this country, he should deal with the grounds on which the contentions of plaintiff and defendant rested. For plaintiff it was contended that all that was necessary for his right to sue was that he should be here "in protection"; and it was said that plaintiff was here in protection and known to the King to be so, not only because he had been registered as an enemy alien, but also because he had been subsequently interned as such. Licence and protection would be implied from his being suffered to remain without being ordered out of the country, and his right to sue was certainly not less clear than that of an alien enemy resident and carrying on business in a neutral or friendly country. For the defendant it was asserted that the right of action recognised in Wells v. Williams was conditioned on plaintiff's being here "without molesting the Government or being molested by it"; that internment was molestation by the Government which put an end to plaintiff's right to sue. Now, in his judgment, it was plaintiff's view which was right and ought to prevail. There had been a gradual and progressive modification in the rules of the old law in their restraint and discouragement of aliens. It was the residence and business domicile of plaintiff that were now all-important, not his nationality. If those were in enemy country a plaintiff might not sue, whatever his nationality, even if he be a friend. If those were in friendly or neutral territory he might sue, even if he be an enemy born. Prima facie, all persons resident in this country were entitled to have access to the Courts, and, although it might still be that an alien enemy resident here must show that he was here with the licence (actual or implied) of the King before (in war time) he could be admitted to sue in these Courts, still even so, as had been held in "the Princess Thurn and Taxis v. Moffitt," registration which plaintiff had effected was sufficient evidence of such a licence. And it might be that the expression being "in protection" meant little more than the consequence to plaintiff of his being licensed to remain. If, however, it meant more, then it had been expressly decided that a prisoner of war was here under the protection of the King, so that plaintiff's position appeared to be complete. Moreover, he could not find any warrant for the contention that internment was equivalent to a revocation of the licence to remain which was implied in registration. It was true that an opinion to that effect was expressed by Mr. Justice Low in the recent case of Rex v. Liebmann, but in that case it was only a question of the right of an interned prisoner of war to sue out a writ of habeas corpus. Finding no precedent in support of defendant's contention he was not disposed to make one, for the contention was based on no kind of principle. He was, therefore, prepared to declare that the contract between plaintiff and defendant was not affected by the fact that plaintiff was now interned within the realm as a civilian prisoner of war, and that plaintiff was entitled to maintain any action otherwise competent to him in respect thereof.

EDUCATIONAL NOTES.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

The Calendar for the 1915-16 Session has been recently published, and gives full particulars of the courses of instruction, teaching staff, examinations, fees, &c. The head of the electrical engineering department is Prof. W. U. Thornton, D.Sc., D.Eng., and the ordinary pass course for the degree of B.Sc. in engineering extends over 3 years. There are well-equipped laboratories and good facilities are given for practical work. Copies of the Calendar may be obtained (post free) for 1s. 4d.

Faraday House Electrical Engineering College.—Dr. W. H. Eccles, M.I.E.E., began a course of lectures on "Wireless Telegraphy" to the senior students of Faraday House on Tuesday last.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 Specifications.

18,328 Hammond. Systems for the control of moving bodies at a distance by radiant energy. (14/7/13.)
19,809 Brustlein. Process for producing the lining of an electric induction furnace.
20,908 Thompson. (Soc. Anon des Telegraphes Edouard Belin.) Arrangements for synchronising apparatus having similar periodic movements.
21,354 Walker. Magnetic clutches.
22,226 Wilkinson. Mercury switches.
24,368 Hope. Fuses or cut-outs for electric circuits. (Addition to 22,575/13.)

1915 Specifications.

498 Imray. (Siemens & Halske Akt.-Ges.) Selecting devices operated by current impulses.
563 Smith, Major & Stevens (Ltd.) & Major. Electric locks and switches for lifts.
982 Meigs. Electrical apparatus for effecting the chemical combination of gases. (23/1/14.)
1,113 W. & T. Avery (Ltd.) & Gibbs. Electric switch for use with weighing scales.
2,236 Robert Bosch (firm of). Electric pedal switches. (29/7/14.)
2,248 Heinsohn. Electric welding. (21/2/14.)
3,565 Imray. (Siemens & Halske Akt.-Ges.) Arrangements for operating switching devices by electric current impulses.
3,997 Wilkinson. Electrically-driven radial arm drilling and the like machines.
4,077 Liebherr. Protection of electric motors. (5/11/13.)
6,196 Smith. Combination electric switch and fuse. (Addition to 8,456/14.)

APPLICATIONS FOR PATENTS

Note.—The undermentioned Applications (those not marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open to inspection at 25, Southampton Buildings, but they have not been published previously to the ordinary way. Numbers in parentheses are those of communications. When Complete Specification has been accepted, application an asterisk is affixed.

September 20, 1915.

13,344 Ulbe. Commutating arrangements for electric motors.
13,357 Siemens. Electric switches.
13,365 Lucas & Thomas. Electric switches.
13,369 Lucas & Edwards. Laminated armatures for magneto-machines, cores for electric coils and the like.
13,391 Dawson. Ignition systems for internal-combustion engines. (24/12/14, U.S.)

September 21, 1915.

13,413 Fleming. Electric (heating) resistances for electric heating and apparatus therefor.
13,426 Cadiot & Perot. Electric ignition of internal-combustion engines.
13,436 Davidson. Production of X-rays.
13,448 Allison. Key [illegible]

September 22, 1915.

13,469 Rylies & Firth. Driving gear for electric dynamo-electric generators.
13,481, 13,482, 13,483, 13,484 Hope. (National Phonograph Co., U.S.) Dynamo electric machines.*
13,498 Mead. Electric pumps.
13,504 Williams. Electric [illegible] systems.

September 23, 1915.

13,[illegible] Hewlett. [illegible]
13,561, 13,562 Schuchardt. Dynamo-electric machines of the commutator type.

September 24, 1915.

13,[illegible] Wall. Measuring [illegible] of [illegible] of a circuit containing inductance and capacity in series.
13,562 Taylor. Automatic signalling, and communicating with trains. (Addition to 19,123/14.)
13,[illegible] Telephone. Transmitters.*
13,[illegible] Telephone. Transmitters.*
13,[illegible] Ball-bearings. Manufacture of tungsten.
13,[illegible] Electric [illegible]*
13,[illegible] Marconi & Indo-European Telegraph Co. Electric selective devices.
13,[illegible] Marconi & Indo-European Telegraph Co. Supply of electric energy to wireless [illegible]

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Notes	31	Single-Way Tumbler Switches With Quadruple Break. Illustrated	4
Imports and Exports of Electrical Manufactures	32	Pardoned Murderer and Electrical Development	4
Business Notices	32	Lighting Efficiency in the Office. Illustrated	6
Bankruptcies, Liquidations, &c.	32	A New Insulator Clip. Illus.	8
Electricity Supply	32		
Traction Notes	33	Foreign Notes	34
Lighting and Power Notes	34	Miscellaneous Notes	35
Telegraph and Telephone Notes	34	Tenders Invited	35
Empire Notes	34	Tenders Received & Accepted	36
		Municipal Accounts	36
The Round Table	1	Companies' Meetings and Reports	37
Electro-Harmonic Society	1	New Companies, &c.	37
The "Point Fives"	1	City Notes	37
"Revo" Electric Fires. Illustrated	2	Electrical Companies' Share List	37
Portable D.C. Testing Set. Illustrated	2		

COMMERCIAL NOTES.

Peace Hath its Mourning No Less Than War.

No greater pleasure is possible to the factory workers and employés in large undertakings than that presented by the annual outing. For many months beforehand anticipation rules high, and the forthcoming event overshadows all else in the way of entertainment and enjoyment. The larger the service with which the coming event is concerned, the greater the excitement and pleasure of anticipation.

This was the condition of affairs with the large army of employés of the Western Electric Co., of Chicago, in the month of July, 1915. The annual excursion of the employés of the Hawthorne Works was to take the form of a river trip and picnic on a more elaborate scale than ever before. The party numbered nearly 7,000, including the employés of the Western Company, their relatives and friends. Five steamers were chartered for the trip, including the "Eastland," and on Saturday, July 24th, at 7:30 a.m., this vessel, with 2,000 souls on board, cast away from the dock at Clerk and Water-streets, Chicago, but completely overturned in the course of doing so, and nearly 1,000 souls perished in the disaster, of whom 500 or more were Western Company's workpeople. (*See* Supplement, p. 4.)

The company publish once a month the "Western Electric News," for the information and pleasure of their employés, and we have just received the number for August, 1915, which is devoted to the mournful duty of recording the incidents of this colossal disaster, of which the only bright outstanding point is the brilliant and heroic work of those of the party who assisted in saving between 1,000 and 1,100 lives from a watery grave. The overwhelming character of the disaster leaves one speechless. In ordinary catastrophes of this kind the circumstances are indeed terrible, but where a large party sets out on pleasure bent, full of anticipation of a long day's enjoyment, for such an awesome accident to happen presents a picture too horrible even to think of. We join most sincerely in the condolences to the relatives and friends of the lost, to the survivors, and to the company in regard to an event which covered with gloom the holiday season of 1915. The record in the "Western Electric News" has clearly been a labour of love, well performed.

* * * *

Legal Status of Interned Aliens.

In our legal column we report an important decision by Mr. Justice Younger on the legal status of an interned alien. The matter is of some importance as there are now some thousands of Germans and Austro-Hungarians interned in this country. There can be little doubt that on general principles and on the authority of decided cases the judgment, which held that an interned alien could maintain an action in this country was correct. To have decided otherwise would have been tantamount to a denial of justice. In all these cases many persons confuse "alien enemies," or persons resident in and domiciled in hostile territory, with aliens who are domiciled here. In the present case it was attempted to prove that there was a difference between an interned and an uninterned alien, but the learned Judge refused (rightly, we think) to acknowledge such a distinction. Whether it is good policy or in the public interest that an interned alien should reap the full benefit of a judgment is quite a different matter, and this point may require further consideration.

* * * *

Gas and the War.

While the electrical industry may justly pride itself upon its constructive contributions to the supply of the sinews of war, the gas industry has furnished many exclusively peculiar devices which make it rank in importance with other national engineering institutions. Quite aside from the methods of frightfulness which it places at the disposal of belligerents, and of which our enemies seem to make full use, we are reminded that gas is having a constructive as well as a destructive influence on the war. The reminder comes in the shape of an attractive pamphlet issued by the Gas Light & Coke Co. We do not often refer to publications emanating from this source, let alone to speak approvingly of them; but the war has raised even gas to the level of electricity, and this must be one reason for our reference to a bulletin which so admirably indicates how gas-heated furnaces, lead baths, blow pipes and annealing machines are playing their part in the great work of munitions production. The bulletin is profusely illustrated, and of great interest are the views of two or three hole furnaces which are used for "bottling" or "nosing" shells.

* * * *

Bakery Installations.

There are many electric power installations which are put down from time to time, and which are regarded as altogether too commonplace to put on record, let alone to make any noise about. A branch of trade and industry in which the cleanliness and general hygenic features of the electric motor are of importance is bakery and confectionery. Of recent years much of the drudgery of this business has been entrusted to machinery, and many extremely ingenious mechanisms are employed for dough mixing, dividing, "rounding," whisking, &c. We believe that a larger quantity of baking machinery is used in this country than was the case a few years ago, but our American friends have probably a little more experience in these matters than we have. In the "Electrical Review and Western Electrician" attention was recently called in an illustrated article to the grocery store and bakery of the Meaker Food Stores, of Auburn, N.Y. This company operates a bakery having a capacity of 10,000 loaves a day and 2,000 cakes, in addition to pies and pastries. The entire installation is electrically operated, and an interesting feature is the control of the oven temperatures by electrically-operated thermostats. A complete motor driven refrigerating plant is also installed. The convenience, cleanliness and efficiency of the electric drive have proved extremely profitable to the proprietors of this installation.

* * * *

A Word to Insurance Companies.

We refer elsewhere to the Police warnings in regard to the greater care necessary in providing protection to warehouses and similar buildings from fire due to aircraft and from the splinters from anti-aircraft gun firing. The duty of the owner or occupier of these buildings is emphasised, and it is suggested that caretakers should be provided for all such premises. Undoubtedly these warnings are necessary, and every care should be taken in the direction indicated, but we would take the opportunity to make the suggestion that the insurance companies (acting for the Government in this aircraft and bombardment business) might very well combine to devise a scheme for the additional protection of the public against these dangers. If this course were adopted, the insurance companies would not only help to protect the Government against heavier demands upon their resources, but they would, at the same time, guard their own interests in regard to ordinary fire risks. The public has been called upon to spend very large sums of money on insurance, and properly so, but it seems to us that a duty devolves upon the insurance companies, with their huge funds, to devise a means for helping their clients in the matter of additional and special safeguards, such as the provision of caretakers and, possibly, watchmen.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Sept. 27, 1915, *to* Oct. 2, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. carbons, 37 pkgs.; unenumerated, 23 pkgs.
GRIMSBY.—*France:* Carbon electrodes, 20 pkgs.; unenumerated, 11 pkgs.
LIVERPOOL.—*U.S.A.:* Elec. motors, 23 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £1,349; carbon candles, £167; wire and cable, £39; lamp parts, £42; unenumerated, £2,097. *Switzerland:* Elec. machinery, £24; carbon candles, £695; unenumerated, £108. *Holland:* Elec. lamps, £2,341; unenumerated, £67. *France:* Elec. lamps, £888; carbon candles, £592. *Denmark:* Elec. machinery, £1,500; unenumerated, £615. *Italy:* Elec. carbon candles, £65; elec. wire, 12 pkgs.; wire and cable, £420. *Sweden:* Telephone materials, £11.
MANCHESTER.—*U.S.A.:* Insulators, 20 brls.
SOUTHAMPTON.—*France:* Unenumerated, 5 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £348; elec. machinery, £331; unenumerated, £107. *Melbourne:* Wire and cable, £8,429; elec. machinery, £539; telegraph material, £24; unenumerated, £413. *Sydney:* Elec. machinery, £92; wire and cable, £6,255; unenumerated, £1,206. *Wellington:* Elec. machinery, £73; wire and cable, £2,130; unenumerated, £1,004. *Brisbane:* Wire and cable, £1,284; unenumerated, £790 *Christchurch:* Wire and cable, £44; unenumerated, £74. *Dunedin:* unenumerated, £123 *Hobart:* Elec. machinery, £150. *Lyttelton:* Unenumerated, £210. *Adelaide:* Unenumerated, £95. *Fremantle:* Elec. machinery, £20; unenumerated, £149. *Cairns:* Elec. machinery; £145; wire and cable, £161. *Townsville:* Unenumerated, £85. *Newcastle:* wire and cable, £2,121. *Rockhampton:* Wire and cable, £376.
AFRICA.—*Durban:* Wire and cable, £299; elec. machinery, £182; unenumerated, £1,049. *Port Elizabeth:* Wire and cable, £317; unenumerated, £220, *Cape Town:* Elec. machinery, £220; wire and cable, £900; unenumerated, £187. *East London:* unenumerated, £74. *Beira:* Elec. machinery, £40; unenumerated, £25. *Delagoa Bay:* Unenumerated, £60. *Inhambrane:* Unenumerated, £22
EGYPT.—*Alexandria:* Elec. machinery, £150; wire and cable, £102; unenumerated, £30. *Port Sudan:* Unenumerated. £121.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wireand cable, £6,958; unenumerated £882. *Antofagasta:* Unenumerated, £50. *Coronel:* Unenumerated, £14. *Guayaquil:* Wire and cable, £28; unenumerated, £217. *Santos:* Elec. machinery, £450. *Valparaiso;* Unenumerated, £56.
JAPAN.—*Yokohama:* Wire and cable, £303; unenumerated, £964.
U.S.A.—*New York:* Telegraph material, £124; unenumerated, £300.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £325; unenumerated, £710. *Calcutta:* Wire and cable, £3,317; unenumerated, £133. *Madras:* Wire and cable, £1,065; unenumerated, £24. *Ceylon:* Wire and cable, £565; elec. machinery, £77; unenumerated, £78. *Singapore:* Wire and cable, £57; unenumerated, £154. *Karachi:* Elec. machinery, £137; unenumerated, £96. *Sarrawang:* Unenumerated, £20.
WEST INDIES.—*Demerara:* Unenumerated, £43. *Trinidad:* Unenumerated, £54. *Barbados:* Unenumerated, £17. *Mauritius:* Unenumerated, £32.
FRANCE.—*Paris:* Telegraph material, £748; unenumerated, £370. *Boulogne:* Unenumerated, £72.
FIGI.—Unenumerated, £26.
PORTUGAL.—*Lisbon:* Unenumerated, £410.
HOLLAND.—*Amsterdam:* Unenumerated, £41.
RUSSIA.—*Petrograd:* Unenumerated, £55.
DENMARK.—*Copenhagen:* Unenumerated, £125.
SPAIN.—*Barcelona:* Unenumerated, £17.
ITALY.—*Genoa:* Unenumerated, £20.

FOREIGN GOODS (duty paid and free).

Alexandria: Unenumerated, £31. *Cape Town:* Unenumerated, £20. *Fremantle:* Unenumerated, £147. *Christchurch:* Unenumerated, £44. *Buenos Ayres:* Unenumerated, £127. *Lyttelton:* Unenumerated, £17. *New York:* Unenumerated, £1,776. *Sydney:* Unenumerated, £19. *Karachi:* Unenumerated, £14. *Durban:* Unenumerated, £304.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The Dowsing Radiant Heat Co. (Ltd.), having purchased the stock, comprising electrical fittings for repair of electric heating and cooking apparatus, from the late Phœnix Electric Heating Co., of 17, Morwell street, W.C., notify that they would be pleased to execute repairs or supply apparatus previously manufactured by that firm.

The Electrical Co. has just issued a stock and price list of d.c. and a.c. motors, small motors, drills, grinders and fans, also cable, conduit, accessories, lamps and sundries. The list is issued to the trade only.

Constance M. Ashton (executrix of the late Harry M. Ashton) and Fredk. B. Holt (trading as Ashton & Holt), electrical and general engineers, 15, Cross-street, Hyde, have dissolved partnership. Debts by Mr. Holt.

Patent Development.—The Submarine Wireless Co., 61, Broadway, New York, advertise that it is desirous of making arrangements for the manufacture and commercial development of patent No. 25,207/1913 relating to "Submarine signal receiving apparatus."

Patent Amendment.—Messrs. Percy Good (28, Victoria-street, London, S.W.) and Albert F. Woodhouse (67 and 68, Chancery-lane, London, W.C.) seek leave to amend the specification of patent No. 19,484/1914, for "Improvements in or relating to devices for supporting and insulating conductors applicable for electric resistances and heaters." Particulars of the proposed amendment are set out in the "Illustrated Official Journal (Patents)" of Sept. 29, and notices of opposition must be given within one calendar month from that date.

BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court on Tuesday the proposal of Robt. Bilsland, electrical engineer, Caxton House, Westminster, to pay a composition of 5s. in the £ was approved. Debtor's unsecured liabilities were stated to be £3,793, and assets £416.

The British Drawn Wire Lamp Co. (Ltd.) is being wound up voluntarily and Mr. F. J. Markie, 83, Alberta-road, Bush Hill Park, Enfield, has been appointed liquidator. A meeting of creditors will take place at the office of Mr. O. B. Thomas, 59, Chancery-lane, London, W.C., on Oct. 9.

ELECTRICITY SUPPLY.

EXTENSIONS.

Barking.—The L.G. Board have authorised the Council to raise loans amounting to £13,654 for extensions of the electric supply undertaking. The Board will consider an application for a loan in respect of buildings when revised estimates based on tenders received have been submitted.

Darwen.—The Corporation have decided to extend the electric supply cables to Hollins Grove Mill and application is to be made to the L.G. Board for sanction to borrow £3,000 for mains extensions and services.

Eccles.—As the L.G. Board have refused to sanction a loan for extensions of mains and services, the Electricity Committee recommends that the cost of the extension in Chatsworth-road be charged against revenue.

Considering the state of the labour supply available it has been decided to communicate with the Minister of Munitions with a view to the prohibition of the employment of members of the staff at the electricity works by other firms or bodies except with the consent of the Corporation.

Rotherham.—As additional generating plant is urgently needed at the electricity works the Electric Light and Tramways Committee have instructed the chairman, Town Clerk and Borough Electrical Engineer to wait upon officials of the Ministry of Munitions, in order to ascertain what assistance that department can give to the Corporation if they purchase such additional plant, which is estimated to cost about £20,000.

West Bromwich.—Owing to the additional demands of manufacturers engaged on war material, it is necessary to extend the generating plant at the electricity works.

The Electricity Committee recommends the purchase of a second-hand turbo-alternator, &c., from Messrs. R. H. Longbotham & Co., the cost thereof to be charged to depreciation and reserve funds.

The Committee proposes to negotiate for a supply of power in bulk to the Corporation, and asks the Council for permission to put down the necessary converting plant.

Wimbledon.—The borough electrical engineer (Mr. H. Tomlinson Lee) has been authorised to arrange for the laying of mains and to undertake the wiring of the proposed military camp on Wimbledon Common, provided the Council incur no financial responsibility in connection with the work, and that ordinary lighting rates are paid for the energy consumed.

Mr. Tomlinson Lee has advised the Corporation that, in order to meet the excess expenditure on certain loans, and the estimated expenditure on mains, house services, motors, and sub-stations for the year to March 31 next, it will be necessary to take up loans amounting to £5,000. It is, therefore, proposed to ask for the L.G. Board's sanction to borrow this sum.

The salary of the acting chief assistant electrical engineer (Mr. W. J. Oswald) has been increased to £200 per annum.

GENERAL.

Aberdeen.—Last month the output of the electric supply department was 1,028,120 units, an increase of 150,930 units over the corresponding period of 1914.

The electricity works are to be insured against loss by bombardment to their full value.

Bath.—Ald. H. T. Hatt, who has been chairman of the Electric Lighting Committee, has been nominated Mayor for 1915-16.

Belfast.—At the last meeting of the Tramways and Electricity Committee the city electrical engineer (Mr. T. W. Bloxam) submitted some applications received for a supply of electricity which involved capital expenditure.

As the applications had been received prior to the committee's previous resolution not to incur expenditure for similar cases, it was decided to

authorise the extension of the mains, but that future applications would only be dealt with subject to the consent of the Treasury to the necessary expenditure.

In reference to the appointment of an engineer-in-charge at the electricity works, the city electrical engineer (Mr. T. W. Bloxam) reported that in response to advertisements in the local press he had not received any applications from candidates with experience of central stations except from members of the present staff. He was unable to recommend any of the latter for the appointment, and he was authorised to re-advertise in the technical journals.

Berehaven (Cork).—The L.G. Board have conferred ubran powers upon the Rural Council for the purpose of establishing electric supply works, and a contract has now be entered into with Mr. P. H. Nugent, of Bantry, for the erection and maintenance of the station, &c.

Bridlington.—Mr. J. L. Ostick, junior engineer at the electricity works, has been given leave of absence to enable him to join H.M. Forces.

Dublin.—In a special report the Electricity Supply Committee recommend that in future the charge for electric current supplies to regular theatres and music halls and also to the daily newspapers be 3½d. per unit.

East Ham.—The Electricity Committee proposes to designate the shift engineers at the electricity works as officals as regards remuneration for sickness and disablement for the purposes of the National Insurance Act.

Electrical Engineering Apprentices.—At the meeting of the Marylebone (London) Borough Council last evening the Electric Supply Committee recommended the adoption of a scheme of apprenticeship in connection with the electrical undertaking.

The committee reported that they had considered the scheme which was submitted by the chairman (Ald. D. Watson) after consultation with the Council's engineers. By the scheme a limited number of apprentices could be admitted, who, after a period of probation, would be indentured. They would be given facilities for gaining a thorough training in the various branches of the department's work. After the first year's training they would gradually become very useful, and towards the end of their period of apprenticeship they would be able to fill responsible positions. That would relieve the Council of the great difficulty they experienced in retaining the services of improvers and would minimise such troubles as were recently experienced in connection with the running staff. Applications would be received only from youths over 15, who had shown special qualifications or talent for engineering work, and who had received a good technical education. During apprenticeship they would be given every possible facility for attending evening classes and technical colleges. Their remuneration would be on a progressive scale, beginning at 5s. per week for the first year, and gradually rising to 20s. per week. All who showed special diligence and ability would be given every opportunity for filling vacancies on the permanent staff.

Glasgow.—On Friday last the members of the Corporation formally inspected the new electricity works which are being erected at Dalmarnock.

Since the outbreak of the war there has been difficulty in obtaining workmen for the completion of the excavations, but the progress already made was sufficient to indicate the extent of the undertaking. The party left the Municipal Chambers at 11 o'clock in a couple of tramcars and on arriving at the works they were received by Bailie Smith, convener of the Electricity Committee; Mr. W. W. Lackie, city electrical engineer; and Mr. Archibald Page, assistant electrical engineer. As the installation of machinery has not yet commenced the inspection was mainly confined to the excavations, especially to the arrangements made for the intake of water from the Clyde to the screening house, and to the foundations of the turbine-room and boiler-houses. The work in connection with the screening house was sufficiently forward to afford the visitor a good idea of the ultimate extent of the water power necessary. Six screens have been constructed, each capable of purifying 50,000 gallons of water per minute. The foundation works are constructed on reinforced concrete system. After the water culverts, workshops, stores, &c., were inspected the party returned to the Municipal Chambers, where luncheon was served under the chairmanship of Bailie Mason.

The CHAIRMAN, in proposing the toast of the "Electricity Committee," regretted the absence of the Lord Provost, who had to keep another engagement. What they had seen showed conclusively that the Electricity Committee were well alive to the needs of the community. He understood that the consumption of electricity during the past three years had doubled, which showed that the department, although one of the youngest of the municipal enterprises, was making remarkable progress. The department had only reached its majority about two years ago, and there would have been some celebration of that event had it not been for the war. During its history it had had only six conveners—Sir James Bell, ex-Bailie Burt, ex-Bailie M'Leay, Mr. J. W. Stewart, ex-Bailie Willock and Bailie Smith, to whom the chairman paid a high compliment for the whole-hearted manner in which he had conducted the work of the department. He also eulogised the work of Mr. Lackie and his assistants.

In reply, Bailie SMITH said that they had only seen the beginning of the work at the new station. They were going to put down plant to develop in a year or two 60,000 H.P., and that would cost £250,000. When it was finished they would get out of their works 200,000 B.T.U. and the cost of the whole would be £1,500,000. He thought that, looking to the future of industrial Glasgow, the increase of output would be required in the course of not very many years. Three years ago the output, including Partick and Govan, was 62,000,000 units, while for the year that was finished, again including Partick and Govan, the output was 117,000,000 units—which was about double. If matters went on at that rate he thought they were justified in the large capital expenditure which they had recommended. The credit of leading the site for the new works belonged to ex-Bailie Willock. He hoped as they went on by various economies to reduce the price of electricity further. The result of the visit which Mr. Lackie and he had paid to America had been very helpful. They had been able to save an immense amount of money in cables. The first installation when finished would result in a saving in cables of £19,000, and the whole installation would save £174,000.

Glasgow Electrical Showrooms.—The electrical showrooms, which have been fitted up, with the co-operation of local electrical contractors, at 257, Sauchiehall-street, were formally opened on the 1st inst., by Miss Dunlop, daughter of the Lord Provost.

The premises are situated directly opposite the Royal Glasgow Institute of the Fine Arts, and it is hoped that the display of fittings, &c., will attract the attention of shoppers in that thoroughfare. All the latest forms of domestic and industrial electrical apparatus are staged, and it is intended to add such new appliances as may be introduced from time to time. In the premises at Sauchiehall-street the three floors are devoted to the display of apparatus. Vacuum cleaners, electric irons, kettles, ovens and other heating and cooking appliances are on view, and daily demonstrations of cooking by electricity will be given. The first floor is exhibited as an electrically equipped house. The various rooms have been furnished by local firms, and the electric fittings are shown in use. These include cooking appliances for the table and various means of heating for the bedroom, including feet-warmers for the bed. In order to encourage the general adoption of electricity for purposes other than lighting, the Corporation have adopted a special rate of ¾d. per unit.

Bailie W. B. SMITH, convener of the Electricity Committee, presided at the opening ceremony, and said that the Corporation considered such a showroom to be a necessary part of the electricity department. They had been fortunate in their relations with those engaged in the electrical business and manufacturers, merchants and wiring contractors were all working in agreement. They had the contractors' goodwill and co-operation; it was not a case in any sense of opposition to them. A showroom was useful in order to demonstrate how they could harness that very mysterious force electricity and to show into what very light harness they could put it. They could employ electricity for light, for power or for heating. As an illustration, he said that before getting up in the morning one could press a button and put on the radiator; then one could heat the water in the bath electrically, and could come downstairs and make one's breakfast on the table by electric appliances.

Miss DUNLOP formally declared the showroom open, and was afterwards cordially thanked for her services on the motion of Bailie Hannay.

Increased Charges for Electric Current.—The following increases in charges for electrical energy are being made:—

Marylebone (London) Council, a further 10 per cent. from Sept. 29: *Faversham* Council, ½d. per unit for lighting and 10 per cent. for power; *Isle of Thanet Electric Tramways & Lighting Co.*, 10 per cent.

Leyton.—Various alterations in the estimates of the tramways and electric supply undertaking have been made.

The effect of the alterations is to increase the estimated tramway deficiency for the half-year from £644 to £1,469, and of the electric supply undertaking from £3,959 to £4,581.

Luton.—The L.G. Board has now sanctioned the borrowing of £4,000 being the balance not yet taken up of a loan of £24,000 for the electric supply undertaking.

St. Pancras.—The Electricity Committee has considered as to filling the position of distributing engineer rendered vacant by the resignation of Mr. W. A. Brown in January.

The duties of the position have been allocated temporarily among three officers of the engineering staff, and the Committee advises that this arrangement should be continued for six months further, pending a settlement of the matter, and that these officers be paid 10s. per week each in respect of the additional duties.

Wimbledon.—The Council has notified that it will apply for a provisional electric lighting order for the parish of Cuddington, in the Epsom Rural district.

TRACTION NOTES.

Cardiff.—At the meeting of the Tramways and Electric Lighting Committee last week the city engineer (Mr. W. Harpur) asked for instructions with regard to the promotion of a provisional order for the extension of the tramways in Whitchurch-road, Cathedral-road, &c.

Mr. HARPUR thought there would be difficulty in getting Parliamentary sanction to the necessary capital expenditure at present, however

desirable the extensions might be, and that the estimates would be unusually high owing to inflated war prices. The Committee, therefore, decided to postpone the question for six months.

East London Railway.—On Monday the new electric lifts at Wapping were brought into operation.

Hitherto passengers have had to climb some 100 stairs from the street level to the platform, and the innovation will, therefore, be much appreciated. The lifts carry 30 passengers each.

Edinburgh.—The electric lighting department has ordered a 30 cwt. Edison battery electric vehicle, capable of travelling 40 miles on one charge.

Ilford.—On the advice of the manager, the Tramways Committee propose to displace the present method of issuing privilege tickets in favour of the token system.

LIGHTING & POWER NOTES.

Bristol.—The Corporation have modified its building scheme, but it has been decided to proceed with the Bristol North Baths, which are to be lighted electrically.

Castlewellan (co. Down).—The L.G. Board have notified Downpatrick Rural Council that they propose to grant the Council's application to be invested with the powers of an urban sanitary authority for the public electric lighting of Castlewellan. It is proposed to place all the lamps within the two townlands comprising the area of charge—viz., Castlewellan and Dundrive.

Gloucester.—Last week the Electricity and Light Railways Committee reported that inquiries had been received about a large supply of electric energy for power and lighting for a new company which it was proposed to form under the name of the Gloucester Paper Mills.

As it would involve very extensive alterations and additions to the existing plant at the electricity works, the matter was referred to a sub-committee with power to act.

The SHERIFF said there was every probability of that important manufacturing concern being established in their midst, and he was sure they all wished the undertaking every success. Their electrical engineer (Mr. Corson) had reported on the application, which had come at a time of extreme difficulty, owing to the shortage of labour and materials, and to the fact that the Government claims on both must take priority over other considerations. It was because it was felt that the establishment of such a factory would be quite as closely connected with national as with local interests, that the Electricity Committee had found it possible to give the project a degree of sympathetic consideration which could not have been justified had the object been one of local advantage only. The supply of electricity required was greater than could be furnished by the existing generating plant, and, if it be undertaken, it would call for extensive additions to and remodelling of the works. The capital expenditure necessary was likely to involve a considerable sum, as over £5,000 a year would be paid to the Corporation for power. A detailed scheme has been drawn up, upon which preliminary estimates had been obtained, and, in view of the necessity that no time should be lost, the Council was asked to delegate to the sub-committee such authority as would enable the matter to be decided as soon as possible.

After discussion, the report was adopted.

Infirmary Lighting.—At the meeting of Barnet Guardians last week a discussion arose as to the electric lighting of the Infirmary.

Mr. HACKFORTH JONES said that if they had foreseen this war they would not have started upon the undertaking. It was reported that £800 might be effected as a saving by putting off the execution of the contemplated works, and this was agreed to.

Street.—A supply of electric current for public and private lighting is now available, the public electric lighting having been inaugurated on the 15th ult.

TELEGRAPH & TELEPHONE NOTES.

New Submarine Telegraph Cable.—It is announced that a duplicate cable has been laid between Colon and New York, via Guantanamo, and that telegrams can now be transmitted to the West Coast of America by this cable, to the relief of the routes via Colon and via Galveston.

New Telephone Regulations.—The Postmaster General notifies that on Sept. 28 he made Regulations repealing Telephone Regulations 1910 and Telephone Amendment (No. 1) Regulations, 1910.

The Post Office has also issued the following notice:—

Until further notice no telephone shall be used for the transmission of any message or communication except in the English language, unless specific permission to employ some other language has been obtained.

As from Oct. 1, where the use of any trunk line involves the use of a submarine cable connecting the mainland of Great Britain with the Isle of Wight, there shall be charged and paid in addition to the rates prescribed by No. 2 (1) of the Telephone Regulations, 1915, the sum of 4d., and where the use of any trunk line involves the use of a submarine cable connecting Great Britain with Ireland there shall be charged and paid in addition to the rates prescribed aforesaid the sum of 2s.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says the loss on the Commonwealth telephone service last year, as ascertained by Mr. McC. Anderson, the financial expert who is investigating the affairs of the various departments of the Public Service, was £296,000.

This Mr. Anderson proposes to end by economies amounting to about £90,000 per annum, and by increasing the charges for telephones. It is considered that any diminution in calls which may result from increasing the tariff will be a public gain, as, in all likelihood, the calls eliminated will be frivolous ones, and if these should be cut out further economies will be possible in the attendance. The increased rates, whatever they may be, will probably operate in the larger cities in the first instance. To make up the shortage in the telegraph department, which last year amounted to £151,000, it is proposed to raise the charge to 1d. per word with a minimum of 12 words per message, instead of the present scale of 16 words for 1s., and 1d. per additional word.

Wollongong Council recently decided to invite tenders for the provision of a distributing system for their proposed electric supply scheme at an estimated capital cost of £6,000, and to ask the consulting engineer, Mr. J. B. Rumford, his terms for supervision. The acceptance of tenders will be contingent upon the Works Department agreeing to the council's offer to take current from the power-house at Port Kembla.

Melbourne (Victoria) Council recently decided to invite tenders for the installation of an electric lift, at an estimated cost of £910.

The Council have also approved of the expenditure of 50 guineas for a report on the construction of an electric tramway from West Coburg, through West Brunswick, to the centre of Melbourne.

Heidelberg (Victoria) Council has approved plans and estimates for an extension of the electric supply undertaking at a cost of £4,000.

Dunedin (N.Z.) Council has decided to borrow £26,000 for new tramcars, remodelling existing cars, and alterations of car sheds approaches.

Prahran and Malvern (Victoria) Tramway Trust has secured the necessary capital for the construction of the Burke-road tramway from Camberwell to link up with the Malvern-road tramway.

India.—"Indian Engineering" says owing to the success of the hydro-electric works at Simla it has been decided to carry out extensions.

A fourth generating set of 500 kw. will be erected at Chaba, also a motor-driven exciter set with turbine attached and a turbine for the existing motor-driven exciter set; two 250 kw. transformers for raising the voltage to 15,000 for transmission to Simla, with additions to existing switchgear. The new switchgear and transformers have arrived and the turbine is on its way out. Three 100 kw. and three 50 kw. transformers will be put in at small sub-stations to reduce the voltage from 2,200 to 200. The extensions all include a high-tension underground cable from Idgah to the Ridge, a new sub-station at Sanjouli and in the bazar. An underground cable for a part of the Mall, 7½ miles of additional l.t. distribution mains, 9 miles of service lines, and 2½ miles of overhead mains. Over 1,000 consumers are now taking current and 350 more have applied to be connected.

South Africa.—At a recent meeting of ratepayers the Cape Town Corporation were authorised to borrow £75,000 for the extension of the electric supply undertaking.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says arrangements are well advanced for the constitution of a local electric lighting company in the city of Concordia (Entre Rios).

The gross receipts of the Compania de Tramways Electricos del Sud (Buenos Ayres) for the year ended June 30 were $1,125,074 m.n. against $1,144,030 in the previous year; working expenses were $934,233 (increase of $82,104), and passengers carried were 8,420,254 (against 7,929,328). The net profit was $87,364 after writing off 10 per cent. for depreciation. A dividend of 2 per cent. was paid and $13,978 apportioned to reserve, directors' fees, &c., and $20,565 carried forward.

China.—According to a British consular report net imports at Shanghai in 1914 included machinery valued at £491,878 (compared with £169,858 in 1913), electrical materials £106,046 (against £146,694), and telegraph and telephone materials £25,257 (against £14,487).

The report also says the importation of machinery and the installation of electric lighting apparatus in China is worthy of study by British

firms. China shows an increasing demand for electricity. Shanghai municipal electricity works supplied over 40,000,000 units in 1914, compared with 21,000,000 units in 1913; 1,500 radiators have been installed in Chinese houses, and small motors are very popular. The installation of plant in the interior has hitherto been largely in the hands of German firms, mainly because they were willing to undertake entire contracts and to finance them. British firms, however, who have been sufficiently enterprising to meet the local conditions, have given the greatest satisfaction to the Chinese companies on whose behalf contracts have been undertaken. British installations have been completed at Soochow, Changchow and Yangchow (province of Kiangsu) and Ningpo (province of Chekiang), and many smaller plants have been supplied for lighting small towns, missions and factories.

It is reported that net imports at Tientsin in 1914 included electrical materials and fittings valued at £44,707 (against £32,636).

The report of the British Consul at Chinkiang contains the following notes on trade in general: Three features of German trade seem to be largely responsible for its success: (*a*) The sending of German experts and the employment of travellers in the interior; (*b*) long credits; and (*c*) underselling. Experts are employed who show Chinese using German dyes how to employ them. The trade is conducted by German firms at Shanghai through Chinese, but the travelling expert keeps in touch with the up-country user; and technical men are employed in all cases in which German machinery is sold.

British firms have steadily set their faces against long credits, and it is admitted that the German firms have incurred serious losses on occasions. One of the chief difficulties is that of exchange. If the foreign importing firm will not take the risk of exchange, a Chinese firm does so. This Chinese firm does not supply goods to the up-country wholesale dealer, but to another Chinese firm which does that. The up-country dealer in turn distributes to the retailer and allows credit. He is given credit by the Chinese firm at the place of entry. This latter firm is generally behind the Chinese firm, which actually pays in foreign money to the foreign importing firm. There are greater opportunities for expansion when a foreign firm is in actual touch with the up-country distributing dealer, and gives him credit without a Chinese firm as intermediary.

It is suggested that British firms should unite to send out a representative to study the chances of establishing themselves at a large treaty port and of trading up-country. The sending of catalogues, even in the Chinese language, is of little use unless there is somebody on the spot to whom the Chinese can apply, and who can quote the price in local currency.

MISCELLANEOUS NOTES.

Electro-Harmonic Society.—We would remind our readers that the first smoking concert of the season will be given this (Friday) evening in the King's Hall, Holborn Restaurant, London, at eight o'clock.

Munitions Act Charges.—Last week the Dublin, Southern and Western Ireland General Tribunal of Munitions inflicted fines of £1 each upon nine electricians lent by Edmundson's Electricity Corpn. to Kynochs (Ltd.), for having left their employment without notice. There was a strike of electricians in Dublin, and the men in question, who were engaged on war work, also came out without notice.

Precautions Against Aircraft Fires.—Notices are being issued by the police authorities throughout the country calling attention to the necessity of greater care in regard to protection of warehouses and similar buildings from the danger of fire from dropping bombs and gun splinters from anti-aircraft gun firing. The warning issued by the City of London Police Commissioner directs attention to the importance of having persons on the premises at night capable either of themselves extinguishing the fire caused by a bomb, or to summon the fire brigade. In this way the spread of fires caused by such means may be materially lessened or avoided. The assistance of employés in such buildings is referred to and their co-operation invited, in view of the fact that a fire of any magnitude affects frequently the employment of large numbers of persons. It is asked that a supply of water and sand (if procurable) should be made available in the upper stories and in rooms situate at the bottom of wells (voids), and that hand pumps for directing the water on flames and liquid chemical fire extinguishers, complying with official specification, should be provided. The dangers to and from neighbouring buildings is also referred to, and is, of course, from all points of view, a matter for serious consideration. We make a suggestion on this subject in another column.

TENDERS INVITED.

Transformers.

HAMMERSMITH (London) Borough Council invite tenders for the supply of air-cooled Static Transformers. Specifications, &c., from the borough electrical engineer (Mr. G. G. Bell), electricity department, 85, Fulham Palace-road, London, W. Tenders to the town clerk (Mr. Leslie Gordon), Town Hall, Hammersmith, London, W., by 9:30 a.m. Oct. 14. *See also an advertisement.*

Accumulators and Power Board.

Tenders are invited for the supply of 294 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders to the Deputy Postmaster-General, Perth (W. Australia), by 3 p.m. Dec. 8. *See also an advertisement.*

Lamps, Fittings, Wiring, &c.

The MERSEY RAILWAY Co. require tenders by noon Oct. 14 for supply of electrical sundries, &c., Metallic and Carbon Filament Lamps and Fittings, &c. Forms of tender from Mr. J. Shaw, Central Station, Birkenhead.

LONDON County Council Asylums and Mental Deficiency Committee require tenders by 11 a.m. Oct. 15 for supply of Electric Lamps, &c. Forms of tender from the Committee's offices, 6, Waterloo-place, London, S.W.

WATFORD Council require tenders by Oct. 18 for Wiring their new water pumping station. Specifications, &c., from Mr. D. Waterhouse, Council Offices, High-street, Watford.

Turbo-Alternator, &c.

DARLINGTON Corporation require tenders by Oct. 22 for a 3,000 kw. Turbo-alternator with Surface Condensing Plant. Specification, &c., from the Borough Electrical Engineer.

Electric Cables, Transformers and Switchgear.

LITTLEBOROUGH Urban District Council invite tenders for the supply and laying of High-tension Cables, &c., and for Transformers and Switchgear for sub-station. Specifications, &c., from the Clerk to the Council (Mr. Geo. H. Wild), to whom tenders are to be sent by Friday, Oct. 22. Plans and specifications may be seen at, but not obtained from, the office of consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Sydney, invites tenders by 2:30 p.m. Nov. 4 for 100 miles Two-twisted and 75 miles Three-twisted Rubber-insulated tinned Copper Wire for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department. Specification, &c., from the Deputy Postmaster-General, Sydney.

Generating Plant, Boilers, &c.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for the supply and maintenance for 12 months of two Water-tube Boilers and Accessories at Newcastle, N.S.W. Specification, &c., from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

LONDON.—The contract for the supply and laying of cables for linking up the electric supply undertakings of Battersea and Fulham Borough Councils at £5,641 has been placed with W. T. Henley's Telegraph Works Co.

SALFORD.—The Electricity Committee has accepted the tender of J. Wolstenholme & Son (at £70. 10s.) for the supply of w.i. piping for the additional 5,000 kw. turbo-alternator.

DEPTFORD.—The Council has placed an order with Haycraft & Son for carrying out alterations of the electric lighting at the New Cross Branch Library.

YORK.—The Electricity and Tramways Committee have accepted the tender of the Dunlop Rubber Co. for the maintenance of the tyres of the Corporation's electric omnibuses at a 'bus-mile rate.

BARNSLEY.—The Education Committee have accepted the tender of E. Broley for wiring the Agnes-road schools.

WOLVERHAMPTON.—The Guardians have accepted the tender of L. Andrew & Co. for metal filament lamps, &c., that of Callender's Cable & Construction Co. for cable, and that of the Edison & Swan United Electric Light Co. for four dozen Leclanché cells, one gross opal shades, &c.

CASTLETOWNBERE (CORK).—The Rural Council have accepted the tender of Mr. P. H. Nugent for the electric lighting of the town for 15 years.

Mr. Nugent will erect, maintain and keep in repair such buildings, machinery, posts, cables, wires and lamps as may be required. The number of lights not to exceed 14 of 100 c.p. each and four of 32 c.p. each. The lamps shall not be required to be lighted except between the lighting-up time as prescribed by the Lights on Vehicles Act, 1907, save that on the mornings of winter cattle fairs, when they may be required to be lighted between 5 and 7:30 o'clock. The Council shall secure all licences necessary for the erection of all posts and cables on the public roads and streets. The contract to be for five years from the date of entering into same, and payment to be at rate of £70 per annum, payable quarterly.

BURNLEY—The Guardians have accepted the tender of Messrs. F. Thornton & Co. for the supply of electrical fittings, &c.

MELBOURNE.—*Correction.*—The City Council have accepted the tenders of the Australian General Electric Co. for 12 'bus-bar supports £6 each, and 212 ft. insulated cable £20. 6s. 4d.; and the British Westinghouse Electric & Mfg. Co. for a 1,500 kw. rotary converter with transformer, £4,562. In our issue of Sept. 24 (p. 936) these contracts were erroneously placed under the heading "Sydney."

The City Council have accepted the tenders of the Australian General Electric Co. for one direct-current generator, with accessories, £1,484. 10s., and the Western Electric Co. for insulated copper cables, £2,505.

LAUNCESTON (TASMANIA).—The Council have accepted the tender of British Insulated & Helsby Cables for 2,640 yds. armoured feeder cable and accessories, £1,082. 10s., subject to market prices of materials.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Aberdeen.—The electricity department's accounts for the year ended July 31 show total capital expenditure £454,572 (increase £10,675), of which £138,093 has been redeemed.

Revenue was £60,693 (compared with £60,801 in previous year) ordinary expenditure was £28,009 (£29,036), and casual expenditure £1,576 (£257). Interest required £9,832 (£10,094), and sinking fund £17,755 (£16,262), leaving surplus £4,635 (£4,960), of which £3,520 has been placed to reserve. Units generated were 12,475,920 (11,693,994) and sold 10,463,269 (9,663,054). Maximum load was 4,560 kw. (4,733 kw.) and load factor 26·19 (23·31) per cent.

The city electrical engineer (Mr. J. Alex. Bell) says in his report an almost continuous rearrangement of duties, due to reduction of staff and employés, has been one of the many new conditions created. 33 members of the staff, or 57·89 per cent. of the men between 18 and 40 years, who have not been declared as for service, have joined H.M. Forces. The shutting down of practically all public lighting and the curtailment of shop window lighting has meant a considerable drop in revenue, lighting sales being over £3,000 down, but there is a considerable increase in power sales, due to war munitions and allied work. The coal consumed was 1,744 tons less than in 1913-14, due to the use of the department's latest generating set and the better load factor due to having less lighting load. 181 new consumers were added, 10 of these being in the county. The total number of consumers is now 3,364. Motors connected increased by 1,041 h.p., and the total is now 9,052 h.p. Costs per unit sold were (total coal, coal used at electric stations, and coal used at gas works): 0·611, 0·644, 0·644. The 2,000-kw. turbo-alternator installed in December, 1913, has generated 13,031,160 units out of 12,475,920 units output during the year. Additional plant will require to be installed by the autumn of 1916 or, and, in view of considerable alterations in the engine room, which cannot be done at the period of the year, and the delays in the delivery of new plant, the matter will require to be dealt with in a special report at an early date. Mr. Bell recommends that the present charge of 10d. remain as at present, and that 1d. per unit be applied to all quarterly accounts.

Stepney (London).—The accounts of the municipal electricity department for the year ended March 31 show total capital expenditure £560,343 (increase £20,771), of which £[illegible] is unexpended.

Revenue was £[illegible] (compared with £[illegible] in previous year), total expenditure was £[illegible] (£[illegible]), the gross profit being £44,580 (£44,580), out of this the following amounts were paid: Interest £15,038 (£14,317), repayment of debt £[illegible], additional provision for annual charges £[illegible] (£2,216), London Council rent and charges £1,305 (£1,708), Temporary Advances Act (1915) and expenses on properties (ground rents and fines, &c.) £419, the net profit being £10,702 (£14,176). Total units generated were 21,[illegible]88,000 (17,469,572) and purchased 15,[illegible]0[illegible] (20,631,130), and sold 18,767,867 (16,197,123), including [illegible] supply 1,[illegible]0,[illegible]0 (1,[illegible]).

The engineer and manager (Mr. W. C. P. Tapper) says in his report the operations of the department were influenced in almost every direction by the effects of the European war. In spite, however, of the general and considerable advance in prices of materials (particularly coal) a net profit of £10,702 has been realised, due, in a large measure, to the peculiarly industrial character of the borough attracting a considerable number of Government contracts, for which a large amount of electric power was required. It has not, up to the present, been found necessary to depart from the pre-war tariff. The numbers of units generated and sold are considerably more than double the corresponding figures of four years ago. Throughout the year the arrangements under the agreement with the Poplar Council for reciprocal supplies were in operation, and the convenience and value of these arrangements were appreciated on both sides. At the end of December the bulk supply to Shoreditch Council was inaugurated. This supply will be continued until September, 1916. During the past year the full supply contemplated could not be given or taken in view of the unavoidable delay in the installation of machinery for both undertakings. Total connections in (equivalent) 30-watt lamps at March 31 were: Private lighting 214,343, power and heating 513,350, public lighting 10,929, and private bulk supplies 143,054, total 880,766. Net increase in consumers was 412, making the total 3,132. The miners' and transport workers' strikes sent up the coal cost, and then, during the past year, one of the first effects of the war was to practically stop all seaborne supplies of coal, thus, for the time being, nullifying the otherwise favourable situation of the Blyth's Wharf generating station with regard to coal deliveries. The full effect of the high price of coal is not apparent in the accounts under review, and will much more seriously affect the results for 1915-16. Had it not been for the abnormal conditions prevailing last autumn, the new generating plant at the Lamphouse station would have been in commission throughout the past winter. The gross profit of £44,670 is equivalent to a return of approximately 8¼ per cent. on the average capital expenditure for the year and 9¼ per cent. on the amount of loan debt outstanding. The result of the year's work in the supply of current and apparatus is upon very satisfactory and amply justifies the [illegible] expended by the committee in the carrying out of bare and late purchase work. Owing to the restrictions placed upon capital expenditure by the Treasury, the further laying of mains has been discontinued. Houses are now being supplied under short period hire-purchase terms. It is suggested that the surplus of £598 realised on this section of the work should be taken to the reserve account, thus bringing the reserve to a sum of £1,[illegible]. This amount is considered ample against the outstanding capital value of £4[illegible]. At the outbreak of war 11 members of the staff were enlisted for active service in H.M. Forces. Up to March 31 last a further 24 men were granted permission to enlist. In many other cases applications for permission to enlist have been made by outgoing members of the staff, but in the interests of the maintenance of the supply of electricity such permission could not be granted. An intimation was received from the Admiralty that the undertaking had been placed upon the list of Admiralty contractors, and the issue of war service badges was authorised to those employés whose services were considered necessary to the proper maintenance of the supply of electricity in Stepney.

COMPANIES' MEETINGS AND REPORTS.

CHILIAN ELECTRIC TRAMWAY & LIGHT CO. (LTD.)—The accounts for 1914 show, after deducting interest and redemption of debentures, London office and other charges) a balance to credit of profit and loss account of £106,086, to which is added £9,438 brought forward, making £115,524. From this amount £60,000 has been placed to renewals reserve account and £7,000 to insurance suspense account, leaving £48,524, which it is proposed to carry forward.

S. SMITH & SONS (MOTOR ACCESSORIES) (LTD.)—At the first ordinary meeting last week the chairman (Mr. Samuel Smith) said that their business for the first year had fulfilled the expectations of the prospectus both as to turnover and profits. From March 31, 1914, to July 31, 1915, the profit was £25,267. 1s. 5d., but the profit for the period March 31 to July 31, 1914, belonged to the old company. After paying directors' remuneration, managing director's commission and income tax, writing off the whole of the underwriting expenses and half the formation expenses, they were paying a dividend of 10 per cent. on the capital, leaving £2,256. 10s. 4d. to be carried forward. The financial position might be considered very satisfactory. The goodwill stood at the low figure of £12,740. 3s. 9d., little over half a year's purchase. The managing director had calculated that the regular business of the company represented 80 per cent. of the turnover for the period under review, the remaining 20 per cent. being represented by direct Government orders. The orders in hand amount to a quarter of a million sterling, and there seemed to be no doubt whatever that for the period of the war the works would be occupied day and night. The colonial branches were now in full swing, and the returns were satisfactory. He saw no reason why the company's ordinary business, on the termination of the war, should not increase very largely owing to the ever-steady and increasing demand for the firm's products, and he looked to the colonial branches as much as to any other part of the company's activities to fulfil his expectations.

TUCUMAN TRAMWAYS, LIGHT & POWER CO. (LTD.)—The accounts for period from March 26, 1914 (the date of incorporation), to June 30, 1915, show a loss after providing for debenture interest, &c., of £42,517.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ACTOSE MFG. CO. (LTD.) (141,657.)—Reg. Sept. 24, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in cellulose, acetate and substitutes therefor, to carry on the business of chemists, manufacturers of electrical and other goods. Private company.

C.E.C. (LTD.) (141,711).—Reg. Sept. 29, capital £5,000 in £1 shares to carry on the business of electrical, constructional, mechanical and general engineers, founders, machinists, constructors of railways, tramways, railway carriages and wagons, &c., and to enter into an agreement with H. E. Ellis. Private company. First directors are H. E. Ellis (permanent governor) and H. E. O. Ellis. Reg. office 96, Ironmonger-row, Old-street, E.C.

ILFORD DRY BATTERY CO. (LTD.) (141,694).—Reg. Sept. 28, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in dry and electrical batteries and apparatus and equipment of all kinds, electricians, engineers, &c. Private company. First directors are W. C. Thick and R. Harvey.

MAGNESIUM METAL CO. (LTD.) (141,667.)—Reg. Sept. 25, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in magnesium and other metals, chemical manufacturers, oil and colourmen, manufacturers of and dealers in surgical, electrical and scientific apparatus, &c. Private company. First directors are P. St. Clair Matthey, R. P. Sellon, A. H. Barker and G. S. E. Caillard (each of whom may retain office while holding 200 shares).

MORTGAGES AND CHARGES.

AUTOELECTRIC TRANSMISSION (LTD.)—At July 27 capital was £10,000 in £1 shares. 9,918 shares taken up. £3,806 paid. £6,112 considered as paid. Mortgages and charges, £200.

T. H. BROOKER & CO. (LTD.)—Equitable mortgage by deposit, charged on all sums due or to become due to company under a Munitions Office contract for supply of clinometers (dated Sept. 23, 1915), to secure all moneys due or to become due from the company to London & South Western Bank.

DELABOLE ELECTRIC LIGHTING & SUPPLY CO. (LTD.)—Mortgage dated Sept. 18, 1915, securing £200, charged on certain chattels, comprising certain electric generating and distributing plant, &c. Holders: E. Bant and Miss E. A. Bant.

DYNAMIC ELECTRICAL CO. (LTD.)—Capital in return at Dec. 31, 1914, was £100,000 in £1 shares (filed June 30, 1915). Seven shares taken up. £7 paid. Mortgages and charges nil.

FERRANTI (LTD.)—Mortgage and charge dated Sept. 10, 1915, to secure £100,125, charged on land, buildings, &c., at Stakeleach or Stephenson Fold, Failsworth, Manchester. Holder: Secretary of State for War.

CITY NOTES.

MEMORANDA (Oct. 6).—Bank rate 5 per cent. (since Aug. 9, 1914). Consols 65. Consols Pay Day Nov. 5. Stocks and Shares Pay Days Oct. 13 and 27. Pay Days Oct. 14 and 28. Price of silver, 27d.

CALCUTTA ELECTRIC SUPPLY CORPN. LTD.—The directors have declared an interim dividend on the ordinary shares [illegible] at rate of 7 per cent. per annum for the six months ended June 30, payable on Nov. 15.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—Interim dividends for the six months ended June 30 have been declared at rate of 10 per cent. per annum (less tax) on the preference shares, and at rate of 5 per cent. per annum (tax free) on the ordinary shares, payable on the 21st inst.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved to pay an interim dividend of 2s. per share [illegible] at 1s. 2d. in the £), such dividend to be payable on and after the 30th inst., making with the interim dividend already paid, a total distribution of 4 per cent. for the half-year ended Sept. 30.

SOUTH BRAZILIAN RAILWAYS CO.—This company, which owns the tramway and electric lighting undertakings and concessions in Curityba, Parana, Brazil, has convened separate meetings of the 5 per cent. First Mortgage Debenture holders (first and second series) to consider a scheme of capital arrangement. It is proposed to raise not exceeding £240,000 by bankers' loans or prior lien debentures to bear interest not exceeding 6 per cent. per annum. The debenture holders are to forego payment of the coupons due Oct. 1, 1914, April 1 and Oct. 1, 1915, and in substitution for the fixed rate interest will be paid on the following basis: The net earnings of the tramways in any financial year commencing from April, 1914, are to be appropriated first to the payment of interest not exceeding 6 per cent. on the first debentures, and the net earnings derived from the electric supply undertaking are to be appropriated to the second series of debentures.

SUBMARINE CABLES TRUST.—Notice is given that on the 15th inst. the coupon due on that date will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Oct. 6. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Oct. 6.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅞	7 2 8	Mar. Sept
10	4½%	Do. 4½% Cum. Pref.	9¼	4 15 8	Feb. Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅞	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	8⅞	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	84	4 15 4	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 9 9	..
5	5%	Do. Ord.	4	6 5 0	Aug. Feb
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb. Aug
10	6/0	Do. 6% Pref.	12¼	4 17 0	Mar. July
St.	5%	Do. 5% Deb. St.	99½	5 0 0	Jun. Dec
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	9⅞	0 1 6	Feb. Aug
St.	4½%	Do. 2nd Deb.	96½	4 13 3	May Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	76½	5 17 8	Jan
5	9%	Kensington and Knightsbridge Ord.	6⅞	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4¼	7 1 2	..
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2⅜	7 7 4	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	95⅞	4 14 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	98½†	6 1 10	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 11 7	Apl, Oct
St.	5%	South London E.S. 1st Mort. Debs.	95	5 5 3	Jan, July
St.	4½%	Urban Elec. Supp 4½% Db. St	84†	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1½	7 2 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	7⅛	6 7 5	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅛	5 7 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	79†	6 11 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	69	8 13 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	69½	5 15 1	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	100	4 10 0	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	84	4 15 3	May Nov
St.	5%	Do. Pref. 1890	80	6 5 0	Feb, Aug
10	5½%	Lanarkshire Tramways	9½	5 17 11	Feb, Aug
10	1%	London Electric Ry. Ord.	1⅛	8 17 9	Jan, July
St.	4%	Do. 4% Pref.	62¾	0 7 3	Mar. Sept
St.	4%	Do. 4% Debs.	85½	4 14 1	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23⅜	4 0 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	80½	4 4 5	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	13	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	67	6 14 4	Feb, Aug

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., Oct. 6	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
St.	6%	Metropolitan Dist. Ry. 6% Perp. Debs	129¼	4 12 8	Jan, July
St	4%	Do. 4% Debs.	66½	5 14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	63½	5 16 9	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅛	..	..
1/0	..	Do. A Ord.	2	..	..
St.	6%	Do. 6% Inc. Debs.	103½	5 16 10	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 16	71¼	8 7 3	Mar, Sept
..	4½%	Do. 4½% Bds.	93½	4 11 6	Jan, July
5	..	Yorkshire W. Riding Ord.	⅛	..	March
5	6%	Do. Pref.	4½	6 14 4	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2 3/16	6 8 0	Apl, Oct
1	5%	Brit. Aluminium Ord.	1 3/16	4 15 3	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 6	Jan, July
1	6%	Do. 6% Pref.	⅞	6 12 5	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞†	7 5 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 9 1	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref	⅛	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1⅛	8 5 6	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73½	5 8 10	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10†	7 6 4	Jan, July
5	2/6	Do. 5% Pref.	4½	5 17 8	Feb, Aug
1	15%	Castner Kellner	3 1/32	4 19 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	8 6 11	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	3	..	Feb, Aug
1	6%	Elec. Construction Ord.	⅝	9 1 2	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10 3/16	9 7 2	July
10	6%	Do. 6% Pref.	9 1/16	6 9 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12 7/16	7 18 10	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7 3/16	6 6 7	Feb, Aug
10	5%	Do. Pref.	8¼	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	98†	4 1 8	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	31	7 11 7	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅝	4 12 1	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	81	4 18 9	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½	4 10 3	Jun, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	100	6 0 0	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22½	6 15 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	6.†	6 1 3	Ja.Ap.Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½†	6 13 4	..
10	4%	Direct United States	6	6 13 4	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	117½	5 18 11	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 6 1	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81	4 18 9	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	12 1/2	5 15 9	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33⅛	7 3 1	Ja, My, Jly
25	13%	Indo-European	42½	7 2 0	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅝	5 6 8	April
1	7%	Do. 7% Pref.	1½	3 19 0	July
10	9d.	West India & Panama Ord.	1⅛	8 17 9	May, Nov
10	6%	Do. 1st Pref.	8½	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12¼	5 15 6	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	100	4 10 0	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap	129½†	6 3 7	Ja,Ap, Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	75½	6 12 5	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅝	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	9 7/8	4 9 8	May, Nov
1	10%	Oriental Telephone Ord.	1⅜	5 2 7	Apl, Oct
St.	4%	Do. Db. St.	80	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	5 1/16	7 6 8	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4	5 3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	Globe Telegr. & Trust	9 3/8†	6 5 2	Sp.Dc.Mr, Jn
10	6%	Do. 6% Pf.	9 3/16†	6 2 4	Sp.Dc.Mr, Jn
100	5%	Mackay Companies' Common	80	6 5 0	Ja, Apl, Jly.O
..	4%	Do. $100 Pref.	64½	6 0 4	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	121	4 19 2	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Tram. 5% Debs.	74½	6 14 3	Jun, Dec
St.	4½%	Do. 4½% Debs.	64½	6 7 4	Jan, July
St.	4%	Do. 4% Debs.	73½	5 9 1	Jan, July
5	2/9	Do. 5% 1st Pref.	3½	5 3	Jan, July
5	2/9	Do. 5% 2nd Pref.	3⅛	7 10 6	Jan, July
100	7%	Brazilian Traction Ord.	64½	6 1 7	Ft.M.Aug.N
100	$1½	Do. 6% Pref.	84¼	6 19 1	Ja.Ap.Jly.O
5	8%	Brisbane Trams Ord.	5 1/8	7 4 3	May
5	2/6	Do. 5% Cum. Pref.	4½	5 5 3	May, Nov
St.	4½%	British Columbia 4½% Cum. Debs.	69½	7 10 6	..
5	9½%	Calcutta Elec. Trams Ord.	9¼	7 12 ..	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	55¼	9 1 1	Feb, Aug
5	6%	Madrid Elec. Tramways 6% Cum. Pref.	5	6 0 0	..
100	5%	Manaos Tramway 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Tramway Ordinary	11	..	Ft.M.Aug.N
..	5%	Do. 5% Bds.	71½	7 6 6	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (Gold)	91	4 19 1	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 5% Bds.	87	6 10 11	Jan, Dec
100	4½%	Toronto Railway Co. 4½% Debs.	93	4 17 3	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4¼	1 9	Mar, Sept
St.	5%	Do. 5% Debs.	70½	7 2 8	Jan, Dec
10	6%	Bombay E. S. & T. Co. Pref.	13½	4 17 9	..
5	9½%	Calcutta E. & Corp. Ord.	9⅞	4 12 1	May, Nov
5	5%	Do. 5% Pref.	5⅞	5 4 3	May, Sept
..	7%	Canadian Gen. Elec. Co. Pref.	113½	6 14 7	Ja,Ap,Jly,O
St.	5%	Mexican Light & Power 5% 1st Mtg. Debs.	73½	7 1 9	Jan, Dec
St.	5%	Do. 5% Cons. Deb. Stock	52	7 1 3	Apl, Oct
..	5%	Shawinigan Water & Power 5% Bds.	101½	4 19 9	Jan, July
..	6%	Do. Com. Stock	137½	4 10 8	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	85	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	84½	5 1 3	May, Nov
1	..	Victoria Falls & Transvaal P. Co. 6% Pf.	1	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	86½	6 4 2	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 6, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13¼d.	English Lead	£25 0 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15d.	**Old Metals.**	per ton.
Brass Wire	12½d	Clean Scrap Copper	£67 10 0
Copper Wire	12½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£52 10 0
Brass Sheets	13½d.	Old Lead	£19 10 0
		Old Zinc	£38 0 0
	per ton.	Hollow Pewter	£110 0 0
Copper Sheets	£98 0 0	Black Pewter	£85 0 0
Spelter	£72 0 0	Gun Metal	£61 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Oct. 5, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£85 0 0	Old Lead	£21 10 0
Clean Mixed Brass	£54 0 0	Tea Lead	£19 10 0
Clean Copper	£69 0 0	Old Zinc	£40 0 0
Braziery Copper	£65 0 0	Hollow Pewter	£110 0 0
Gun Metal	£64 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £63. Commercial Tinman's Solder, £83; Blowpipe Solder, £98.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Sept. 29	1,767	— 150	17	32,420	+ 1,129
Anglo-Argentine	,, 30	49,939	— 665	39	1,930,825	— 137,719
Ashton-under-Lyne	Oct. 2	441	+ 35	27	13,325	+ 760
Ayr Corporation	,, 2	353	+ 75	20	9,822	+ 461
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	,, 3	1,355	+ 106	27	37,185	+ 2,716
†Birmingham Corporation	Sept. 25	16,359	— 3,733	26	353,068	+ 37,634
Blackburn Corporation	,, 29	1,243	— 28	27	36,552	— 572
Blackpool Corporation	,, 30	5,188	+ 482	27	59,140	+ 849
Blackpool and Fleetwood	Oct. 2	998	— 141	39	34,384	— 317
Bolton Corporation	,, 3	2,545	+ 19	27§	73,064	— 3,095
†Bournemouth	Sept. 29	2,148	— 290	26	60,317	+ 2,559
Bradford Corporation	Oct. 2	6,393	+ 516	26	178,272	+ 7,774
Brighton Corporation	,, 3	1,101	+ 14	27§	32,808	— 230
Bristol Trams { Trams	,, 1	4,609	— 31	39	183,926	+ 392
Bristol Trams { Buses, &c.	,, 1	5,093	+ 1,033	39	191,874	+ 33,406
Burmah E. Trams & Ltg.	,, 2	R3,427	— R662	39	R139,158	+ R366
Burnley Corporation	,, 2	1,592	+ 149	26	58,085	+ 1,694
Burton Corporation	,, 3	255	— 2	27	7,896	— 356
Bury Corporation	,, 3	1,329	+ 79	27§	37,735	— 1,129
Calcutta Tramways Co.	,, 2	R66,365	+ R8,312	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	,, 2	2,706	+ 77	26	73,596	— 3,261
Cork Electric Trams Co.	Sept. 30	503	— 16	39	19,789	— 75
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	Oct. 5	1,014	+ 45	26¼	28,567	+ 594
Dover Corporation	Sept. 25	334	+ 73	25	8,518	+ 1,629
Dublin & Lucan Railway	Oct. 1	165	+ 10	13	2,261	+ 42
Dublin United	,, 1	6,265	+ 114	39	240,663	+ 8,957
Dundee Corporation	Sept. 29	1,348	+ 61	20	47,231	+ 1,177
East Ham Council	Oct. 2	1,274	+ 56	26	35,535	+ 5,397
Exeter Corporation	,, 1	367	+ 7	26	10,608	+ 613
Glasgow Corporation	,, 2	23,054	+ 2,477	13‡	387,892	+ 22,746
Glossop Trams	,, 2	148	+ 21	40	5,009	— 2
Gloucester Corpn.	Sept. 29	342	— 25	26	9,089	— 17
Halifax Corpn. { Trams	,, 28	2,344	+ 330	26	61,202	+ 738
Halifax Corpn. { Buses	,, 28	80	+ 4	26	1,865	+ 5
Hastings Elec. Trams Co.	,, 30	1,032	— 52	39	39,481	— 54
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	Oct. 2	3,067	+ 42	26	83,989	— 2,833
Ilford District Council	,, 2	627	+ 35	26	17,833	+ 2,714
Ilkeston Corporation	Sept. 29	137	+ 12	26	3,557	+ 59
Ipswich Corporation	Oct. 2	541	+ 105	25	15,502	+ 2,358
Isle of Thanet Co.	Sept. 30‡	257	— 102	39	22,750	— 11,031
Kilmarnock Corporation	..	..	..	..	..	..
Lanarkshire Trams Co.	,, 30	2,426	+ 577	39	76,751	+ 2,617
Lancashire United	,, 29	1,788	+ 202	39	68,737	+ 3,963
Leeds Corporation	Oct. 2	8,000	+ 200	27	242,882	+ 18,895
Leicester Corporation	,, 2	2,978	+ 305	40	119,330	+ 5,722
Leith Corporation	,, 2	750	+ 110	30	12,961	+ 834
Lincoln Corporation	,, 2	133	+ 29	27	3,851	+ 391
Liverpool Corporation	Sept. 25	13,477	+ 1,491	38¶	512,479	+ 4,020
Llandudno&ColwynBayR.	Oct. 1	361	+ 86	44	15,490	+ 1,358
London County Council	Sept. 22	46,760	+ 4,484	25	1,095,822	+ 995,715
Lowestoft Corporation	Oct. 2	136	— 57	22§	2,134	— 2,291
Maidstone Corporation	Sept. 30	265	— 11	..	6,102	+ 62
Manchester Corporation	Oct. 5	17,629	+ 600	39	481,176	+ 12,714
Nelson Corporation	,, 2	201	— 24	26	5,340	— 106
Newcastle-on-Tyne Corpn.	,, 2	6,744	+ 810	27	169,121	+ 23,989
Newport (Mon.) Corpn.	,, 2	831	+ 44	27	22,832	— 7
Northampton Corporation	,, 1	707	+ 95	39¶	20,171	+ 4,142
Nottingham Corporation	,, 2	3,682	+ 444	26	99,677	+ 6,765
Oldham Corporation	,, 3	2,169	+ 30	28	65,065	+ 1,285
Portsmouth Corporation	Sept. 29	2,493	+ 242	27	69,405	..
Preston Corporation	,, 29	964	+ 77	26••	25,515	+ 269
Ramsgate	..	..	..	..	..	..
Rotherham Corporation	,, 29	1,164	+ 38	26	30,351	+ 3,102
Sheffield Corporation	Oct. 4	5,414	+ 297	27‡	142,004	+ 4,212
†Southhill Corporation	,, 3	9,181	+ 1,522	27‡	244,339	+ 30,748
Southampton Corpn.	Sept. 29	1,547	+ 278	26	1,547	+ 3,353
Southend Corporation	,, 29	814	— 145	26	24,662	— 7,119
Stockport	,, 25	799	+ 104	26§	21,009	+ 438
Stoke-on-Trent, &c., Jt. B	..	..	..	..	..	..
Sunderland Corporation	Oct. 3	1,454	— 145	27	40,764	— 651
Swansea Improvt.	Sept. 29	1,369	— 46	48	27,363	— 649
Swindon Corporation	,, 29	1,164	— 30	26	5,375	+ 563
Tynemouth Trams Co.	,, 29	1,164	— 144	12	8,033	— 78
Walsall Corporation	Oct. 2	1,197	+ 39	26	36,278	+ 8
Warrington Corporation	,, 2	775	+ 139	40	29,149	+ 4,179
Warrington Corporation	,, 2	813	+ 87	27	25,872	+ 3,076
Warrington Corporation	Sept. 30	429	+ 80	26	11,296	+ 430
West Ham Corporation	,, 30	3,081	+ 300	26	80,598	+ 8,231
Wigan Corporation	,, 30	1,553	+ 147	26	40,304	+ 1,210
Wolverhampton Corpn.	,, 29	1,118	+ 95	26	29,391	+ 1,175
Yorkshire W.R. Trams	Oct. 3	1,579	+ 107	40	63,751	+ 5,329

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 39
Arrangements for the Week .. 42
Harmonics in Transformer Magnetising Currents. By J. F. Peters. Illustrated. *Concluded* 43
Electric Welding. By C. B. Auel. Illustrated 45
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated 48
The Iron-Cobalt Alloy, Fe_2Co, and its Magnetic Properties. By Trygve D. Yensen. Illustrated 52
On the Relation Between the Alternating-Current Conductivity of a Dielectric and its Change of Capacity with Frequency. By G. E. Bairsto, D.Sc. Illustrated. 53
PROGRESS OF ELECTRIC WELDING 56
REVIEWS 57
Tramway Track Construction and Maintenance [Holt]: Reviewed by R. G. H. Clements.
First Principles of Production [Peddie].
Aircraft in the Great War [Grahame-White and Harper].
Electrification on the London & South-Western Railway. Illustrated. *Continued* 59
CORRESPONDENCE 61
The Audion Amplifier (E. H. Armstrong).
The Direction Finder (E. Bellini).
Earth Resistance (W. H. F. Murdoch).
Thermal Characteristics and Intermittent Rating. Illustrated 62
Insulating Compounds in Telephony 64
The "Electrician" Commercial and Industrial Section 65–76

NOTES.

Magnetic Dispersion in Induction Motors.

IT has long been recognised that the dispersion coefficient is the principal factor governing the performance of an induction motor, for on this coefficient depends the power factor and overload capacity of the motor. About 15 years ago Mr. B. A. BEHREND proposed a simple formula for estimating the value of the leakage factor, as it was then called. By experiment he found that this factor was proportional to the distance across the air-gap and inversely proportional to the pole-pitch. A constant depending upon the shape and size of the slots was introduced, and it was stated that "the constant depended upon a great many other conditions on which we are still profoundly ignorant." This work paved the way to a thorough understanding of the principles underlying the design of induction motors. BEHREND strongly advocated the building of the mathematical superstructure upon a sound experimental foundation, and it is interesting to note that practically all the additions to our knowledge on the subject have been reared on such a foundation. Mr. H. M. HOBART included another constant factor in BEHREND'S formula in order to take into account the effect of the so-called "zig-zag" dispersion along the heads of the teeth, and for squirrel-cage motors a third factor was introduced. Later, an empirical method, based on a large number of tests, was given by the same authority. From the busy designer's point of view the method is satisfactory, in so far as it is easy to apply and gives fairly reliable results.

SOME time after BEHREND had enunciated the principles, Dr. BEHN-ESCHENBURG contributed a valuable Paper, entitled "The Magnetic Dispersion of Induction Motors and its Influence on the Design of these Machines" to the Institution of Electrical Engineers, in which the matter was investigated theoretically and experimentally, and the basis was laid for the design of motors. The exhaustive series of comparative tests described in this Paper helped to clear up many of the obscure problems connected with the subject, and in the expression for the dispersion coefficient account was taken of the influence of the end connections, of the embedded portion of the winding and of the proportions of the teeth on the magnitude of the coefficient. Another forward step was made in the series of articles contributed to THE ELECTRICIAN by Dr. R. GOLDSCHMIDT. These articles (since much amplified and published in book form), it will be remembered, were characterised by simplicity of treatment, and were prepared with the object of developing methods for the calculation of the no-load current and the leakage of induction motors, taking account of all influences as far as possible. We commence in this issue the publication of a further contribution to the theory of the subject. In this article the author, Mr. E. A. BIEDERMANN, develops a method of pre-determining approximately the dispersion coefficient of a three-phase induction motor from its known dimensions, and shows how the proportions of a motor of given output may be so chosen that it shall have the least dispersion possible under certain given conditions. This means that the power factor and overload capacity of the motor will be a maximum. We venture to think that Mr. BIEDERMANN'S method will throw further light on the subject.

Depreciation of War Plant.

AT the present time some uneasiness is beginning to be felt by electricity supply authorities in regard to their financial burdens in the near future on account of generating plant which is now being put in for supplying electrical energy to factories engaged in munition work. The demand that has arisen on this account has been heavy, and consequently in many cases, for example at Birmingham, it has been necessary to put down special plant. After the war the demand in this direction will no doubt fall off considerably, and many authorities will find themselves with plant which is no longer required. The question therefore arises whether the Ministry of Munitions should come to the assistance of the authorities so that the capital charges for plant of this kind should not fall too heavily upon the undertakings. It appears to us that the subject falls into two classes. In the first is that type of plant which is purely temporary in character. For the supply authority such plant will probably be unsuitable for extension, and therefore not of much value. It is obviously put down for war purposes only, and as such we think its cost should be met very largely by the Government. On the other hand, it may happen that

plant has been put down which would in any case have been installed later on to meet the ordinary demands. The programme has merely been accelerated. The load on the plant will certainly be less after the war, and possibly the plant will not be fully utilised for two or three years. But in that case its usefulness will merely have been postponed, and temporary help by the Government should prove sufficient. In any event, we think that the subject is one that should be given benevolent consideration by the Government.

Magnetic Properties of Iron and Cobalt Alloys.

It has generally been held that the magnetic qualities of alloys of iron would be inferior to those of iron that is pure, but this view must now give way in the light of researches by Mr. T. D. Yensen, which are described in another column. This investigation is the outcome of an observation by P. Weiss in 1912 that the alloy Fe_2Co showed a saturation value of magnetisation higher than that of pure iron. Mr. Yensen has now found that the saturation value is 13 per cent. above that of iron; and, what is more important, that the magnetisation is 25 per cent. higher in medium fields. It will be remembered that an important investigation by Mr. Yensen, which was described recently in our columns, dealt with the magnetic properties of iron which had been melted *in vacuo*, and showed the enormous importance of small traces of iron oxide. In the case of iron-cobalt alloy there is also an improvement by this treatment, though not very great. The maximum permeability obtained by Mr. Yensen for the alloy after melting *in vacuo* was 13,500, which is much higher than that obtained for the best grades of transformer iron.

It is curious that cobalt should have this beneficial effect, whereas nickel appears to give quite the opposite result. This is particularly strange considering the fact that iron and cobalt are such closely allied members of the iron group, having nearly the same atomic weights and being extremely similar in their chemical properties. Moreover, both nickel and cobalt have only low permeabilities. When we come to practical applications these do not seem to be so very promising. From the point of view of utilisation of material it would certainly be a great advantage if an alloy of this kind could be used for armature teeth where the flux density is always very high, more particularly since the hysteresis loss is as low as in commercial grades of iron. Both iron and copper could be saved in this way. Unfortunately, however, the mechanical properties of the alloy are by no means good. It is brittle, and this is likely to militate very greatly against its use. Nevertheless, the subject is undoubtedly worthy of further investigation, both from the practical and theoretical points of view. It would seem as though investigations of this kind should throw a good deal of light on our views of the production of magnetism.

Water-power in Prussia.—In an article in a recent issue of the "E.T.Z.," based on a German Government publication, statistics are given of the water powers of the mountainous districts of Prussia. The area covered by the statistics is about 35,900 square miles, and there is available in this district 1,800,000 H.P. of water power, of which only 450,000 H.P. has been developed, while 1,350,000 H.P. remains to be developed.

A New Electric Hammer Drill.—The Western Electric Co. are now making a line of electric hammer drills for mining work. A small motor drives through laminal gears a crank giving an oscillatory motion to a plunger that hits the drill or hammer rod. Elasticity is given by an ingenious magnetic grip for the plunger, so arranged that the coil is stationary and is in series with the motor. These hammers can deliver from 1,400 to 4,000 blows per minute.

A Practical Aeroplane Telephone.—According to the "Scientific American," a telephone has been made for use between pilot and passenger on aeroplanes, which operates satisfactorily notwithstanding the roar of the engine. It employs transmitters strapped to the chest and provided with soft rubber caps, the chest muscles transmitting the vibrations of the voice. The battery consists of three dry cells, which give sufficient energy for 100 hours' continuous service.

Kite-Supported Aerials for Radiotelegraphy.—In the recent manœuvres of the United States Army the Signal Corps made some experiments with aerials consisting of a string of kites reaching to an altitude of 6,600 ft. A field radiotelegraphy set thus equipped could transmit 150 miles, though with the ordinary mast aerial the range is only 25 miles. Receiving is also greatly improved by this method. Extensive tests will be undertaken, as it seems probable that the range of the sets can in this way be increased from 6 to 16 times.

New Electrical Journal.—We extend a cordial welcome to our contemporary "Elektron," which is the latest addition to the list of electrotechnical journals. "Elektron" is published monthly at Reykjavik, the capital of Iceland, frequently termed the land of waterfalls. We are pleased to learn that the development of hydro-electric works and the use of electrical energy for lighting and power have made considerable progress in Iceland during recent years. We wish every success to our young contemporary, which has been established to foster the electrical industry in Iceland.

Separate Unit for Electric Auxiliaries.—Writing in "Power," Mr. A. D. Williams describes how in the Cleveland municipal power plant a 1,000 kw. turbo-generator is used entirely for the electrical auxiliaries, thus making these independent of line troubles. There are two sets of 2,300-volt 'bus bars for the auxiliary plant, one set connected through an oil switch to the 1,000 kw. turbo-generator, and the other to three single-phase transformers, the high-tension (11,000 volt) sides of which are fed from the main 'bus bars. Some of the power is used in 2,300-volt motors, but most of the pump motors are worked by stepped-down current at 440 volts, while there are also rotary converters supplying 250-volt continuous current.

Automatic Electric "Boosting" Pumps.—An interesting application of electric pumping is furnished by the installation at the Hotel Baltimore, Kansas City, Missouri, U.S.A. This is a 12-story building in which water is distributed from a tank on the roof normally kept full by the pressure from the city mains. This pressure, however, sometimes drops, and to meet these conditions three "booster" pumps have been fitted to assist in lifting the water. These are motor-driven Gould's double-suction centrifugal pumps. Two work in parallel, and a Cutler-Hammer pressure-controlled automatic starter cuts in one of these when the pressure falls below a certain value; the other is kept in reserve. The third pump, in series with the others, is brought into play when the pressure in the city main falls altogether. The pumps, which have a capacity of 300 gallons per minute each, are driven by Westinghouse 25 H.P. motors running at 1,400 revs. per min.

The Electric Furnace for Copper Ore Smelting.—It is reported from Norway that trials have been undertaken at the Hon Smelting Works, Trondhjem with an electric furnace of 1,000 H.P. for the smelting of copper ore, from which it is expected to produce 2,000 tons of copper per year. Experimental investigations have indicated that it should be possible to treat copper ores as successfully in the electric as in the combustion furnace, for in the latter the fuel takes no part in the reactions by which the copper is separated, except possibly in the case of oxide ores being smelted alone without any additional sulphides. This, however, is hardly ever done. In semi-pyritic smelting the oxidation of the sulphides and iron is effected by the oxygen of the air from the tuyères, and the coke simply supplies the amount of heat for the process which is not supplied by the oxidation itself. Messrs. Lyon and Keeney, who have carried out experiments in connection with

tests made by the U.S. Bureau of Mines, believe that the electric copper smelting furnace should be both metallurgically and commercially practicable.

Ionization Potential of an X-Ray Tube.—Under the above title Mr. E. C. Drew recently read a Paper before the American Physical Society. The author remarks that in many recent publications the statement is made that the ionisation potential of an X-ray tube is very much greater than the running potential, or, in other words, it takes a much higher voltage to break down the resistance of the tube than it does to maintain the flow of current, once it is started. An experimental investigation of the point has been made by the author with several standard type tubes. The current through the tube and the fall of potential across the tube are recorded by a loop oscillograph. The measurement of potential by an indirect method eliminates the objection to a direct one—viz., same current through the loop as through the tube. Each loop system is calibrated to read drop or current as required, and the instantaneous values of the wave form are scaled off. From the values thus obtained curves are plotted, which indicate that the ionising potential is not of the same order as generally supposed. The law of current in the tube is not that of Ohm. The energy of ionisation and the percentage that this bears to the total energy supplied is not the same in different types of tubes.

Oscillating Audion in Long-distance Radiotelephony.—We have received a letter from the De Forest Radio Telephone & Telegraph Co., stating that for the first time in a public trial the oscillating audion was used at both transmitting and receiving stations in the recent long-distance radiotelephone demonstrations from the Arlington station to the San Francisco and Honolulu stations.

At the transmitter a bank of large bulbs very similar in structure to, and embodying the elements and circuits of, the De Forest Oscillion, illustrated and described in THE ELECTRICIAN, June 12, 1914, was used. These were energised from a common dynamo, their "output" circuits acting in unison on the common radiating antenna. Other auxilliary audion paths which were in their turn voice-controlled (from a "master microphone") controlled this high-frequency energy as generated. The demonstration was remarkable in the large amount of power for the first time generated here, but the cost of the maintenance of the comparatively large number of really expensive bulbs, and the difficulty of maintaining the requisite high vacuum, make it, as yet, less practical than the arc-in-hydrogen transmitter. The main point in its favour (the oscillion) is the ease with which the large power outputs can be controlled by a small master microphone. At the receiving station the De Forest audion detector and amplifier were used, connected so as first to amplify the high-frequency currents to approximately 100 times their original intensity, and then to transform these into low-frequency telephone currents capable of actuating the telephone receivers.

Our correspondents complain that the Western Electric Company's engineers who worked out the details under the Navy auspices, at Arlington and San Francisco, are quite loath to admit publicly the use of the devices and principles as above described. However, the essential facts are as here stated. The essential fact that the Western Electric Company, one year ago, purchased from the Radio Telephone & Telegraph Co. licences under all the De Forest audion and stone wireless telegraph patents is one which the public records in the United States Patent Office demonstrate. The letter concludes by stating that in this recent phenomenal radiotelephone work (as was the case in the announcements of the opening last January of the trans-continental wire telephone) the essential part played therein by the audion detector or amplifier as a telephone repeater, has been concealed or denied as completely as was found possible.

The Turbo-Electric Ship "Mjolner."—A description of this interesting Swedish vessel was given recently in the weekly shipbuilding edition of the "Journal of Commerce." The installation on the "Mjolner" has been carried out by the Svenska Turbinfabriks Aktiebolaget Ljungström of Finspong, known here as the British Ljüngstrom Marine Turbine Company, the steamer being built for the Svea Company for coasting trade round Sweden. The vessel is 225 ft. long and has a displacement of 2,250 tons. The normal speed is 11 knots, for which 900 shaft horse-power must be delivered by the propelling plant. This is in two units, each consisting of a Ljüngstrom double-rotation turbine driving two alternators, which deliver three-phase current to two motors driving a common helical spur wheel on the propellor shaft. The capacity of each turbo-generating unit is 400 kw. and their speed 7,200 revs. per min. The voltage is 500, and the frequency 120 cycles. The motor speed is [illegible] revs. per min. and that of the propellor shafts 55 revs. per min. Electric pumps are employed for the condensers, but the bilge pumps are steam driven. Governors are fitted to the turbines and speed regulation obtained by resistance in the motor circuit. The two boilers are of the ordinary cylindrical marine type with a diameter of 10 ft. 10 in. and a length of 10 ft. 9 in., and operate at 220 lb. pressure. They are fitted with Howden's system of forced draught and Schmidt's superheating arrangement, the air for the draught being the ventilating air from the generators. Saturated steam is supplied to the electric light plant and to other auxiliary machinery. An interesting feature of the main gearing is the introduction of slipping clutches between the motors and their spur wheels to guard against the teeth being broken when in ice-bound waters. A sister ship was at the same time constructed with reciprocating engines and ordinary drive, and the "Mjolner" is guaranteed to give a coal consumption at least 30 per cent. less than that of this other vessel, while calculations indicate a probable saving of 38 per cent. The loading space is also increased by reason of the small room required for the plant and because the lower consumption makes the necessary bunker space smaller.

OBITUARY.

KILLED IN ACTION.—Capt. Wm. Casson, of the 7th London Regiment (T.F.), was recently killed in action. Deceased was educated at Ruthin Grammar School and the Central Technical College. He was a member of the Institutions of Electrical and Mechanical Engineers, and before the war he was engaged at the District Railway Works, Ealing Common.

We regret to learn that on Sept. 25 Lieut. A. Leslie Hamilton Jacob, 18 Batt. (London Irish Rifles), the only surviving son of Mr. and Mrs. Arthur Jacob, of Sterndale, Hatch End, Middlesex, was killed in action in France. Lieut. Jacob, who was born in Dublin in 1896, was educated at Bowden House, Seaford, and Felsted, Essex. He was gazetted in September last, and obtained promotion in May.

We have also to record the death of Captain Ivan Richard Gibbs, 10th Gloucesters. He was 24 years of age, and had gained the B.Sc. degree, after which he became an assistant demonstrator in science at the Imperial College of Science and Technology at South Kensington. He then belonged to the Inns of Court Rifles, but after the outbreak of war took a commission in the 10th Gloucesters.

Corporal Fawcett, formerly a driver in the employment of Accrington Corporation tramways department, has been killed in France.

Private J. C. Wooster, of the 6th Wilts Regiment, formerly employed by the Richmond (Surrey) Electric Light & Power Co., has been killed in France.

Private Hy. Saxon, formerly with the Tudor Accumulator Co. at Dukinfield, has been killed at the Dardanelles.

PERSONAL.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

London Electrical Engineers : F. A. V. Morse to be Second Lieutenant.
Hampshire (Fortress) Engineers : Sapper Hy. A. P. Bale (from London Electrical Engineers) to be Second Lieutenant.

APPOINTMENTS VACANT AND FILLED.

Holmfirth Urban District Council require an electrical engineer to take charge of their electrical undertaking, one having had experience with suction gas plant and overhead wiring preferred. Commencing salary £2. 5s. per week. Applications to the clerk of the Council, Mr. A. Percy Ruscoe, Council Offices, Holmfirth, by Wednesday, Oct. 20. *See advertisement.*

Huddersfield Corporation electricity department requires a skilled mechanic to maintain and repair the generating plant, auxiliary plant and boilers. Applications to the borough electrical engineer, Mr. A. B. Mountain, St. Andrew's-road, Huddersfield. *See advertisement.*

A patent agent's technical assistant is required in London, with good scientific qualifications and knowledge of electrical engineering. *See an advertisement.*

A works superintendent is required in the Southampton tramways department for the duration of the war. Commencing salary £150 per annum.

Mr. Roderick Jones has been appointed general manager of Reuter's Telegram Co. Mr. S. Carey Clements, the assistant secretary, becomes manager and secretary, in succession to Mr. W. F. Bradshaw, who has retired after 40 years' valuable service to the company.

Mr. R. Simpson, of Tynemouth, has been appointed manager of the Worcester Electric Tramways Co.

Mr. H. W. Sanders, senior draughtsman of the Manchester electricity department, has been promoted to the position of chief draughtsman, in succession to Mr. F. E. Coupe, resigned.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—The Council have elected Mr. J. E. Kingsbury to be honorary treasurer of the Institution in place of the late Mr. Robert Hammond. The first meeting of the session will take place on Thursday, Nov. 11, when Mr. C. P. Sparks will deliver his presidential address. Papers during the first half of the session will be read by Prof. A. B. Field, on "Difficulties of Design of High-speed Generators," on Nov. 25; by Mr. J. R. Beard, on "The Design of High-pressure Distribution Systems," on Dec. 9; by Prof. Miles Walker, on "The Predetermination of the Performance of Dynamo-electric Machines," on Jan. 13; and by Mr. N. W. Storer, on "The Possibilities in the Design of Direct-current Traction Motors, &c.," on Jan. 27.

West of Scotland Branch of the Association of Mining Electrical Engineers.—The first meeting of this branch was held at Glasgow on Saturday, Mr. A. B. Muirhead, president, in the chair. In speaking of the work planned for this session, Mr. Muirhead specially referred to the coal-cutting demonstrations arranged to be held on Saturdays (not yet fixed) through the kindness of Mr. Arnott, of the United Collieries, and Mr. Kivlen, of Bradisholm Colliery. Mr. Muirhead then gave an address on "The Development of Electricity in the Scottish Mining Industry," in which he said that the yearly output of coal in Scotland was now about 45,500,000 tons, or more than double what it was 30 years ago. In that country, however, difficulties were encountered which were not always appreciated by those who had seen fit to make laws governing the whole of British mining. These difficulties had been the reason for the adoption of so much electric power in Scotland. There was now about 137,200 E.H.P. in motors above and below ground and the number of electric coal-cutters amounted to 747. The compressed air cutter, he said, need not be considered as a serious rival to these machines in Scotland to-day.

Greenock Electrical Society.—The Greenock Electrical Society hold their first meeting for the new session to-day (Friday), when the honorary president, Mr. Frank H. Whysall, M.I.E.E., chief electrical engineer, Greenock, will give a lecture on "The Construction of Storage Batteries." Mr. W. B. Smith, A.M.I.E.E., chief assistant electrical engineer, Greenock, is the president for the ensuing session, and the hon. secretary is Mr. H. G. Wright, electricity offices, Greenock.

Faraday Society.—The Faraday Society will hold a general discussion on "The Transformations of Pure Iron," on Tuesday, Oct. 19, 1915, at 8 p.m., at the Institution of Electrical Engineers. The President, Sir Robert Hadfield, F.R.S., will preside over the discussion, which will be opened by Dr. A. E. Oxley, of Sheffield. Tickets may be obtained from the secretary of the Faraday Society, 82, Victoria-street, S.W.

Electric Vehicle Committee.—A meeting of this committee was held in London under the chairmanship of Mr. R. A. Chattock on Oct. 1, 1915. Mr. A.V. Mason took his seat on the committee as the representative of the Light Railways and Tramways Association. The committee had submitted for their inspection by the Krieger Electric Carriage Synd. (Ltd.) the first of the new "Ward" light delivery vans to arrive in this country from America. It was reported that the sales of No. 4 issue of the "Electric Vehicle" had been very satisfactory. As to further publicity work, it was decided that no more could be done at the present time than to concentrate upon keeping going successfully the official organ, the "Electric Vehicle." The further standardisation of details in connection with lead plate batteries was discussed, and the committee will now await the decision of the Accumulator Makers' Section of the B.E.A.M.A. upon their proposals.

Association of Engineers-in-Charge.—The opening meeting of the new session was held on Wednesday when Mr. Frank Bailey, M.Inst.C.E., gave his presidential address. He commenced by dealing with the resources of the opposing powers in the present strife, in connection with which he mentioned that the Allies comprised a population nearly six times as great as that of the enemy, while the territories are as 20 to 1 and the export trade of the Allies before the war was three times that of the Austro-Germans. Mr. Bailey then outlined the progress of invention and discovery in the manufacture of explosives from the experiments of Edward Howard in 1800 to the present day, when picric acid and trinitrotoluol are so largely used. The foresight of the Germans in carbonising their fuel so extensively in coke oven recovery plants so as to produce benzol, and consequently toluene, was also dealt with. Passing on to the subject of shell design, Mr. Bailey emphasised the need of great accuracy in munition work and spoke of the way in which bomb-throwing had been brought into use again in this war.

Aeronautical Institute.—The Executive Committee of the recently formed Aeronautical Institute of Great Britain consists of the following members: Mr. Charles Bright, consulting engineer to Commonwealth of Australia; Prof. G. H. Bryan, professor of pure and applied mathematics at the University College of North Wales, a member of the Government Advisory Committee for Aeronautics; Sir George Greenhill, formerly professor of mathematics in the Artillery College, Woolwich, a member of the Government Advisory Committee for Aeronautics; Col. F. N. Maude, C.B.; Mr. L. Blin Desbleds, consulting aeronautical engineer, lecturer in aeronautical engineering at the London Polytechnic. The temporary address of the Institute is 39, Victoria-street, Westminster, S.W.

Diesel Engine Users' Association.—The meetings of this Association are being resumed this month, and the next meeting is to be held on Wednesday, the 20th inst., at the Institution of Electrical Engineers, when the subject of lubrication of Diesel engines is to be further discussed. The acting hon. secretary is Mr. Percy Still, 19, Cadogan-gardens, London, S.W.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 15th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at the Institution of Civil Engineers, Great George-street, Westminster. Paper on "The Theory of Grinding with Reference to the Selection of Speeds in Plain and Internal Work," by Mr. J. J. Guest.

TUESDAY, Oct. 19th.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. General Discussion on "The Transformations of Pure Iron," introduced by Dr. A. E. Oxley.

FRIDAY, Oct. 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Agenda: Papers on "The Radiation and Convection from a Heated Wire in an Enclosure of Air," by Dr. Thomas Barratt; "On the Determination, by the Method of Diffusive Convection, of the Coefficient of Diffusion of a Salt Dissolved in Water," by Dr. Albert Griffiths; "The Magnitude of the Thermal Resistance introduced at the Slightly Conical Junction of Two Solids, and its Variation with the Nature of the Surfaces in Contact," by Dr. Thomas Barratt.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at 39, Victoria-street. Paper on "Safety Precautions for Transmission Machinery," by Mr. W. V. H. Capps.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

The following orders have been issued for the week commencing Oct. 18, 1915:—

Drills: 6.15 to 7.15 p.m.; 7.15 to 8.15 p.m.

Monday, October 18.—Section 1, Technical; Section 4, Squad.
Tuesday, October 19.—Section 2, Technical; Section 3, Shooting.
Thursday, October 21.—Section 3, Technical; Section 2, Shooting.
Friday, October 22.—Section 4, Technical; Section 1, Squad.

Signalling class and Technical classes, Mondays and Fridays, but members will attend with their sections.

Recruits attend on Mondays and Fridays.

Members will fall in for all drills at the new headquarters, Chester House, Eccleston place, S.W., on and after Monday, October 18.

HARMONICS IN TRANSFORMER MAGNETISING CURRENTS.*

BY J. F. PETERS.

(*Concluded from p.* 26.)

Summary.—The purpose of this Paper is to show in a concise manner the cause and effects of higher harmonic currents in magnetising currents of transformers. A hypothetical case is analysed to show the cause of the harmonics; then the schemes of connecting transformers that are commonly used for polyphase transformation are taken up and the effects of the harmonics on each case pointed out. The author also shows the reason why third harmonic voltages are not developed in the three-phase "core type" transformer when connected star-star.

If a star-delta bank of transformers is fed directly by a star-connected generator and the neutral of generator and bank of transformers are connected together as shown by Fig. 7, then if the generator contains a third-harmonic voltage, this voltage will cause an additional third-harmonic current to circulate in the transformer and generator windings The magnetising current for this scheme of connections will be supplied in the same manner as when the source of supply is a bank of transformers with their secondaries connected in star, with its neutral grounded, as well as the neutral of the step-down bank, but the third-harmonic voltages of the generator are impressed on the transformers between line terminals and neutral

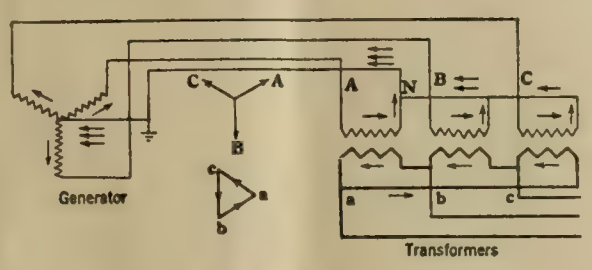


FIG. 7.

The third harmonic voltages from the different phases of the generator are all in the same direction since the generator voltages of fundamental frequency are 120 deg. apart and therefore the third-harmonic voltages 3×120 or 360 deg. apart. These voltages are impressed on the primaries of the transformers which in turn induce corresponding voltages in the secondaries. The secondaries being connected in delta, their windings and connections between phases produce a closed local circuit for the induced third-harmonic voltages, consequently a third-harmonic current will circulate. The magnitude of this circulating third-harmonic current is determined by the total third-harmonic voltages of the generator and the combined impedance of the transformer bank and generator.

This current may be of considerable magnitude, for example: Assume that the normal output of the bank of transformers is small, as compared with that of the generator, which is often the case when one generator feeds a number of independent lines, each having its own transformer bank. In such cases the generator impedance may be negligible when compared with that of one bank of transformers. Assume further that the generator has 10 per cent. inherent third-harmonic voltage in each phase, and that each transformer in the bank has 4 per cent. inherent impedance at fundamental frequency, then at triple frequency the total impedance per phase will be approximately 3×4, or 12 per cent.; consequently, a third-harmonic current of $10/12=83$ per cent. of the normal transformer full load current will circulate in the primary and secondary of each transformer in the bank. The paths for these circulating currents on the generator side are over the line between generator and transformer terminals, through the transformer primaries, and back to the generator through the neutral connections. The current carried by the neutral connection will be the sum of the three currents in the phases. On the secondary or delta side of the transformer bank, the third-harmonic current will circulate around the circuit produced by the transformer windings and the connections between phases.

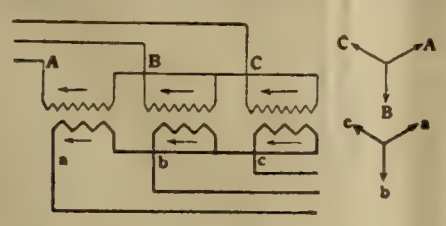


FIG. 8.

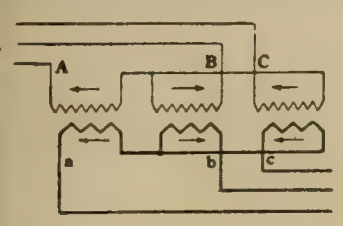


FIG. 8A.

* Paper presented at the Panama-Pacific Convention of the Am.Inst.E.E., slightly abbreviated.

If the bank of transformers had been connected delta-delta, the magnetising currents would have been supplied in a similar manner, except that a part of the third harmonic current would circulate in the primary local circuit and a part in the secondary, dividing up in inverse proportion to the impedance of the two windings. If the bank had been connected delta-star, all of the third-harmonic magnetising current would have circulated in the primary local circuit.

With the bank connected star-star as shown by Fig. 8, the third harmonic component cannot flow, since it cannot be drawn from the line and there is no closed local circuit in which it can circulate. Consequently, a third-harmonic voltage will appear in both primary and secondary windings between the neutral points of the bank and the lines.

Since the third-harmonic component of magnetising currents are in the same direction in all three phases, and the voltage produced by a magnetising current is 90 deg. later in time phase, it follows that the third harmonic voltages are in the same direction in all three phases. The neutral point of the bank therefore, does not remain at zero potential, but oscillates around the zero point at triple frequency. The voltages of the star-star connected bank are represented in Fig. 9

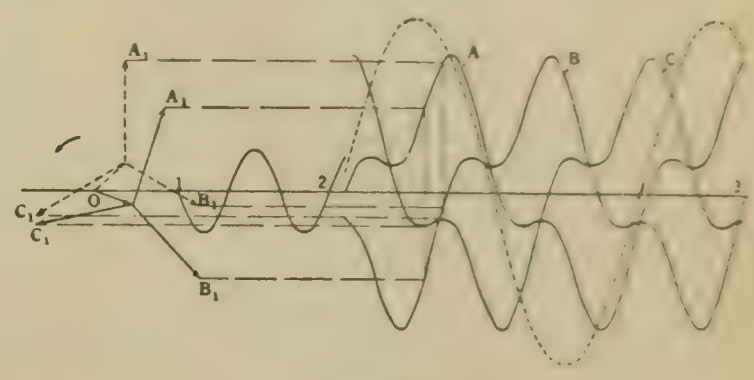


FIG. 9.

by means of the crank diagram. The three fundamental voltages are represented by the vectors A_1, B_1 and C_1, which are 120 deg. apart. The neutral of the three-phase vector is located on the end of the third-harmonic voltage vector. There is only one third-harmonic vector, since the third-harmonic voltages of all three phases are in the same direction and, therefore, coincide. The voltage waves are constructed in the usual manner by rotating the radial vector in the direction indicated by the arrow, and projecting points out to corresponding points of time on the time angle axis, the third-harmonic vector, of course, being rotated three times as fast as the fundamental The wave shown from 1 to 2 is that of the neutral point. From 2 to 3 are the composite waves of all three phases.

The voltage between lines, say, A to B, Fig. 8 is the voltage from O to A, minus the voltage O to B, therefore the voltage between lines A and B is the difference between wave A and wave B in Fig. 9. This voltage wave is shown dotted. It will be noted that this resultant is a sine wave, and that it is 173 per cent. of the fundamental in either phase OA or OB. Therefore it is evident from the above that, although there are third-harmonic voltages in the phases of a star connected bank, they do not appear in the line. They do, however, produce extra stresses in the insulation of transformers.

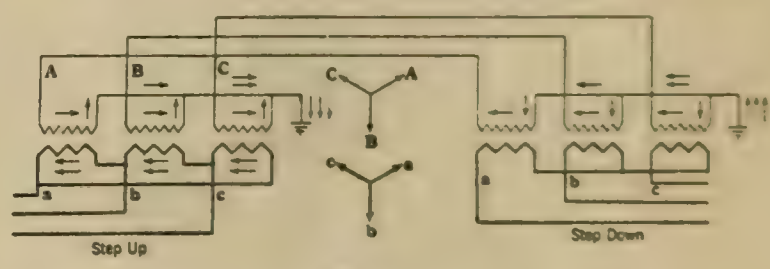


FIG. 10.

If the primary neutral point of the bank is grounded and the secondary neutral of the step-up bank is not grounded, these third harmonic stresses will appear between coils and ground. Also since the neutral point is pulsating or rotating around the zero point, it is obvious that the whole system is made to pulsate above and below ground an amount equal to the third-harmonic voltage in the phases. This may be of a dangerous value from the standpoint of charging current and also from the standpoint of static disturbances in neighbouring communication lines. From the standpoint of charging current, let us assume that the third harmonic voltage is 50 per cent. as great as the phase voltage of fundamental frequency. Then, since it is at triple frequency the charging current due to it will be 3×50 or 150 per cent. as great as that produced by the same voltage at fundamental frequency.

The third harmonic voltages in a star-star connected bank of

transformers can be eliminated by providing a small winding in each phase and connecting these windings in delta. The third harmonic magnetising current will then circulate in this winding in the same manner, and due to the same cause, as it does in the secondary of a star-delta connected bank. If the neutral point of the star-star connected step-down bank of transformers is grounded on the primary side, and the neutral of the step-up bank is grounded on the secondary side, as shown by Fig. 10, then there is a complete circuit through the lines and neutral connections for the third-harmonic component of the magnetising current and consequently the third-harmonic voltages will be eliminated from the transformers. This will, of course, eliminate electrostatic induction but the three triple frequency currents in phase in the lines and returning in the earth may cause electromagnetic disturbances in neighbouring lines.

Transformers are sometimes connected in open delta or "V" for three-phase transformation. This scheme of connection is shown in Fig. 11 (*a*). The manner in which the third harmonic components of the magnetising currents are supplied is very similar to that of the delta-connected bank. The phase voltages of fundamental frequency are 120 deg. apart, and, therefore, the third-harmonic components of the magnetising currents are 3×120, or 360 deg. apart. That is, they flow in the same time phase as indicated by the arrows. With this connection, unlike the conditions with a closed delta, the third harmonic component of the magnetising current is drawn from the line through leads A and C, and, therefore, must pass through the impedance of the line and generator or source of supply. Consequently there will not be quite sufficient third-harmonic current and a third harmonic voltage will exist in the phases. In most cases these third harmonic voltages are of small value and of little or no importance.

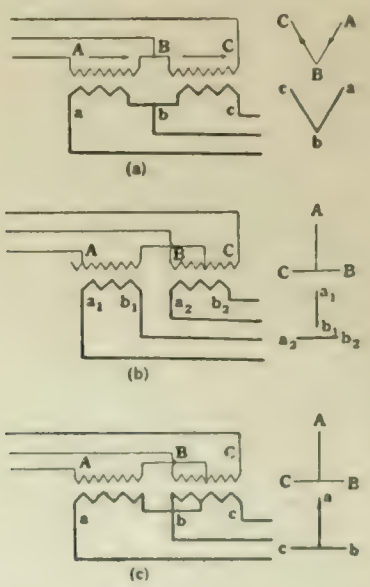


FIG. 11.

Fig. 11 (*b*) shows a three-phase—two-phase, connection magnetised from the three-phase side, and at 11 (*c*) is shown a three-phase T-connected bank. In both of these cases the magnetising current for the transformers are 90 deg. apart in time phase, and, therefore, the third-harmonic currents are 3×90, or 270 deg. apart. With these connections lead A carries the magnetising current for one phase and B and C the magnetising current for one phase plus one-half of the current from the other phase combined at 90 deg.; that is, $(\sqrt{1^2 + 0{\cdot}5^2}) = 113$ per cent. of the current for one phase. In these connections like the V, the third harmonic current flows through the impedance of the line. Therefore, a small third harmonic voltage may exist.

The foregoing considerations were based on the banks being made up of single phase units connected for polyphase transformation. If the three phase banks consisted of three phase units of the so called "shell form," the conditions with respect to magnetising currents and higher harmonic voltages would be substantially the same as for single phase units connected in the same relation. In the three phase shell form of construction, the magnetic circuits for the three phases are built up as one unit. The electrical connections for the middle phase are reversed as shown in Figs. 5 (*a*) and 8 (*a*), so as to place the magnetic flux of this phase 60 deg. from the fluxes of the phase on either side. The object of this reversal is to decrease the necessary area of the magnetic circuit between phases. Each phase of the unit has a magnetic circuit completely surrounding it, and consequently there are no interchanges of magnetomotive forces from one phase to another. But if the three phase banks consist of three-phase units of the core "type" construction, the conditions with respect to magnetising currents and higher harmonic voltages in the star-star-connected bank are considerably changed.

With the latter type of construction the magnetic circuit for the three phases are mutually connected, in that the magnetic flux of any one phase has its return path through the other two phases. Now since the magnetic fluxes go and return through the same three cores it is evident that the resultant of the three fluxes in any one direction must at all times be zero. But, if there are any third harmonic voltages in the phases due to the absence of the third-harmonic magnetising currents in the star-star-connected unit they are induced in the same direction in all three phases and, therefore, their

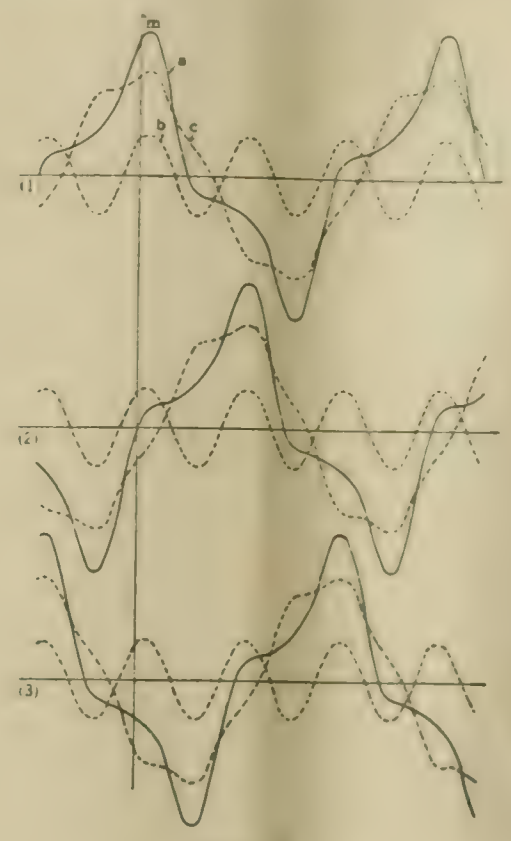


FIG. 12.

third-harmonic magnetic fluxes are all in the same direction. This would require that the third-harmonic flux return outside of the cores through high reluctance paths. They would consequently be of very small value.

It would appear from the above that third-harmonic voltages which are due to the absence of the third-harmonic component of magnetising currents in the star-star-connection are prevented in the three-phase core form units by the high reluctance return paths of the third harmonic magnetic fluxes. But this is not strictly true; what really happens is that the deficit in magnetomotive force in parts of the cycle in each phase is supplied by the other two phases. Fig. 1 shows three magnetomotive force waves 1, 2 and 3, 120 deg. apart. (*a*) is the required wave of magnetomotive force to produce a

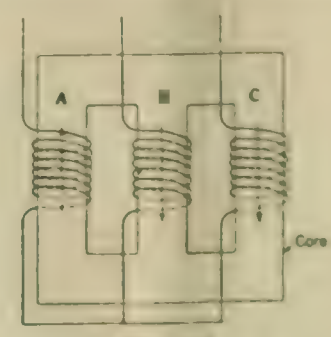


FIG. 13.

sine wave of magnetic flux, (*b*) is the third-harmonic component of the required magnetomotive force wave, and (*c*) is the magnetomotive force wave that is drawn from the line. It is wave (*a*) minus wave (*b*). Referring to point *m*, it will be seen that (*c*) in 1 is lacking sufficient magnetomotive force, while 2 and 3 at the same point have a surplus of magnetomotive force. Consider this point on the cycle to be such as to have a magnetic flux up through core A in Fig. 13, and down through B and C. The extra magnetomotive force tending to produce the surplus of flux down through B and C will be expended in supplying the deficit up through A, A being the return path for B and C. In this way there is an interchange of magnetomotive forces between phases, which results in the production of sine wave of magnetic flux and, therefore, sine wave of voltage in all three phases. In an appendix the author describes in detail the method of analysing the magnetic flux wave of Fig. 3.

ELECTRIC WELDING.*

BY C. B. AUEL.

Summary.—In this Paper the author describes in detail the arc, incandescent and electro-percussive processes of electric welding. The arc process is subdivided into the Zerener, Benardos and Slavianoff systems, and the incandescent process into the La Grange-Hoho and Thomson systems. Several interesting tables showing cost of electric welds and smith welds are given, and the strength of welds is discussed at some length.

Electric welding can be accomplished by any one of several processes, but none of them is of universal applicability—that is to say, each one is more or less limited to a certain field as well as to a given range in such field. There are three clearly-defined processes—namely, arc, incandescent and electro-percussive, of which the last mentioned is very recent. The first two of these are capable of subdivision: the arc into the Zerener, Benardos and Slavianoff processes; the incandescent into the La Grange-Hoho and Thomson processes. The arc processes are autogenous in that welding can be accomplished without pressure, simply by allowing the metals to melt under the influence of the electric current, then to mix and unite as they cool; the incandescent and electro-percussive processes, however, invariably require pressure as a necessary adjunct to their successful accomplishment.

Arc Process.

Zerener Process.—In the Zerener process the apparatus employed resembles certain types of direct-current flaming arc lamps, the carbons being inclined and automatically adjusted by a suitable mechanism. By means of an electromagnet the arc, which is formed between the ends of the carbons, is directed downward in the shape of a pencil point. The metals to be welded are brought within the influence of the arc where they are then melted or fused as desired. Owing to the pointed appearance of the arc, which is rather like an oxy-hydrogen torch, the name "electric blowpipe" has been given to this apparatus. While it may be constructed so as to be held in the hand, or else suitably suspended for convenience of operation, the apparatus is complicated, and does not lend itself readily to the carrying of large currents; for this reason it is used to a very limited extent.

Benardos Process.—In the Benardos process the arc is drawn between a carbon electrode, which forms one terminal of a direct-current circuit, and the metal to be welded, which forms the other electrode. The welding apparatus itself, aside from the current supply, is exceedingly simple, and there is, therefore, little to get out of order. As a minimum, 15 kw. at approximately 70 volts should be provided, though rather greater capacity is desirable, especially when large work is likely to be undertaken. The voltage across the arc will ordinarily range from 40 to 50 volts, depending upon the class of work.

Slavianoff Process.—In the Slavianoff process the arc is drawn between a metal electrode, which forms one terminal of a direct-current circuit, and the metal to be welded, which forms the other electrode. With this exception, the apparatus is very similar to that used in the Benardos process, although the minimum current supply necessary in this latter process may be said to be the maximum supply required in the Slavianoff process. The voltage across the arc is also lower in the Slavianoff than in the Benardos process, ranging from 18 to 30 volts.

Temperature of Arc.—The temperature of the carbon arc has been variously estimated to lie between 3,500°C. and 4,000°C., it being the hottest flame known, so that all metals may be readily melted by it. In a direct-current carbon arc the greatest energy consumption, and therefore the highest temperature, occurs at the positive terminal, and may perhaps be explained on the theory that the vapour in the immediate vicinity of the positive electrode is of much higher resistance than that in the rest of the arc. No extended data have, however, been published on the performance of arcs in which one or both electrodes are of metal; but if the assumption be made that there is not a wide divergence between carbon and metal arcs in this feature, it is evident that different results should be obtained in welding when the metal to be welded is made the positive electrode than when the reverse condition exists.

When using the Benardos process, and making the metal to be welded the positive electrode, as is the practice, melting of the metal should, and does, take place at a faster rate than if the carbon electrode were made the positive. In the latter case it is exceedingly difficult to weld at all below 500 amperes. The reason for this may lie in the fact that the conductivity of an arc depends in great measure upon the kind as well as the quantity of vapour in it. As iron and steel are more readily vaporised than carbon, and their vapours better conductors than carbon vapour, there is, for a given current and with the metal forming the positive electrode, a greater quantity of metal vapour in the arc than would be the case were the polarity reversed, and, therefore, current flows more readily from the metal to the carbon electrode.

In the Slavianoff process, where both electrodes are of metal, the limitation just explained does not exist, and welding may be effectively done with either the work or the electrode as positive, though it is more usual to make the former positive. There might, however, be occasions when it would perhaps be of advantage to reverse these conditions, and make the metal electrode positive, so that the melting, and therefore the deposition of metal, would be more rapid owing to the greater heating effect at the electrode.

Current.—Direct current, at approximately 70 volts for the Benardos and 50 volts for the Slavianoff process, is necessary, and may be secured from any reliable source. If only a higher voltage is available it may also be used, but is wasteful, and only to be recommended where the amount of welding required is either so small or so infrequent as not to make advisable the installation of a separate outfit; and any excess voltage must first be reduced to the proper amount by the introduction of suitable resistance into the circuit. Satisfactory welds may be made in the Benardos process with 15 kw. capacity, and even less; it is, however, preferable to have more where large pieces are to be handled, or where more than a single operator is to be employed, and similar reasons govern in the Slavianoff process. If current is obtained from an independent source, as is usually the case, instead of from public supply mains, the dynamo should be compound wound (although shunt may be used), with an over-compounding of about 5 per cent. Either a direct-connected motor-generator set or a belted outfit may be used, and while the latter has the marked disadvantage of occupying greater floor space, it has the compensating advantage of a flexible connection through the belt, which tends by its slipping to relieve the strains on the outfit when the load is suddenly thrown on in closing the circuit by touching the electrode to the work.

Control.—There must obviously be some means at hand for controlling the current supply and the voltage across the arc, since welds of different kinds will require varying current strengths at varying voltages across the arc, and this is attained by the use generally of resistance introduced into the main circuit, though sometimes the same result may be secured by weakening the field of the dynamo. This latter method is, however, extremely limited in its application, as it can only be used when a single operator is at work, otherwise other operators on the same circuit would be seriously handicapped.

The table given below is the record of three oscillograph tests made to determine the electrical data of the welding operation:—

Results of Oscillograph Tests—Electric Arc Welding.

Test No.	9.	10.	11.*
Type of electrode	Carbon	Iron	Iron
Size of electrode, diameter, inches	⅜	¼	¼
Resistance in series with arc, ohms	0·0709	0·296	0·296
Voltage of welding circuit, volts	46·0	67·5	65·0
Theor. max. current, striking arc, amperes	650·0	228·0	"
Actual max. current, striking arc, amperes	390·0	205·0	...
Average welding current, amperes	300·0	155·0	...
,, drop across arc, volts	23·0	22·5	0
Time to strike arc, seconds	0·07	0·06	...
Ratio of (*f*) to (*h*)	2·17	1·48	...
,, (*g*) to (*h*)	1·3	1·32	...

Electrodes and Holders.—For both processes the electrode holders consist simply of metal receptacles suitably insulated for gripping by the hand, the electrodes being designed to take rods of various diameters. Carbon electrodes range from ¼ in. to 1½ in. in diameter by 6 in. to 12 in. in length, depending upon the class of welding, and both of these higher limits may be exceeded in certain cases. The carbons should be solid, not cored, should neither crack, crumble nor spindle, and should preferably be "graphitic" rather than "common," as the former type is of higher electrical and thermal conductivity. Metal electrodes range from ⅛ in. to 5/16 in. in diameter, by approximately 12 in. in length, likewise depending upon the class of welding. For welding in wrought iron and steel nothing can excel the genuine Norway or Swedish iron.

Covering for Operator.—Electric welding, more especially when effected by the Benardos or carbon arc process, requires, on account of the brightness of the arc, to be done in an enclosure, so that any other work going on in the vicinity will not be interfered with. The operator must also be thoroughly well covered over the entire body,

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

* In test No. 11 electrode was allowed to stick or "freeze." Current gradually rose from 215 amperes to 250 amperes.

head, eyes and hands. Exposure to the arc rays, even if but of brief duration, causes an irritation or inflammation closely resembling sunburn, but, fortunately, with no more serious consequences. For carbon electrode welding it is necessary to envelop the head completely, and for metal electrode welding sufficient protection is afforded by simply holding the hood in front of the face, due to the very small arc.

Regardng the eyes, as they are so much more sensitive, even greater care should be taken in their protection. Until a comparatively recent period it was assumed that any coloured glasses which apparently enabled the operator to look steadily at the arc, afforded proper protection, and when a combination of ordinary coloured glass met this specification no further thought was given to the matter. Without going into any more detail, it may be said that authorities now state that the eyes should be protected (*a*) from ultra-violet rays, owing to the destructive effect upon animal tissue; (*b*) from infra-red rays, which, being heat rays, are surmised to be the cause of eye fatigue and other eye troubles; (*c*) from excessive brightness because of the blinding effect; and (*d*) from mechanical injury. This protection can be successfully accomplished by the use of specially prepared glass, suitably mounted, which cuts off the ultra-violet as well as the infra-red rays, and which is at the same time of sufficient density to prevent excessive brightness.

Fluxes.—A great diversity of opinion seems to exist as to the value of fluxes, and many operators have their own secret formulæ. It may be stated, however, that no flux is needed for welding either wrought iron or steel, the field to which arc welding has thus far proved to be particularly adapted.

Filling Material.—For welding wrought iron or steel various filling materials may be used, among them being Norway or Swedish iron rods, boiler iron, scrap, bits of steel castings, &c.; for cast or malleable iron, Norway or Swedish iron rods, or special cast-iron rods with a high percentage of silicon.

Welding.—In the Benardos process the carbon electrode must, as already stated, be connected to the negative terminal of the circuit, the metal to be welded to the positive terminal either directly or, if more convenient, indirectly by being laid upon a metal table to which the positive terminal has previously been connected. In the Slavianoff process welding may be effected regardless of the connections. The resistance of the circuit should next be adjusted to the proper amount, after which the circuit-breaker or relays and the line switch are closed. The operator then takes his position with the electrode holder in one hand and the hood (for the Benardos process) or the shield (for the Slavianoff process) in the other. Bringing the electrode as close to the metal to be welded as possible without actually touching it, he then pulls the hood down over his head or raises the shield in front of his face, touches the electrode to the work and instantly pulls it away the required distance, thus striking the arc, which, when a metal electrode is used, will approximate $\frac{3}{16}$ in., while when a carbon electrode is employed will vary from $\frac{1}{2}$ in. to 2 in. or even more in length, according to the work being done.

In using the carbon electrode the arc should be given a rotary motion by hand, thus heating the metal to be welded more uniformly and preventing burning. It should also be borne in mind that the longer the arc the less chance there is of carbon entering the metal and producing a hard weld. When the metal reaches a molten condition filling material is added to it little pieces at a time, the arc being interrupted only just long enough to add such material, then being struck and played upon the mass again; or the filling material can be used in the form of a long rod, one end of which is inserted in the molten metal and the arc played upon it until the end is melted off and fused with the mass. In working with the metal electrode rather more skill is required in striking the arc than when the carbon electrode is used; for if the electrode is not instantly pulled away it will stick to the work, or if pulled too far away the arc will go out. As the arc may be as small as $\frac{1}{8}$ in., and possibly less, it will be appreciated that the limits are rather close in which to manipulate it successfully.

When the welding involves the building up of a lug or projection this can be accomplished by the use of a supporting rim of suitable shape, made either of sheet copper, fire-clay or carbon blocks, although it is preferable to avoid, if possible, the two latter, since they are liable to soften and mix with the weld. As soon as the weld has been completed, and while still at a white heat, it should be briskly hammered in order to give the metal a finer grain. All oxide and other impurities should, of course, be kept out of the weld. It is, therefore, important that the materials be thoroughly clean and free from slag and dirt, not only before commencing to work, but at all stages. The metal to be welded should accordingly be chipped or machined in the vicinity where the weld is to be made; or the same result may be accomplished by tilting it to a suitable angle, then turning the carbon arc upon it and allowing the slag in melting to fall away by gravity. Heating the metal preparatory to welding is always beneficial as preventing and relieving strains, but is not resorted to except in special cases. A temporary furnace, especially for large work, is easily made when needed. Annealing is also desirable at times, but, like pre-heating, is not done except when absolutely necessary. A very decided economy can sometimes be effected by repairing a defect discovered during a machining operation by making the repairs without removing the piece from position.

Flue Welding.—The welding of flues in locomotive boilers offers a most fertile field for the Slavianoff or metal electrode process. Several different methods of preparing the flues and the flue sheet preparatory to welding are in use, one of the most promising being that developed by Mr. O. C. Wright, assistant engineer of motive power of the Pennsylvania lines (West), which the author describes in detail, and, including the cutting away of the rim, about 12 flues can be welded per hour by this method. Flues welded in this manner have been tested to destruction, and have shown a crushing force of over 30 tons along the axis of the flue, at which pressure the flue itself failed; this as against 17 tons, at which pressure flues fired in the usual manner are found to fail.

Metals which can be Welded.—Both of the electric arc processes are particularly well adapted to the welding of wrought iron and steel of various kinds, and while certain other metals, including cast iron, can also be welded, the work is not generally speaking done to any advantage over some of the other processes. Welds in cast iron will prove quite variable when made by the average operator, being frequently glass hard (though this may not matter where no machining is done) and uncertain as to strength, so that at the present time it would be rather unwise to make any pronounced claims for arc welding in this connection. With malleable iron the results obtained are even more variable than with cast iron. In the welding of cast iron very good results are obtained by the use of the carbon electrode process with a suitable cast-iron filling rod, first pre-heating the metal to white heat, making the weld while in this condition and then cooling gradually.

Fig. 1.—Rate of Cutting with the Electric Arc using a Graphite Electrode 1 in. in Diameter.

Comparison of Arc Processes.—With the Benardos or carbon electrode process more welding can be performed in a given time than can be accomplished with the Slavianoff or metal electrode process, and, viewed from this standpoint alone, the former is the cheaper. As with cast iron, the welds will, however, at times be decidedly hard, so much so as to be occasionally impossible of machining due to carbon from the electrode entering the metal; but when no subsequent machining is necessary hardness is no disadvantage, and in some kinds of work, such for example as the rebuilding of the ends of rolling mill wabblers, pinions, &c., this very condition is a decided advantage. In the Slavianoff process the difficulty of hard welds is largely overcome owing to the use of the metal electrode; the welding of thin sheets can be more readily done, and, in fact, a finer grade of work of the lighter kinds performed than with the Benardos process; finally, the ability to reverse connections may be an occasional advantage. The Slavianoff process is confined strictly to welding, while the Benardos process is used both for welding and cutting, as well as for heating under certain conditions.

Cutting.—Cutting of wrought iron and steel can be very successfully done with the Benardos or carbon arc process, though the cut will be wider and the edges not comparable in smoothness with any of the oxy-gas cutting processes. However, where electric current is readily available and the finish of the cut is not of especial importance, as in the removal of sink heads and risers from steel castings, it is probably one of the cheapest methods for such work, since almost no time need be spent in setting up the casting in position as is necessary when cutting by machine or hand. Various authorities give the rate of cutting as being from $\frac{1}{2}$ sq. in. to 1 sq. in. per minute per 100 amperes, with a minimum of 300 amperes. Fig. 1 shows,

however, that the rate of cutting approximates more nearly the lower limit.

Other Applications of the Arc.—The electric arc processes of welding were originally largely confined to repair work in wrought iron and steel, but since becoming better understood their uses are extending. For example, surplus metal, including fins, risers, sink heads and nails are easily removed from steel castings, holes are bored in wrought-iron or steel plates, wrought-iron or steel pipe sections are readily joined together or flanged, the ends of wrought-iron rings are welded, wire nails may be pinned to wrought-iron or steel plates, tap holes or tuyères in furnaces are opened, broken drills and taps are easily removed from castings, &c.

Opening of Tap Holes.—In the opening of the tap hole or a tuyère of a cupola the Benardos process is employed. The furnace is made the positive terminal, the negative terminal consisting of a rod of carbon 2 in. or 3 in. in diameter by about 48 in. in length, fitted securely to a holder of wrought-iron or steel pipe 10 ft. or more in length, and suitably insulated so that it can be readily handled. If a cinder is met during the burning it is necessary to drive into it an iron bar until fused iron is encountered, as cinder is an insulator, after which the arc is sprung between this iron bar and the carbon electrode and the operation resumed. Great care must be used so that, as the operation nears a finish, molten metal will not be blown out upon the operator. A current of about 800 amperes is recommended for such work, and with this the burning will be at the rate of approximately 30 in. per hour.

Statistics.—It is exceedingly difficult—and, in fact, impossible—to make any absolute statements in connection with costs, speeds, most economical and efficient currents, best sizes of electrodes and strengths of welds on account of the many variables involved, such as skill of operator, fluctuations in current and rate of work, differences in composition of filling material and metal to be welded, so that the data here given are offered in the main simply as results which can be easily duplicated by the average operator, and not necessarily as extreme in any respect.

Costs.—Blacksmith *versus* carbon arc welded rings. The following figures have been obtained in the works of the Westinghouse Electric & Mfg. Co., East Pittsburg (U.S.A.) :—

Sections.	Smith welds.*	Arc welds.*
1 in. by 1½ in.	2·26s.	2·04s.
1¼ in. by 1½ in.	2·64s.	1·20s.
1½ in. by 2 in.	4·52s.	1·80s.
1¾ in. by 2½ in.	5·00s.	1·80s.
2 in. by 6 in.	12·2s.	3·40s.

* Labour costs only included in above.

The following figures were supplied by one of the large American railways, being taken from actual jobs at various times and compared with that of restoring the apparatus to service by previous methods, either by replacement or repair. The arc welding costs were based on an hourly power cost of 2·12s. for the carbon arc and 0·71s. for the metal arc, together with the cost of direct labour and an overhead charge of 40 per cent. The power costs are somewhat higher than those obtained in average work.

Operation.	Cost of welding	Cost of replacement or repair by former methods.
Welding tender draft casting	£0·22	£3·66*
,, tender centre draft casting	0·872	3·81*
,, tender draft arm	0·22	3·82*
Plugging 51 holes in expansion plate, hole 1 in. diameter by ½ in. deep	0·550	2·03
Repairing mud ring	1·30	6·91‡
Building up flat spots on locomotive drivers	0·08	45·0†
Building up four piston valve flanges	1·90	4·84*
Repairing mud rings	1·11	6·54‡
Plugging four holes 2 in. dia. by 4 in. thick	0·23	0·89
Cutting four 6 in. holes in tender deck sheets ½ in. thick	0·22	1·67
Plugging holes in two driving box cellars	0·11	0·51
Welding eccentric strap, broken through neck	0·22	8·26*
Building up jaws of two pedestal caps	0·70	2·00
Welding one driving box for type K-2 locomotive, broken through crown	1·15	7·86*
Welding frame stiffener on locomotive	0·66	2·95
Welding main rod, broken through end	1·27	14·1*
Repairing fire box	27·0	174·0§
Welding two spokes in trailer wheel centre	1·54	13·6*
Welding two spokes in driving wheel centre	1·60	20·0*
Welding three spokes in driving wheel centre	2·24	25·3*
Welding two spokes in driving wheel centre	1·03	22·4*
Welding cracks in bulk head in tender crank	0·47	1·60
Welding cracks in side and door sheets of fire box	0·85	4·87‡
Welding bridge in flue sheets	0·58	4·02‡
Welding cracks in side sheets	5·23	6·36
Repairing air drum	0·57	2·53*
Welding guide yoke	0·34	3·23‡

* New parts required. † Estimated cost to turn down all drivers as would otherwise be required. This would mean also the loss of at least one year's wear on the tyres. ‡ Repair. § New fire box required.

Speeds of Welding and Cutting.

1. *Filling Drilled Hole in Cast Steel Axle Cap (W.E. & M. Co.).*—Size of hole, 1¼ in. diameter by 2 in. depth; size of carbon electrode, 1½ in. by 6 in.; current, 500 to 650 amperes; time, 55 minutes.

2. *Welding Sheet-steel Seams (Cravens).*—

Gauge. BWG or inch.	Metal electrode, diameter. BWG or inch.	Current. Amperes.	Speed of welding. Feet per hour.
28 to 20	18	10 to 25	30
18 to ⅛	16	20 to 40	25
⅛ to 3/16	12	30 to 60	20
3/16 to ¼	8	50 to 100	15
¼ to ⅜	3/32	75 to 150	10
Over ⅜	7/32	150 to 180	Variable

3. *Burning Hole in Wrought-iron Plate (W.E. & M. Co.).*—Size of hole, 1¾ in. diameter by 1½ in. depth; size of carbon electrode, 1½ in. by 6 in.; current, 370 to 1,000 amperes; time, 3 minutes 30 seconds (includes 45 seconds for reversing plate).

4. *Removal of Sink Head from Cast-steel Axle Cap (W.E. & M. Co.).*—Size of sink head, 2¼ in. by 6 in. area=13·5 sq. in.; size of carbon electrode, 1½ in. by 6 in.; current, 600 to 850 amperes; time, 4 minutes 45 seconds (includes time for set-up).

5. *Cutting Steel with the Electric Arc (W.E. & M. Co.).*—Using a graphite rod 1 in. in diameter as the negative electrode.

Rate of Cutting.

Size of section cut. In.	Area cut. Sq. in.	Cutting current. Amp.	Cutting time. Min.	Cross section cut per min. Sq. in.	Cross section cut per min. per 100 amperes. Sq. in.
8·000×8·0	64·0	810	27·00	2·37	0·293
8·000×8·0	64·0	600	41·75	1·53	0·255
8·000×8·0	64·0	320	98·00	0·65	0·203
6·000×6·0	36·0	810	14·50	2·48	0·306
6·000×6·0	36·0	600	21·67	1·66	0·277
6·000×6·0	36·0	320	44·33	0·81	0·253
4·000×4·0	16·0	810	4·70	3·40	0·420
4·000×4·0	16·0	600	5·62	2·85	0·475
4·000×4·0	16·0	320	10·08	1·60	0·500
2·000×4·5	9·0	810	2·50	3·60	0·445
2·000×4·5	9·0	600	2·53	3·56	0·577
2·000×4·5	9·0	320	5·05	1·78	0·557
1·375×3·25	4·47	810	1·10	4·06	0·502
1·375×3·25	4·47	600	1·17	3·82	0·637
1·375×3·25	4·47	320	2·25	1·98	0·619
0·625×4·0	2·5	810	0·67	3·73	0·451
0·625×4·0	2·5	600	0·83	3·07	0·512
0·625×4·0	2·5	320	0·88	2·84	0·888

Average rate of cutting, 0·454 sq. in. per minute per 100 amperes.

Strength of Welds.—Often the strength of the weld is of small consequence, as it is simply a matter of filling up blow holes or equivalent imperfections, and even where strength of weld is involved the metal to be welded usually has a very large factor of safety, so that, even though the welded portion may not be equal in strength to the original material, it still will have a considerable margin of safety. Furthermore, the material at the weld can often be reinforced so that a strength equal to the original can thus be obtained. With the carbon electrode process the current will range from possibly 100 to 600 amperes or more, depending upon conditions; in cutting, the figures will usually run slightly higher. With the metal electrode process the current for welding will range from 10 to 200 amperes.

In Figs. 2, 3 and 4 are shown results obtained by both processes. It will be noted that in these curves there seem to be indicated certain best limits for current and size of electrode, and in the carbon arc process the further fact that too rapid work, as indicated by Fig. 3, curve D, is harmful. The converse of this, although not shown by the curves, is likewise true. It may also be said that either process will give about the same strength of welds, but that in machine-steel the ultimate strength will average approximately 80 per cent. of the original, while in cast-steel the strength of the welds will run 10 to 12 per cent. lower.

Methods of Testing.—In the Paper full particulars of the methods of testing are given, and tables are included of mechanical tests. The curves, Figs. 2, 3 and 4, are drawn from the data in the tables.

In addition, the author discusses the physical and chemical characteristics of the welds.

Conditions for Metallic Electrode Welding.—Besides strength of weld, both with respect to the yield point and the ultimate breaking point of the original material, there are other considerations which must be taken into account. With large electrodes and small currents welding proceeds slowly, the arc is harder to maintain and the heat developed is insufficient to make the metal flow readily. Small

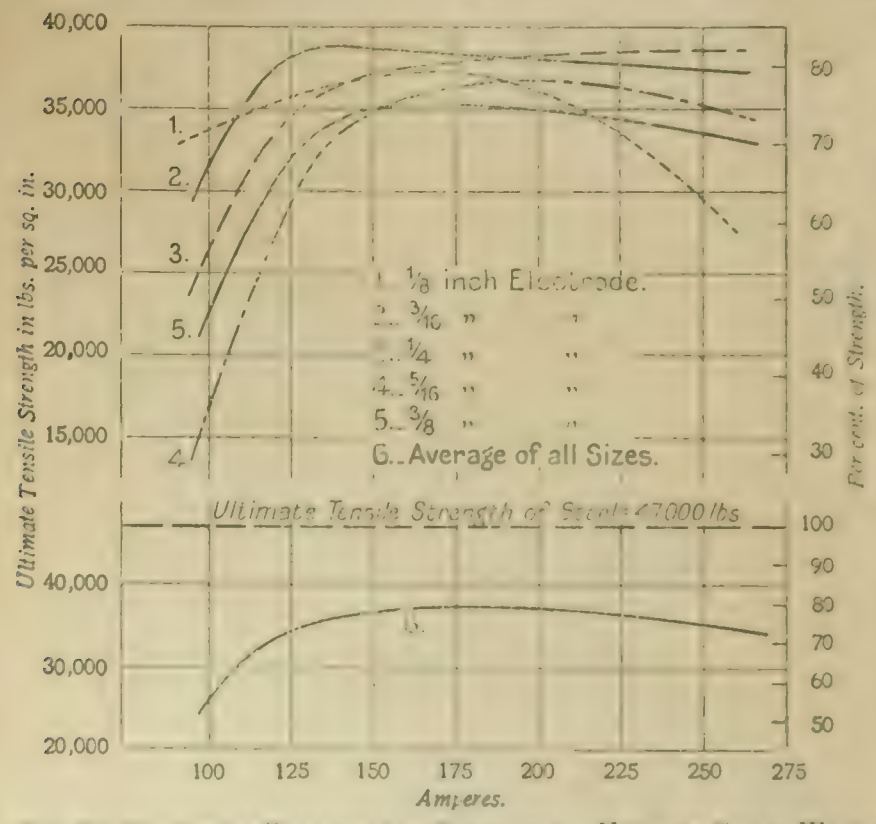


Fig. 2.—Curves of Current and Strength. Machine Steel Welded with Norway Iron Electrode.

electrodes and heavy currents are likewise undesirable, as here the metal flows too freely, the electrodes become white hot, molten drops of metal spatter from the weld and blisters form upon the metal. Though it might naturally be considered that the rapidity of welding would increase with the amount of current used, such is not the case beyond a certain limit. The fact that the added metal flows too rapidly and that fairly short electrodes must be used in the holders makes welding with small electrodes and heavy currents slow and laborious. Any combination of current and electrode which causes

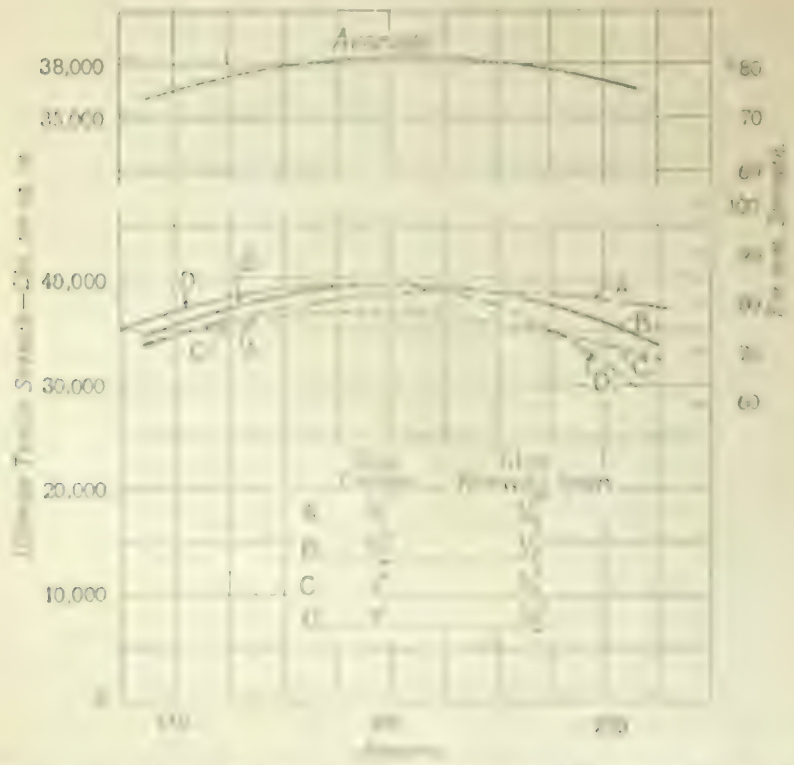


Fig. 3.—Curves of Current and Strength. Machine Steel Welded with Carbon Electrodes and Cast Norway Iron Filler.

the metal to flow very readily is useful only in those particular instances where the added metal cannot run away as soon as it is applied.

Potential Drop Across Arc.—The average potential drop across the metallic arc varied between 21 and 28 volts, increasing slightly with the current and with the size of electrode, at times reaching as high as 35 volts or as low as 12. With the carbon electrode the average varied from 40 to 50 volts, being nearer 40. This potential drop, as well as the current, depends upon the distance from the electrode to the metal being welded. It is manifestly impossible to maintain an exact distance, and there is, moreover, a personal equation involved, some operators keeping the electrode nearer to the metal being welded than others.

Direction of Current.—(*a*) Metallic electrodes. Twenty bars were welded with the current reversed—*i.e.*, with the electrode positive

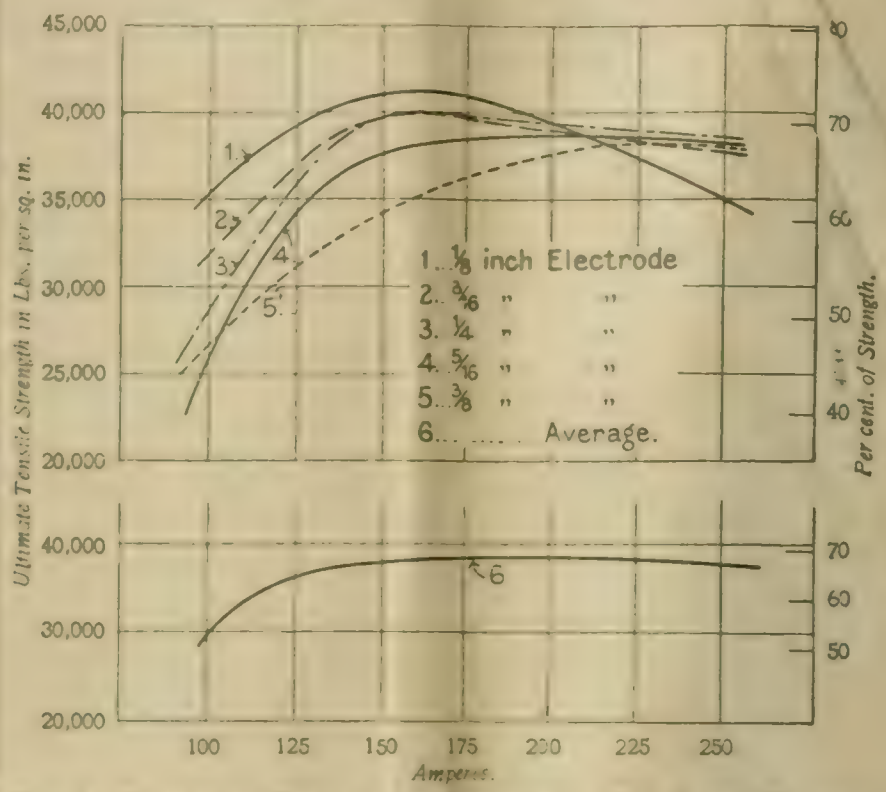


Fig. 4.—Curves of Current and Strength. Cast Steel Welded with Norway Iron Electrodes.

in polarity. Ten of these bars were welded with $\frac{3}{16}$ in. electrodes and 175 amperes, and 10 with $\frac{1}{4}$ in. electrodes and 200 amperes. From the results obtained it appears quite evident that it is more desirable to have the electrode negative, since welds made under the same conditions, but with the electrode positive, averaged 11·25 per cent. lower in tensile strength, 2·3 per cent. lower in elongation, and 2 per cent. lower in contraction of area than with the electrode negative.

(*b*) Carbon electrodes. The electrodes were in all cases made negative in polarity.

(*To be concluded.*)

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

Introduction

The dispersion coefficient of an induction motor may be defined as the ratio,

$$\frac{\text{Magnetising current}}{\text{Short-circuit current}},$$

and is usually denoted by the symbol σ.

The magnetising current is the ideal current which would be taken by the motor at no load if there were no losses of any kind.

The short circuit current is the ideal current which would be taken by the motor, on normal voltage, with the rotor clamped or held so as to prevent rotation, the motor being still supposed to have no losses.

The R.M.S. value of the magnetising current will be denoted by I_m, that of the short-circuit current by I_s, so that $\sigma = I_m / I_s$.

This ratio is slightly smaller than the ratio

$$\frac{\text{Actual no-load current}}{\text{Actual short-circuit current}},$$

because losses increase the no-load current (copper losses are negligible), but decrease the short-circuit current compared to

their ideal values. The difference, however, is usually small, and for practical purposes may be neglected in the majority of cases.

The dispersion coefficient σ is the principal factor which determines the performance of an induction motor. Both the power factor and the overload capacity of the motor are almost entirely dependent on it. It is, therefore, important to have some means of pre-determining σ in designing a motor. Moreover, the theory of the induction motor shows that the smaller σ the better will be the performance of the motor; indeed, a small dispersion coefficient is the first essential for a good motor.

The objects of this article are (I.) to develop a method of pre-determining approximately the dispersion coefficient of a three-phase induction motor from its known dimensions, and (II.) to show how the proportions of a motor of given size may be so chosen that it shall have the least dispersion possible under certain given conditions.

A list of symbols is given below:—

List of Symbols.

$a=\delta/d$=Length of air-gap ÷ Internal diameter of stator.
b=Width of slot.
b_1, b_2=b for stator and rotor slots respectively.
d=Internal diameter of stator.
δ=Radial length of air-gap.
e=Thickness of over-hanging tooth-edge or of thin part of iron slot bridge.
e_1, e_2=e for stator and rotor slots respectively.
h=Depth of slot.
h_1, h_2=Depth of stator and rotor slots respectively.
i_m=Magnetising current (instantaneous value).
i_s=Stator short-circuit current (instantaneous value).
i_s'=Rotor short-circuit current (instantaneous value).
I_m=Magnetising current (R.M.S. value).
I_s=Stator short-circuit current (R.M.S. value).
k=Flank dispersion constant.
k_z=Reluctance of main paths ÷ reluctance of air-gap.
$K=d^2l_i$.
l_1, l_2, l_3=Components of l_s.
l_1', l_2', l_3'=Components of l_r.
l_i=Axial length of stator and rotor, excluding air-ducts.
$l_s=(L_s-M)$.
$l_r=(L_r-M)$.
L_s=Coefficient of self-induction of stator.
L_r=Coefficient of self-induction of rotor.
L=Mean of L_s and L_r.
M=Coefficient of mutual induction between stator and rotor.
μ=Permeability.
n=Number of conductors per slot.
p=Number of poles.
P=Slot permeance or mean of P_1 and P_2.
P_1, P_2=Stator and rotor slot permeances respectively.
q=Number of ampere-conductors per centimetre periphery of stator.
$Q=Pwp^2K/k$.
r_1=Numerator of ratio S_1/S_2 when reduced to its lowest terms.
r_2=Denominator of ratio S_1/S_2 when reduced to its lowest terms.
$R=Bw\tau_i/Pa\tau$.
S_1=Number of stator slots per pole.
S_2=Number of rotor slots per pole.
S=Mean of S_1 and S_2.
σ=Dispersion of coefficient.
σ_1=Component of σ due to main dispersion.
σ_2=Component of σ due to peripheral dispersion.
σ_3=Component of σ due to flank dispersion.
τ=Pole-pitch.
τ_i=Pole-pitch less slot openings, or thin parts of iron slot bridges, per pole (mean of stator and rotor).
v=Width of slot opening, or of thin part of iron slot bridge.
v_1, v_2=v for stator and rotor slots respectively.
V=Applied voltage.
w_1=Stator slot pitch.
w_2=Rotor slot pitch.
w=Mean of stator and rotor slot pitches.
x=Displacement between centres, or corresponding sides, of two coils.

Part I.—Estimation of the Dispersion Coefficient.

Section I.

In this section it will be shown how σ depends on the coefficients of self-induction of the stator and rotor, and the coefficient of mutual induction between the two.

Let L_s, L_r, M denote these coefficients respectively. L_s represents the total linkage of magnetic flux with the stator winding which there would be per unit stator current if there were no closed rotor windings to react upon the stator. L_r represents the total magnetic linkage with the rotor winding which there would be per unit current in the rotor if there were no closed stator winding reacting on the rotor. M represents the total magnetic linkage with the *rotor* winding which would occur, due to unit current in the *stator* winding, *if the rotor winding were open, so that there were no rotor currents to cause* the *stator currents*. This linkage is, of course, equal to that with the *stator* winding, due to unit current in the *rotor* winding, when the *stator* winding is open.

In estimating any of the above quantities the state of saturation of the iron must be supposed to be that which actually exists in the motor, and *not* what it would be under the hypothetical conditions of the above definitions. These definitions have been given at some length because of their fundamental importance in the development of the formula to be given in this and the following three sections.

If i_m, i_s, i_s', V denote respectively the instantaneous values of the magnetising current, the stator short-circuit current, the rotor short-circuit current, and the applied voltage, we have the following equations for the ideal case of no losses:—

Stator circuit at no-load

$$L_s\, di_m/dt = V. \qquad (1)$$

Stator circuit at short-circuit

$$L_s\, di_s/dt + M\, di_s'/dt = V. \qquad (2)$$

Rotor circuit at short-circuit

$$L_r\, di_s'/dt + M\, di_s/dt = 0. \qquad (3)$$

From (3)—

$$M\, di_s'/dt = -(M^2/L_r)\, di_s/dt.$$

Equating (1) and (2) and substituting for $M\, di_s'/dt$, we obtain

$$L_s\, di_m/dt = L_s\, di_s/dt - (M^2/L_r)\, di_s/dt,$$

or,

$$\frac{di_m/dt}{di_s/dt} = 1 - \frac{M^2}{L_sL_r}.$$

Assuming the right-hand side of the equation constant throughout the cycle, which must be at least very nearly the case, we may substitute

$$\frac{I_m}{I_s} \text{ for } \frac{di_m/dt}{di_s/dt},$$

where I_m, I_s, as before, denote the R.M.S. values of the currents. Therefore,

$$\sigma = I_m/I_s = 1 - M^2/L_sL_r.$$

σ Independent of the Number of Stator and Rotor Conductors.—If N_1, N_2 denote respectively the number of conductors in stator and rotor, L_s is proportional to N_1^2, L_r to N_2^2 and M to $N_1 \times N_2$. Consequently, M^2/L_sL_r is proportional to $(N_1N_2)^2/N_1^2N_2^2$—*i.e.*, is independent of N_1 and N_2.

This result is important because it enables us to introduce the simplification of supposing the number of rotor conductors to be the same as the number of stator conductors.

The value of σ calculated on this supposition will be the correct value of σ whatever be the relative numbers of the stator and rotor conductors.

Simplified Expression for σ.—With the assumption of equal numbers of stator and rotor conductors M becomes a quantity only slightly less than L_s or L_r. If there were no magnetic leakage we should have $L_s=M=L_r$.

A certain amount of magnetic leakage is, however, unavoidable, though in well-designed motors it is very small.

We, therefore, have

$$L_s = M + l_s,$$

and

$$L_r = M + l_r,$$

where l_s, l_r represent respectively the total linkages of the stator and rotor *leakage* fluxes, and are small quantities compared with L_s, L_r and M.

Then

$$\sigma = 1 - \frac{M^2}{L_sL_r} = \frac{(M+l_s)(M+l_r) - M^2}{L_sL_r} = \frac{M(l_s+l_r)}{L_sL_r},$$

neglecting $l\, l_r$ compared with $M(l_s+l_r)$. Further, we may put

$M/L_sL_r=M/L^2=1/L$, where L is the mean of L_s and L_r, for M is only slightly less than L_s or L_r.

Therefore, finally, $\sigma=\dfrac{(l_s+l_r)}{L}$.

Separation of Leakage Fluxes.—Both stator and rotor leakage may be divided broadly into three distinct parts :—

1. Leakage due to the fact that the effective linkage of the *main flux*, with the exciting winding (either stator or rotor) is greater than with the excited winding (rotor or stator).

2. Leakage due to lines which pass across the slots containing the exciting winding and do not link at all with the excited winding.

3. Leakage due to lines which link with the end connections of the exciting winding without linking with the excited winding.

The first leakage, often referred to as the " ziz-zag " leakage, will be termed in this article the main dispersion, because it is due, *not* to any actual leakage flux zig-zagging between the teeth of stator and rotor, but to *the difference in effective linkage of the main flux* with exciting and excited windings.

The second and third leakages are generally termed the peripheral and flank dispersion respectively.

Returning to the expression $\sigma=(l_s+l_r)/L$, let l_1, l_2, l_3 denote the above three components of stator leakage respectively, while l_1', l_2', l_3' denote the corresponding components of rotor leakage.

Then

$$\sigma=\frac{(l_1+l_2+l_3)+(l_1'+l_2'+l_3')}{L}=\frac{(l_1+l_1')+(l_2+l_2')+(l_3+l_3')}{L},$$

$$=\sigma_1+\sigma_2+\sigma_3,$$

where

$$\left.\begin{aligned}\sigma_1&=(l_1+l_1')/L\\ \sigma_2&=(l_2+l_2')/L\\ \sigma_3&=(l_3+l_3')/L\end{aligned}\right\}.$$

The above method of separating the different components of the dispersion coefficient, developed here at some length, was used by Dr. Behn-Eschenburg in his Paper read before the Institution of Electrical Engineers in 1904.*

Section II.—Main Dispersion.

Suppose all the conductors per pole of one phase of the stator winding were concentrated in a single slot, so that *all* the flux produced by unit current flowing in the coils linked with *all* the coils. Let N denote the total magnetic linkage with these, due to the main portion of the flux which passes from stator to rotor. When the conductors are distributed in a number of slots the resulting linkage will be less than N. Let $\beta_1 N$ denote the linkage under these conditions, where β_1 is a coefficient less than unity. Again, unit current flowing in a second phase of the stator winding, would, if this second phase were coincident in position with the first phase, produce a magnetic linkage with the coils of the latter phase equal to $\beta_1 N$. As the positions of the coils of the two phases do not coincide, the linkage produced is only $\beta_2 N$, where β_2 is a coefficient less than β_1. Similarly, unit current in the coils of the third phase produces a magnetic linkage with the coils of the first phase equal to $\beta_3 N$, where β_3 is another coefficient.

Again, the linkages with a rotor phase of the rotor winding due to unit current in the three stator phases may be written $\beta_1' N$, $\beta_2' N$, $\beta_3' N$, where β_1', β_2', β_3' are all coefficients less than unity, assuming equal numbers of conductors in stator and rotor windings.

The coefficients β take account only of the relative positions of the different phases, the current having been assumed the same in each phase.

Effect of Phase Differences of Currents.—Assuming a sine wave of current we have, at any instant for unit maximum value of currents,

$$\left.\begin{aligned}i_1&=\sin\theta\\ i_2&=\sin(\theta-120^\circ)\\ i_3&=\sin(\theta+120^\circ)\end{aligned}\right\}.$$

Resultant magnetic linkage with the coils of stator phase 1, at any instant, is

$$\beta_1 N i_1+\beta_2 N i_2+\beta_3 N i_3.$$

$$=N\{\beta_1\sin\theta+\beta_2\sin(\theta-120^\circ)+\beta_3\sin(\theta+120^\circ)\},$$

$$=N\left\{(\beta_1-\tfrac{1}{2}\beta_2-\tfrac{1}{2}\beta_3)\sin\theta+\frac{\sqrt{3}}{2}(\beta_3-\beta_2)\cos\theta\right\},$$

$$=N\sqrt{(\beta_1-\tfrac{1}{2}\beta_2-\tfrac{1}{2}\beta_3)^2+\tfrac{3}{4}(\beta_3-\beta_2)^2}\sin(\theta-\varphi)$$

$$=N\sqrt{\beta_1^2+\beta_2^2+\beta_3^2-\beta_1\beta_2-\beta_2\beta_3-\beta_3\beta_1}\sin(\theta-\varphi)$$

$$=\beta_s N\sin(\theta-\varphi),$$

where $\beta_s=\sqrt{\beta_1^2+\beta_2^2+\beta_3^2-\beta_1\beta_2-\beta_2\beta_3-\beta_3\beta_1}$,

and φ is also a function of β_1, β_2, β_3, whose value is not required.

The maximum value of the resultant linkage is $\beta_s N$.

In an exactly similar manner it can be shown that the maximum resultant magnetic linkage with the coils of a rotor phase is $\beta_m N$, where

$$\beta_m=\sqrt{\beta_1'^2+\beta_2'^2+\beta_3'^2-\beta_1'\beta_2'-\beta_2'\beta_3'-\beta_3'\beta_1'}.$$

Similarly, the resultant magnetic linkage with a rotor phase, due to unit maximum currents in all phases of the rotor with their proper phase relations, is $\beta_r N$, where β_r is determined in the same way as β_s, β_m.

Expression of σ_1 in Terms of β_s, β_r, β_m.—

$$\sigma_1=\frac{(l_1-l_1')}{L},$$

where l_1 is that part of (L_s-M) due to the main flux produced by a current in the stator linking more effectively with the stator than with the rotor windings—*i.e.*,

$$l_1=\beta_s N-\beta_m N.$$

Similarly, $$l_1'=\beta_r N-\beta_m N.$$

Again, if we neglect the peripheral and flank leakage in comparison with the main flux,

$$L=\tfrac{1}{2}(L_s+L_r)=\tfrac{1}{2}(\beta_s N+\beta_r N).$$

$$\therefore\ \sigma_1=\frac{l_1-l_1'}{L}=\frac{(\beta_s N-\beta_m N)+(\beta_r N-\beta_m N)}{\tfrac{1}{2}(\beta_s N+\beta_r N)},$$

$$=\frac{\beta_s+\beta_r-2\beta_m}{\tfrac{1}{2}(\beta_s+\beta_r)}=2\left|\frac{\tfrac{\beta_s+\beta_r}{2}-\beta_m}{\tfrac{1}{2}(\beta_s+\beta_r)}\right|.$$

Calculation of the Coefficients β_s, β_r.—The distribution curve for the flux due to any single coil, such as AB, Fig. 1, spanning

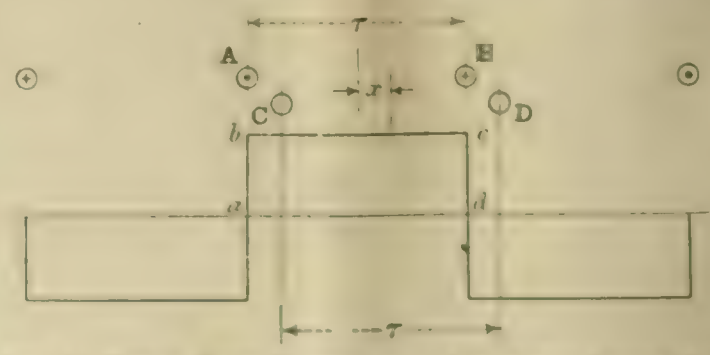


Fig. 1.—Ideal Flux Distribution Curve for Single Coil.

a pole pitch, is very nearly of the rectangular shape *abcd*, shown in the figure, provided there are no slot openings. The effect of slot openings will be examined further on. Since the coefficients β_s, β_r, β_m are merely ratios entirely independent of the number of conductors per slot and of the magnitude of the flux, we may so choose these as to simplify the calculation as far as possible. It will be simplest to suppose that there is but one conductor per slot, and that unit flux is produced per unit length of the periphery of the stator. Thus, the flux produced by the coil AB is equal to τ, where τ denotes the pole pitch. The magnetic linkage with any other coil, such as CD, Fig. 1, which also spans a pole-pitch, and is displaced relatively to the coil AB by any distance x, is equal to $(\tau-2x)$. Such linkage is to be regarded as positive when the magnetic lines pass through CD in the same direction as through AB, and negative when they pass through CD in the reverse direction, x being always regarded as positive.

The sign, as well as the magnitude of the magnetic linkage, is expressed by $(\tau-2x)$, which becomes negative when $x>\dfrac{\tau}{2}$.

* "On the Magnetic Dispersion in Induction Motors and its Influence on the Design of These Machines," by Dr. Hans Behn-Eschenburg. "Journal" of the I.E.E., Vol. XXXIII., Part 2, April, 1904.

No stipulation has been made as to whether the coils AB, CD are on the same or opposite parts of the motor. They may both be on the stator, both on the rotor, or one on the stator and the other on the rotor.

First, suppose there are any number of coils such as AB, CD *all* on the stator, or else all on the rotor. Then the total magnetic linkage due to equal currents in all the coils is given by $\Sigma(\tau-2x)$ if it be understood that in this summation every coil must be taken with itself and with every other coil.

Secondly, suppose there are any number of coils such as AB on the stator (or rotor), and any number such as CD on the

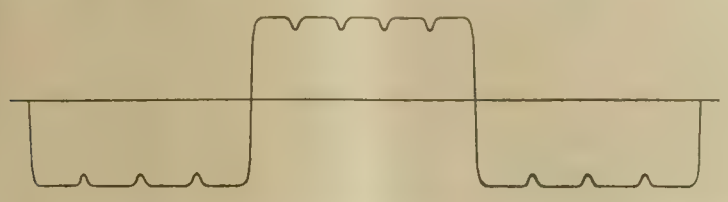


FIG. 2.—GENERAL EFFECT OF SLOT-OPENINGS ON FLUX DISTRIBUTION CURVE.

rotor (or stator). Then the total magnetic linkage with all the rotor coils due to equal currents in all the stator coils, or vice versa, is $\Sigma(\tau-2x)$, where, in this summation every stator coil is to be taken with every rotor coil, or vice versa.

Now, β_1, β_2, &c., each represents the ratio of the value of an actual linkage to that which would be obtained *if all the coils coincided in position*. The linkage in the latter case would obviously be $\Sigma\tau$.

Thus, in general, $\beta=\Sigma(\tau-2x)/\Sigma\tau=1-2\Sigma x/\Sigma\tau$.

Consider, now, the effect of any small openings in the slots. The curve of flux distribution will then be somewhat as shown in Fig. 2. The flux over a whole pole-pitch would be reduced

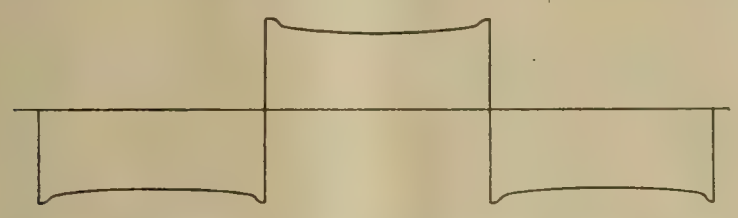


FIG. 3.—GENERAL EFFECT OF VARYING RELUCTANCE OF MAIN MAGNETIC PATHS.

from τ to some less amount τ', but the flux over the distance x would also be reduced *on the average* in approximately the same proportion, so that $\Sigma x'/\Sigma\tau'$ must be very nearly equal to $\Sigma x/\Sigma\tau$.

Again, owing to the state of saturation of the teeth not being constant over the whole pole-pitch, and also to some of the magnetic lines having a greater length of path in iron than others, the distribution will not be of quite a rectangular shape, but somewhat as shown in Fig. 3, where for the sake of simplicity the effect of any slot openings has been omitted. The expression $(\tau-2x)$ for the linkage with the coil CD (Fig. 1) due to the coil AB is no longer quite true, the second term $2x$ tending to become larger relatively to the first term τ.

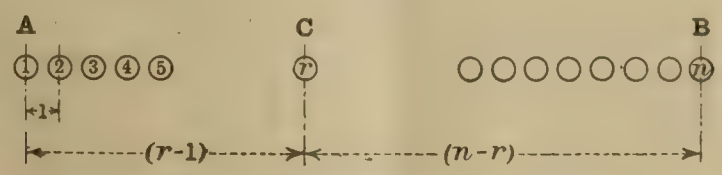


FIG. 4.—COIL-SIDE DISTRIBUTED IN n SLOTS.

We are eventually concerned, however, not with the actual values of β_1, β_2, &c., but with the difference of two coefficients β_s, β_m, each of which depends on quantities such as β_1, β_2. But β_s, β_m must both be affected to an approximately equal degree by the variation of the flux distribution from the true rectangular shape, due both to slot openings and variable saturation of the iron. For example, if β_s is reduced to (β_s-a) and β_m to (β_m-b), the difference $(a-b)$ would be small compared with $(\beta_s-\beta_m)$, so that $\{(\beta_s-a)-(\beta_m-b)\}=\{(\beta_s-\beta_m)-(a-b)\}=(\beta_s-\beta_m)$ approximately.

It has been thought advisable to enter at this length into the question of the errors to be expected from basing our calculations of β_s, β_r, β_m on the hypothesis of a flux distribution curve of true rectangular shape, in order to establish the validity of results based on such an assumption, even though that assumption is not strictly true.

The relative displacement of any two coils, both spanning a pole-pitch, is the relative displacement of corresponding coil sides (*i.e.*, left or right hand). It is easier to regard it as the displacement of the coil sides.

Fig. 4 represents a series of n slots in which the coil sides of all the coils of one phase and pair of poles are distributed. Let C be the rth slot, reckoning slot A as the first slot. Then, taking C with every other slot (slot pitch=1),

$$\Sigma x \text{ for coil } c = 1+2+3+\ldots\ldots\text{to } (r-1) \text{ terms} + 1+2+3+\ldots\ldots\text{to } (n-r) \text{ terms}$$

$$=\left\{\frac{r}{2}(r-1)+\frac{(n-r)}{2}(n-r+1)\right\}=\left\{r^2-(n+1)r+\frac{n}{2}(n+1)\right\}.$$

Therefore, for *all* the coils,

$$\Sigma x=\Sigma_{r=1}^{r=n}\left\{r^2-(n+1)r+\frac{n}{2}(n+1)\right\},$$

$$=\left\{\frac{n}{6}(n+1)(2n+1)-\frac{n}{2}(n+1)^2+\frac{n^2}{2}(n+1)\right\}.$$

$$=\frac{n}{2}(n+1)\left\{\frac{(2n+1)}{3}-(n+1)+n\right\}=\frac{n}{3}(n^2-1).$$

$$\therefore\quad \beta_1=\left\{1-2\frac{\Sigma x}{\Sigma\tau}\right\}=\left\{1-\frac{\frac{2}{3}n(n^2-1)}{n^2\tau}\right\}.$$

$$=\left\{1-\frac{\frac{2}{3}(n^2-1)}{n\tau}\right\}.$$

If S denote the number of slots per pole, $n=S/3$ and $\tau=S$ (slot pitch=1), so that

$$\beta_1=\left\{1-\frac{\frac{2}{3}(S^2/9-1)}{S^2/3}\right\}=\left\{1-2(1/9-1/S^2)\right\}.$$

$$\therefore\ \beta_1=\frac{7}{9}+2/S^2.$$

Fig. 5 shows a group of coils arranged in the most usual way for three-phase machines.

To determine β_2 we have to find Σx, where x is the distance between any of the slots containing the left (right) coil-sides of phase 2 and any of those containing the left (right) coil-sides of phase 1. In this case *all* the left-hand slots of phase 2 lie to the left of *all* the left-hand slots of phase 1.

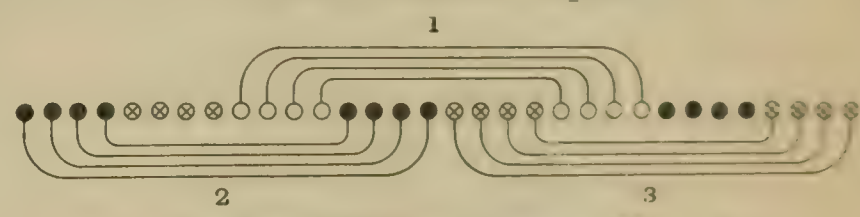


FIG. 5.—HEMITROPIC ARRANGEMENT OF WINDING.

Consequently, $\Sigma x=(S/3)^2\frac{2}{3}\tau$, S/3 being the number of slots per pole per phase, and $\frac{2}{3}\tau$ the *mean* distance between the left-hand slots of phases 1 and 2.

$$\therefore\ \beta_2=\left\{1-2\frac{\Sigma x}{\Sigma\tau}\right\}=\left\{1-\frac{2(S/3)^2\frac{2}{3}\tau}{(S/3)^2\tau}\right\}=-\frac{1}{3}.$$

From the symmetrical arrangement of the coils it is evident that $\beta_3=\beta_2=-\frac{1}{3}$.

Now, when $\beta_2=\beta_3$.

$$\beta_s \text{ or } \beta_r=\sqrt{\beta_1^2+\beta_2^2+\beta_3^2-\beta_1\beta_2-\beta_2\beta_3-\beta_3\beta_1}.$$

$$=\sqrt{\beta_1^2+\beta_2^2+\beta_2^2-\beta_1\beta_2-\beta_2^2-\beta_2\beta_1}.$$

$$=\sqrt{\beta_1^2-2\beta_1\beta_2+\beta_2^2}=(\beta_1-\beta_2).$$

$$\therefore\ \beta_s \text{ or } \beta_r=\frac{7}{9}+\frac{2}{S^2}+\frac{1}{3}=\frac{10}{9}+\frac{2}{S^2}.$$

If S_1, S_2 denote respectively the numbers of slots per pole in the stator and rotor,

$$\beta_s=\frac{10}{9}+\frac{2}{S_1^2},$$

and

$$\beta_r=\frac{10}{9}+\frac{2}{S_2^2},$$

$$\therefore\ \frac{\beta_s+\beta_r}{2}=\frac{10}{9}+\frac{1}{S_1^2}+\frac{1}{S_2^2}.$$

(To be continued.)

THE IRON-COBALT ALLOY, Fe_2Co, AND ITS MAGNETIC PROPERTIES.*

BY TRYGVE D. YENSEN.

Summary.—The author describes the preparation and testing of samples of iron-cobalt alloy, and records the magnetic properties and apparent usefulness of this alloy.

During the last four years experiments have been carried on by the writer in the engineering experiment station of the University of Illinois on the magnetic properties of pure iron and iron alloys.† Electrolytically refined iron has formed the basis of these experiments, and, in order to prevent contamination, the melting has been done in a vacuum furnace. On account of the high permeability and low hysteresis loss obtained by the vacuum method of melting, it was suggested to the writer by Dr. Jacob Kunz that an iron-cobalt alloy of the composition Fe_2Co, melted in vacuo, might show some interesting properties. This alloy was produced by Dr. P. Weiss,‡ of Zurich, in 1912, who found that it had a saturation value of magnetisation 10 per cent. higher than that of pure iron, although it was then generally accepted that no alloy had a higher saturation value than pure iron.

This article gives the results obtained for pure iron and for the alloy, Fe_2Co, melted and annealed in vacuo. For the sake of comparison a sample of Fe_2Co, obtained from Dr. P. Weiss, was tested both in the original state as forged, and after being remelted in vacuo Furthermore, the following commercial grades of iron were tested,

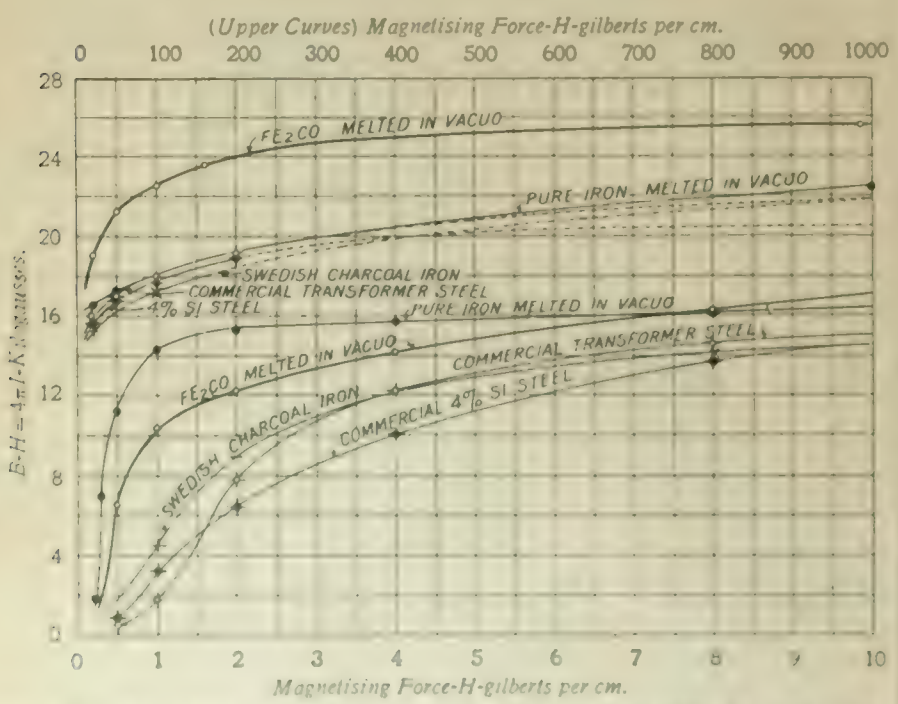


FIG. 1.—MAGNETISATION CURVES FOR VARIOUS GRADES OF IRON AND IRON ALLOYS. ANNEALED.

and the data included here: (1) Ordinary cold rolled steel; (2) standard transformer steel; (3) 4 per cent. silicon steel; (4) Swedish charcoal iron. Nos. (2) and (3) were received from the manufacturers and had received their standard heat treatment. The results include the magnetic properties at low, medium and intense fields, the electrical resistance, the mechanical properties, chemical analyses and microstructure.

The iron consisted of slowly reduced electrolytic iron containing 0·02 0·03 per cent impurities. The melting was done in an Arsem type vacuum furnace, at a pressure of 0·5 mm. of mercury. The charge was left in the furnace until cold, and the resulting ingots were then forged into rods 1 in. in diameter. From these rods the test pieces were machined into the proper form.

The magnetic testing for low and medium fields was done by means of the Burrows ring permeameter, double bar and yoke method, using rods 14 in. (35·5 cm.) long and 0·782 in. (2 cm.) in diameter. The saturation values were obtained by Dr. E. W. Williams, of the Physics Department. He employed for this purpose an electromagnet with conical pole pieces between which a field of 10000 gilberts per centimetre could be obtained. The test pieces consisted of ellipsoids about 1 cm. long. After testing as forged the magnetic test pieces were annealed at 900°C., and then at 1,100°C. The annealing was done in a vacuum furnace to prevent oxidation.

The following were the specimens tested:—

Electrolytic iron, melted in vacuo, C—0·01 per cent. Si—0·01 per cent.

No. 3Co01, iron-cobalt, melted in vacuo, at a pressure of about 3·0 mm. Hg. Co—33·36 per cent.

No. 3Co02, iron-cobalt, melted in vacuo, at a pressure of about 1·0 mm. Hg. Co—33·33 per cent.

No. 3Co03, iron-cobalt, melted in vacuo, at a pressure of about 0·5 mm. Hg.

Iron-cobalt, forged from a casting obtained from Dr. P. Weiss.

Same as above, remelted in vacuo at a pressure of 0·5 mm. Hg.

The following commercial grades were also tested:—

Cold rolled steel.

Standard transformer steel of commercially high permeability.

4 per cent. silicon steel for transformer cores.

Swedish charcoal iron C—0·163 per cent., Si—0·032 per cent., S—0·0002 per cent.

The magnetisation curves for these are shown in Fig. 1, while Figs. 2—5 compare the hysteresis loops and permeability curves of Fe_2Co with those of commercial grades.

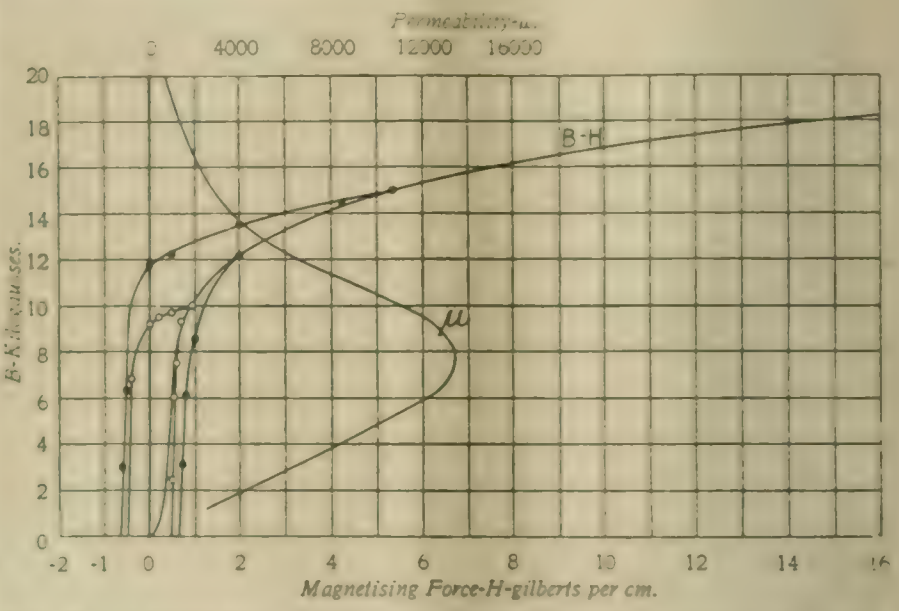


FIG. 2.—HYSTERESIS LOOPS AND PERMEABILITY CURVE FOR IRON-COBALT (Fe_2Co) MELTED IN VACUO. ANNEALED AT 900°C.

The iron-cobalt alloys, although forging and machining readily, were quite brittle when cold, and the rod from specimen No. 3Co01 broke in the lathe, so that it could not be used for magnetic tests in low and medium fields. Other test pieces were also lacking, so that the only specimens for which complete sets of tests were obtained are the pure iron specimen—which is an average representative of a large number—and specimen No. 3Co02, but sufficient data are available for the rest to allow definite conclusions to be drawn.

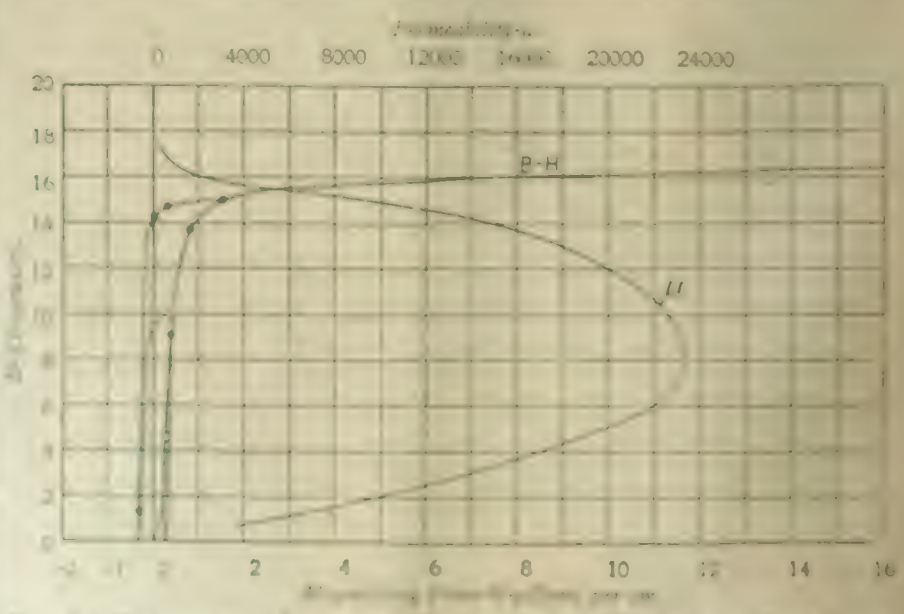


FIG. 3.—HYSTERESIS LOOPS AND PERMEABILITY CURVE FOR PURE IRON MELTED IN VACUO. ANNEALED AT 900°C.

From the chemical analyses it appears that the iron-cobalt alloys contain 33·33 per cent. cobalt, and may thus be said to conform quite closely to the formula Fe_2Co.

The magnetisation curve and hysteresis loop for pure iron as shown in Fig. 1 and Fig. 3, represent average results recently obtained, giving a maximum permeability of 23,000 at a flux density

* Abstract of an article in the "General Electric Review."

† No. 1. "Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo." "Bulletin" No. 73 of the Engineering Experiment Station, University of Illinois, 1914. No. 2. "The Effect of Heat upon the Magnetic and other Properties of Electrolytic Iron Melted in Vacuo," "Bulletin" No. 77, 1915.

‡ "Compt. Rend.," 156, 1979 to 81, 1913.

of 8,000 gausses. The hysteresis loss for $B_{max.}=10,000$ and 15,000 is 764 and 1,610 ergs per cubic centimetre per cycle, respectively.

With regard to the saturation values, the results obtained in this investigation show that the iron-cobalt alloy, Fe_2Co, has a saturation value about 13 per cent. higher than that of pure iron, irrespective of the method of melting. However, the saturation values both for pure iron and for the iron-cobalt alloy are raised about 3 per cent. by melting the substances in vacuo. While the saturation value is primarily of scientific interest, Fig. 1 shows that the iron-cobalt alloy may be of practical importance in the electrical industry. While its magnetisation curve is 13 per cent. above that for pure iron at saturation, it is 25 per cent. higher in medium fields, such as H=50 to H=200. However, its maximum permeability is 13,500, which is much higher than is obtained for the best grades of transformer iron

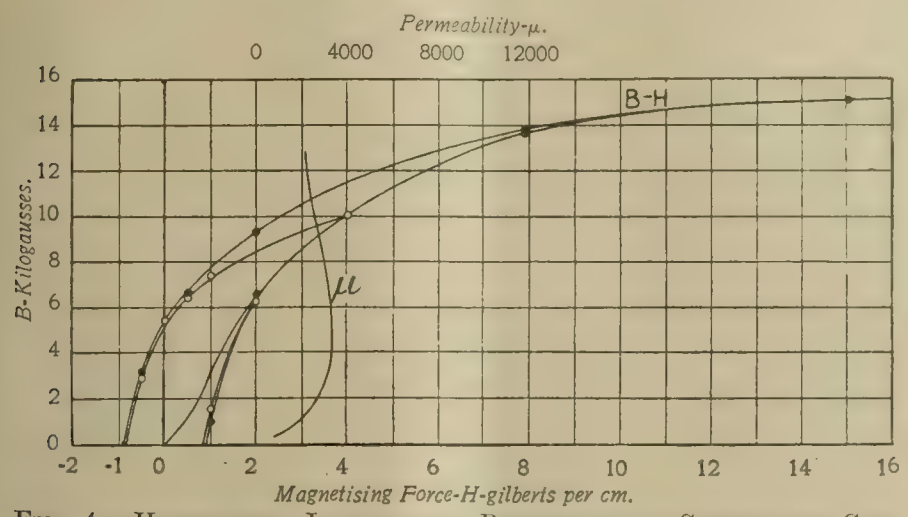


FIG. 4.—HYSTERESIS LOOPS AND PERMEABILITY CURVE FOR COMMERCIAL 4 PER CENT. SILICON STEEL ANNEALED.

at the present time. Its hysteresis loss, too, is as low as or lower than that in commercial grades of iron. Its chief importance, however, lies in its high magnetic permeability at high densities. An increase here of 25 per cent., when coupled with a low hysteresis loss, is a highly desirable characteristic, for instance, for the teeth of the armatures of dynamo machinery, where the density is always very high. Without going into detail, a few considerations will make this apparent. By increasing the density in the teeth the armature may be shortened a corresponding amount, and so may the pole pieces if the alloy is also used there. Iron and copper can, therefore, be saved in both armature and field. The I^2R loss is reduced in direct proportion to the reduction in copper used. Furthermore, as the hysteresis loss is lower per pound for the Fe_2Co alloy than for ordinary iron, and as the eddy current loss is about the same, the total core loss should

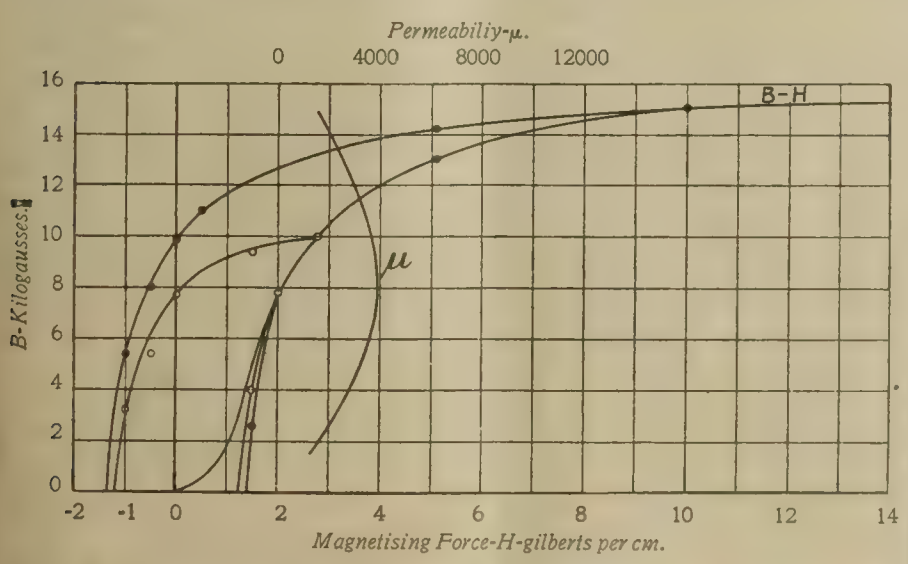


FIG. 5.—HYSTERESIS LOOPS AND PERMEABILITY CURVES FOR COMMERCIAL TRANSFORMER STEEL. ANNEALED.

be considerably less than with ordinary iron, in spite of the increased density.

The mechanical properties of this iron-cobalt alloy are not particularly advantageous. In the forged state, while rather brittle, it is considerably stronger in tension than pure iron. After being annealed at 900°C., however, its tensile strength has decreased to about one-third, and it is even more brittle than in the forged state. It may be that the alloy could be annealed at a lower temperature than 900°C., and retain some of the strength that it exhibits in the forged state, at the same time acquiring the magnetic properties obtainable by annealing 900 deg.

The electrical resistance of the Fe_2Co alloy is about the same as for pure iron, and makes the alloy unsuitable for use in places where the eddy current loss is of chief importance.

Annealing the Fe_2Co alloy at 1,000°C. reduces the permeability and increases the hysteresis loss considerably, although the saturation value remains the same as before.

The results may be summarised as follows:—

1. The iron-cobalt alloy, Fe_2Co, has a saturation value of magnetisation 13 per cent. higher than that of pure iron. However, the values for the maximum product, both for pure iron and for the Fe_2Co alloy, are about 3 per cent higher than for the corresponding grades melted under ordinary conditions.

2. When melted in vacuo its maximum permeability is above 13,000 at a density of 8,000 gausses. While this is lower than for pure iron, melted in vacuo, its permeability in medium fields is 25 per cent. higher than that for pure iron or for commercial grades of iron

3. Its hysteresis loss at densities of 10,000 gausses or below is considerably less than for the best grade of commercial transformer iron, though at densities of 15,000 or above it is about the same.

4. Its specific electrical resistance is about 10 microhms, or about the same as for pure iron.

5. Mechanically it is brittle but fairly strong. Annealed, the ultimate tensile strength of the Fe_2Co alloy and of the pure iron is about the same, while in the forged state the alloy is more than twice as strong as pure iron.

In this iron-cobalt alloy, Fe_2Co, is thus found a substance that is suitable for use in places where the magnetic density is very high, such as armature teeth of dynamo machinery. While its electrical resistance is low, there is reason to believe that this may be raised by the addition of other alloying elements. The cost of cobalt prohibits the general use of this alloy at the present time, but there are indications that the price of cobalt will be less in the future.

ON THE RELATION BETWEEN THE ALTERNATING-CURRENT CONDUCTIVITY OF A DIELECTRIC AND ITS CHANGE OF CAPACITY WITH FREQUENCY.

BY G. E. BAIRSTO, D.SC.

Summary.—The author shows, from the results of Prof. J. A. Fleming and Mr. G. B. Dyke, that the percentage change of capacity of a dielectric for a given range of frequency is a definite function of the alternating-current conductivity.

Although it has been noticed by several observers in a general kind of way that those dielectrics which have large alternating-current conductivity also exhibit to a considerable degree the phenomena of dielectric absorption and residual charge, with a corresponding change in capacity when tested at different frequencies, the writer is not aware that any experimental relationship between the two has so far been established.

In a recent Paper of Fleming and Dyke* a large number of careful measurements are given of the conductivity and capacity of dielectrics for alternating currents of telephonic frequencies and at different temperatures. The present Paper is an analysis of the results given therein. The above-mentioned observers found that σ, the alternating current conductivity could be expressed as a linear function of the frequency n, viz.:—

$$\sigma = a + bn.$$

The author's object has been to trace some connection between $\Delta C/C$, the change of capacity for a given range of frequency, and the b term in the formula $\sigma = a + bn + cn^2$, a third term cn^2 being added to take account of the fact that the results do not follow the simple linear law given above. With that end in view the Table below has been calculated, giving in parallel columns the values of b and $\Delta C/C$ at different temperatures for various dielectrics. $\Delta C/C$ is taken to be equal to the quantity $(C_{920}-C_{4600})/C_{920}$ expressed as a percentage. C_{920} and C_{4600} being the capacities at the respective frequencies 920 and 4,600, the extreme limits between which measurements were made. σ was measured in 10^{-12}mhos/cm. cu.

* "Journal" Inst. Elec. Eng., Vol. XLIX., p. 323.

Temperature °C.	b	$\Delta C/C$
Glass.		
0	0·0295	1·0
17	0·0565	2·2
49	0·103	1·8
62	0·158	3·4
88	0·320	8·9
Celluloid Undried.		
0	0·0175	0·8
19	0·056	1·4
42	0·140	4·2
60	0·240	7·8
81	0·335	11·8
Celluloid Well Dried (G.E.B.)		
2·5	0·025	2·7
15	0·0096	0·7
30	0·040	3·2
51	0·060	3·7
60	0·112	3·5
68	0·135	5·8
80	0·155	6·0
— 11	0·028	1·8
— 38	0·039	2·2
— 75	0·039	3·0
—120	0·024	3·2
—140	0·020	2·1
—184	0·0025	0·0
Vulcanised Indiarubber.		
0	0·012	0·8
17	0·000	0·8
42	0·003	0·4
60	0·011	0·4
83	0·018	1·3
103	0·023	0·9
—14	0·017	1·2
—23	0·050	3·3
—32	0·056	3·1
—42	0·018	1·6
Gutta-percha.		
0	0·033	1·9
15	0·029	1·4
19	0·031	2·3
27	0·011	1·6
50	0·001	0·4
—14	0·019	1·8
—25	0·015	1·3
Dried at 50°C. tested at 16°C.	0·038	1·9
Soaked in water at 50°, dried and tested at 16°	0·038	2·1

Temperature °C.	b	$\Delta C/C$
Ebonite.		
0	0·007	0·4
19	0·011	1·0
45	0·025	1·0
62	0·115	4·0
84	0·21	6·1
Manilla Paper. (Dried.)		
0	0·008	0·4
19	0·0055	0·4
42	0·008	0·8
(Undried).		
18	0·056	4·4
After 1½ hours at 44°C.	0·110	11·8
After 19 hours at 45°C.	0·005	0·7
Blotting Paper.		
Undried	0·21	17·0
Dried	0·0095	1·6
Table X. No. D ...	0·11	13·8
Table X. No. F ...	0·11	12·9
Paraffined Manilla Paper. (Dried before impregnation.)		
0	0·022	0·65
17	0·011	0·8
48	0·008	0·05
(Not dried before impregnation.)		
0	0·034	1·5
19	0·064	3·3
41	0·19	5·4
Slate. (Undried.)		
15	4·4	20
42	3·05	24
63	1·8	22
(Partially dried.)		
19	2·8	28
40	1·9	22
59	1·0	12
82	0·76	13
(Well dried.)		
0	0·22	9
17	0·58	5·2
36	0·57	10
54	0·64	11·2
83	0·96	11·5
(Another condenser, G.E.B.)		
Undried	7·55	55
Partially dried ...	4·35	42·5

The results are depicted in the four sets of curves, Figs. 1-4, in which b has been plotted to $\Delta C/C$, each point on a given curve corresponding to a different temperature.

Fig. 1.—In the case of glass and ordinary undried celluloid, we see that straight lines are obtained showing that b is proportional to $\Delta C/C$. In the case of well-dried celluloid the results are somewhat irregular. This the author believes is due to the fact that celluloid seems to undergo a permanent change in structure and composition at temperatures above 60°C., and that some of the results given in the Table were taken before, and some after, the celluloid had been subjected to this temperature.

Fig. 2.—Here again in the case of ebonite and vulcanised indiarubber we have straight lines connecting the two quantities. In the case of gutta-percha, however, there does not seem to be such a good agreement, but it must be remembered that in no case is $\Delta C/C$ more than about 2 per cent., which is very small. There is one point, however, that should be noticed. It does not matter whether the gutta-percha is well dried or soaked with water, the points so obtained do not depart from the curve.

Fig. 3.—In the lowest figure are given several sets of results for paper. The observations marked with a ⊙ refer to dried Manilla paper; those given by ⊡ to ordinary undried Manilla paper, which is a very poor dielectric; those given by ● to three distinct condensers made up of undried blotting paper; finally, ▽ refers to dry blotting paper. All these points lie on the same curve; hence we may conclude that the curve is independent of the kind of paper and of the amount of moisture present. But as soon as we add another dielectric to the cellulose, which is the principal component of either kind of paper, we get quite different results. This is shown in the top curve (points denoted by crosses) which refers to Manilla paper

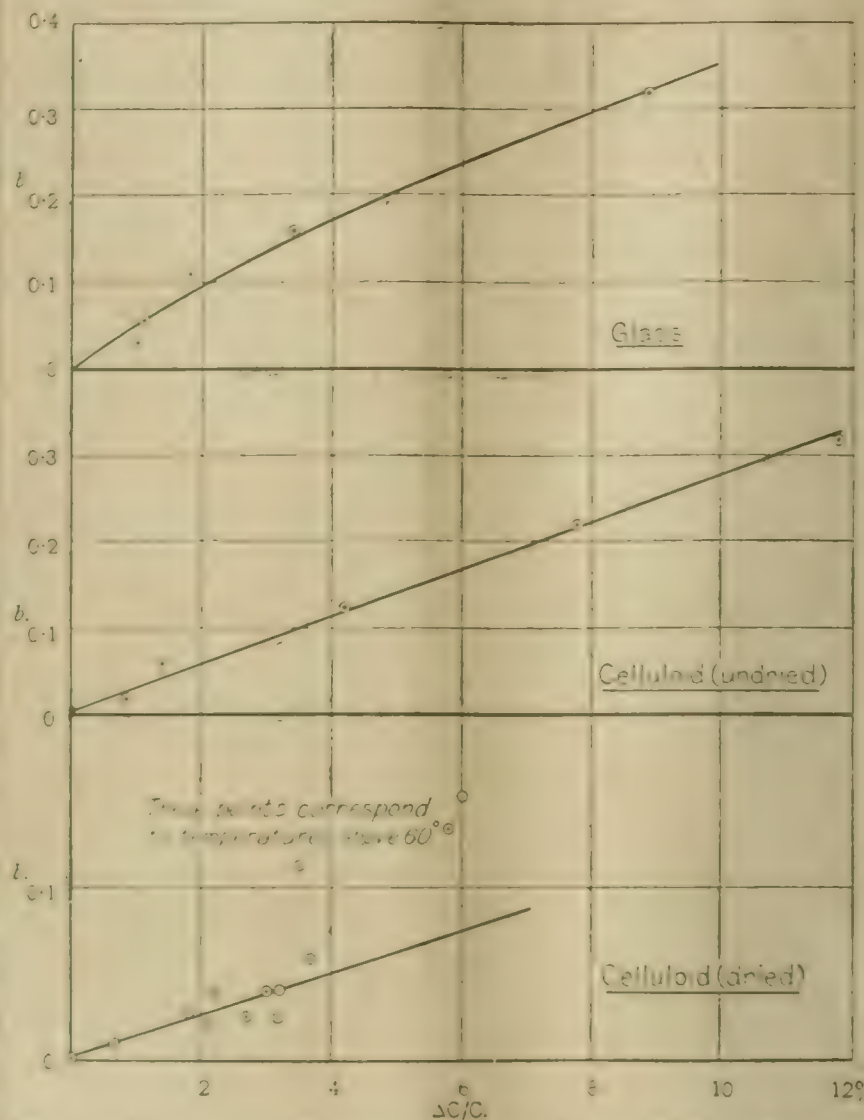


Fig. 1.—Showing the Relation between b and $\Delta C/C$ for Glass and Celluloid.

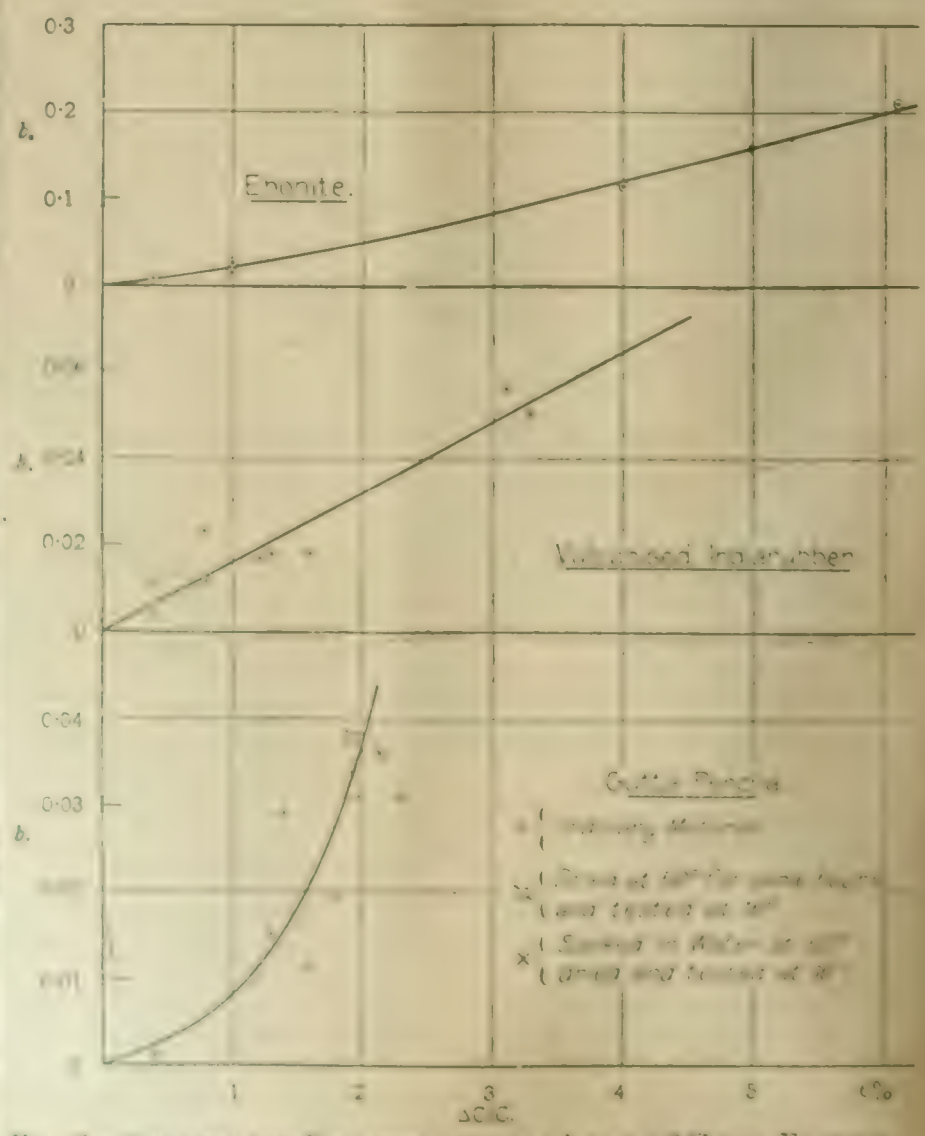


Fig. 2.—Showing the Relation between b and $\Delta C/C$ for Ebonite, Vulcanised Indiarubber and Gutta Percha.

that had been impregnated with paraffin wax. It will be seen that we get quite a different curve.

That moisture has no influence on the shape of the curve, but only increases each of the quantities b and $\Delta C/C$ in equal proportions, is well illustrated by the top curve of Fig. 3, which gives the results of measurements made on a slate condenser

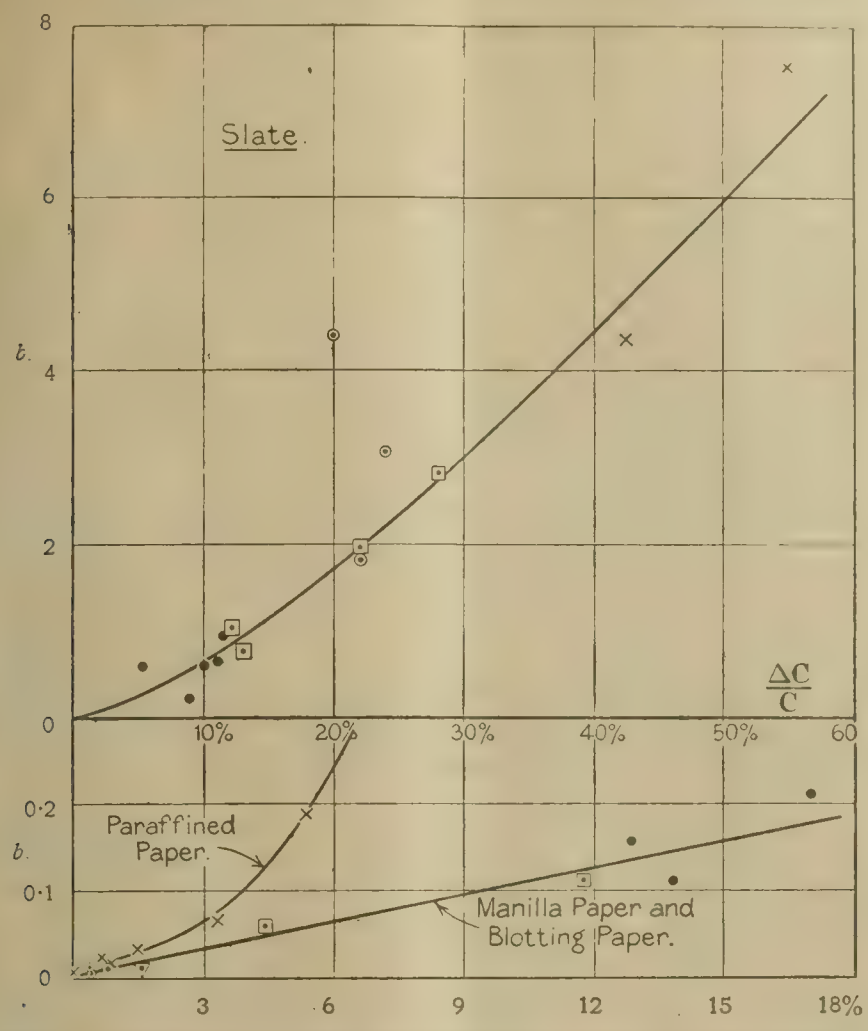


FIG. 3.—SHOWING THE RELATION BETWEEN b AND $\Delta C/C$ FOR SLATE AND PAPER.

OBSERVATIONS ON SLATE.	OBSERVATIONS ON PAPER.
⊙ Not dried.	⊙ Dried manilla paper.
⊡ Partially dried.	⊡ Undried manilla paper.
● Dried.	▽ Dried blotting paper.
× A second condenser (G.E.B.)	● Undried blotting paper.

in different states of moisture content. The points denoted by ⊙ refer to undried slate; ⊡ to the slate after it had been partially dried with heat; ● to slate after it had been thoroughly dried. With the exception of one point, which seems

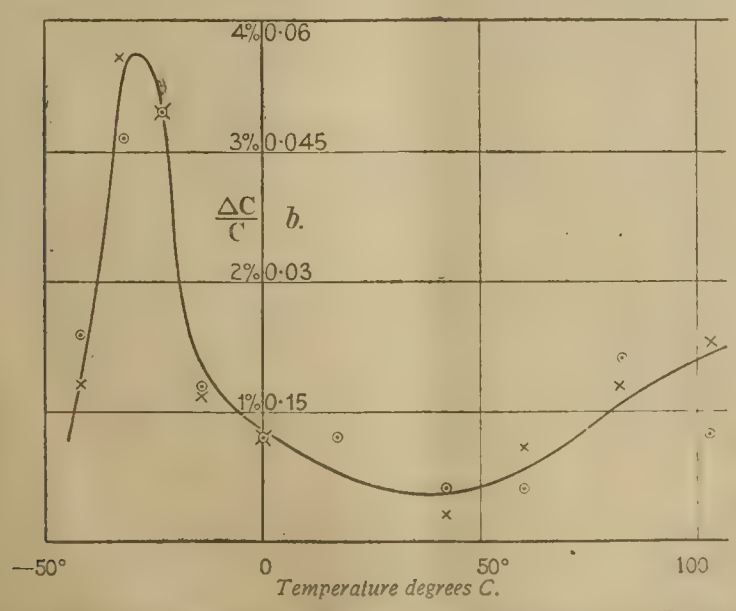


FIG. 4.—SHOWING THE VARIATION OF b AND $\Delta C/C$ WITH TEMPERATURE VULCANISED INDIARUBBER.

($\odot = \Delta C/C$, $\times = b$.)

to have been misplaced owing to a printer's error, they give a very good curve which is nearly a straight line. During the course of some other work, the author had occasion to make up another condenser from another sample of slate which had a much greater moisture content. A similar set of measurements were made with it, the results being given at the end of the Table, and plotted on the same figure by means of crosses. As before, they lie on the same curve as the one given by the first set of results. Celluloid is an apparent exception to this law, for the line obtained for the dried material is [illegible] the one for the undried. But as already mentioned, when celluloid has been subjected to a temperature in excess of about 60°C., it seems to undergo a permanent change, and in addition to driving off moisture we are also volatilising the camphor of which it is partly composed.

In order to show how remarkably close is the proportionality of b to $\Delta C/C$, these two quantities for the case of vulcanised indiarubber have been plotted to temperature, using approximately the same scale for each. It will be seen that the curves, Fig. 4, gives quite a good representation of both sets of points. Vulcanised indiarubber was chosen as an example because it has such a sharp peak on its conductivity—temperature curve. Each of the other dielectrics, gutta-percha and celluloid, which are known to have points of maximum conductivity at certain temperatures, give similar results.

We may briefly summarise the above results as follows: The percentage change of capacity, $\frac{\Delta C}{C}100$, of a dielectric for a given range of frequency is a definite function of the alternating current conductivity and in nearly all cases $\Delta C/C$ is proportional to b, where b multiplied by the frequency represents the main part of the *alternating*-current conductivity. $\frac{\Delta C}{C}$ is a constant which is independent of the temperature of the dielectric and its state of moisture-content.

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PROGRESS OF ELECTRIC WELDING.

Electric welding is looked upon by some as a recent application of electricity, and others are of the opinion that the process is one which requires little skill on the part of the operator. Many of our readers will, no doubt, be surprised to learn that the art dates back to the earliest days of electrical engineering. It is on record that DE MERITENS, in 1881, used an electric arc for the welding of storage battery plates. The widely used resistance or incandescent process had its origin in a laboratory experiment made by Prof. ELIHU THOMSON as long ago as 1877. Those interested in the origin and development of the several methods will find helpful a bibliography issued in 1913 by the New York Public Library. This contains references to a large number of articles and books, and the most important patents are noted. Not only are several of the processes old, but they have, in addition, been practised for many years by engineering firms and others in this country. Although in some cases the work is of such a character that it can be properly executed by unskilled labour, it is the common experience of many firms that skill of a high degree is required in the making of reliable welds. In his treatise on "Welding and Cutting Metals," Dr. L. A. GROTH gives as an example of the low cost of electric welding the making of 900 welds, each of 4·5 sq. in. area, in a working day of 10 hours. He enters labour charges at 4s., energy charges at 7s. 6d., and interest and depreciation charges at 1s. 7d. per working day. We are of the opinion that these figures, namely, 13s. 1d. for the making of 900 large welds, or 0·174d. per weld, would not find ready acceptance to-day. The same author, in determining the cost of smith-welds, would have one believe that the wage of a skilled smith was 4s. per day!

Of the several methods of arc welding the two best known

are those devised by BENARDOS and OLSZEWSKI and by SLAVIANOFF. The Zerener method is of less importance. In the Benardos and Olszewski method, the arc is struck between a carbon electrode and the metal to be welded, and the electrode is invariably negative. A metal electrode is used in the Slavianoff process. ZERENER'S apparatus resembles a flame arc lamp with automatically adjusted inclined carbons, and the arc is directed downwards by an electromagnet. By far the most widely used of the incandescent processes is that due to THOMSON. In this process the pieces to be welded are connected in the secondary circuit of a transformer by means of relatively heavy water-cooled jaws. On closing the primary circuit the joint is quickly heated to the point of fusion, and the pieces are forced together by hand or automatically. An interesting modification of this process, introduced, we believe, about eight years ago, is spot-welding. In spot-welding, ridges are formed on the surfaces to be welded in in such a way that a number of joints of equal electrical resistance are made between the two. These set up local heating, and when the correct temperature has been attained the joint is closed by mechanical pressure. This method is of wide application.

Practically the only method of electric welding of recent origin is that known as the electro-percussive process. It is founded on tests conducted about 10 years ago with electrolytic condensers and rectifiers. During these tests it was observed that wires could be connected to the aluminium plates by the condenser spark when the cells were discharged, and it was noticed that copper wires could be attached to aluminium, or that two pieces of aluminium could be joined together. This was, of course, only a feeble welding of the metals for temporary connections. But later, in view of the demand for a method of welding aluminium, Messrs. C. E. SKINNER and L. W. CHUBB, after a thorough investigation of their earlier tests with electrolytic condensers, tried out the method of welding with a condenser discharge on a larger scale. The results were embodied in a Paper read last year before the American Electrochemical Society, and an abstract of the Paper was given in THE ELECTRICIAN, Vol. LXXV., p. 5.

The principle involved is that of percussive contact between two metals with a condenser discharge occurring at the instant of such contact. The process is especially adapted to the welding of small sections of like or unlike metals. In many cases work can be done which it is impossible to carry out by other methods; joints can be made without overheating the metals, and the welds are found to be ductile and strong. SKINNER and CHUBB gave oscillograms of the current through and voltage across the weld during the operation of welding an 18 B. & S. gauge wire. From these it was found that electrically the weld was complete in 0·0012 second, and although at a certain instant 23 kw. were being dissipated between the ends of the wires, the total energy used at the weld amounted only to 0·00000123 kw.-hour. At 1d. per kilowatt-hour the cost of this energy would be about one-millionth of a penny.

Elsewhere in this issue we give an abstract of an informative Paper on "Electric Welding," presented at the International Engineering Congress, San Francisco, by Mr. C. B. AUEL. This recent contribution to the literature on the subject, besides giving much general information on the several processes, contains a valuable record of cost data, working speeds and cutting speeds. In addition, detailed particulars are given of an important series of mechanical tests on the strength of welds made by the Benardos and Slavianoff arc processes. From these it will be noticed that both processes give welds of about the same strength. The author states that in machine steel the ultimate strength will average approximately 80 per cent. of the original strength, while in cast steel the strength of the welds will run 10 to 12 per cent. lower.

From tests made in the works of the American Westinghouse Company on the cost of welded rings, it appears the labour costs of smith-welds and arc-welds on sections measuring 1 in. by 1·5 in. are 2·26s. and 2·04s. respectively. In sections of larger size arc welding is much more economical. For instance, to weld a section measuring 2 in. by 6 in. costs 3·4s. by the arc process, and the cost of the corresponding smith-weld is 12·2s. The fact that labour charges are higher in America than in this country will not affect the ratio. In the same works it has been found that steel can be cut at the rate of 0·454 sq. in. per minute per 100 amperes by means of the carbon arc process.

A novel application of the Thomson process, namely, the bonding of tram rails, is described. For the purpose of bonding two rails an alternating current of about 2,000 amperes at 5 volts is required for two or three minutes, and it is stated that three men can average 100 welds per day of 12 hours. In the welding of rails by this process about 30,000 amperes at 5 to 7 volts are applied for two to three minutes with a pressure of 1·8 tons per square inch on the weld. With a gang of six men, 40 welds are said to have been made per day of 12 hours. An interesting table in the Paper, taken from the report for 1910 of the Board of Supervising Engineers, Chicago Traction, gives the results of several years' experience with electrically-welded rails approximating 50,000 in number. As pointed out by AUEL, owing to the apathy of the general public, the possibilities of electric welding have not been fully appreciated until comparatively recently, with the result that the art has failed to reach the stage of advancement it undoubtedly should have reached, the fundamental patents both in arc and incandescent welding having expired. The absurd secrecy practised by many firms, in some cases as a cloak to hide their ignorance of the process they are using, has had a marked effect on retarding the development of the art. We hold that where secrecy is not of vital importance to the well-being of an industrial concern, such secrecy is as short-sighted as the conduct of a workman who fails "to fill the unforgiving minute."

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Tramway Track Construction and Maintenance. By R. BICKERSTAFFE HOLT. (London: "Tramway and Railway World." Pp. xv.+249. 10s. 6d.

A popular but intangible definition of engineering states that "engineering is the use and adaptation of the great forces of Nature for the use of man:" if its fruition is modified to read "for the comfort of man," then Mr. Bickerstaffe Holt's observations on tramway track engineering, which forms the subject of the volume under review, are a valuable contribution to the literature of this branch of professional practice.

It is refreshing to find that the author has wisely considered it best to confine himself rigidly to the core of tramway engineering and, from his own exceptional experience in a large industrial centre, to lay down the conditions essential to the fulfilment of the ideals of sound engineering work, of economy in maintenance, and of the comfort of the travelling public. In this latter direction especially the author must be congratulated.

He gets very quickly to his subject when he says, with a

truth which comes home to most of us, that street track work has been too often designed in the past by men who had little to guide them as to its practical maintenance and upkeep under service conditions, with its inevitable rectification of the defects and troubles which arose only too soon after the opening ceremony ; and the author's insistence of the value of patient skilled personal supervision of work of so specialised a character is entitled to the greatest commendation. It cannot be too often said, careful practical forethought in the details of the progress of the work, its design and manner of execution will repay themselves many times over on the life of the track.

The soundness of his opinions upon the foundation work, and the packing and paving in of the rails, will be endorsed by all who have experienced that "bugbear" of tramway engineering, "a loose road." Again, his statements are fully borne out as to the unwisdom of unduly leaving open long lengths of bolted up and packed rails exposed to much temperature variation before paving in.

In his revival of the ever attractive rail section controversy it must not be overlooked that the British Standard section was "sat upon" for some considerable time before it received the approval of the Standards Committee. No one will claim that it could be regarded as a perfect rail section from a traction point of view, and there is much that is attractive in Mr. Holt's views. The theory that perfect tractive contact is only made with a partly worn tyre upon a partly worn rail is abhorrent and bad engineering. One cannot but agree that this amounts to an admission of the principle of the grinding in of rail and tyre.

The author has confined himself narrowly to the groove of his subject in not developing more fully the investigation of wheel wear upon the life of his rails. The rolling contact of a car-wheel tyre upon its rails is a dual partnership in which at least the active member cannot be ignored. The track gauge is only correct or efficient so long as the wheel-tyre gauge is standard or undeformed by wear. When this deformation of tyre section and gauge reaches certain limits the best of tracks relatively are deformed also. Much of the "tail wagging" of truck cars and the "hunting" of the wheels for their correct equal contact diameters is due to this. The onus should be brought home to the offending partner. The author no doubt, as a lover of a good track, holds strong views on this and it would have been helpful had he indicated these more fully.

It is a common failing of tramway track engineers, and in some slight degree the author has not escaped, to forget that the tramway track is fundamentally part of the road surface. It is always his function to maintain his track levels coincident, and simultaneously, with the surface and general contour of the road. Indeed in this question of paving within the track and on the adjacent roadway is bound up one of the most difficult and expensive problems to be dealt with.

The variation in the nature of traffic conditions between street and street, even in the same town, makes it very difficult to design a consistent and satisfactory form of paving, and too often the interests of the tramway track and the road breasts on either side do not conform to a common general policy. Much of the author's indictment of rail wear due to vehicular traffic selecting the rails on account of the smaller tractive effort required is due to this cause ; this is particularly the case with stone sett paving, and, though initially more costly, the nidged dressed blocks laid close jointed both for track and breast paving may prove a true economy in the connection. The experimental paving with Norwegian Grey Royal Granite blocks laid in Holborn by the Borough Council and elsewhere should be carefully watched.

Again, the author, after thoroughly and properly condemning hard wood paving, might have expatiated at greater length upon soft wood for track paving.

In a work containing so much that is excellent one hesitates to bring forward any suggestions which would tend to expand it beyond the scope intended by the author. Some tabulated costs from the Author's experience would have been extremely valuable, and even though subject to fluctuations in price of material and labour they would be comparative and helpful.

Again, there is a further omission in the electro-technics of tramway work, both upon overhead equipment and power cable distribution ; this is to be regretted. Even rail bonding has been left out. The author's practical views on these should be valuable ; he may perhaps see his way to include either or all in a future edition.

In the compact chapters at the end of the book on track work and setting out, one or two errors have unavoidably crept in.

While bewailing the present heavy cost of construction and maintenance, the author does not indicate or recommend any lines for the development of a tendency toward reduction of expenditure. He suggests its desirability, but it should be noted that the whole trend of his recommendations is the doing of such things, wise in themselves, which undoubtedly tend to increase first cost at least.

The illustrations to the text are full and very commendable. Photographs of progressive stages of the works and of details have been very judiciously used to bring out the special points of the author.

The book, which throughout is essentially practical rather than academic, leaves upon the mind the impression of a thoughtful and helpful contribution to the knowledge of engineers engaged upon these works. The ultimate opinion of one who has bought his wisdom through past years' of practice and experiment, of success and maybe of failure, is always of great value to those who follow after. R. G. H. CLEMENTS.

First Principles of Production. By J. TAYLOR PEDDIE. Pp. 231. (London : Longmans, Green & Co.) 5s. net.

This volume consists of a number of Papers, many of which have appeared from time to time, some of them in the columns of THE ELECTRICIAN. They are contributed by Mr. Peddie and other authors, and they deal with various aspects of industry. It is pointed out in the introduction that if Germany has to pay heavy war indemnities in the near future the standard of wages and living prevailing in Germany prior to the declaration of war will have to be reduced to a lower level. Consequently the German costs of production will be on a much lower scale than hitherto, and thus it becomes of extreme importance that we should see that our methods of production in this country are highly efficient. In the first article the elementary principles of production are set out so as to lay emphasis upon the four factors which affect cost, namely, material, labour, establishment charges and profit. In the second Paper the "Influence of State Action on the Growth of Industry" is discussed and it is pointed out that the success of a "wake-up" policy depends as much upon the interest manifested by the State in industry as upon the interest manifested by those responsible for the management of the industry. Another Paper is devoted to the thorny question of tariffs. Here the reasonable attitude is taken that it is ridiculous to make a subject of this kind a question of party politics. There are a number of other Papers, all of which should be of general popular interest, including Sir Norman Lockyer's address to the British Association on "The Influence of Brain Power on History and Industry," and Prof. Percy Frankland's recent lecture before the Society of Chemical Industry on "The Chemical Industries of Germany." The book is one that should do something towards the spreading of rational ideas.

Aircraft in the Great War. By C. GRAHAME WHITE and H. HARPER. (London : T. Fisher Unwin.) Pp. 346. 7s. 6d. net.

The authors give an interesting account of the increasingly important part which is being played in the present war by aircraft. All its various phases are discussed starting from a description of the work of the air pilot and describing the dangers which he runs. Some account is then given of the results obtainable by such means as regards scouting and bomb dropping. Finally the authors take up the question of directing artillery by means of aeroplanes and the methods used in aerial fighting. The book is by no means technical, but it will certainly appeal to the public at the present time, and from the point of view of giving a popular description of what is being done by our air service, the volume is excellent and is exceedingly well printed

ELECTRIFICATION ON THE LONDON & SOUTH-WESTERN RAILWAY.

(*Continued from Vol. LXXV., p. 965.*)

The type and arrangement of motor with which the bogies are equipped is well shown in Figs. 8 and 9, from which the details are apparent. The commutator is mounted on an extension of the armature spider, so that the shaft can be replaced at any time with ease.

The collector shoe, which is carried by a teak beam, is shown in Figs. 10 and 11. A long leakage path is thus provided. The shoe is recessed in the centre, the idea being to give two surfaces of contact rather than one continuous surface. The flexible connections from the shoe are taken to a fuse box just above the teak beam, one advantage of this arrangement being that the whole equipment can be made dead very easily. In the event of a short circuit in the cab it is distinctly desirable to be able to cut off the power without depending upon apparatus within the cab itself, as it may be difficult to bring this into operation under certain circumstances. This precaution does not imply that such occurrences are

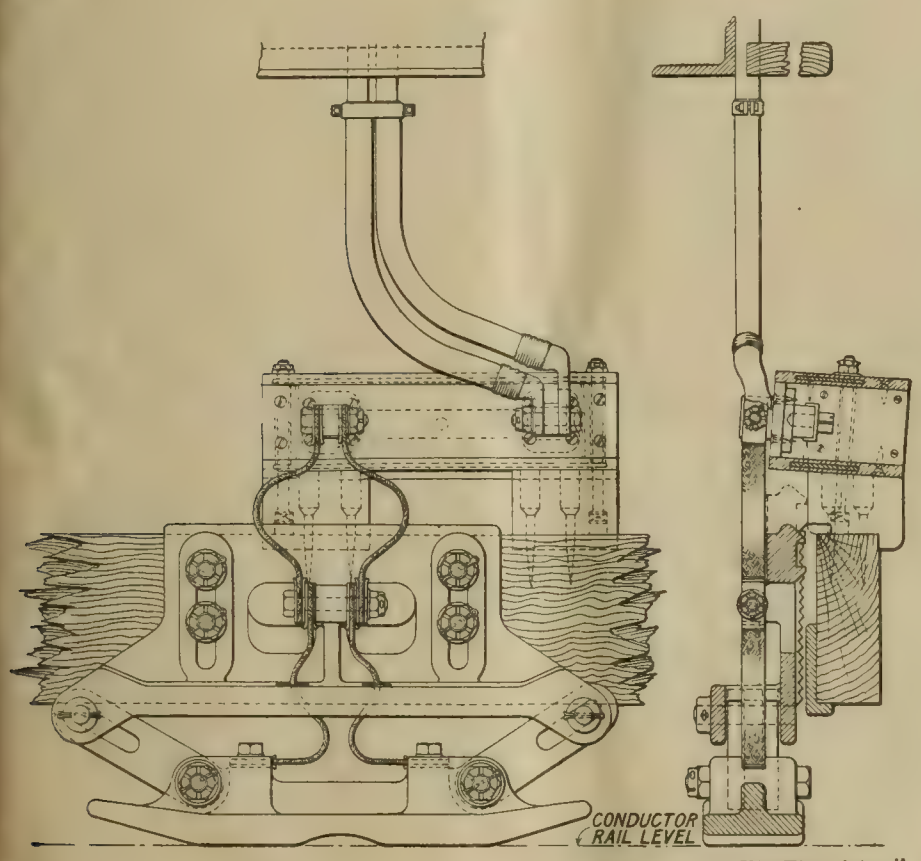


FIG. 10.—ELEVATION (FROM THE INNER SIDE) AND CROSS SECTION OF THE COLLECTOR SHOE.

expected, but it is undoubtedly better to provide for them. As a last resource each cab is provided with the usual short-circuiting bar.

It will be noticed that two cables are carried from the shoe to the control compartment, the cables being in parallel. This is due to the fact that a standard size of cable is used throughout, and consequently if a double section is desired two cables are placed in parallel.

TRACK WORK.

The track work involved the laying of third rail, and the bonding of running rails, to about 150 single line miles of railway. The third rail consists of special high-conductivity steel and weighs 100 lbs. per yard. Its resistance is approximately $6\frac{3}{4}$ times that of copper of equal volume. The joints are bonded with four copper bonds having a total cross section of 1·4 sq. in. The arrangement of the bonding is shown in Fig. 12, and the joint in Fig. 13. The fish plates for the third rail weigh $7\frac{1}{2}$ lbs. per pair.

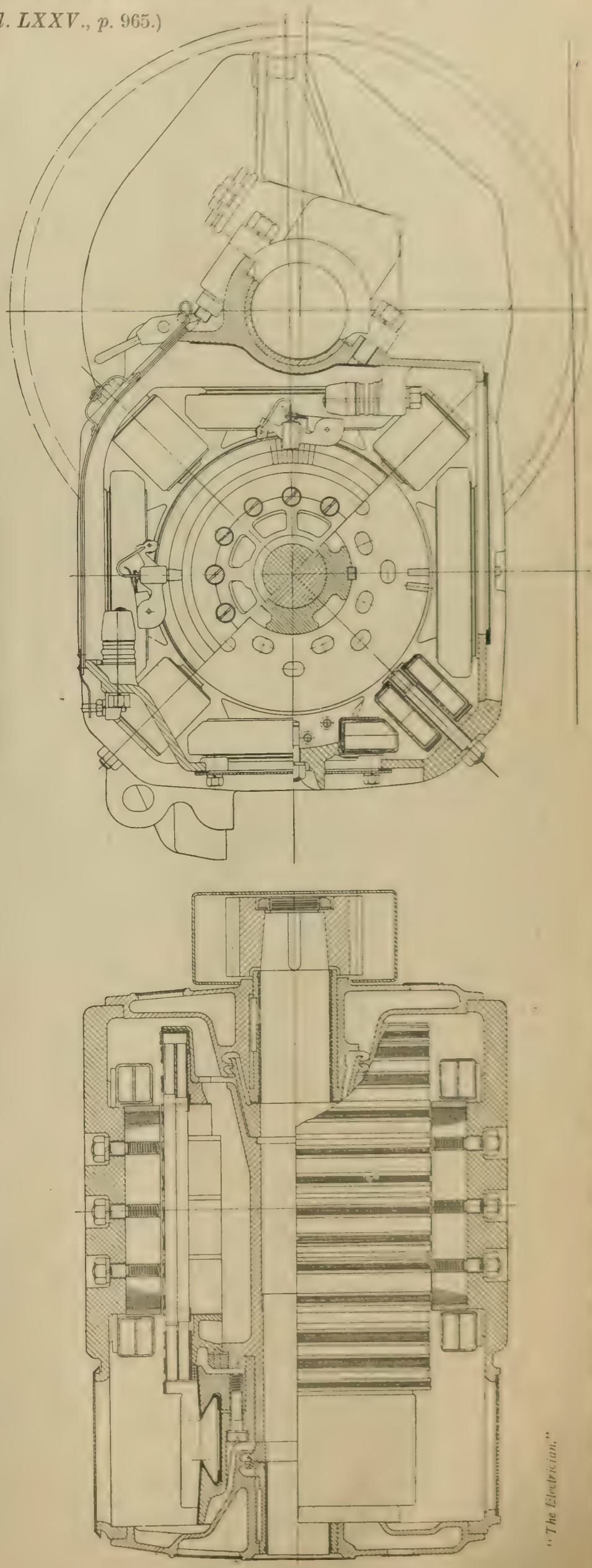


FIG. 9.—CROSS SECTION OF BRITISH WESTINGHOUSE TRACTION MOTOR, 275 H.P.

FIG. 8. LONGITUDINAL SECTION OF BRITISH WESTINGHOUSE TRACTION MOTOR, 275 H.P.

The third rail is laid on one side of the track, 16 in. from the line and 3 in. above rail level, as shown in Fig. 14. It rests on malleable cast-iron caps which in turn are carried on porcelain insulators. The rail is bent down at the ends to form ramps. The jumper cables connecting adjacent lengths of third rail at crossings and other points where it is necessary to have a gap are 1 sq. in. in sectional area and made up of 127/0·101 in. copper wires, rubber insulated, bitumen sheathed and braided.

Protection to the third rail is afforded at certain points by means of boarding carried by brackets fixed to the sleepers.

The return circuit is formed by the running rails, the joints of which are bonded with two copper bonds of the protected



"Electrician" Photo.

Fig. 11.—View of the Collector Shoe and Third Rail.

type placed under the fish plates. These bonds, which are of copper strip, have a total cross sectional area of 0·33 sq. in. The running rails are cross bonded at frequent intervals to equalise the current returning by the different rails.

The low-tension rubber-bitumen cables for the jumpers and also those for connecting up the third rail to the sub-stations have been supplied by Chas. Macintosh & Co., who have handled this part of the work, together with the cross bonding. This firm also manufactured the cables for the electrical equipment of the rolling stock.

sections of the line were used for track circuit signalling by means of continuous current. Owing to the present use of the rails for power purposes, it was necessary to

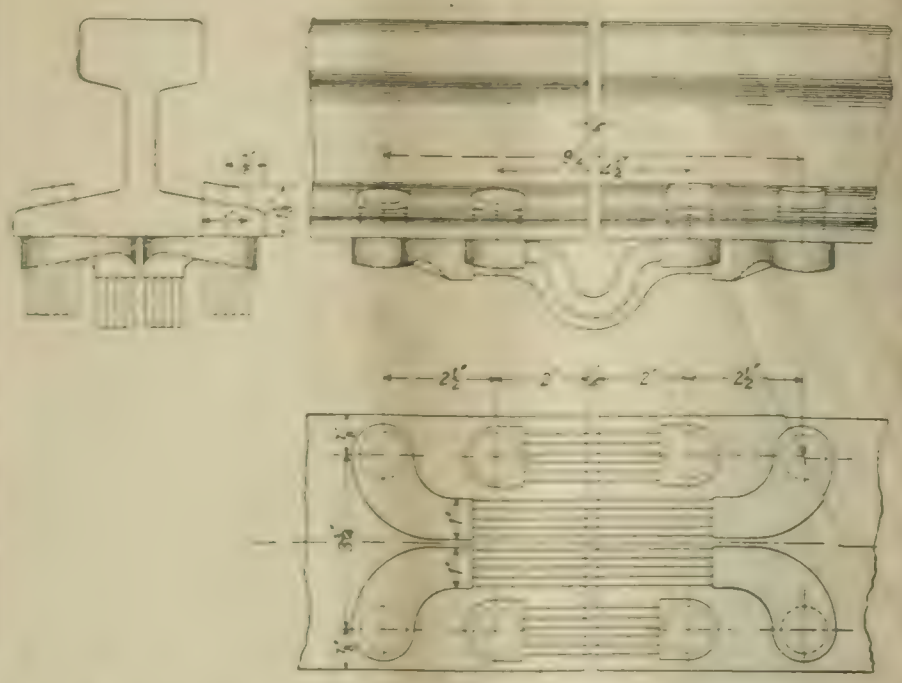


Fig. 12.—Arrangement of Conductor Rail Bonding.

change from continuous-current to alternating-current working for the track circuits, and a frequency of 75 cycles has been adopted for this purpose. The equipment of the

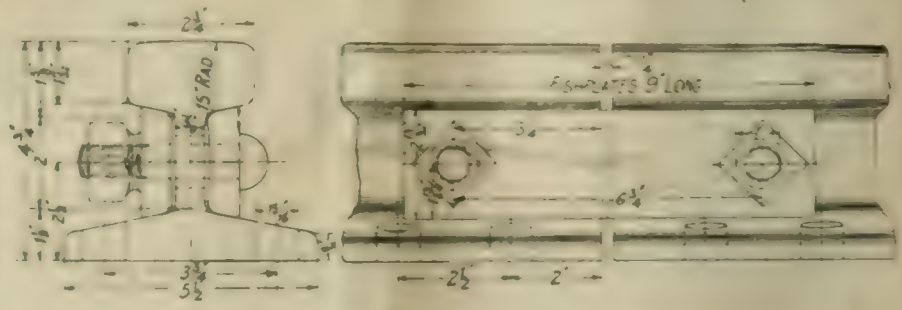


Fig. 13.—Detail of Conductor Rail Joint.

signals has been carried out by the McKenzie, Holland & Westinghouse Power Signal Co., under the supervision of Mr. A. W. Szlumper, the chief engineer, and Mr. A. H.

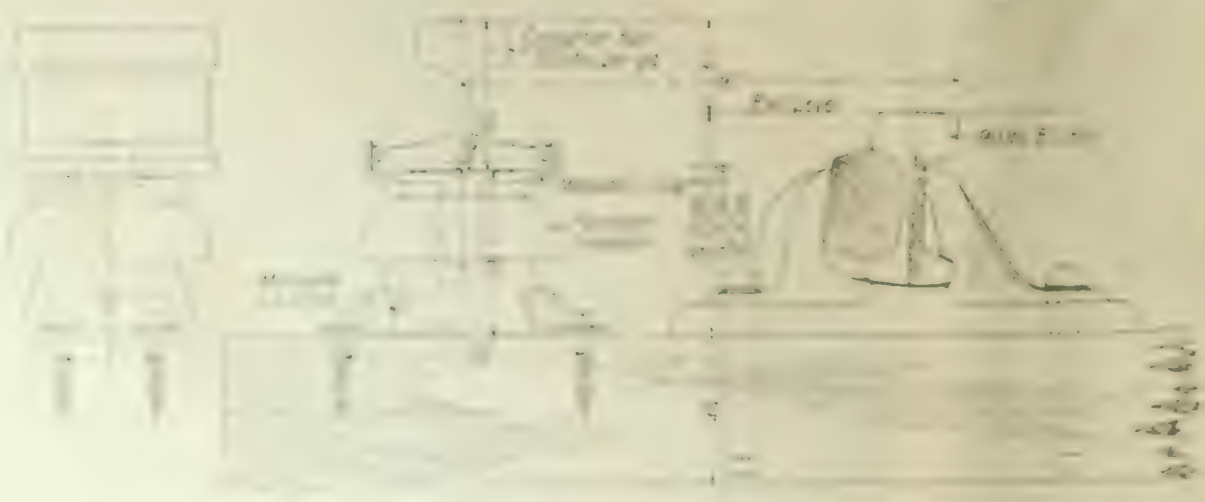


Fig. 14.—Arrangement of Conductor Rail and Insulator.

Connection to the low tension feeders is made by means of sockets fixed by two bolts to the web of the rail. The negative feeders are similarly connected to the running rails, except at Waterloo and Clapham Junction where the connections are made through reactance bonds so as not to interfere with the use of these rails for signalling purposes by means of alternating currents.

Before the electrification the running rails on certain

Johnson, signal and telegraph engineer, of the Railway Company.

Transmission Cables.

The high-tension transmission from the power house to the sub-stations is by means of three-phase paper-insulated, lead-cased and heavily wire-armoured cables, manufactured and laid

by Siemens Brothers & Co. The cables are generally run above ground, being hung on cast-iron brackets, bolted to creosoted wood posts. Where the cables cross the running lines and at level

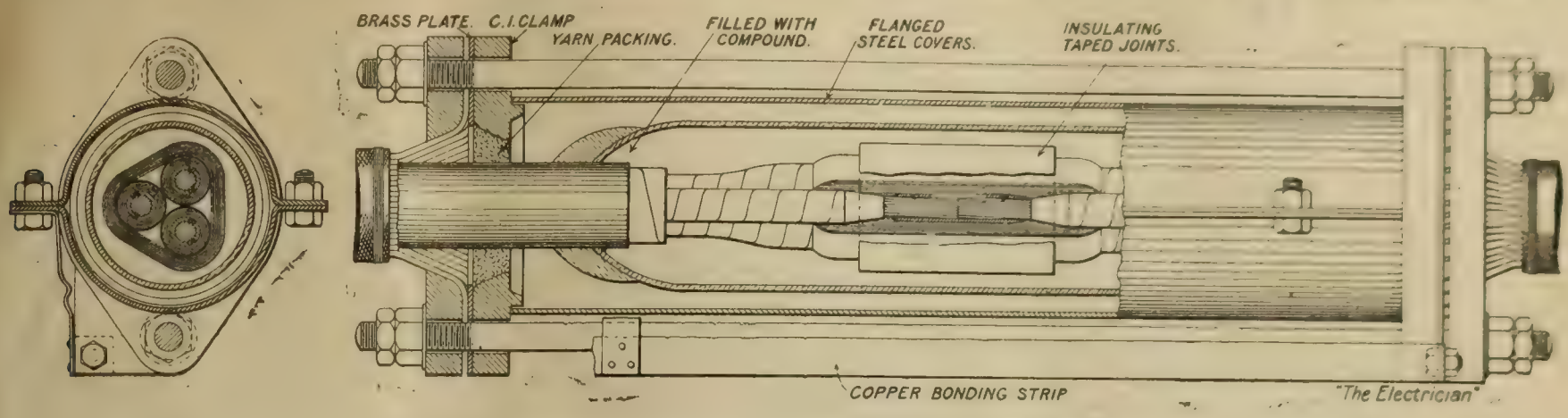


FIG. 15.—SECTIONS OF JOINT IN 3-PHASE H.T. TRANSMISSION CABLE.

crossings and other special points, they are laid underground in Howard asphalt troughing.

The fact that the feeders are supported on posts by the side of the track called for special provision to be made to prevent any trouble due to expansion and contraction. Change of temperature might cause in this way considerable strain on the joints. The type of joint adopted to meet this was a modification of Siemens' standard practice for mining cables, which combines efficient bonding of the wires with mechanical strength and protects the joint from strain.

The three cores are connected by extra long copper sleeves, and the joint proper enclosed in a lead sleeve wiped on to the



FIG. 16.—SECTION OF HIGH-TENSION TRANSMISSION CABLE.

lead of the cable in the usual manner. This sleeve is protected by a pressed steel cover, made in two halves and bolted together. The armour wires are held at each end of the cover by a pair of heavy cast-iron clamps bolted together by two long bolts which connect the two ends of the joint. The bolts are tightened up until all strain is taken off the joint. An additional bonding of the sheathing is effected by tinned brass plates, placed between the cast-iron clamps, and connected by a tinned copper strap. The arrangement is seen in Fig. 15.

The cables are designed for a working pressure of 11,000 volts, and were tested at the works at a pressure of 25,000 volts for half an hour, and on site, after laying and jointing, at 20,000 volts for half an hour.

Altogether upwards of 80 miles of three-phase cables of various sections have been supplied by Siemens Brothers & Co. for this work. A typical cross section is shown in Fig. 16.

(To be continued.)

CORRESPONDENCE.

THE AUDION AMPLIFIER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of July 16th, p. 559, you publish a letter from Dr. Lee De Forest in regard to the audion and certain methods of its use. It is stated that the reaction relay system of amplification and its adoption for beat reception, as developed and patented in Great Britain by Messrs. Franklin and Round, are the inventions of Dr. Lee De Forest, discovered by him as early as 1912 and demonstrated before the Washington meeting of the American Physical Society in April, 1914. Dr. De Forest did demonstrate the apparatus as he says, but he neglects to add that his right to claim the invention was challenged by Prof. Pupin in the presence of Prof. Rutherford and other members of the Society, for reasons which I wish to bring to the attention of the readers of THE ELECTRICIAN.

For a number of years the audion has been under investigation at Columbia University for the purpose of determining its action as a detector and repeater. The results of a part of this work, together with an oscillographic study of the various phenomena, carried out by Prof. Morecroft and myself, were first made public in a discussion of a Paper entitled "Long Range Reception with Combined Crystal Detector and Audion Amplifier," presented before the Institute of Radio Engineers, Dec. 2, 1914, by Mr. Haraden Pratt. A more detailed account was later published in the "Electrical World" of Dec. 12, 1914. During the course of this work I discovered the regenerative system of amplification and its use as a beat receiver, and the results of the work along these lines were presented in a Paper before the Institute of Radio Engineers in March, ~~1914~~ 1915.

Toward the end of 1913, however, news of what had been accomplished reached Dr. De Forest, who thereupon made various attempts to secure a demonstration of my system and various proposals to handle it commercially. It was impossible for me to become associated in any way with Dr. De Forest, and when this fact became apparent to him he at once laid claim to the invention as his own. Since that time there has been issued to me U.S. patent 1,113,149 covering the reaction or regenerative system of amplification, and in view of this fact it is difficult to understand Dr. De Forest's claim of this principle. The above-mentioned patent was applied for Oct. 29, 1913, and a certified diagram of the second figure dated Jan. 30, 1913, is on record at the U.S. Patent Office. Dr. De Forest did not apply for a patent on circuits involving the regenerative principle until March 12, 1914, three months after he had proposed that I submit my apparatus to him and allow him to

introduce it in the federal stations (Poulsen system) on the Pacific coast!

The above communication is not written for the purpose of urging my own claims in this matter, as the two publications above referred to and my U.S. patent are sufficient evidence; it is written simply in the interest of accuracy, for the purpose of presenting in Great Britain the facts as they are known in the United States. For confirmation of these facts the readers of THE ELECTRICIAN are respectfully referred to Profs. Pupin, Arendt and Morecroft of Columbia University.—I am, &c.,

Columbia University, E. H. ARMSTRONG.
New York, Sept. 28.

THE DIRECTION FINDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my letter dated September 22nd I promised to inform you on the subjects of the two judgments that Prof. Artom cited in his letter published in the issue of THE ELECTRICIAN of September 17th.

I am now in a position to declare that Prof. Artom's affirmations as to the contents of these judgments are incorrect and misleading. Neither of the two Italian patents cited by him was subject to the decision of the Courts. They were quite outside the issues before the Courts. No declaration about the inventors of the subject of these patents is contained in the judgments. The question of the inventions, if it exists, remains unprejudiced.

The tenacity of Prof. Artom in claiming the invention of the radiogonometer is only equalled by his obstinacy in refusing the proofs of his affirmations; but it should be remarked that his claims are never clear—they are always hidden under formal artifices.

Similarly, at the International Electrical Congress held in Turin in 1911, in the section of Telegraphy and Telephony, the president of which was Major O'Meara, Prof. Artom followed the same course, consisting in making general claims, in sowing the doubt and in refusing proofs. To my several demands for proofs he did not answer; he preferred to continue his personal and general attacks.

This skirmish has now lasted eight years: it is time to put an end to it.

Capt. Tosi and myself have several times proposed to Prof. Artom to submit the question to a commission of technical men, chosen by the two parties, but Prof. Artom always refused. Now I repeat here formally the same invitation to him. Will he submit the question to a commission? Will he give in this journal the proofs of his alleged inventions?

If Prof. Artom will not accept any of these solutions, I have the right to require him not to trouble me any longer with his unbounded recriminations.—I am, &c.,

Englien-les-Bains, Oct. 8. E. BELLINI.

EARTH RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—With reference to the interesting Paper by Dr. E. W. Marchant in THE ELECTRICIAN of the 17th ult., it may be of interest to mention that the limiting case of the hemispherical earth together with several other cases is found in Gray and Mathews's "Bessel's Functions," p. 125 *et seq.* Interesting as this method of viewing the problem is, I am not at all satisfied that this is the correct method of considering earth resistance.

An example will make this clear. The resistance between two electrodes of radii a of cylindrical section, inserted a distance $\frac{1}{2}$ into a conducting bounded by *badly conducting* material, and a distance D apart is

$$\frac{\rho}{2\pi l}\log_e\frac{D^2}{a^2} \text{ approximately.}$$

Consequently, if the distance and size of electrodes is constant we should expect that the resistance of an earth should vary not as the Area of electrode, but as the depth.

Taking Dr. Marchant's figures his results are:—

$$\text{Ratio of areas } \frac{\text{copper}}{\text{iron pipes}} = \frac{27}{5{\cdot}8} = 4{\cdot}65.$$

$$\text{Ratio of } \frac{1}{\text{resistances}} = \frac{11}{6{\cdot}6} = 6{\cdot}21.$$

Now, we are told the copper plate was at a depth of 6 ft., and iron pipes were only inserted 1 ft. Hence the ratio of resistances being inversely as the depths should be 6/1. The ratio above is the ratio of the *mean* of his values, and we see it is a much closer agreement than the ratio of the surfaces—viz., 4·65.

My view of the matter is that, *provided the area is sufficient* to make a good contact, the resistance depends on the depth.—I am, &c.,

Millhill, Oct. 12. W. H. F. MURDOCH.

THERMAL CHARACTERISTICS AND INTERMITTENT RATING.

Summary. Reference is made to the general theory of heating and cooling, and values are given of the heating time-constants of various machines. The load-factor method of rating intermittent machines is described and the principles are illustrated by means of examples. In conclusion, an account is given of the R.M.S. method of rating.

In recent years several important Papers on intermittent rating have been written, and certain of these are enumerated in the bibliography at the end of this article. From the point of view of the student these Papers are unsatisfactory in so far as they assume knowledge which, as a rule, he does not possess. At the same time the problem is of live engineering interest. In our lectures on the subject we have made a practice of roughing out on the blackboard the elementary theory of the thermal characteristics before dealing with the engineering side of the problem, and in the following note the elementary theory referred to is set out. It was drawn up after reading Prof. Kapp's treatise on "Transformers," and is partly based on the method therein described.

NOTE ON THE GENERAL THEORY OF HEATING AND COOLING.

The Heating Curve.—Assuming that the heated body is homogeneous and that a constant amount of heat is generated in it uniformly, the equation to the heating curve can be deduced. Thus, in a motor running under normal conditions on a certain load there will be a certain loss, W, which raises the temperature of the motor, and the temperature will continue to rise till the heat generated is equal to the heat dissipated.

Denoting the final temperature rise by θ_f we have for the stable condition,

$$\theta_f = W \div A.k. \quad \ldots\ldots\ldots \quad (1)$$

wherein A = area of cooling surface and k is a specific dissipation factor.

Let θ be the temperature rise of the motor, above surrounding objects, after being heated for time t. For a small temperature rise $d\theta$ the energy stored is $M.s.d\theta$, wherein M = mass of body and s = specific heat. In the corresponding interval of time dt the energy dissipated from the surface of the motor is $\theta.A.k.dt$, and the heat supplied during this time is $W.dt$. Therefore, since heat supplied = heat stored + heat dissipated, we have $W.dt = M.s.d\theta + \theta.A.k.dt$, which may be written

$$\frac{d\theta}{\theta - \frac{W}{A.k}} = -\frac{A.k}{M.s}\,dt.$$

In this form the equation is at once recognised as leading to

$$\theta = \theta_f(1 - \varepsilon^{-\frac{t}{T_h}}). \quad \ldots\ldots\ldots \quad (2)$$

wherein ε is the base of the natural system of logarithms and $T_h = \frac{M.s}{A.k}$ is a constant for a given motor.

In order to determine the time t required to produce a tem-

perature rise θ it is more convenient to put equation (2) in the form

$$t = T_h \log_e \{\theta_f/(\theta_f - \theta)\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The curve, Fig. 1, has been plotted from equation (2). In drawing the curve it is convenient to take the three points: $t=0$, $\theta=0$; $t=T_h$, $\theta=0{\cdot}630_f$; and $t=3T_h$, $\theta=0{\cdot}950_f$; and to remember that OB is a tangent and AC an asymptote to the curve. Since the final temperature-rise $\theta_f = W \div A.k$, it is evident that if we know the temperature-rise for a given loss we are able to determine the temperature-rise for any other loss by simple proportion, because A and k are constants for a given motor.

Values of T_h.—In the simple case considered the heating time-constant T_h=(mass × specific heat)÷(area of cooling sur-

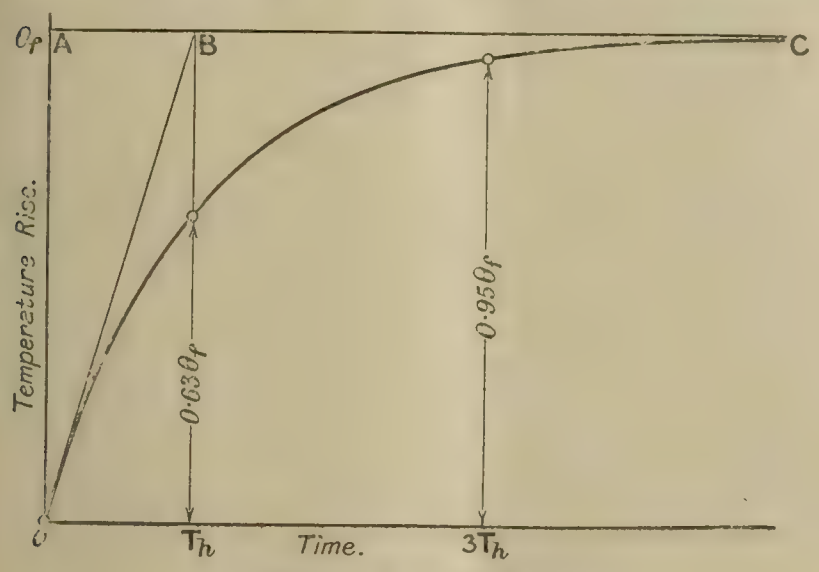


Fig. 1.—Heating Curve.

face × specific dissipation). For a non-homogeneous body heated in different places at different rates, the most important factor influencing T_h is the ratio: Weight ÷ effective cooling surface. According to Grice* for open-type machines T_h varies from 1 to 1·67 hours for armatures up to 24 in. in diameter and from 1·67 to 2·5 hours for armatures of 24 in. to 100 in. in diameter. For machines of the enclosed type T_h varies from 1·67 to 3·33 hours for armatures up to 15 in. in diameter, and from 3·33 to 5 hours for armatures of 15 in. to 26 in. in diameter. Armatures ventilated by ducts and vanes blowing air on to the heated parts usually have a low value of T_h, and values of 0·6

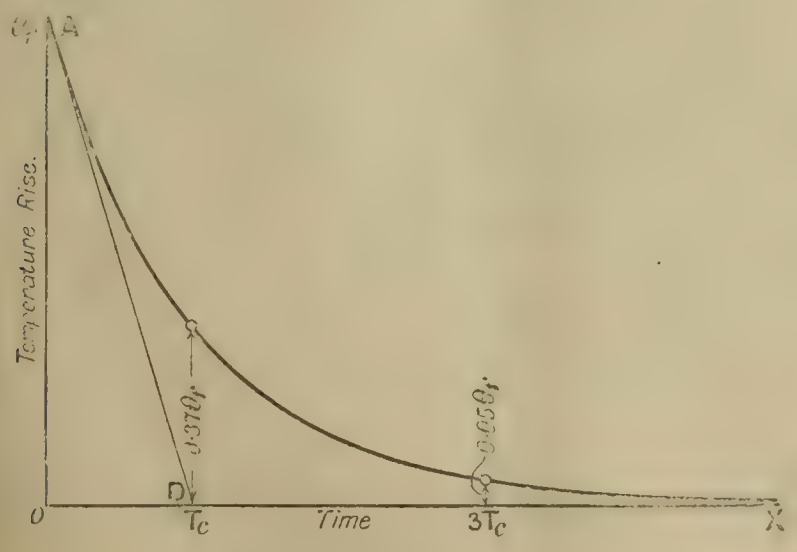


Fig. 2.—Cooling Curve.

to 1·16 hours are common. Shunt field coils have a value of T_h varying from 1·67 to 2·67 hours. In high-tension alternators the thickness of the insulation retards the cooling and keeps T_h comparatively high. For transformers the value of T_h is very variable, but it may reach anything up to 9 or 10 hours.

The Cooling Curve.—Next consider what happens on stopping the motor, or on removing the load and allowing the motor to run light. If the temperature falls $d\theta$, the energy stored is $-M.s.d\theta$, and the energy dissipated in the time dt is $\theta.A.k_1.dt$, therefore: $-M.s.d\theta = \theta.A.k_1.dt$, from which

$$\theta = \theta_f . \epsilon^{-\frac{t}{T_c}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

wherein $T_c = M.s \div A.k_1$.

With the motor at rest the cooling surface will as a rule be less efficient than with the armature in motion. Hence for the cooling-curve the specific dissipation factor, k_1, must differ from k for the heating curve.

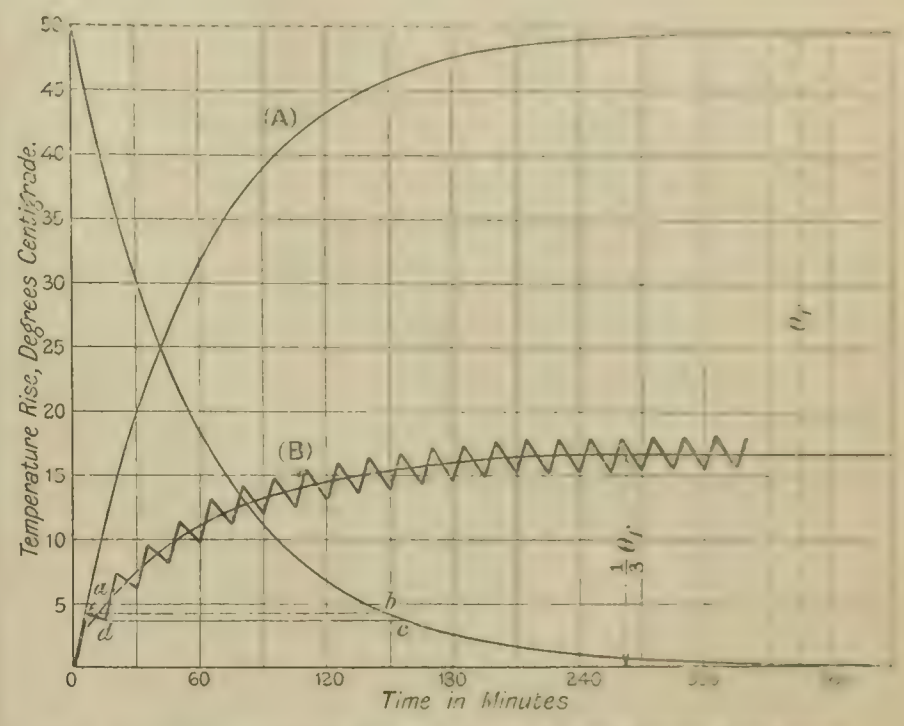


Fig. 3.—Intermittent Run on a Cycle of Short Duration.

The cooling-curve is depicted in Fig. 2. In sketching-in the curve it is convenient to take the three points: $t=0$, $\theta=\theta_f$; $t=T_c$, $\theta=0{\cdot}370_f$; and $t=3T_c$, $\theta=0{\cdot}050_f$, and to remember that AD is a tangent and OX an asymptote to the curve.

Equation (4) can also be put into the form,

$$t = T_c \log_e (\theta_f \div \theta) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Armed with a thorough understanding of the above principles the student will have little difficulty in following the argument given below on intermittent rating.

Intermittent Rating.

On intermittent work the motor will run under load for t_1 minutes and will run unloaded, or be at standstill, for t_2

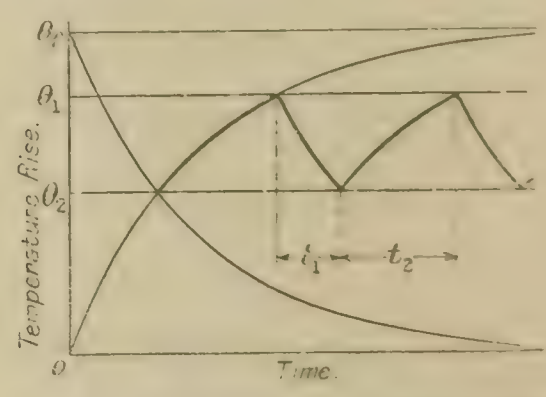


Fig. 4.—Thermal Characteristic on Intermittent Load.

minutes, making a cycle of $t_1 + t_2$ minutes' duration. Two cases of intermittent running have to be considered, namely: (*a*) the cycle of short duration and (*b*) the cycle of long duration.

(*a*) *Intermittent Running on a Cycle of Short Duration.*—Take as a typical example a crane motor. On a long-hour run the motor heats up as shown by the curve (A), Fig. 3, and on an intermittent run of, say, one-third load-factor, with the load "on" for five minutes and "off" for 10 minutes, the thermal characteristic takes the form of a saw-tooth curve (B), Fig. 3. It is composed of parts of the heating and cooling curves.

* "Heating and Cooling of Electrical Machinery," "Journal" Inst. E.E., Vol. LI., p. 840.

Starting cold, and running under load for five minutes, the motor warms up as shown by the curve *Oa*. On stopping, the motor cools down for 10 minutes, as indicated by *bc* on the cooling curve. This little bit of the curve is sheared over to the left to *ad*, till *b* and *a* coincide. In this manner the entire curve (B) has been drawn, and it will be noticed that, after a time, thermal equilibrium is established; or, rather, that the temperature-rise during the running period is equal to the fall of temperature during the idle period.

To obtain quantitative results it is less laborious to investigate this condition mathematically. In order to make the notation clear, Fig. 4 has been prepared. From equation (3), for the heating period,

$$t_1 = T_h \log_e (\theta_f - \theta_2) \div (\theta_f - \theta_1) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and from equation (5), for the cooling period,

$$t_2 = T_c \log_e (\theta_1 \div \theta_2). \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Eliminating θ_2 from equations (6) and (7) and solving for θ_1 we get

$$\theta_1 = \theta_f (\varepsilon^{\psi(t_1+t_2)/\psi T_h} - \varepsilon^{t_2/\psi T_h}) \div (\varepsilon^{\psi(t_1+t_2)/\psi T_h} - 1). \quad . \quad (8)$$

wherein $\psi = T_c \div T_h$.

A number of important conclusions can be drawn from this equation. In an intermittent motor the cycle is generally of short duration. We may, therefore, put $\varepsilon^{(\psi t_1 + t_2)/\psi T_h} - 1 = \{(\psi t_1 + t_2)/\psi T_h\}$, and $\varepsilon^{t_2/\psi T_h} - 1 = (t_2/\psi T_h)$. Hence the expression for θ_1 (equation 8) becomes

$$\theta_1 = \theta_f \cdot \psi t_1 \div (\psi t_1 + t_2).$$

and since temperature-rise and lost power are proportional, we have also

$$W_1 : W = \psi t_1 : (\psi t_1 + t_2).$$

from which

$$W = W_1(\psi t_1 + t_2) : \psi t_1. \quad . \quad . \quad . \quad . \quad (9)$$

wherein W is the lost power corresponding to the allowable intermittent load which produces the same temperature-rise as the lost power W_1 on continuous working.

If the heating and cooling time-constants are equal, then $\psi = 1$, and

$$W = W_1(t_1 + t_2) \div t_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

This equation shows that the allowable loss on any load-factor is inversely proportional to the load factor. Thus in Fig. 3, on account of the smallness of the peaks, the saw-tooth curve may, without appreciable error, be replaced by the smooth curve shown. Applied intermittently on one-third load-factor the load which, when continuously applied, produces a final temperature-rise of 50° C., will only produce a final temperature-rise of 50/3 = 16·7° C. It follows, therefore, from equation (1) that under these conditions the allowable loss can be trebled. Hence a loss-load curve (which can be drawn from the efficiency curve) enables us to ascertain the allowable load for a given load-factor. This applies equally to the general case, namely, when the time-constants are unequal.

(To be concluded.)

INSULATING COMPOUNDS IN TELEPHONY.*

For some considerable time efforts were made by Post Office engineers to discover some compound which would do away with the inconvenience and danger of using a heated jet in such places as the top of a pole or ladder. The compound formerly used for filling in the tops of terminal and leading-in insulators was solid at ordinary temperature, and required to be heated to melt it for pouring in. Great difficulty was experienced in evolving a compound which would combine the following qualities:—

(1) Soft enough to be easily and conveniently pressed cold into the insulator top; (2) not materially affected in consistency by changes of temperature likely to be met in practice; (3) high insulation resistance dry, and maintained when in contact with water.

Many mixtures were tried and found wanting before a reliable one was secured. A mixture of coal-tar and whiting having been found very successful in sealing the joints of stoneware ducts, it was thought that a compound of this nature might possibly be used in the above connection. Two compounds were accordingly made up of (*a*) coal-tar and whiting; (*b*) coal-tar and French chalk.

In spite of careful drying of the whiting, mixture (*a*) proved useless both on account of low insulation resistance dry and a progressive drop in resistance when immersed in water. As whiting (calcium carbonate) is a comparatively soluble salt, this is not surprising. Compound (*b*), however, gave a high insulation resistance and no progressive drop in resistance on immersion, French chalk (magnesium silicate) being practically insoluble in water. The French chalk was carefully dried by heat, and mixtures of several consistencies made up and experimented on in insulators wired up as in general use.

The best mixture was of about the consistency of marzipan at ordinary temperatures, and this varied only slightly up to 150°F. This compound was of a somewhat dry and inelastic nature, and a small addition of palm pitch was suggested to make it more plastic. This on trial turned out an improvement both in consistency and insulation resistance, provided not too much pitch was added, as the mixture would then become too hard at an ordinary temperature but too fluid at about 100°F.

The compound was also frozen in a mixture of ice and salt at a temperature in the proximity of 0°F. It became harder, but by no means brittle or liable to crack.

The most satisfactory mixture was made up of 56 per cent. French chalk, 32 per cent. palm pitch and 12 per cent. coal-tar (by weight). The insulation resistance in the case of an ordinary insulator wired up was infinity when dry or immediately after immersion in water; and there was no drop after prolonged immersion.

The cost of this compound works out at about 1d. per lb. It is also of simpler composition than the compound hitherto used, and is, on the whole, expected to prove a considerable advance on previous practice.

The compound is to be thoroughly pressed into the cavities of the insulators so as to enclose completely the bare wire joints, care being taken to see that the cavities are quite dry before it is put in.

This plastic compound is now used also for sealing the joints in subscribers' premises between the leading-in paper core cables and the cable used as house leads. A modification of the above compound consists of 47 parts by weight of French chalk, 47 of coal-tar and 9 of palm pitch.

* From the "Journal" of the Post Office Electrical Engineers. Slightly abridged.

NEW BOOKS AND NEW EDITIONS.

(Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Office on payment of the price indicated in parentheses. It is only necessary to remit the trade price, excluding remittance.)

585. "Introduction to Applied Mechanics." By E. S. Andrews. (Camb. Technical Series.) 4s. 6d. net (4s. 9d.).

586. "Engineer's Pocket Book of Reinforced Concrete." By E. L. Hedderwick. 2nd edition. 15s. net.

587. "Handbooks Relating to Juvenile Employment: Vehicle-making and Miscellaneous Metal Trades." 2d. (4d.).

588. "Manual of Mechanics and Heat." By Gregory and Hadley. 3s. (3s. 3d.).

589. "First Course in Engineering Science." By Haler and Stuart. 2s. 6d. (2s. 9d.).

590. "Boy's Book of Wireless." By A. F. Collins. 3s. 6d. net (3s. 10d.).

591. "Table of Compound Interest and Anti-Logarithms." By J. J. Stuckey. 21s. net.

592. "Engineering for Architects." By D. C. Bond. 8s. 6d. net.

593. "Russian Self-Taught." By Thumm and Marshall. (Russian and Roman characters.) 2s. 6d. (2s. 9d.).

594. "Turkish Self-Taught." By C. A. Thumm. (Turkish and Roman characters.) 2s. 6d. (2s. 9d.).

595. "Quantitative Laws in Biological Chemistry." By S. Arrhenius. 6s. net (6s. 3d.).

596. "Mathematics for Machinists." By R. W. Burnham. 5s. 6d. net (5s. 10d.).

597. "Five-Figure Mathematical Tables." By R. Chappell. 5s. net (5s. 4d.).

598. "Engineering for Architects." By D. C. Pond. 8s. 6d. (8s. 9d.).

599. "Practical Exercises in Heat: Laboratory Course for Schools and Colleges." By E. S. A. Robson. 2s. 6d. (2s. 9d.).

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	65	Osram-Robertson Red Cross Van. Illustrated	11
Imports and Exports of Electrical Manufactures	66	The "Safuse" System. Illustrated	11
LEGAL INTELLIGENCE	66	"Ediswan" Fittings Catalogue. Illustrated	14
PARLIAMENTARY INTELLIGENCE	67	New Holophane Handbook. Illustrated	15
Educational Notes	67	The First Electro-Harmonic Concert	16
Business Notices	67	Glasgow's New Showroom	16
Electricity Supply	67		
Lighting and Power Notes	68	Tenders Invited	71
Traction Notes	69	Tenders Received & Accepted	72
Telegraph and Telephone Notes	69	Municipal Accounts	73
Empire Notes	69	Companies' Meetings and Reports	74
Foreign Notes	70	New Companies, &c.	75
Miscellaneous Notes	70	City Notes	75
The Round Table	9	Electrical Companies' Share List	75
The "Point Fives"	9		
A.C. and D.C. Overload Relays. Illustrated	10		

COMMERCIAL TOPICS.

Increased Railway Rates.

Another disagreeable consequence of the war is to be found in the announcements by the railway companies as to the increase of rates (subject to statutory maxima) by goods train of from 1s. to 2s. 6d. per ton, and on perishable produce by passenger train from 3d. to 4d. per cwt. So far as these notices have been issued up to the present moment the new rates refer only to goods sent from England and Wales to Ireland, but it may be that this is only a foretaste of what is to come. Those engaged in the electrical industries who have business with Ireland should make themselves acquainted with the new tariff, which comes into effect on Nov. 1, 1915.

* * * *

Definition of the term "Workman."

Considerable importance will be attached by industrial firms to a decision given last week by the Coventry Munitions Tribunal, in the matter of an application by a draughtsman for permission to leave the service of one firm to enter that of another. In times like the present it is essential that such decisions should have the full authority of the law to support them, and it is difficult to believe that the Coventry decision would stand this test. It may be that a draughtsman is not a "workman" within the literal meaning of the word, but his position in the industry of engineering must, we hold, bring him within that category. If it is legal for a draughtsman to leave his employment in the manner described before the Coventry Tribunal, then one of the objects of the appointment of these tribunals seems to us to be in jeopardy.

* * * *

Halfpenny Postage.

In THE ELECTRICIAN for Sept. 24 (p. 902), we expressed the view that the re-arrangement of the postal charges by the Budget proposals of the Chancellor of the Exchequer would most prejudicially affect the electrical trade. In view of the importance of this matter to industry generally, it is satisfactory to record that a great united effort was being made by general traders, printers and publishers to bring about the abandonment of this unpopular proposal. The view generally held was that all trades would suffer, and that some trades, including the electrical, would be seriously affected by the abolition of cheap postage rates. The fact that the International Postal Convention secures to other countries the advantage of the halfpenny rate into this country was a deciding factor against its abolition in the United Kingdom. It is, therefore, gratifying to know that the agitation against the Chancellor's proposal has been successful. No [illegible] unpopular financial re-arrangement has been suggested since Robert Lowe's match tax.

* * * *

Electrical Progress in China.

In our last issue we gave an abstract of the British Consular Report for the year 1914 for the Shanghai district. The subject dealt with is an important one and it deserves the serious attention of electrical manufacturers and exporters. The report is, however, somewhat belated, because in our issue for June 18 the annual report and accounts of the Shanghai municipal electricity department were set out in full. In that issue we emphasised the growing importance of the Chinese market for electrical machinery and apparatus. At Shanghai alone the output of the municipal electricity works increased to over 40 million units, compared with 21 million units in 1913, the increase being mainly due to the greatly increased demand for electrical energy for motors, radiators, &c. Many cotton mills and factories are connected to the mains; 1,500 radiators have been installed in Chinese houses, and the small motor is exceptionally popular. Important extensions of the Shanghai generating plant and mains are in progress, and it is satisfactory to note that German machinery, which has hitherto been employed, will be displaced by British goods. The consular report lays particular stress on the special features of the German trade, and the reasons for its successful development in China. There are many large towns and important commercial districts in China, which may almost be said to be a virgin field from the electrical point of view, but combined action by British electrical manufacturers and exporters will be necessary in order to capture and retain the Chinese trade. We are aware that there is an existing organisation (the British Engineers' Association, which was formed in April, 1912) for advancing the interests of British manufacturing engineers abroad and especially in China, but we believe that electrical manufacturers and machinery exporters and dealers might also co-operate among themselves in order to study the electrical prospects in China and the Far East. There is no reason why this newer organisation should not work in harmony with the existing association, and, in fact, we think the two could be of mutual assistance. At all events now is the time to prepare for that expansion of the exports of this country which is so vital for its continuance as the pioneer of peaceful development and progress.

Special attention may well be directed to the return to this country of Mr. T. M. Ainscough, who was appointed by the Board of Trade special commissioner to inquire into the prospects for the development of British trade in China. We refer to this matter under "Foreign Notes." The opportunities for trade with China are regarded by many who have had the subject under consideration to be exceptionally good. China is settling down into a more peaceful condition than for a long time past, and it is well known that the Japanese commercials and industrials are opening up trade in many parts of the vast Empire. Some idea of the possibilities of trading in China is furnished by a statement recently made by the British representative for the consular district of Tientsin that that port serves a population roughly estimated at 80,000,000. Peking has a population of 1,500,000, Tientsin 800,000.

* * * *

Visiting Day.

The practice of visiting the generating and substations on the part of Municipal Electricity Committees is an excellent one, and should be indulged in at least once a year. During normal times it may be made the occasion of a little festivity, but in war time a "dry" visit should be the order of the day. Among company-owned undertakings a regular inspection by the shareholders either individually or in bulk might be considered impertinent interference, at any rate by the technical staff. With municipal stations a more democratic spirit seems to prevail, and in many large towns the visit of the committee promotes interest and is mutually helpful, at least, we think this is the case. As we recorded recently, the Glasgow Corporation during the past week had a meeting of its members at the site of the new station at Dalmarnock, the 100,000 kw. plant that is

to be, and subsequently a large electrical showroom in Sauchiehall-street was opened. A point worthy of note in regard to the latter is the co-operation between the electricity department and the city electrical contractors; this stands out in sharp contrast with the policies of inactivity or antagonism which prevails in many other cities and towns throughout the country.

* * * *

Enemy Cable Messages. By way of the Postmaster-General's recent announcement that telegrams for neutral countries, for Serbia and for Russia, would be delayed (an order promptly withdrawn) attention is called to the fact that the German and Austrian Empires are entirely dependent on the Allies for any communication (commercial or otherwise) with the outer world.

It is true that Germany can still send her cable messages to Scandinavia, or might communicate with Greece through Roumania and Bulgaria. But to reach the great places of the world her messages must pass over cables which land in territories of one or other of the Allies. From Scandinavia the only communication by cable to the West and thence to the Far East is by way of the British Isles. Germany can, of course, send wireless messages to the United States, but the wireless stations in that country have now all come under U.S. Government control.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Oct. 4, 1915, *to* Oct. 9, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FRANCE. *France:* Unenumerated, 6 pkgs.

LIVERPOOL. *Madeira:* Elec. machinery, 2 pkgs.

LONDON.—*U.S.A.:* Elec. machinery, £2.578; carbon candles, £156; lamp parts, £105; elec. lamps, £680; telephone materials, £546; unenumerated, £2.066—584 pkgs. *Switzerland:* Carbon candles, £215; unenumerated, £32. *Holland:* Elec. lamps, £6.475; 27 pkgs.; wire and cable, £22; elec. machinery, £74; [illegible] £26; [illegible] Elec. lamps, £253; [illegible] £74; *France:* Unenumerated, £57—152 pkgs. *Italy:* Unenumerated, £17. *Sweden:* Elec. lamps, £100; elec. machinery, £1.517; lamp [illegible] £472. *Norway:* Unenumerated, £15. *Japan:* Elec. carbons, 475 pkgs.

EXPORTS.

TASMANIA. *Auckland:* Wire and cable, £1,264; elec. machinery, £37; unenumerated, £440. *Melbourne:* Wire and cable, £1,518; elec. machinery, £188; unenumerated, £132. *Sydney:* Unenumerated, £164. [illegible] Elec. machinery, £479; wire and cable, £2,328; unenumerated, £1,253. *Brisbane:* Wire and cable, £22; elec. machinery, £39; elec. glow lamps, 13,033 (No.); unenumerated, £1,205. *Christchurch:* Wire and cable, £1,474; telegraph material, £162; unenumerated, £131. *Dunedin:* Wire and cable, £1,752; unenumerated, £313 *Hobart:* Elec. machinery, £25. *Lyttelton:* Unenumerated, £145. *Adelaide:* Wire and cable, £58; unenumerated, £149. *Perth:* Elec. machinery, £749; unenumerated, £103. *Cairns:* Unenumerated, £307. *Nelson:* Telegraph material, £9. [illegible] Wire and cable, £1,317; [illegible]

AFRICA.—*Durban:* Elec. machinery, £645; unenumerated, £[illegible] *Cape Town:* Unenumerated, £19.

[illegible]

ADEN.—Telegraphmaterial, £11; [illegible]

[illegible] Wire and cable, £164; [illegible] £31; [illegible] £1,000; [illegible] £126; [illegible] £47.

[illegible] Unenumerated, £10

[illegible]

PORTUGAL. [illegible] *Archangel:* [illegible]

FOREIGN GOODS (duty paid and free)

[illegible]

IN TRANSIT.

[illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Alien Shareholders in British Companies.

At Bow-street (London) Police Court on Friday last the Phœnix Telephone and Electrical Works (Ltd.) was summoned for unlawfully failing to send in writing to the Public Trustee particulars of shares and stock of the company held by and for the benefit of enemies.

Mr. TRAVERS HUMPHREYS (who prosecuted) said that the proceedings were taken under the Trading with the Enemy Amendment Act. The requirements of the Act were published and it would be difficult to plead companies did not know the law on the subject. The Phœnix Telephone and Electrical Works had a capital of 8,284 preference shares of £1 each and 2,757 ordinary shares of 1s. each. Four shareholders in the company residing in Germany held 1,284 preference and 426 ordinary shares. No notice of that was sent to the Public Trustee, but he became aware of the fact through the returns made by the company to Somerset House. When the managing director (Mr. Oppenheimer) was spoken to on the subject, he stated that no dividends had been paid to enemy shareholders, and eventually a full return was made to the Public Trustee. Neither that nor the succeeding cases were put forward as cases in which the company or the officials had deliberately desired to conceal from the authorities that they had enemy shareholders. He also wished to point out that although the returns made to Somerset House disclosed the names of enemy shareholders, they did not comply with the Act, the object of which was to enable the Public Trustee to see that no moneys were paid to those persons.

Mr. WALTER-FRAMPTON (for defendants) said that they were now solely occupied in executing Government contracts. Before the war they had purchased certain machinery and materials from Germany, and their customers there had accepted part payment in shares.

The MAGISTRATE (Mr. Graham Campbell) said he must impose a substantial penalty as a warning to others, and imposed fines and costs amounting to £185. 10s.

In two other cases, companies were ordered to pay penalties amounting to £125 (and £10. 10s. costs), and £50 (with £10. 10s. costs) respectively.

Workmen's Compensation Cases.

In the Bow (London) County Court last week his Hon. Judge Smyly, K.C. (with Dr. Bate, as Medical Referee) heard an application by David Jas. Drury, electrician's labourer, for the continuation of an award against the Charing Cross, West End and City Electricity Supply Co. It appeared that on February 18 applicant fell from a boiler, a distance of 22 ft. and broke his shoulder blade, besides causing other injuries. He was treated at the West Ham Hospital, and had attended there only the previous day. Applicant admitted that he had been offered work by the Company, but urged that he was quite unable to do it. He was quite nimble before the accident, but to show how bad he had become he was refused for the army as being quite unfit.

Dr. HOWITT (for respondents) said the setting of the fractured collar bone had been very badly done, but it did not prevent free play for the shoulder. Respondents paid compensation up to July and then ceased, and he considered the man could have worked after that.

Judge SMYLY decided that the man was now fit for work, and as respondents had paid in a sum up to Oct. 5, he entered judgment for respondents with costs.

In the City of London Court on Tuesday an electrical fitter named Vasse sought an award of compensation against the British Thomson-Houston Co. for damages for serious burns. The evidence showed that after doing some work Vasse was told to knock down a bulge in an electric strip at the supply station at Teddington when he got into touch with a cable carrying current at 3,000 volts, and was so seriously hurt about the arms that he was laid up for 11 weeks. Defendants pleaded that applicant was warned of the danger of the work and told not to put his hand inside a switch when the current was on. He did so, and so caused the injuries. He had, therefore, been guilty of serious and wilful misconduct.

Judge Rentoul, K.C., upheld defendants' plea and found for the company, with costs.

It was intimated that Vasse's trade union would appeal.

In the City of London Court last week a telegraphist named Lawbuary was awarded 25/- compensation against the Postmaster-General, as applicant was suffering from telegraphist's cramp.

PARLIAMENTARY INTELLIGENCE.

POST AND TELEGRAPH RATES.

In the House of Commons on Tuesday the Postmaster-General (Mr. H. Samuel) stated, in reply to a question, that with reference to the proposal to abolish the halfpenny postal rate, it was clear from the representations received that rate, if it were adopted for the period of the war there would be a widespread demand for the return of the halfpenny rate when peace was restored. The additional rate could not be regarded,

therefore, as likely to prove a continuing revenue. As to the amount of revenue to be expected, the Post Office estimate was presented to the Committee on retrenchment as speculative, since there was no previous experience which could afford any guidance. In view of all the circumstances and of the disturbance of business arrangements which would be involved, the Government will not proceed with the proposed increase in the postcard and halfpenny rates. At the same time it was considered that the regulations by which any registered daily or weekly newspaper up to the limit of 5 lb. in weight must be carried by the Post Office for a halfpenny should be no longer continued. He would propose that the halfpenny rate should be confined to newspapers weighing 6 oz. or less, which would include all the ordinary numbers of the daily papers, and that above that rate the charge shall be an additional halfpenny for every 6 oz. With respect to the Press telegraphic rate, he had been in communication with the representatives of all the Press organisations, and should propose by agreement with them a modified scale of charges. He would make a further statement on the second reading of the bill to alter the statutory limits of postal and telegraph rates.

The Bill to alter the postal and telegraph rates has been issued. One shilling for every 80 words (instead of 100 words, as at present) transmitted between 6 p.m. and 9 a.m. to a single address; 1s. for every 60 words (instead of 75 words) between 9 a.m. and 6 p.m.; 3d. additional for every 80 or 60 words, as the case may be, when the same matter is telegraphed to an additional address, instead of 2d. for every 100 or 75 words. The rates for Press telegrams shall not be raised "above the limits existing immediately before the passing of this Act until after Dec. 31, 1916." Provision is also made for the increase in the minimum charge for ordinary telegrams from 6d. to 9d.

Re Mexican Light & Power Co. (Ltd.)—On Tuesday Mr. Justice Sargant (on the application of Mr. Thos. G. Scott) appointed Mr. Knox Little receiver of the assets of the company in this country.

EDUCATIONAL NOTES.

University of Durham, Armstrong College, Newcastle-upon-Tyne.—The session commences on Sept. 27. At this college there are departments of mechanical, marine, civil and electrical engineering, naval architecture, mining, metallurgy, agriculture, pure science, arts and commerce. Particulars from the secretary, Mr. F. H. Pruen, M.A.

University of London, University College.—A course of six lectures on "Electric Heating and Electric Furnaces" will be delivered by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., on Fridays at 5 p.m. The course will begin on the 29th inst., and will be open both to members and non-members of the University. Fee, £1. 11s. 6d. Application for tickets of admission to be made to the secretary, Mr. Walter W. Seton, M.A., D.Lit., Gower-street, W.C.

University of Glasgow.—Prof. John Ferguson has resigned the chair of chemistry, which he has held for 41 years.

BUSINESS NOTICES.

Swedish General Electric (Ltd.) has removed to Canada House, Kingsway, London, W.C.

The Accessories Mfg. Co. has removed to Dunedin House, Basinghall-street, London, E.C. Telephone: 7,149 City.

Sale by Auction.—Messrs. Fuller, Horsey, Sons & Cassell are instructed to sell by auction in lots on the premises, South Wharf, St. Leonard's-street, Bromley-by-Bow, London, E., on Nov. 10 and following days, an extensive engineering plant, comprising a horizontal compound condensing engine, a 30 kw. electric lighting set (Belliss engine and Crompton dynamo), two cast-iron tanks, steam pumps, automatic weighing machines, conveyors and elevators, &c., and a quantity of miscellaneous engineering plant. Orders to view and catalogues from the auctioneers, 11, Billiter-square, London, E.C. *Further particulars are given in an advertisement.*

Messrs. Horne & Co., 34, Old Queen-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, 21st inst., some unserviceable and obsolete stores, including quantities of iron and steel, lead, antimony, white metal, &c., motor cycles, motor tyres, rubber, &c. Lots may be viewed on the Monday, Tuesday and Wednesday previous to and on morning of sale, and catalogues may be obtained at Armament Buildings, Whitehall-place, Westminster, S.W.; Imperial House, Tothill-street, S.W.; Ordnance Office, Tower; and Ordnance Office, Royal Arsenal, Woolwich. *Further particulars are given in an advertisement.*

Advance in Prices.—The Electric & General Works (Ltd.), 15, Victoria-street, S.W., notify that in consequence of the increasing cost of manufacture due to prevailing conditions they have been compelled to increase the advance on their catalogue prices for switchgear to 20 per cent. The new advance represents an increase of 5 per cent.

Restoration of Lapsed Patents.—An order was made on Oct. 5 restoring letters patent (17,817/1907) granted to [illegible] Hyde for "Improvements in making electrodes for [illegible] metallic filament incandescent electric lamps."

ELECTRICITY SUPPLY.

EXTENSIONS.

Chesterfield.—The L.G. Board have authorised the Corporation to borrow £5,000 for new electric generating plant, &c.

Derby.—The Council have decided to extend the electric cables to Cotton to give a supply of electrical energy to Messrs. Eastwood, Swingler & Co.

It is proposed to spend £150 on the construction of an [illegible] from Osmaston-road to London-road, to enable a supply of electricity to be given to the branch library on London-road. The Council is recommended to apply to the L.G. Board for sanction to borrow £3,[illegible] for mains and motors required for war purposes only. The Council is also recommended to grant £270 for the purchase of three transformers and an additional switch panel for the sub-station at the works of Messrs. Rolls-Royce (Ltd.)

Edinburgh.—Last week the Corporation accepted tenders amounting to over £30,000 for generating plant for the new Portobello generating station:—

There was a request for delay and a motion was made to have the matter reconsidered, but Mr. Bruce Lindsay pointed out that the demand for electric current was going up. If they did not look ahead, the electric supply department would be in a serious position in a few years. There would be such a demand for material after the war that prices would be much higher than they were now.

The CHAIRMAN of the Electric Supply Committee (Mr. Stevenson) said he wanted to get on with the building at once, because they needed it, and because it was not true to say that they had sufficient machinery in hand just now to keep going with the demand made upon it. At present there were people asking for power who could not get it. If they were not in a position to supply power to one large firm in town, a new factory which was being built would stand doing nothing.

Mr. CAMERON referred to the movement to secure German trade and hoped they were going to have new industries in Edinburgh, and they should prepare for that eventuality.

Pwllheli.—Recently the Council inquired of the North Wales Power & Traction Co., which is extending its transmission line to Trevor, whether it would consider a proposal to extend the line into the town, and in reply the company has stated that its engineer would make inquiries during his next visit, and a further communication would be made.

Wolverhampton.—The Electricity Committee has decided to lay the necessary mains, &c., for giving a supply of current to three new consumers.

The estimated cost is £1,365, and it is proposed to ask for the sanction of the L.G. Board to borrow this sum, and also to borrow £5,000 for defraying expenditure to be incurred in connection with the laying of other mains.

The committee proposes to renew, for a further period of five years, the agreement for the supply of electric current to the premises of the British Oxygen Co.

GENERAL.

Banbridge.—Messrs. R. Hale & Co., a local firm of tradesmen who recently installed some electric generating plant at their premises in Bridge-street, have been asked by neighbours for a supply of electric current.

The firm have therefore asked for permission to erect a few poles and overhead wires, or to lay underground cables, subject to the approval of the surveyor. The legal position of the Council was discussed at some length, and ultimately it was decided that Messrs. Hale should submit plans to the surveyor, and the Law Committee were given full power to act in the matter.

Bath.—The Electric Light Committee unanimously recommend an increase of 3s. per week in the wages of engine drivers, and [illegible] of 5s. per week to the second engineer, and 4s. per week to the third engineer.

Bexhill.—In future consumers with prepayment meters will be charged 1s. a quarter for meter rent.

This is estimated to be equivalent to an increase of 10 per cent. on the cost of current. All new consumers using prepayment meters will pay a meter rent of 2s. 6d. per quarter.

Birmingham.—There was a stoppage of the tramway service for about half an hour on Tuesday evening, and the electric lighting was also affected, but there was no failure of the supply.

An official explanation attributed the stoppage to "a combination of unforeseen circumstances." The demand for electricity during the day for some time past has been exceedingly heavy, and to add to the difficulties of the department it was found necessary to place two boilers out of action temporarily at Summer-lane station for the purpose of cleaning them. Consequently when the demand for current became unusually excessive towards dusk, it was obvious that the resources of the department would be unequal to the strain. It was necessary, therefore, that there should be a partial suspension of the supply for a short time in order to regulate matters and ensure the continuance of electricity in the direction it was most needed. The officials decided to suspend the traction supply and maintain that for manufacturing purposes. The tramways department were accordingly notified, and there was a suspension for about half an hour. At the end of that time the supply current was renewed all round, and the tramcars recommenced running. The problem of providing an adequate supply of electricity has occupied the attention of the Council and the Electric Supply Committee for a considerable period. In May, 1913, the Council sanctioned the erection of a new power-house at Nechells, and it was anticipated that this would be available for a supply of current by the winter of 1916-17. In January last the Committee reported that, for the normal supply of the department it was intended to instal 5,000 kw. of temporary plant at Chester-street (Aston Manor), but applications for large supplies for power purposes had been received from manufacturers of war material. Up to then those totalled 11,000 kw., and there was no doubt that still greater demands would be made upon the undertaking in the near future. The Committee felt that in order that those manufacturers might not suffer from any shortage in the supply, and that the Council might be able to discharge their statutory obligations, immediate steps should be taken to provide the plant necessary to meet the demand. As the Nechells station could not be ready for supply until the winter of 1916-17 the Committee had come to the conclusion to erect a temporary generating station on land adjoining the destructor station at Nechells. The Council agreed to the recommendations, and the L.G. Board sanctioned the necessary loan. For some time everything went smoothly, but towards the summer deliveries of plant became irregular, and machinery which should have been installed by June was not delivered before September. It was hoped the temporary station would be in full work by August, but it will be another three weeks before the plant can be utilised to the fullest extent. The officials are, however, of opinion that they will be able to meet the great demand for current without any further interference of the supply and when the new station is at full work an ample supply of electricity will be available throughout the winter.

Colchester.—At the end of August there were 2,754 consumers of the electric supply department, against 2,636 at the corresponding period of 1914.

The Electricity Committee have refused an application by the shift engineers for an increase of 5s. weekly in their wages.

Croydon.—The L.G. Board have sanctioned the borrowing of £3,600 for the installation of a new telephone fire alarm system.

Dover.—The Electricity Commitee has considered its estimates for the year ending March next.

Owing to the greater cost of fuel (£1,421) and the loss of the street lighting (about £2,283) the electricity undertaking is expected to have a loss of £555 after the payment of interest and sinking fund instead of the surplus balance of £2,525 which was obtained last year. The price of current has not been raised and the deficit will be met out of the reserve.

Ellon.—The formal inauguration of the local electricity supply works took place on the 2nd inst., when Mrs. Duncan switched on current for street lighting.

Gillingham.—The Anglo-American Oil Co. recently notified the Council that the price of fuel oil in rail tank cars was 102s. 6d. ex Purfleet or 113s. 9d. delivered at the electricity works.

The electrical engineer (Mr. A. D. Chalmers) reported that the company was willing to enter into a contract for six or twelve months at the price quoted. It was, however, resolved to report the matter to the Board of Trade and to ask for advice in the matter.

Increased Charges for Current.—The following electric supply undertakers have made the following increases in their charges for current :—

Blackburn Corporation 15 per cent. for all purposes (existing rates 4d. per unit for lighting and 1½d. for power); Stretford Urban Council, 15 per cent. for lighting and power from Nov. 1; Worcester Corporation, 10 per cent. for lighting, heating and power as from Sept. 30 last. Arbroath Elec tric Light & Power Co., 20 per cent. as from Oct. 1.

Kirkheaton (Yorks).—The Council has resolved to support the application of the Electrical Distribution of Yorkshire for a provisional electric lighting order for the district.

Oldham.—A dispute has arisen as to the wages of the men employed at the electricity works.

Originally the Municipal Employés' Association claimed on behalf of about 250 men an advance of 4s. per week. This claim was refused, and on July 1 a war bonus of 2s. per week was demanded and the Corporation agreed to a bonus of 2s. per week for those not in receipt of 30s. per week. About 80 members of the Municipal Employés' Association did not come within this category, and the Association asked for the bonus to be extended to all their men. This was refused and notices which would have expired on the 6th inst. were handed in. On Wednesday a private meeting of the Association was held when it was reported that a communication had been received from the Town Clerk to the effect that the Corporation said those employed in the electricity department were munition workers. The men contended that they could only be included by proclamation or the definite authority of the Minister of Munitions. The dispute will, however, be submitted to the arbitration of the Board of Trade, and the men have decided to post-date the notices until the whole of the facts have been submitted to the Board.

Pembroke (Dublin).—Some time ago the Diesel engine at the electricity works broke down and the Council are making a claim against the contractors in connection therewith.

It is probable that legal proceedings will ensue, but in the meantime the Council have decided, on the advice of counsel, to purchase a new engine at a cost not exceeding £2,000.

Ross.—The Board of Trade have allowed the Ross Electric & Power Co. to charge up to a maximum of 8d. (instead of 7d.) per unit for electrical energy as from Sept. 30.

Rotherham.—The Treasury have informed the Corporation that they will raise no objection to the borrowing of an amount sufficient to meet the various sums expended before the imposition of Treasury restrictions on borrowing and also that in the particular circumstances of the case, they would raise no objection to the borrowing of £2,500 for extensions of the boiler house.

Last week the Corporation authorised the Electric Light & Tramways Committee to enter into arrangements with the Minister of Munitions for the installation of such additional generating plant as may be deemed necessary in order to supply electrical energy for munition factories in the district, such additional plant to be provided upon such terms and conditions as may be agreed between the Munitions Department and the Corporation. The total estimated cost of the new plant, including foundations, filter, pipe work and accessories, is £23,000.

South East London Linking Scheme.—The Finance Committee of Woolwich Borough Council has been in correspondence with the London County Council as to the Borough Council's application for sanction to borrow £4,700 for linking up the undertaking with that of the South Metropolitan Electric Light & Power Co.

The sanction is being issued on the understanding that the balance of the loan for plant will be repaid by the Borough Council when the plant is no longer in use for the purposes of the undertaking generally, and subject to the approval of the Board of Trade to the agreement between the Borough Council and the company.

Walsall.—The interest on the loan from the tramways department to the Electricity Committee is to be increased to 4 per cent.

Warcop (Cumberland).—Messrs. T. Longstaff & Son, timber merchants, have recently put down electric lighting and power plant. Electric current is also supplied to the Wesleyan Methodist Church, the Temperance Institute, &c.

Wednesbury.—The Corporation is inviting tenders for loans amounting to £6,991 for periods varying from 15 to 30 years. The money is required for the electricity undertaking and other public works.

West Bromwich.—Owing to the greatly increased demand for electric current for works engaged upon munitions the Council has had to refuse all new applications for a supply for general purposes, and has decided to discontinue connecting private houses for lighting.

Woolwich.—The borough electrical engineer (Mr. G. W. Keats) has been instructed to purchase a new or second-hand centrifugal pump for the Globe-lane station.

The Royal Arsenal Authorities have accepted the Electricity Committee's quotation for a permanent supply of electric current to the Dockyard, and an order has been placed with Ferranti (Ltd.) for the supply of the necessary switchgear.

Various members of the engineering staff have had their salaries increased as from the 1st inst.

Wrexham.—Stansty Parish Council will offer no objection to the Corporation's application for an extension provisional order.

LIGHTING & POWER NOTES.

Bainbridge.—The Parish Council have made an arrangement with the Bainbridge Electric Light Co. for the public lighting of the village.

Electricity in Mines.—At the annual conference of the Miners' Federation of Great Britain last week Mr. J. Butler moved, on behalf of Lancashire and Cheshire, that the federation should "initiate and

focus its attention at the earliest opportunity to secure by legislation the abolition of all electrically driven coal-cutting machines in mines."

The President (Mr. R. Smillie) pointed out that the resolution only dealt with coal-cutting machinery and that it applied to all mines. Electrical machinery was used underground in many other ways than in coal-cutting, and it was just as unsafe when so used as in cutting coal. So far the proposed legislation in that direction was only applicable to dry, dusty and gassy mines.

The resolution was passed and remitted to the Executive Council with a view to the enlargement of its scope, it being felt that as at present drafted it only contained a minimum of reform.

Harbour Lighting.—Arklow Harbour Board have asked Messrs. Kynochs to consider the question of the electric lighting of the two quays and to submit estimates to the Board.

Kilmallock (Limerick.—The ratepayers have appointed a committee to organise an improved public electric light service. Messrs. J. J. Murphy & Co. supply the service at present and they will maintain it until April. A local company will probably be formed.

Village Lighting.—The village of Holme (Yorks) was lighted electrically for the first time on the 2nd inst.

Electric current is supplied by the Holme Electricity Co., whose shareholders are residents of the village, and Coun. Charley Tinker is chairman. The company purchased the old Rake Mill with its water power, and a turbine driver set was installed. There is a paraffin engine for reserve.

TRACTION NOTES.

British Electric Railways.—The Board of Trade annual return for 1913 relating to the railways of the United Kingdom has been issued.

At the end of the year the total length (in equivalent of single track) worked solely by electricity was 205 miles; the length worked partly by electricity being 314 miles. The corresponding lengths at the end of 1912 were 210 miles and 281 miles respectively. The total quantity of electricity used in 1913 was 268,289,000 units, compared with 252,926,000 in 1912.

Burnley.—It was stated at the last meeting of the Council that 232 of the tramway employés had joined the colours, and it was claimed that no tramways staff in the country had recruited its staff in such large proportion.

Glasgow.—The traffic receipts of the municipal tramways department from June 1 to Oct. 2 were £387,891. 13s. 6d., against £359,145. 10s. 1d. in the corresponding period of 1914. The number of passengers carried was 119,913,555, against 110,916,395.

Liverpool.—The revenue of the Corporation Tramways for the nine months ended September show an increase of £4,000 over the corresponding period of 1914, and this notwithstanding that over 5,000,000 free passes (value £25,000) have been issued to members of His Majesty's Forces and Nurses during the period.

Manchester.—At the meeting of the Tramways Committee on Tuesday a statement was submitted by the general manager (Mr. J. M. McElroy) on the working of the tramways during the half-year ended Sept. 30.

Traffic revenue was £472,799 (against £460,339 for the corresponding period of 1914). Total revenue was £480,692 (£467,681). Revenue per car-mile was 12·224d. The total working expenses were £278,106 (£295,448). War service allowances amounted to £45,522. The surplus (excluding provision for renewals) is £78,479 (against £95,330).

Ald. Bowes states that £14,000 has been collected on the cars for various charitable purposes since the war began, which he considers a good achievement, in view of the statement by Ald. Linsley (Salford) at the recent meeting of the Municipal Tramways Association that the total collected on all the tramways of the United Kingdom was £23,500.

Newcastle-on-Tyne.—The municipal tramways are in a flourishing condition for the receipts for the six months to Oct. 1 were £169,589 (increase of £25,677 over 1914), and the number of passengers carried was 37,546,978.

Rawtenstall.—The Corporation have intimated to Accrington Corporation that they are willing to continue the existing through running arrangements on the tramways for 12 months further.

Southampton.—The Tramways Committee recommend the purchase of an Edison electric chassis (at £627) for a motor tower waggon, also a motor-generator (at £250) for the charging vehicle, provided the Electricity Committee supply current at 1d. per unit. The vehicle to be charged off the peak load.

Walsall.—The Tramways Committee propose to make a contribution of £2,000 in aid of rates for the year ending Dec. 31.

Women Tramcar Conductors.—Women conductors are now employed on the Oldham, Peterborough and Rawtenstall tramways.

The tramways manager at Walsall reports that the introduction of female labour on the cars has been successful, and that at present 18 women are engaged as conductors.

TELEGRAPH & TELEPHONE NOTES.

New Submarine Cable.—It is announced that a new [illegible] from San Domingo (Dominican Republic) to [illegible] is about to be laid by the Compagnie [illegible] graphiques.

Radiotelegraph Notes.—Announcement has been made [illegible] ships of the Standard Oil Co. of America are replacing the [illegible] owned Telefunken wireless apparatus with the equipment of the Marconi Wireless Telegraph Co. of America. All the lines composing the American Steamship Association will, it is stated, take similar action.

The new service has been perfected in connection [illegible] account to hand) within the last seven weeks by the Marconi Company and greatly increases the transmission and receiving [illegible] apparatus. The equipment to be supplied to the ships is to ensure that messages can be sent over a radius of from 400 to 500 miles under day conditions and from 1,200 to 1,500 miles at night, or approximately 100 per cent. more than was possible with the Telefunken apparatus used on the ships. The advantages claimed by the Marconi Company for their 2 kW. set are :—

1. The radio outfit is mounted on a single panel, increasing the ease of operation.
2. The spark-gap is noiseless.
3. Rapid means of changing from one wave-length to another.
4. Increase by about 100 per cent. the range of both transmission and receiving.

The total number of vessels to be equipped is 106. There is to be, in addition, a number of coastwise vessels, lines on the Pacific Coast and on the Great Lakes. The Marconi Company supplies the equipment, takes all responsibility for the working of the apparatus, trains and [illegible] operators, and relieves the renting company of all concern with the transmission. This latest development is regarded as most important to the U.S. mercantile marine.

A number of small radio stations are being established by the Dominican Republic. The national telegraph system of the State is reported to be in an unserviceable condition.

Telegraph and Postal Rates.—The Postmaster-General has decided to drop his proposal to abolish halfpenny postage, but has established a minimum for registered newspapers of ½d. for 6 oz. and a further ½d. for each additional 6 oz. This will affect chiefly weekly trade and technical newspapers.

With regard to telegrams, Press rates have been increased and the minimum charge of 9d. in place of 6d. for 12 words in ordinary telegrams has been maintained. "The Times" is responsible for the statement that the increased Press telegram rate will not come into effect until after Dec. 31, 1916!

EMPIRE NOTES.

Aden.—In a report by the American Consul at Aden it is stated that an electric railway between the various parts of Aden Town, Maala, Crater and Shaikh Othman, would undoubtedly pay well, and comparatively small capital would be required. The power plant could also supply electricity at Aden for lighting and power, including electric fans, &c.

Australasia.—The "Australian Mining Standard" says the expenditure on the electrification of the Melbourne suburban railways to July 28 was £946,000. The Broken Hill Pty. Co. have a contract to supply 15,800 tons of rails and 660 tons fishplates, for £143,393.

The capital of the City Electric Light Co. (Brisbane) is to be increased from £250,000 to £500,000.

The engineer-in-chief of the Metropolitan Board of Water Supply and Sewerage, Sydney, has recommended that new electric pumps and motors be installed at Marrickville pumping station at a cost of £3,850, electric power to be obtained from the City Council at 1¼d. per unit.

The Victorian Cabinet has adopted recommendations of the Lifts Inquiry Board, with respect to provisions to be made for the greater safety of lifts by requiring the adoption of mechanical safety devices, particularly in passenger lifts. Passenger lifts with a travel exceeding 30 ft. must, in addition to other safety devices, be fitted with speed governing gear, which will cost about £5. Where wedge clamp safety gear is used, other safety appliances will be insisted upon. Lifts in Government offices, which have not been under the regulations of the factories department hitherto, will be inspected in the ordinary way. A certificate as to the breaking load of the metallic lifting ropes will have to be lodged in the office of the chief inspector of factories before lifts are operated, and passenger lifts, whether electric or hydraulic, must be fitted with interlocking gear, which will make it impossible to open any door leading into the lift well unless the car is opposite the door or to start the

motor unless the doors are shut. The interlocking gear will cost about £4 for each lift. There are about 4,000 lifts in Victoria.

The following recommendations have been made to Sydney City Council from the Electric Lighting Committee: That, with regard to tenders received for a 12,000 kw. turbo-alternator, each of the firms tendering be informed that its tender is informal and the deposits sent in with the tenders be returned; and in view of the growth of the demand for electricity having been checked the consideration of the extension on a large scale of the generating plant at the power house be postponed. That, with regard to the proposal made by the British Westinghouse Co. offering (if the Council would place an order with them for one of the 12,000 kw. sets) to accept such order in full settlement of all their claims against the Council in connection with their contract entered into with that company for the supply of a 500 kw. turbine, but subsequently cancelled by the Council—in view of the recommendation of the Electric Lighting Committee not to accept any tender for new machinery at present, no further action be taken. That during the present war a 10 per cent. preference be given to goods manufactured by British companies on the price ex works, and a 5 per cent. preference be given to goods manufactured by Allied companies. (This is in continuation of the policy which was adopted in December last when it was decided that the matter should come before the Council again.)

Since the passing of the Victorian Electric Light and Power Act, 1896, 107 orders-in-council have been granted authorising the supply of electricity. Of these 57 were granted to municipal councils, 49 to companies or persons, and one to the Commonwealth. Eight of these orders have been cancelled, wholly or in part, and six municipal councils have transferred all or portion of their powers to companies. Last year 11 orders were granted.

South Perth (W. Australia) Council have received a letter from Messrs. Leslie & Co., engineers, inquiring whether the Council would be disposed to entertain a proposal for the construction and working of an electric or petrol tramway system in South Perth. A committee has been appointed to meet the firm and discuss the proposal.

No tenders were received by the Bendigo (Victoria) Drainage Board in response to their recent invitation of tenders for equipping a power station and providing electric pumps to unwater the mines. The Minister of Mines states, however, that he is expecting to receive shortly an offer of a plant to do the work.

South Africa.—Imports from the United States into British South Africa in the first half of 1915 included electrical machinery to the extent of 30·4 per cent. of the total imports of that class (compared with 20·4 per cent. during 1914). The total value of British goods received showed a decrease of £2,584,000, compared with the corresponding half of 1914, while United States goods increased £148,000, chiefly machinery and iron and steel manufactures.

"South Africa" states that there is a shortage of arc lamps, half-watt lamps, flexible wire and electro-medical apparatus in South Africa.

Toronto Hydro-Electric System.—The Annual report and accounts for the year 1914 (the fourth year of working) have been recently issued.

The gross income was $1,501,291.47, and the cost of electric current and the expense of operation and management (including repairs and maintenance) absorbed $874,358.58, leaving a balance of $626,932.89. Charges and allowances not strictly attributable to the operating expenses for the year 1914, and other charges and allowances applicable to prior years, absorbed $69,536.10, leaving $557,396.79. Interest, depreciation and sinking funds for the year absorbed $556,513.55, leaving $883.24. The whole of the cost of getting and promoting new business was met out of the year's income. The surplus income on operating account (after providing for interest, depreciation and sinking funds) amounted to $70,419.34, and of this $69,536.10 was absorbed by charges and allowances not strictly attributable to operating account, and by other charges and allowances arising out of the transaction of previous years, the final net surplus being $883.24. The net earnings of $557,396.79 (after meeting the special charges mentioned, but before providing for interest, depreciation and sinking funds) represent approximately 9¼ per cent. upon the average amount of capital invested in the fixed plant during the year. No provision having yet been made for working capital as distinct from construction capital, the debt to Toronto Corporation for interest and sinking funds has not yet been paid. Satisfactory progress was made during the year, the increase in gross income over that of 1913 being 29½ per cent. The increase in commercial power over that of 1913 was 40 per cent. The commercial income for the year amounted to nearly 64 per cent. of the total, the municipal power representing 36 per cent. At Dec. 31 last there were 42,678 meters in use (against 24,999 in 1913), and there were 46,998 street lamps in use (against 1,652). The peak load was 28,750 h.p. (against 22,250 h.p.). Additions to the system were necessitated in connection with street car lighting, the civic car line supply and the supply of commercial customers. Further extensions will be required from time to time to meet the demands of the public, and in October, 1914, the City Council authorised the issue of $1,000,000 of 4½ per cent. 30-year debentures covering the additional expenditure. A new schedule of rates was established by the Provincial Hydro-Electric Commission, as from the beginning of the present year. The charge for residence lighting has been reduced from 4·60 to 4 cents per unit, for commercial lighting from 3·69 to 3·85 cents, power from 1·56 to 1·31 cents, and street lighting from 2·40 to 2·12 cents. It is claimed that the hydro-electric system has secured substantial advantages upon the power and light consumers of the city of Toronto, as the charges have been greatly reduced. The report concludes with an acknowledgment of the efficient services of the general manager (Mr. H. H. Couzens) and his staff. The Toronto hydro-electric system is the largest single unit of the provincial system, and the commissioners look forward with confidence to the future of the public movement.

In the report of the general manager (Mr. H. H. Couzens) particulars are given of the more important extensions put in hand during the year. The net increase in consumers was above 9,000, or more than 40 per cent. over the number at the end of 1913. The total number of consumers is over 31,500, and their connected load over 88,000 H.P. During the year over 5,600 irons were disposed of by the appliance department. Mr. Couzens states that, taking these things alone on the basis of three hours' use a week, they represent about 480,000 units per annum, or a revenue of $13,000; but the new reduced rates are expected to give a great impetus to the use of irons, cooking and heating apparatus, &c. 2,400 street lamps were added during the year, making the total equivalent to 40,800 100-watt lamps at the end of 1914. During the year 84,592,300 units of electrical energy were sold for all purposes, against about 69,000,000 units in 1913.

FOREIGN NOTES.

China.—Mr. T. M. Ainscough, the Special Commissioner appointed by the Board of Trade to inquire into the conditions and prospects of British trade in China, has now returned to this country and is prepared to interview (by appointment) representatives of British firms who may be able to see him at the offices of the Commercial Intelligence Branch of the Board of Trade. In order that appointments may be satisfactorily arranged, British firms who desire to interview Mr. Ainscough should apply as soon as possible to the Director of the Commercial Intelligence Branch, 73, Basinghall-street, London, E.C.

France.—A consular report on the Brest district says the use of electricity for various purposes is developing, and the increased demand for current has necessitated an increase in the capacity of the generating plant of the local electricity company to 12,000 H.P. during the current year.

Hawaii.—A consular report on the trade of Hawaii in the year ended June 30, 1914, states that imports of electrical machinery were valued at £116,944 (compared with £109,054 in previous year).

Italy.—A British consular report from Catania says amongst the German and Austro-Hungarian goods hitherto imported into that district are boiler tubes, iron tubing, electric lamps, porcelain, glassware, &c. Some of the goods received from Austria have been of German origin.

United States Exports to South Africa.—According to "South Africa," during the first half of the current year United States exports to South Africa showed an increase in value of £148,000.

The classes of goods mainly contributing to the increase are machinery and iron and steel manufactures. The United States share of fencing wire imports was 72·8 per cent. (against 43·9 in 1914); of electrical machinery 30·4 per cent. (against 19·1 per cent.); and of mining machinery (including buckets and tip trucks) 36·7 per cent. (against 20·4 per cent.). In the same period British exports fell off by £2,584,000.

MISCELLANEOUS NOTES.

Competition with Germany and Austria-Hungary.—The Commercial Intelligence Branch of the Board of Trade have issued lists 39, 40 and 41 of the articles of which the sources of supply or markets have been interfered with by the war, and in regard to which inquiries have been received for names of manufacturers or producers. The articles wanted include glass and china ware, globes and shades, Chemicals, &c. United Kingdom manufacturers and exporters can obtain copies from 73, Basinghall street, London, E.C.

Electric Torches for Special Constables.—At Brighton special constables on night duty in the suburbs of the town are to be provided with electric torches.

Exports to China and Siam.—The London "Gazette" for Oct. 8 contains additions and corrections to the list (abstracted in our issue of Oct. 1, p. 973) of persons in China and Siam to whom articles sent from the United Kingdom may be consigned.

The following are added:—

China.—Ministries and Departments of the Chinese Government, Government Corporations, Provincial Governments and their Departments, Legations of Allied Powers at Peking, Anderson, Meyer & Co., Anglo-Chinese Eastern Trading Co., Chinese Electric Light & Power Co., Kiangnan Dock & Engineering Works, Nicholas Tsu Engineering Works

(Shanghai), Oriental Exp. Co., Peking Motor Co., Vickers (Ltd.), Gibb, Livingstone & Co. (Foochow), Municipalities of the Allied and Neutral Concessions (Shanghai), Alex. Ross & Co. (Shanghai).

Siam.—Legations of Allied Powers, Legations of Neutral Powers, Ministries and Departments of Royal Siamese Government.

Exports to the Netherlands.—The Privy Council have issued a schedule in substitution for the schedule to the Proclamation of June 25 regarding restriction of exports to the Netherlands.

Under the new schedule the exportation of all articles to the Netherlands is prohibited except printed matter, empty receptacles returned to the Netherlands, worn clothing and other personal effects and live animals other than animals used for human food unless consigned to the Government of the Netherlands (with the permission of the Secretary for Foreign Affairs), any British diplomatic or consular officer of an allied or a neutral country (with the permission of the Secretary for Foreign Affairs), the Netherlands Oversea Trust or (in case of any prohibited or restricted goods which are authorised by licence to be exported) the person named in the licence as the consignee.

Munitions Tribunal Decision.—On Friday last, before the Coventry Munitions Tribunal, Mr. John A. Northfield complained that the certificate of leaving was unreasonably withheld by Messrs. Willans & Robinson, of Rugby.

The CHAIRMAN (Prof. Tillyard) said the case raised a new point—whether a draughtsman was a workman within the meaning of the Munitions Act. Applicant produced a letter from the Ministry of Munitions, in which it was said

"I am directed by the Minister of Munitions to reply to your letter of August 31 respecting the position of draughtsmen and other salaried employes, as distinct from workmen, with regard to leaving their employment and obtaining other engagements elsewhere. . . . The Minister is advised that the term 'workman' should be construed in its ordinary sense as meaning a person who, substantially, does his work with his hands, or at all events, by physical exertion."

There was the further question whether Northfield was engaged on munitions, and Mr. Briggs (representing the company), said the engines on the plans of which applicant was working, were sold almost exclusively to armament firms. Then Northfield had been offered more responsible work elsewhere.

The CHAIRMAN said the decision of the Court was that applicant was not a workman within sec. 7 of the Act, and a statement would be made that no certificate was necessary for him.

Will.—The late Frederick H. W. Higgins, for many years chief engineer of the Exchange Telegraph Co., left £4,536, including £4,459 net personality.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during September, 1915, and (*b*) the aggregate figures from Jan. 1 to Sept. 30, with the increases or decreases compared with the corresponding periods of 1914 :—

Electrical machinery, (*a*) £104,109 (including generators and motors other than for aeroplanes, motor cars and cycles, £21,747, and electrical machinery unenumerated, £82,362) (increase £30,[illegible]), (*b*) £1,[illegible] (including generators and motors other than for aeroplanes, motor cars and cycles, £208,753 and electrical machinery unenumerated, £1,014,071) (increase £117,857); telegraph and telephone cables, submarine, (*a*) £4,888 (increase £4,728), (*b*) [illegible] other than submarine £25,615 (decrease £10,379); telegraph and telephone apparatus, (*a*) £12,200 (decrease £5,079), (*b*) £91,713 (decrease £106,017); other electrical wires and cables, rubber insulated, (*a*) £10,302 (increase £7,598), (*b*) £74,817 (decrease £150,[illegible]); with other insulations, (*a*) £9,139 (increase £8,354), (*b*) £[illegible] carbons, (*a*) £11,597 (increase £8,974), (*b*) £107,005 (increase £4,[illegible]) glow lamps, (*a*) £15,828 (increase £11,966), (*b*) £105,707 (increase £4,[illegible]) arc lamps and electric searchlights, (*a*) £[illegible] (decrease £1,260); parts of arc lamps and searchlights (other than carbons), (*a*) £8,371 (increase £2,845), (*b*) £68,417 (increase £303); primary and secondary batteries, (*a*) £15,255 (increase £13,211), (*b*) £[illegible] (increase £34,574); meters and measuring instruments,* (*a*) £1,[illegible] (*b*) £20,[illegible]; switchboards,* (*a*) £175, (*b*) £5,264; electrical goods and apparatus unenumerated, (*a*) £18,133, (*b*) £153,953. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £[illegible] (increase £59,599), (*b*) £766,128 (decrease £263,084).

Exports.—The exports of electrical machinery, material, &c., (*a*) during September, 1915, and (*b*) from Jan. 1 to Sept. 30, with the increase or decrease compared with the corresponding periods of 1914, were as follows :—

Electrical machinery, (*a*) £113,950 (including railway and tramway motors, £3,804, generators and motors other than aeroplanes, motor cars and cycles £55,645, and electrical machinery unenumerated £54,501) (increase £6,130), (*b*) £1,028,504 (including railway and tramway motors £96,915, generators and motors other than for aeroplanes, motor cars and cycles, £483,122, and electrical machinery unenumerated, £448,467 (decrease £709,933); telegraph and telephone cables, submarine (*a*) £3,256 (increase £2,498), (*b*) £277,845 (decrease £[illegible]); other than submarine, (*a*) £25,596 (increase £13,976), (*b*) £321,[illegible] (increase £84,233); telegraph and telephone apparatus, (*a*) £24,[illegible] (increase £5,820), (*b*) £153,050 (decrease £42,546); other electrical wires and cables, rubber insulated, (*a*) £43,226 (increase £18,504), (*b*) £233,237 (decrease £27,336), with other insulation, (*a*) £71,358 (increase £36,170), (*b*) £349,637 (increase £27,799); carbons (*a*) £739 (increase £718), (*b*) £6,254 (decrease £326); glow lamps, (*a*) £17,991 (increase £7,027), (*b*) £113,540 (increase £18,537); arc lamps and searchlights, (*a*) £528 (increase £25), (*b*) £3,842 (decrease £8,478); parts of arc lamps and searchlights (other than carbons), (*a*) £2,783 (increase £2,213), (*b*) £18,730 (decrease £3,067); primary and secondary batteries, (*a*) £11,867 (decrease £2,[illegible]) (*b*) £147,381 (increase £15,781); meters and measuring implements,* (*a*) £9,814, (*b*) £112,394; transformers,* (*a*) £2,439, (*b*) £5,[illegible]; switchboards,* (*a*) £5,618, (*b*) £47,621; electrical goods and apparatus unenumerated, (*a*) £42,534 (decrease £20,332), (*b*) £434,351 (decrease £235,[illegible]). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £262,088 (increase £82,015), (*b*) £2,270,267 (decrease £114,123).

* Not enumerated separately in previous years.

TENDERS INVITED.

Coal Conveyor, Coal Hopper, Water Cooler, Water and Feed Pumps.

The Electricity Committee of MANCHESTER Corporation invite tenders for the supply, delivery and erection of Coal-conveying Plant, New Coal Hopper, &c., Water Cooler, two Electrically-driven Circulating Water Pumps and Turbine-driven Boiler Feed Pump. Specifications, drawings and forms of tender from the Secretary of the Electricity Department (Mr. F. E. Hughes), and further particulars and information can be obtained from the chief electrical engineer (Mr. S. L. Pearce). Tenders, addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall, Manchester, by 10 a.m. Wednesday, 27th inst. *See also an advertisement.*

Telegraph and Telephone Material.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *See also an advertisement.*

Automatic Telephone Exchange.

Plans and forms of tender are being prepared for the installation of an automatic telephone system in CHRISTIANIA (Norway), at an estimated cost of about £53,600. Specifications, &c., from the Kristiania Telefonanlag, Toldbodgt, 30, Christiania.

Telegraph Stores.

The directors of the NORTH EASTERN RAILWAY Co. are prepared to receive tenders for 6 or 12 months' supply (from Jan. 1 1916) of Telegraph Apparatus, Wire and Line Stores. Forms of tender from the Telegraph Superintendent (Mr. C. H. Ellis), and tenders must be sent to the Secretary, Mr. R. F. Dunnell, York. *See also an advertisement.*

Turbo-Alternator, Generating Plant, Boilers, &c.

DARLINGTON Corporation require tenders by Oct. 22 for a 3,000 kw. Turbo-alternator with Surface Condensing Plant. Specification, &c., from the Borough Electrical Engineer

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for the supply and maintenance for 12 months of two Water-tube Boilers and Accessories at Newcastle, N.S.W. Specification, &c., from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Electric Cables, Transformers and Switchgear.

LITTLEBOROUGH Urban District Council invite tenders for the supply and laying of High-tension Cables, &c., and for Transformers and Switchgear for sub-station. Specifications, &c., from the Clerk to the Council (Mr. Geo. H. Wild), to whom tenders are to be sent by Friday, Oct. 22. Plans and specifications may be seen at, but not obtained from, the office of consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

Wiring, Lamps, Fittings, &c.

WATFORD Council require tenders by Oct. 18 for Wiring their new water pumping station. Specifications, &c., from Mr. D. Waterhouse, Council Offices, High-street, Watford.

DUNDEE Harbour Trustees require tenders by 10 a.m. Oct. 21 for Wiring of shed Y at the new wharf at Gourlay's Old Shipbuilding Yard. Specifications from the General Manager and Engineer.

The GREAT NORTHERN RAILWAY Co. (IRELAND) require tenders by 10 a.m. Nov. 4 for 12 months' supply of Electric Cable and Wire, Electric Light Carbons, Electric Fittings, Lamps, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Sydney, invites tenders by 2:30 p.m. Nov. 4 for 100 miles Two-twisted and 75 miles Three-twisted Rubber-insulated tinned Copper Wire for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department. Specification, &c., from the Deputy Postmaster-General, Sydney.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders are invited for the supply of 294 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders to DeputyPostmaster-General, Perth(W.Australia),by 3 p.m. Dec. 8.

The Deputy Postmaster-General requires tenders by 2:30 p.m. Nov. 4 for about 59 miles of Paper-insulated Lead-covered Cable (schedule 172, N.S.W.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Nov. 17 for Switchboard Parts and Accessories (schedule 343), Telegraph Instruments (schedule 345), Protectors and Parts, &c. (schedule 346), and Ironwork (schedule 358) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Specifications, &c., for the contracts under the above heading can be obtained from the respective Deputy Postmasters-General.

Electric Capstans.

SYDNEY Harbour Trust Commissioners invite tenders by 2 p.m. Oct. 25 for the supply of 6 Electrically-operated Wharf Capstans. Specification, &c., from the office of the Commissioners, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

SOUTHAMPTON.—The Council has accepted the following tenders: A. Kinghorn & Co. for [illegible] at £18 18s., that of Edgar Allen & Co. (at £370) for the supply of tramway points and crossings. Hadfield's Steel Foundry (Ltd.) also tendered for the latter at £240.

In reference to the contract with British Thomson-Houston Co. for the supply of a rotary converter, the British Electric Transformer Co. (the sub-contractors) intimated that their original price (£496) for the transformers would not hold good owing to the increased cost of materials, and the Committee agreed to the amount being altered to £542.

The Committee has deferred the question of providing slot meters in view of the difficulty of obtaining meters at present.

DERBY.—The Corporation have accepted the tender of C. A. Parsons & Co., for repairing a steam turbine at £800.

WOOLWICH.—The Borough Council have placed an order with Ferranti (Ltd.) for switchgear, at £101.

ERITH.—The Urban Council have accepted the tender of Fraser & Chalmers for a turbo-alternator and condensing plant, at £10,432.

ROCHDALE.—The Corporation have placed an order with W. T. Glover & Co. for 12 months' supply of electric cable.

JOHANNESBURG.—R. H. Gould & Co. recently secured an order from the Corporation for the supply of eight 100 kw. single-phase transformers, at £803.

BRISTOL.—The Dock Committee have accepted the tender of Johnson & Phillips for the supply of 7/16 paper-insulated lead-covered and armoured main cable.

BUXTON.—For supply of two feeder pillars and four feeders the Council has accepted the tender of the British Insulated & Helsby Cables, at £207.

WOOLWICH.—The following tenders have been accepted by the Electricity Committee:—

S. B. Goslin & Sons, c.i. chute plates, £29; Bell's Asbestos Co., covering 3 in. and 8 in. steam pipe in connection with 3,000 kw. turbo-alternator, £38. 17s. 2d.; Ferranti (Ltd.), switchgear for 1,000 kw. converter, £120. 9s. 2d.

HALIFAX.—The Guardians have accepted the tender of the Garth Electrical Engineering Co. for electrical fittings and that of the Rugby Lamp Co. for lamps.

The Corporation have also placed orders with Babcock & Wilcox for a water-tube boiler and superheater (£2,940); with the Underfeed Stoker Co., for two underfeed stokers (£538); and with the Premier Cooler & Engineering Co. for two water-cooling towers (£2,450).

EDINBURGH.—The following tenders for the supply of electric generating plant for the new Portobello power station have been accepted by the Corporation:—

Fraser & Chalmers, turbines and alternators (with Vickers alternators) £23,251, and for condensing plant (with Richardsons, Westgarth & Co. as sub-contractors), £7,611, delivery in both cases to be made in the summer of 1917.

STEPNEY (LONDON).—The Electric Supply Committee has accepted the tender of T. Crow & Sons to supply 50 tons of moulded pitch at £1. 9s. 6d. per ton.

SYDNEY (N.S.W.)—The City Council have authorised the following purchases under existing contracts:—

British General Electric Co., four 415 v. transformer panels, six 475 v. distributor panels £273, 10,000 50 c.p. vacuum lamps £713. 6s.; Australian General Electric Co., 350 lanterns £1,137. 10s., 200 reflectors £260, 350 compensators £565, 1,000 750-watt nitro lamps £1,487, 2,000 500-watt ditto £2,448, 1,000 300-watt ditto £1,050, 2,000 750 watt ditto £1,925 200 500-watt ditto £1,325, three 5,000 v. panels for No. 2 Lang Park sub-station £291, eight transformers £1,730. 8s., 24 three-pole outdoor pole-type switches £716. 16s., two 5,000 v. transformer panels £264, two 10,000 v. ditto £266; N. Guthridge (Ltd.), 10 100 k.v.a. transformers £1,320, three ditto £396, eight 200 k.v.a. ditto £1,520, five ditto £950, 10 50 k.v.a. ditto £980, four ditto £392, 10 100 k.v.a. ditto £1,320, three ditto £396, eight 200 k.v.a. ditto £1,520, five ditto £950, 10 feeder panels £1,355, four ditto £601. 4s., six transformer panels £687. 12s., four ditto £482. 16s.; Noyes Bros., four feeder panels £566, eight transformer panels £1,184; Lawrence & Hanson, for cutouts and replacements, 15 ampere 2s. 4½d. and 11d., 25 ampere 3s. 11d. and 8¾d., 50-ampere 4s. 6d. and 1s. 3d., 100 ampere 9s. and 1s. 11½d., 200 ampere 22s. and 3s. 10d., 300 ampere 34s. 7d. and 7s.; Standard Waygood Hercules (Ltd.), 5,000-volt transformer panels £97, 33,000 v. ditto £239, 33,000 v. incoming feeder panels £255, 33,000 outgoing ditto £302, 415 v. transformer panels £221, 415 v. summation panels £67, 33,000 v. 'bus bar insulators £1. 6s., 5,000 v. ditto 13s., 33,000 v. operating rods for link switches £3, 5,000 v. ditto £2. 5s. each, three 500 v. feeder panels £403.10s., six 10,000 v. ditto £1,191, two ditto £290.

The following tendered for d.c. and single phase a.c. meters: Noyes Bros. for Ferranti meters (*recommended for acceptance*), Standard Waygood Hercules (Ltd.) for British Westinghouse meters, Haes & Eggers for Bat meters, Edison & Swan United Electric Light Co. for Chamberlain & Hookham meters, Australian General Electric Co. for General Electric (U.S.A.) meters.

W. G. Watson & Co. tendered for Reason d.c. meters and Lawrence & Hanson for Lands & Gyr single-phase meters; and the following tendered for three phase meters: Standard Waygood Hercules (Ltd.), Haes & Eggers, Edison & Swan Co., Noyes Bros., Lawrence & Hanson, Australian General Electric Co.

For maximum demand indicators the following firms tendered: W. G. Watson & Co. for Reason meters (*recommended for acceptance*), Australian General Electric Co. for General Electric (U.S.A.) meters.

The Council are recommended by the Electric Lighting Committee to

place orders with Willans & Robinson for a set of reaction blading for their 5,000 kw. turbo-alternator at £898. 10s., and with Babcock & Wilcox for two spare motors (for induced draught fans for the two boilers on order with that company) at £675 (estimated).

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Victorian Railways.—W. T. Henley's Telegraph Works Co., l.t. cables, at rates ; British Insulated & Helsby Cables, l.t. cables, at rates ; R. W. Cameron & Co., electro-mechanical interlocking apparatus and spare parts ; Thompson & Co., railway and electric tramway crossing for Glenferrie, at rates.

Metropolitan Board of Water Supply, &c., Sydney.—Australian General Electric Co., 17 electric meters for pumping stations.

W.A. Government Tender Board.—Horace Summers, metal filament lamps 30 and 60 watt 1s. 1d. each, 100-watt 2s., 200-watt 4s. 6d. ; Chas. Atkins & Co., electric desk fans, £1,294. 15s.

Postmaster-General's Dept., Adelaide.—R. Johnson, Clapham & Morris, 10 tons copper wire £115. 10s. per ton, 5 tons ditto £115. 10s. per ton ; India Rubber, Gutta Percha & Telegraph Works Co., 50,000 copper binders 2s. 5d. per 100, 5,000 ditto 7s. 4½d. per 100.

Postmaster-General's Dept., Hobart.—A. J. Todd & Co., 5,000 jointing sleeves £6. 12s. 1d. per 1,000, 5,000 ditto £5. 12s. 5d. per 1,000 2,000 ditto £4. 12s. 3d. per 1,000, 2,500 d tto £3. 11s. 9d. per 1,000, 2,000 ditto £3. 7s. 9d. per 1,000, 2,500 ditto £3. 6s. 5d. per 1,000 ; Western Electric Co., ½ ton copper-clad steel wire £143. 3s. 6d. per ton, 27,500 paper jointing sleeves 2s. 6d. per 1,000, 5 miles wire £17. 12s. 9d. per mile, 5 miles ditto £25. 9s. per mile, 3 miles ditto £16 per mile, 3 miles paper-insulated lead-covered cable £215 per mile ; Brunswick Brick, Tile & Pottery Works, 200 glazed earthenware conduits 2s. 11d. each, 700 ditto 2s. 9d. each, 3,900 ditto 1s. 11¾d. each ; British General Electric Co., 5 miles tinned annealed copper wire £19. 1s. per mile, 5 miles ditto £11. 14s. per mile ; India Rubber, Gutta Percha & Telegraph Works Co., 6,000 copper binders 3s. 9d. per 100, 3,000 ditto 2s. 9½d. per 100, 10,000 ditto 2s. 3d. per 100, 6,000 copper tapes 2s. 10½d. per 100, 10,000 ditto 1s. 11d. per 100, 1,000 zincs 5d. each, 1,000 porous pots 8½d. each, 3 cwt. salammoniac 57s. 6d. per cwt. ; Callender's Cable & Construction Co. (per Noyes Bros.), 3 miles paper-insulated lead-covered cable £130 per mile ; F. S. Lee, 5 tons copper wire £116 per ton, 2 tons bronze wire £142 per ton, 5 tons ditto £142 per ton.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

14,125 DAWSON & BUCKINGHAM. Electrical apparatus for transmitting and receiving signals.

17,863 BRINKMANN. Electric contact apparatus, particularly for telephone systems (24/10/13.)

A contact apparatus in which a common contact actuating member is under the control of a plurality of operating devices having equal ranges of movement, and connected with the member by levers of different ratio, so that the equal movements of the operating devices cause different extents of movement of the actuating member.

19,492 ALLGEMEINE ELEKTRICITATS-GES. Internal-combustion engine with electrically-driven charging pump. (6/9/13.)

19,854 STERLING TELEPHONE & ELECTRIC CO. & BARCLAY. Electric signalling systems, particularly for use in mines.

19,977 VIDAL. [illegible]

20,687 H[illegible] & B[illegible]. [illegible] the like.

21,529 W[illegible] & M[illegible]. T[illegible]

23,212 DAY. Electric-coupling devices.

23,534 SCHAICHER & [illegible]. [illegible] application 3,106/15.)

24,293 MI[illegible] & V[illegible]. [illegible] for use on motor-cars and the like.

24,766 SA[illegible]. [illegible] A lamp is [illegible] in the lamp of a loose [illegible]

[illegible]

4,012 MARCANOLA & TESTA. [illegible] (14/3/14.)

5,672 SIMPSON. Brushes and brush holders for magneto-electric machines [illegible] application on 19,784/14. Sept. 15.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications [illegible] public inspection until after acceptance of Complete [illegible] open to inspection 12 months after the date attached to them [illegible] previously in the ordinary course. Names within parentheses [illegible] of inventions When complete Specification accompanies application [illegible]*

September 24, 1915.

13,618 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (W[illegible] Co., U.S.) Insulating airtight joints for terminal [illegible]

13,624 QUARZLAMPEN G.M.B.H. [illegible] quartz lamps. (15/9/14, Germany.)*

September 25, 1915.

13,655 PASQUIER & SLATER. Automatic circuit-interrupting devices.

13,679 LEWIS. Electromagnetically-operated mechanisms.

September 27, 1915.

13,681 COOPER. Electromagnetic couplings.

13,697 BROWN & DOLLARD. Dynamo or motor.

13,727 MANDER. Electric flashlight signalling instruments.

13,733 JOLY. Sparking plugs.*

13,750 MORDEY. Apparatus for augmenting the effect of small electric currents.

13,754 STANDARD CO. Stationary electrode for igniters. (26/9/14, U.S.)*

September 28, 1915.

13,762 KLUIJTMANS. Electric heating, boiling and flat-ironing apparatus.

13,769 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Loading coils for telephone lines. (Addition to 12,434/15.)*

13,774 DOLLARD & BROWN. Electromagnetic power transmission for motor car.

13,788 SUCHOSTAWER. Electric generators.

13,801 THURY. Electrical supply systems at constant current strength and varying voltage. (16/6/15, Switzerland.)*

13,806 LOVELACE, FORD & EDISON & SWAN UNITED ELECTRIC LIGHT CO. Electric bells and the like.

13,807 BELLAMY. Miners' electric lamps.

September 29, 1915.

13,837 ROCH. Regulators for X-ray bulbs and like apparatus.*

13,852 MARCONI'S WIRELESS TELEGRAPH CO. & EWEN. Hot-wire ammeters.

13,867 POLLARD & MENCO-ELMA SYND. Power transmission systems.*

13,869 AUBERT. Horary electric meters. (1/10/15, Switz[illegible] *

September 30, 1915.

13,886 & 13,888 HEYS. (Neuland Patents (Ltd.), U.S.) Dynamo-electric machines.*

13,899 SUETER, GROVES & BINYON. Apparatus for use in wireless telegraphy and the like.

13,901 BURT & HUNTALITE (LTD.). Fittings for electric incandescent candle lamps.

13,904 B.T.-H. CO. (G.E. Co., U.S.) High-frequency dynamo-electric machines.

13,912 NEULAND. Electromagnetic power transmission [illegible] *

13,915 CORRELL. Construction of electric head-lamp reflectors.*

13,918 MEURLING. Signalling devices.

October 1, 1915.

13,928 DAVIS & SON & DAVIS. Signalling apparatus.

13,934 RAILING & GARRARD. Operating rotary converters and [illegible] machinery. (Addition to 10,841/13.)

13,943 HUNTER. Manufacturing the caps for electric incandescent lamps.

October 2, 1915.

13,984 CRAWFORD. Portable electric-lamp apparatus.

13,985 BRITISH WESTINGHOUSE E[illegible]TRIC & M[illegible] C[illegible]. St[illegible] ments for internal-combustion engines. (3/10/14, U.S.)*

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Alloa.—The electricity department's accounts for the year ended May 15 show total capital expenditure £32,050 (increase £6,713), of which £4,027 has been repaid.

Revenue was £3,811 and working and general expenses were £2,062, leaving gross profit £1,749. £826 was required for interest, £250 for instalments of loans, £513 for sinking fund, and £333 for two instalments of compensation to British Electric Plant Co. ; total £1,922, which the gross profit was insufficient to meet by £173. Units generated were 670,661 (compared with 418,410 in previous year) and 540,671 (360,942) sold. Total maximum supply demanded was 290 kw. (229 kw.).

Cheltenham.—The Electricity and Lighting Committee's accounts for the year ended March 31 show receipts £23,694, against £24,437 in previous year.

After providing for working expenses the gross profit was £13,690 (£14,585). Capital charges were £10,890, leaving a net profit of £2,800 (£3,737). Capital expenditure increased £1,147, making the total £174,711, of which £85,146 is outstanding.

Derby.—The profit on the past year's working of the electricity supply department was £1,500, which has been carried forward.

There was a net deficit of £2,218 on the year's working of the tramway, compared with a surplus of £8,193 for the previous year.

East Ham.—The accounts of the electricity supply department for the year ended March 31 show total capital expenditure £154,702 (increase £2,941), or £151,272 after deducting £3,430 original cost of assets disposed of. £104,903 is outstanding, and the sinking fund stands at £17,677.

Revenue was £28,568 (compared with £30,829 in previous year), and total costs were £17,281 (£18,392), leaving gross profit £11,287 (£12,437). Interest required £4,766 (£4,745) and sinking fund and repayment of principal £5,391 (£5,186), the net profit being £1,130 (£2,506). Fuel cost 0·45d. (0·50d.) per unit sold, and total operating costs were 0·97d. (0·98d.). Units sold were 4,276,391 (4,577,033), and the average price obtained for all purposes) was 1·59d. (1·60d.). The total maximum load on feeders was 1,784 kw. (2,135 kw.) and the load factor 30·1 (27·9) per cent. The number of consumers increased from 1,454 to 1,531, and the connections (exclusive of traction) from 102,506 to 102,749 (equivalent) 8 c.p. lamps.

The tramway accounts show total capital expenditure £169,309, of

which £6,495 has been borne by direct contributions from revenue. The outlay during the year was £4,080. Outstanding loans amount to £129,334, and the accumulated sinking funds to £10,628. Revenue was £60,232 (against £54,915) and operating costs were £51,619 (£48,129), leaving gross profit £8,613 (£6,786). Interest required £5,279 (£5,569) and sinking fund and principal £6,858 (£6,882), the net result being a deficit of £3,524 (£5,665). Total operating costs were 7·75d. (7·65d.) per car-mile, and revenue was 9·05d. (8·73d). Passengers carried were of 18,916,971 (16,671,505), car miles run 1,596,984 (1,510,251) and units used 2,461,677 (2,385,535). Average fare charged per mile was 0·63d.

Keighley.—A report on the past year's working of the tramways department was presented to the Council last week.

It was stated that owing to the effect of halfpenny fares the revenue had not returned to what it was before the cheaper fares were introduced. The total revenue had been £9,253, against £9,380 in the previous year. Working expenses increased from £6,105 to £6,744. The number of passengers carried was 3,552,016, a decrease of 54,202, although the car-miles run had increased from 241,917 to 247,791. There was a deficit of £112, after providing for £935 interest and £1.876 for sinking fund. 24 of the staff had enlisted, and up to the present it had not been found necessary to employ girls as conductors, but during the last few weeks greater difficulty had been experienced in filling gaps with suitable men, and, as a preliminary to the possible employment of female labour, it was suggested that a deputation should visit one or two towns where such labour had been adopted.

Owing to delays caused by the war, the trackless car system had not been in operation as early as they had expected, but in order to give a rough idea of how the system was working particulars had been got out for the three months ended June 30. The total mileage run on the three routes was 23,715, the number of passengers carried 16,023, and the traffic revenue was £1,327. The total revenue was £1,355, and the expenditure (including interest and capital repayments) £984, leaving a net profit of £370. Since the end of March the revenue on the cars had been very satisfactory. It was suggested that some sort of accumulator-driven 'bus could be run with advantage between the Bingley tramway terminus at Crossflats and the Keighley terminus at Stockbridge.

Mr. A. Smith, in moving the adoption of the report and accounts, said the committee had considered the fares, and one suggestion that had been made was that they should try to run halfpenny fares for working people in the mornings and evenings. The committee thought that no halfpenny fares should be collected on the cars, but that they should issue prepaid halfpenny tickets which would allow workpeople to ride between 5:30 and 9 in the morning, 12:30 and 2 at midday, and 5 to 7 o'clock in the evening. The tickets might be supplied to employers to sell to their workpeople.

After discussion the report was adopted.

Maidstone.—The accounts of the electricity department for the year ended March 31 show an increase of £2,836 in the gross capital expenditure. Total capital raised was £94,094, of which £58,163 is outstanding.

Revenue was £19,983 and working expenses were £11,993, leaving gross profit of £7,900. Interest and repayment of loans required £6,347, leaving a surplus of £1,553.

In submitting the auditor's report at the last Council meeting Ald. Vaughan said there were 1,043 consumers, motors connected amounted to 2,340 h.p., units sold were 2,887,857. When the new turbine was completed they would have 2,800 kw. of generating plant. No addition was made to the price of current until July 1, when the price of current for power only was increased.

There was no increase in the capital expenditure on the tramways. Revenue was £11,004 (against £10,965 in previous year) and expenditure £7,559 (£7,290), leaving gross profit £3,445, plus £55 received from the Highways Committee. Interest and repayment of loan required £4,448, the net deficit being £948 (£822). Passengers were 2,423,514.

Mr. Lyle, who submitted the auditor's report on the tramways accounts at the last Council meeting, said the female conductors on the cars were attentive and punctual and he believed they had come to stay.

Newcastle-upon-Tyne.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £1,332,133 (increase £47,753). The total amount of sinking fund instalments is £125,117, and £349,456 of loans has been repaid.

Revenue was £302,611 (compared with £298,496 in previous year), and operating costs, including public lighting, were £160,468 (£177,582), leaving gross profit £142,143 (£120,914). Interest and redemption required £72,930 (£72,707), leaving a surplus of £66,105 (£39,841), which is accounted for as follows:—Relief of rates £19,481 (£13,470), provision of motor 'buses £6,237, chassis £362 (£4,237), allowances to employés on active service £4,369, net surplus £24,826 (£8,134). Passengers carried were 65,085,462 (67,840,666), car miles run 5,775,322 (5,535,875), and units used 11,367,733 (10,289,493), total operating costs (including public lighting) were 6·66d. (6·61d.) per car-mile, and traffic revenue was 12·16d. (11·58d.).

The report of the engineer and general manager, Mr. Ernest Hatton, states that the outbreak of war produced greater activity in the district than has hitherto been known, the receipts being a record, although the expenses increased in proportion. £121,487 has been paid in rates by the undertaking since its incorporation in 1901, £66,000 has been contributed directly in relief of rates and £13,515 by taking over old horse tramways loan charges. £6,599 has been charged to revenue for purchase of motor 'buses. Owing to the enlistment of the motor drivers the 'buses cannot be put into service. There are 141 women conductors and 24 women cleaners, and 75 volunteers have come forward to drive and conduct cars morning and evening, which has relieved the difficulty caused by the numerous enlistments of the employés in H.M. Forces. The number of enlistments up to March 31, 1915, was 309. The Council have made up the wages of the men on military service to the amount they receivedin the council's service, and war bonuses of 1s. to 2s. 6d. per week have been granted to the remaining employés. During the year eight new cars were built in the car works, and 15 purchased from contractors. The number of cars in stock is 223, plus 12 motor 'buses, one water car and six salt and sand cars. The lines over which the Corporation cars run are equal to 69 miles single track, of which 6½ are owned by Tyneside Tramways & Tramroads Co.

Pontypridd.—The electricity department's accounts for the year ended March 31 show total capital expenditure £82,223 (increase £1,399), of which £58,693 is outstanding.

Revenue was £11,556 (compared with £11,418 in previous year), and working and general expenses were £5,427 (£5,078), leaving gross profit £6,129 (£6,339), or £6,226, including consumers' deposits, bank interest, &c., and after providing for capital charges, &c., the net result was a deficit of £181 (compared with a profit of £1,035). Units generated were 1,920,006 (1,791,387), and sold 1,594,055 (1,479,402). Total maximum supply demanded was 917 kw. (905 kw.) Total costs per unit sold (exclusive of capital charges) were 0·817d. (0·823d.)

The tramway accounts show total capital expenditure £134,419 (increase £1,276) of which £110,770 has been repaid. Revenue was £23,246 (compared with £23,597 in previous year), and working expenses were £16,670 (£17,860), leaving gross profit £6,576 (£5,737). After providing for capital charges, &c., the net deficit for the year was £2,271 (£2,452). Car-miles run were 426,639 (426,228).

Shoreditch (London).—The electricity department's accounts for the year ended March 31, 1915, show total capital expenditure £410,357 (increase £18,581), of which £82,155 has been repaid.

Revenue was £63,485, and total working expenses were £40,899, leaving gross profit £22,585, and after providing for capital charges, allowances to special constables (£125), allowances to men in H.M. Forces (£848), interest on deposits (£30), stand-by charges, refuse destructor account (£300) and Stepney Borough Council £424, and accrued wages £165, there was a balance of £1,509 to transfer to appropriation account, besides £120 brought forward from previous year. £1,400 has been transferred to reserve, £137 paid as the year's contribution to change of pressure expenses, and £92 carried forward. Units generated were 10,125,600 (9,900,109) and purchased 992,960 (1,689,590) and sold 8,477,453 (8,635,682). Total maximum supply demanded was 4,606 kw.

Stockport.—The electricity department's accounts for the year to March 31 show total capital outlay £135,263 (increase £18,439), of which £39,763 has been redeemed.

Revenue was £32,885, working expenses were £12,237, and gross profit was £13,648, of which £376 has been used to defray cost of repairs of boiler house roof, £418 for capital works in excess of borrowing powers, £467 for bank interest, £2,534 for interest on loans, £6,519 for repayment of loans, and £2,331 transferred to reserve, £1,000 remaining available in aid of rates. Units generated were 10,792,741, and sold 9,179,595. Plant capacity is 6,100 kw.

COMPANIES' MEETINGS AND REPORTS.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—An extraordinary meeting was held on Monday when a resolution to increase the capital from £500,000 to £750,000 by the creation of a further 50,000 shares of £5 each.

AMALGAMATED WIRELESS (AUSTRALASIA) (LTD.)—The net profit for the first half of the year 1915 was £1,672. With the balance brought forward the sum available was £6,901, of which £4,900 was absorbed in a dividend of 3½ per cent., and £1,101 was carried forward. The directors, who have had under consideration the extension of the manufacturing plant for the complete manufacture in Australia of wireless telegraph apparatus, are now manufacturing the bulk of the company's requirements. Trading for the period has been seriously interfered with by the war and profits have suffered somewhat severely. The ships message traffic has shown a slight improvement, but is still subject to disabilities. The steamship stops now operated by the company have been increased by six during the period, the total number being 85.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—The directors announce that the accounts for the six months ended June 30 have been received, and although the currency results are not altogether unsatisfactory they consider it inadvisable to declare an interim dividend on the ordinary shares. The Board have declared a half yearly dividend at the rate of 6 per cent. per annum (less tax) on the preference shares.

DICK, KERR & CO. (LTD.)—The profits earned during the 12 months' trading to June 30 amount to £46,959 17s. 5d., which added to amount

brought forward (£25,525. 7s. 11d.) make a total of £72,485. 5s. 4d. The debenture interest and trustees' fees have been paid and there has been reserved the sum required to provide for premium payable on redemption of debenture stock. These items absorb £10,838. 13s. 8d., leaving £61,646. 11s. 8d., out of which it is proposed to pay a dividend of 6 per cent. per annum on the preference share capital (£18,300), to set aside as a reserve against contingencies £25,000, and to carry forward the balance £18,346. 11s. 8d. In view of the abnormal conditions prevailing, the directors are unable to recommend the payment of a dividend on the ordinary shares.

HURST, NELSON & CO. (LTD.)—The accounts for the year ended July 17 show an available sum (after providing for depreciation, &c., and including £16,811 brought forward) of £68,390. The directors propose to place £13,694 to reserve for preference dividend and £15,000 to general reserve, to reserve a sufficient sum for payment of preference dividend up to May 15, 1916, and recommend a distribution of 10 per cent. on the ordinary shares, leaving £15,696 to be carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

FELTHAM & DISTRICT ELECTRIC LIGHTING CO. (LTD.) (141,806).—Reg. Oct. 8, capital £100 in £1 shares, to carry on the business of generators, producers and distributors of electrical energy within the area of supply mentioned in the first schedule to the Feltham and District Electric Lighting Order, and to adopt an agreement with F. H. Edwards. Private company.

W. A. & R. J. JACOBS (LTD.) (141,783).—Reg. Oct. 6, capital £3,000 in £1 shares, to carry on the business of manufacturers of electrical apparatus and fittings, electric lamps and cycle and motor accessories, &c., and to enter into an agreement with W. A. Jacobs and R. J. Jacobs. Private company. First directors are W. A. Jacobs and R. J. Jacobs (both permanent). Reg. office: 94, Leonard-street, Finsbury, E.C.

H.S.M. PATENT BELT FASTENING CO. (LTD.) (141,732).—Reg. Oct. 1, capital £500 in £1 shares, to carry on the business of manufacturers of and dealers in belt fastening devices, engineers, metal workers, electricians, &c., and to adopt an agreement with H. K. Mackay, C. H. Sherwood and W. W. Hartley. Private company. First directors are H. K. Mackay C. H. Sherwood and W. W. Hartley. H. K. Mackay signs as "managing director." Reg. office: 25, Clarence-chambers, 4, Piccadilly, Manchester.

SIDNEY MINNS & CO. (LTD.) (141,817).—Reg. Oct. 8, capital £8,000 in £1 shares, to carry on the business of mill furnishers, oil and grease merchants and boiler composition and fluid manufacturers, electricians, mechanical, electrical, motor and general engineers, manufacturers of motor and car accessories, &c. Private company. Reg. office: 16, Trafalgar-road, Dalston, N.E.

TEES BENZOL SYND. (LTD.) (141,782).—Reg. Oct. 6, capital £100 in £1 shares, to manage certain works on behalf of His Majesty's Minister of Munitions, and to carry on the business of colliery proprietors, coke manufacturers, chemicals and bye-products produced from coal, electricians, suppliers of energy for light, heat, power or otherwise, &c. Private company. First directors are Sir Hugh Bell, Bt., A. J. Dormans, A. F. Pease, J. H. Pease, W. I. Johnson and G. B. Nancarrow. Reg. office: Royal Exchange, Middlesbrough.

SMITH & CO. (FOLKESTONE) (LTD.) (141,726).—Reg. Sept. 30. capital £2,000 in £1 shares, to carry on the business of ironmongers, house furnishers, electrical and sanitary engineers, &c., and to adopt an agreement with G. C. Slipper for the acquisition of the business carried on by him as Smith & Co. Private company. G. C. Slipper is sole permanent director. Reg. office 74, Sandgate-road, Folkestone.

STATUTORY RETURNS.

BIRMINGHAM DISTRICT POWER & TRACTION CO. (LTD.)—In return to July 5 capital is £1,050,000 in 35,000 cumulative preference, 35,000 preferred ordinary and 35,000 deferred ordinary shares, all of £10 each. 20,978 cumulative preference, 35,000 preferred ordinary and 35,000 deferred ordinary shares taken up. £10 per share called up on 20,978 cumulative preference, 27,000 preferred ordinary and 35,000 deferred ordinary. £829,780 paid. £80,000 considered as paid on 8,000 preferred ordinary. Mortgages and charges, £411,260.

JOHN DAVIS & SON (DERBY) (LTD.)—Return to July 9 gives capital as £35,000 in £1 shares (15,000 preference). 15,000 ordinary and 11,000 preference shares taken up. £1 per share called up. £26,000 paid. Mortgages and charges: Nil.

MORTGAGES AND CHARGES.

PINTSCH'S ELECTRIC MANUFACTURING CO. (LTD.) (in vol. liq.)—Charge on hereditaments and premises, &c., dated Sept. 16, 1915, to secure not more than £350. Holders: Pintsch's Patent Lighting Co., Ltd. (in vol. liquidation).

CITY NOTES.

MEMORANDA (Oct. 13).—Bank rate 5 per cent. (since Aug. 3, 1914). Consols 65. Consols Pay Day Nov. 1. Stocks and Shares Pay Days Oct. 27 and Nov. 11. Pay Days Oct. 28 and Nov. 12. Price of silver, 24d.

BABCOCK & WILCOX (LTD.)—The directors have declared an interim dividend of 6 per cent. on the ordinary shares (tax free), compared with 5 per cent. a year ago.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Oct. 8: Anglo-French (Foreign & Colonial Patents) Co., Birmingham Electrical Supply, British Automatic Telephone Synd., British Magneto Co., Chemical Research Co., Consolidated Electric Works & Appliances, Continental Dredge Motor Engine Co., Eclipse Boiler Furnace (London & South), Gambles Patent Telephone Recorder Co. (Continental), Haywards Heath Electric Supply Co., Magnetic Separator, Pacific Radio-Telegraph Co., Pyrenees Telegraph Synd., Premier Electric Control, Radio & Electric Power Co., Spiral Turbine Synd., Sunturbo Engineering Co., Transvaal Concessions Synd., Transportable Bridge Co., Tungsten Metal Co., United Electrical Construction Co.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—The directors have declared an interim dividend of 2½ per cent., payable Nov. 5.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at rate of 5 per cent. per annum (tax free), payable Nov. 1.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The directors have declared the following interim dividends: 3 per cent. on the 6 per cent. cumulative preference shares for the current year (less tax), and 4 per cent. on the ordinary shares (tax free). Warrants will be posted on the 30th inst.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—The directors have declared a dividend of 2½ per cent. on the common stock for the past quarter.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—An interim dividend of 3 per cent. has been declared on the ordinary share capital (tax free) for the half-year ended June 30, payable Nov. 1.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Oct. 13. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Oct. 13.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9½	6 0 0	Feb, Aug
5	10%	Brompton & Kensington Ord.	8½	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	84	4 15 4	Jan, July
5	2/3	Do. 4½% Pref.	3½	6 5 0	..
5	5%	Do. Ord.	4	6 5 0	Aug, Feb
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	12½	4 17 0	Mar, Sept
St.	5%	Do. 5% Deb. St.	99½	5 0 0	Jan, Dec
10	7%	County of London Ord.	10	7 0 0	Mar, Sept
10	6%	Do. 6% Pref.	9½	6 0 10	Feb, Aug
St.	4½%	Do. 2nd Deb.	97	4 12 9	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	76½	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	8½	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4½	7 1 2	..
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	23	7 7 4	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	95½	4 14 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½†	6 0 7	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 3	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1½	5 10 4	Apl, Oct
4	5%	South London E.S. Ord	3½	6 8 0	Mar, Sept
St.	4½%	Urban Elec. Supp. 4½% Db. St.	84½	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1½	7 2 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	78½	6 . 5	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	88	6 10 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	69½	5 15 1	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 6	..
St.	4½%	Do. 4½% Pref.	100	4 10 0	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	84	4 15 3	May, Nov
St.	5%	Do. Pref. 1894	80	6 5 0	Feb, Aug
10	5½%	Lanarkshire Tramways	94½	5 17 11	Feb, Aug
10	1%	London Electric Ry. Ord.	13½	5 17 6	Jan, July
St.	4%	Do. 4% Pref.	62½	6 7 3	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23½	4 11 0	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 0	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	12½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	67	6 14 4	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	129½	4 12 3	Jan, July

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., Oct. 13	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
St.	4%	Metropolitan Dist. Ry. 4% Debs.	66½	5 14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	68½	5 16 9	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1⅜	..	..
1/0	..	Do. A Ord.	⅝	..	..
St.	6%	Do. 6% Inc. Debs.	103	5 16 6	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 16	70⅜	8 9 8	Mar, Sept
..	4½%	Do. 4½% Bds.	99½	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	⅜	..	Maren
5	6%	Do. Pref.	4⅜	6 17 2	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅞	6 6 2	Apl, Oct
1	6%	Do. 6% Pref.	1⅞	4 17 11	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	4 15 3	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 6	Jan, July
1	6%	Do. 6% Pref.	⅞	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛†	7 5 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 9 1	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1¼	6 6 8	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	73½	5 8 10	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10¼	7 6 4	Jan, July
5	2/6	Do. 5% Pref.	4½	5 17 8	Feb, Aug
1	15%	Castner Kellner	3	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅛	8 14 7	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	¼	..	Feb, Aug
1	6%	Elec. Construction Ord.	⅛	9 1 2	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10⅜	9 12 3	Jan, July
10	6%	Do. 6% Pref.	9⅞	6 9 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅛	7 18 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4¼	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7⅝	6 6 7	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	97½†	4 2 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	31⅛	7 13 7	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅝	4 12 1	May, Aug
1	6d.	Do. 5% Pref.	⅞	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	82	4 17 7	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99⅜	4 10 3	Jun, Dec
		Telegraphs.			
100	5%	Amazon Telegh. Co. 5% Debs.	95	5 5 3	Jan, July
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 6	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22⅛	6 13 0	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	66†	6 1 3	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅝	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½†	6 13 4	..
10	4%	Direct United States	5⅛	6 16 2	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	120	5 16 8	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	68¼	5 7 0	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	82	4 17 7	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11⅜	5 17 2	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	7 3 1	Ja, My, Jly
25	13%	Indo-European	47½	6 16 1	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1½	3 19 0	July
10	9d.	West India & Panama Ord.	1	10 0 0	May, Nov
10	6%	Do. 1st Pref.	8¾	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12½	5 14 3	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	100	4 10 0	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	129½†	6 3 7	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	75½	6 12 5	Jan, Jly
1	7½d.	Marconi Wireless Telephn. Ord.	⅝	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101¼	4 8 9	May, Nov
1	10%	Oriental Telephone Ord.	⅛	5 2 7	Apl, Oct
St.	4%	Do. Db. St.	80	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	⅜	7 5 10	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	9⅞†	6 1 4	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	9¾†	6 4 8	Sp,Dc,Mr,Jn
100	5%	Marconi Companies' Common	80	6 5 0	Ja, Apl, Jly,O
..	4%	Do. £10 Pref.	7⅛	5 16 9	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust	121	5 16 9	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	75½	6 12 11	Jun, Dec
St.	4½%	Do. 4½% Debs.	⅛	6 5 10	Jan, July
St.	4%	Do. 4% Debs.	75	..	Jan, July
5	2/9	Do. 5½% 1st Pref.	⅜	5 13 0	Jan, July
5	2/9	Do. 5½% 2nd Pref.	4⅛	6 1 7	Feb,Aug,N
100	..	Brazilian Traction Ord.	6⅛	6 1 7	Ja,Apl,Jly,O
100	$1½	Do. 6% Pref.	⅞	4 3	Mar
5	8%	Buenos Ayres Tramways	⅛	5 5 11	May, Nov
5	2/6	Do. 5% Cum. Pref.	⅛	..	..
St.	4½%	British Columbia 4½% Cons. Debs.	60½	..	..
5	9½%	Calcutta Elec. Trams. Ord.	⅛	5 13 1	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	⅛	..	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	5†	..	..
100	5%	Malaga Tram. 5% Debs.	69	..	Jan, July
..	..	Mexico Trams Common St.	31	..	Fb,M,Aug,N,
..	5%	Do. 5% Bds.	⅛	13 1 5	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	⅛	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Trams, Light & Power Bds.	71⅛†	..	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds.	⅛	..	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	⅛	..	Mar, Sept
St.	5%	Do. 5% Debs.	⅛	..	Jun, Dec
10	6/-	Bombay E. S. & T. Co., Pref.	10⅛	..	..
5	9%	Calcutta E. S. Corp. Ord.	⅛	..	..
5	5%	Do. 5% Pref.	⅛	..	..
..	7%	Canadian Gen. Elec. Co. Pref. St.	108	..	Ja,Apl,Jly,O
St.	5%	Mellersta Elektriska Aktiebolaget Debs.	⅛	..	Jan, July
St.	5%	Do. 5% Cons. Deb. St.	⅛	..	Apl, Oct
..	5%	Shawinigan Water & Power 5% Bds.	1⅛	..	Jan, July
..	6%	Do. Cons. Stock	14⅛†	..	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Debs. St.	⅛	..	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	⅛	..	Mar, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf.	⅛	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	⅛	..	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 13, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13d.	English Lead	£25 0 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15d.	**Old Metals:**	**per ton.**
Brass Wire	12½d	Clean Scrap Copper	£67 10 0
Copper Wire	12½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£52 10 0
Brass Sheets	13½d.	Old Lead	£19 10 0
		Old Zinc	£38 0 0
	per ton.	Hollow Pewter	£110 0 0
Copper Sheets	£98 0 0	Black Pewter	£85 0 0
Spelter	£72 0 0	Gun Metal	£61 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Oct. 12, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£85 0 0	Old Lead	£21 10 0
Clean Mixed Brass	£54 0 0	Tea Lead	£19 10 0
Clean Copper	£70 0 0	Old Zinc	£39 0 0
Brazlery Copper	£62 0 0	Hollow Pewter	£115 0 0
Gun Metal	£62 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £68; Commercial Tinman's Solder, £83; Blowpipe Solder, £98.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Oct. 6	17,295	+ 166	18	34,150	+ 1,295
Anglo-Argentine	„ 7	53,082	— 761	18	2,033,907	— 138,480
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	„ 9	284	+ 32	21	10,106	+ 494
Bath Electric Trams, Ltd	..	..	..	..	..	..
Birkenhead Corporation	„ 10	1,355	+ 145	28	38,540	+ 2,861
† Birmingham Corporation	„ 2	16,033	+ 3,411	27	368,273	+ 41,046
Blackburn Corporation	„ 6	1,135	— 44	28	37,687	— 622
Blackpool Corporation	„ 7	1,293	+ 289	28	60,434	+ 1,041
Blackpool and Fleetwood	„ 9	665	— 68	40	35,049	— 232
Bolton Corporation	„ 10	2,693	+ 211	28§	75,757	— 2,884
† Bournemouth	„ 6	1,968	+ 227	27	61,482	+ 2,787
Bradford Corporation	„ 9	6,267	+ 272	27	184,539	+ 8,046
Brighton Corporation	„ 10	1,099	+ 61	28§	33,906	— 150
Bristol Trams { Trams	„ 8	4,528	+ 84	40	188,455	+ 446
Bristol Trams { Buses, &c.	„ 8	4,568	+ 887	40	196,442	+ 34,292
Burmah E. Trams & Ltg.	„ 9	R3,889	+ R565	40	R143,047	+ R951
Burnley Corporation	„ 9	1,564	— 154	21	1,564	+ 154
Burton Corporation	„ 10	317	+ 8	28	8,213	— 347
Bury Corporation	„ 10	1,332	+ 70	28§	39,067	— 1,059
Calcutta Tramways Co.	„ 9	R69,689	+ R16,646	..	..	..
Camborne-Redruth	„ 4	139	+ 3	39	5,392	— 20
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	„ 7	542	+ 19	40	20,331	— 56
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
• Derby Corporation	„ 12	1,016	+ 67	29½	29,584	+ 881
Dover Corporation	„ 9	306	+ 43	27	9,134	+ 1,710
Dublin & Lucan Railway	„ 8	151	+ 12	14	2,412	+ 54
Dublin United	„ 8	6,077	+ 255	40	246,740	+ 9,195
Dundee Corporation	„ 6	1,449	+ 109	21	28,640	+ 1 277
East Ham Council	„ 9	1,246	+ 30	27†	36,781	+ 5,428
Exeter Corporation	„ 8	362	+ 13	27	10,971	+ 626
Glasgow Corporation	„ 9	22,359	+ 1,727	19‡	410,251	+ 30,479
Glossop Trams	„ 9	135	+ 36	41	5,145	+ 288
Gloucester Corpn.	„ 6	386	+ 55	27	9,475	+ 72
Halifax Corpn. { Trams	„ 5	2,150	+ 53	27	63,353	+ 792
Halifax Corpn. { Buses	„ 5	48	+ 1	27	1,413	+ 6
Hastings Elec. Trams Co.	„ 7	984	— 5	40	40,465	— 59
Huddersfield Corpn.	„ 2	2,822	+ 519	26	73,717	+ 11,954
Hull Corporation	„ 10	3,064	— 296	27	84,054	— 3,129
Ilford District Council	„ 9	620	+ 52	27	18,453	+ 2,761
Ilkeston Corporation	„ 6	133	+ 12	27	3,691	+ 72
Ipswich Corporation	„ 9	521	+ 108	26	16,026	+ 2,466
Isle of Thanet Co.	„ 9	341	— 146	14¶	456	— 272
Kilmarnock Corporation	„ 9	164	+ 15	21	3,684	+ 82
Lanarkshire Trams Co.	„ 7	2,101	+ 314	40	78,853	+ 2,932
Lancashire United	„ 6	1,705	+ 188	40	70,466	+ 4,151
Leeds Corporation	..	..	..	..	..	..
Leicester Corporation	„ 9	3,124	+ 185	41	122,354	+ 6,041
Leith Corporation	„ 9	765	+ 77	21	16,736	+ 911
Lincoln Corporation	„ 9	128	+ 19	28	3 979	+ 410
Liverpool Corporation	„ 2	13,492	+ 887	34¶	525,961	+ 4,607
Llandudno&Colwyn Bay R.	..	..	..	..	..	..
London County Council	..	..	..	..	..	..
Lowestoft Corporation	„ 11	133	— 44	1	176	— 90
Maidstone Corporation	„ 7	243	+ 37	26	6,355	+ 99
Manchester Corporation	„ 9	18,304	+ 1,401	27	499,480	+ 14,075
Nelson Corporation	„ 9	200	+ 56	27¶	5,540	— 88
Newcastle-on-Tyne Corpn.	„ 9	6,509	+ 806	28†	176,095	+ 25,160
Newport (Mon.) Corpn.	„ 9	814	+ 36	28	23,646	+ 28
Northampton Corporation	„ 8	675	+ 74	27¶	20,847	+ 4,217
Nottingham Corporation	„ 7	3.725	— 248	27	103,403	+ 6,516
Oldham Corporation	„ 10	2,373	+ 420	29	67.438	+ 1,705
Portsmouth Corporation	„ 2	2,372	— 75	27	71,777	..
Preston Corporation	„ 6	962	+ 89	27••	26,515	+ 353
Rhondda	..	..	..	..	..	..
Rotherham Corporation	„ 6	1.179	+ 49	27	31.531	+ 3,152
Salford Corporation	„ 11	5,302	— 503	28‡	147.305	+ 4,708
Sheffield Corporation	„ 10	9,190	+ 1,514	28‖	253,555	+ 32,278
Southampton Corpn.	„ 6	1,555	+ 298	27	41.909	+ 3,652
Southend Corporation	„ 6	723	— 123	27	25,385	— 7,242
South Shields	„ 2	790	+ 90	26¶	21,800	+ 561
St'lyb'dge, Hyde, &c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	„ 10	1,479	+ 133	28	42,243	— 518
Tees-side District	„ 6	764	— 384	49	27,927	— 1,003
Swindon Corporation	„ 6	198	+ 18	27	5,584	+ 592
Tynemouth Trams Co.	Sept. 29	619	— 90	13	8,052	— 164
Wallasey Corporation	Oct. 9	1,213	+ 94	27‖	37,491	+ 102
Walsall Corporation	„ 9	802	+ 186	41	29,402	+ 4,365
Walthamstow	„ 9	811	+ 51	28	26,682	+ 3,128
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	„ 7	3,635	+ 220	27	85,633	+ 8,501
Wigan Corporation	„ 7	1,587	+ 137	27	41,864	+ 1,346
Wolverhampton Corpn.	„ 6	1,000	— 106	1	1,000	— 106
Yorkshire W.R. Trams	„ 10	1,340	+ 76	41	65,291	+ 5,406

(a) These comparisons are with the corresponding period last year. • Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 77
Arrangements for the Week .. 80
The Effective Illumination of Streets. By Preston S. Millar. Illustrated 81
Electric Welding. By C. B. Auel. Illustrated. *Concluded* 84
Great Western Railway's Electrical Machinery 86
Electrification on the London & South-Western Railway. Illustrated. *Continued* 87
Thermal Characteristics and Intermittent Rating. Illustrated. *Concluded* 93
THE ILLUMINATION OF STREETS 96
REVIEWS 97
Wireless Telegraphy [Rolfe-Martin].
The Standard Handbook for Electrical Engineers [Fowle].
Electric Railway Handbook [Richey].
The Use of Accumulators in Alternate-Current Stations. By L. Schröder. Illustrated 98
Superimposed or "Phantom" Telephone Circuits. Illustrated 99
CORRESPONDENCE 102
The Design of Transformers (W. Tolmé Maccall).
Transformer Core Loss as Affected by Triple Harmonics (R. C. Clinker).
The "Discharge Tube" Used as a Wireless Valve. By G. W. White, M.Sc. 103
Relation Between Steam Turbine Rating and Water Rate. Illustrated 103
A Method for Measuring Earth Resistivity. By Frank Wenner 103
LEGAL INTELLIGENCE 104
The "Electrician" Commercial and Industrial Section .. 105–112

NOTES.

Intermittent Rating.

THE proper rating to be given to intermittently loaded electrical machinery and apparatus depends upon two factors—namely, the ratio of the load period to the idle period, or of the load period to the total period, and the duration of the running period. In 1900 Mr. E. OELSCHLÄGER determined experimentally a large number of curves for electrical machinery, showing the temperature rise with different loads, as well as the cooling curves of such machinery. He showed mathematically that the time constant (or the time required by the motor to attain 63 per cent. of its final temperature rise) is the critical constant in all problems on intermittent rating, and curves were constructed for various cycles of intermittency. Although there have been many workers in the field in recent years, since this research but little has been published on the subject which was not anticipated and used by OELSCHLÄGER. Although commercial considerations doubtless prevented the publication of the greater part of the work, sufficient data were given to enable the correct rating of a given motor working on a certain cycle of operations to be determined, and to show that for an intermittent test a continuous run of a certain number of minutes' duration may be substituted. If the machine does not attain the maximum temperature rise during the continuous run, neither will it attain the maximum temperature rise on the intermittent work for which it is destined. The practical importance of this method of rating was dealt with by Mr. ALEXANDER SIEMENS in the discussion on Mr. C. W. HILL's valuable Paper on "Crane Motors and Controllers," read before the the Institution of Electrical Engineers in 1906.

FROM the point of view of the student, many of the Papers on intermittent rating are unsatisfactory in so far as they assume knowledge which, as a rule, he does not possess. In this issue we conclude an article entitled "Thermal Characteristics and Intermittent Rating," in which an attempt has been made to deal with the elementary principles of the subject. While no claim of originality is made, it is thought that the article will be of distinct educative value in setting out the principles in a clear manner, and showing their practical application. Reference is made to the general theory of heating and cooling, and values are given of the time constants of various machines. The load-factor method of rating intermittent machines is described, and an account is given of the root-mean-square method of rating. In applying the latter method it must be remembered that the heat is not carried away at the same rate all the time, for at standstill, and at the reduced speeds of acceleration and retardation, the ventilation is less than at full speed, and, in consequence, during these times the cooling surface is less efficient. To allow for this it is customary to correct the root-mean-square value of the cycle of operations by such a factor as shall represent the difference between the average dissipation of heat over the cycle and the dissipation at full speed.

The Use of Accumulators on A.-C. Systems.

ACCUMULATORS have been found so very beneficial on continuous-current systems where the load is very fluctuating that it is only natural some attempt should be made to use them in a similar way on alternate-current networks. Any attempt to do so is, of course, complicated by the fact that some means of converting continuous current into alternating, and *vice versa*, must be introduced between the battery and the network. In other words, it is necessary to handle the whole of the battery power by a rotary machine instead of only a part. There is also the difficulty of providing reversal of magnetism from an alternating current source. Provided, however, that this is suitably arranged, a battery can be used for buffer purposes in a way similar to that which is well known on continuous-current traction systems. In another column we give in abstract some experiments by Mr. L. SCHRÖDER, showing what can be done in this way, and from an inspection of the records which are reproduced it will be seen that the results obtained are eminently satisfactory. Both synchronous and asynchronous motor generators were tested for the purpose, and both proved to be suitable. As to whether this method of using accumulators would be worth while in actual practice is a matter that can only be decided in each particular case. The method cannot receive such wide application as in the case of continuous-current networks, owing to the fact that it involves considerably higher capital expenditure, but it is quite possible that in cases where there are serious fluctuations the capital outlay may prove to be money well spent.

State-Aided Research.

We commend to the notice of the older engineering institutions and to the older members of those institutions the recent vigorous action of the automobile engineers. According to the "Engineer," the Technical Committee of the Society of Motor Manufacturers and Traders, in connection with the Institution of Automobile Engineers, having proposed research upon a matter of such immediate interest that the Admiralty and War Office have appointed representatives on the joint committee, the Society guaranteed that £1,000 should be forthcoming, provided the Government would contribute £1,000. As this research is calculated to benefit more or less directly a number of firms, an invitation was issued to members to guarantee a portion at least of the £1,000 in question, with the result that a sum exceeding £600 has been guaranteed, and at the time of writing the list is still open. The work of the Alloys Research Committee is probably the most important research undertaken by any of our engineering institutions. If we remember rightly, the cost was, for the most part, defrayed by the Institution of Mechanical Engineers. Probably a few of the larger firms have derived more benefit from the research than most of the members combined, and, admirable as it undoubtedly is of this Institution to bear the brunt of the expense, we think it would be better cricket if the firms deriving the benefit had to contribute a little more towards the cost. Failing this, it is the duty of the State to contribute, the more so as the record of the research is generally open to all, irrespective of nationality or of membership in a particular institution.

Steam Turbine Economy.

Aiming at very high vacuum, considerable boiler pressure and high superheat in steam turbine units is not necessarily good engineering. Although these effect an appreciable reduction in the steam consumption, it must not be forgotten that the provision of boiler and condenser equipment for securing the highest possible superheat and vacuum involve considerable capital expenditure. Unless the value of the fuel saved is greater than the interest, depreciation and maintenance charges on the plant represented by the increased expenditure, then the policy of aiming at high superheat and vacuum is an unsound one to pursue. The point is sometimes overlooked by engineers desirous of keeping their equipment up to date and of securing economical operation. In a Paper read recently before the Association of Iron and Steel Electrical Engineers of America, Mr. P. M. Lincoln referred to this, and stated that a 1,000 kw. unit would not save enough in fuel to make it pay to instal the plant necessary for securing the lowest steam consumption, while in a 30,000 kw. unit the installation of such plant would pay handsomely. The 30,000 kw. units installed during the past year in the power house of the Interborough Rapid Transit Co. of New York, under specified conditions of operation, give more economical operation than the guarantee of 11·27 lb. of water per kilowatt-hour at the bus bars.

Abnormal Voltages in Transformers.

From the first use of transformers the occurrence of abnormal voltages between adjacent turns or sections of the winding forced itself upon the attention of engineers on account of punctured insulation. It was early recognised that the instantaneous effect of a sudden application or change of voltage at the transformer terminals would be to concentrate the voltage across the end turns. To protect the winding against such concentration the practice of connecting choking coils between the transformer and the line, and of providing extra end-turn insulation was introduced. At the Panama Pacific Convention of the American Institute of Electrical Engineers, Mr. J. Murray Weed presented a Paper dealing with the electrical behaviour of transformer windings when subjected to steep wave fronts and high-frequency wave trains. In this Paper the author divides practical windings into two general classes, one in which the inductance and capacity are uniformly distributed, and the other in which the capacity is more or less concentrated at certain points, with concentrated inductance intervening. Distinct mathematical analysis is given to these two classes of winding to determine the ratios of the internal voltages to the voltage of the external wave or wave train. We believe that a careful study of Mr. Weed's examination of the facts and fundamental principles involved will enable designers to insulate for and guard against excessive internal voltages.

Electric Flying Machines.—We have received a long letter from Mr. W. P. Durtnall, in which he discusses the possibility of using electric transmission in the propulsion of flying machines. From his letter it appears that Mr. Durtnall is working on new lines, but is unwilling at present to publish any details.

A 5,000-Volt Continuous Current Railway.—The Michigan United Traction Co. has placed in service on its Jackson to Grass Lake line continuous-current motors with two 2,400-volt armatures mounted in one frame and connected in series, power being drawn from a trolly supplied by mercury-arc rectifiers.

L. & S.W. Railway.—The first portion of the newly electrified lines, from Waterloo to Wimbledon (through East Putney), will be opened for traffic on Monday next. The second portion of the electrified system (Waterloo, Barnes, Richmond, Kingston, Wimbledon, Clapham Junction, Waterloo) will be in operation in a week or so.

Electric Railway in Sweden.—The electrification of the railway from Kiruna to Riksgransen, in the extreme north of Sweden, is now complete. It will be remembered that this electrification was described in The Electrician, Vol. LXIII., p. 12. It is the first line on which the Swedish State Railways have employed hydraulically-generated energy for railway traction. The line is also noteworthy by reason of the fact that a large section of it is within the Arctic Circle, where 50 deg. of frost are often experienced in the winter. It was to deal with the transport of iron ore from the mines at the southern end of the line to the Norwegian frontier that the electrification was undertaken.

"News for Neutrals."—Writing under this heading to "The Times" of the 14th, Mr. Charles Bright, F.R.S.E., urges that the fullest possible use should be made of the Eiffel Tower Wireless Station for disseminating war reports broadcast, and as promptly as the German versions are distributed. Further, that by present arrangements no less than five Government Departments are concerned with our telegraphic communication systems, but no Board has yet been established whereby representatives of each department can meet together to discuss and settle issues concerned with this highly important subject. Mr. Bright suggests that it is time such arrangements were remodelled in view of the great necessity for counteracting the continuous stream of war news from enemy sources into neutral countries.

Largest Steam Turbine in the World.—According to the "Electrical World" the new generating station of the Philadelphia Electric Company at Christian-street, Philadelphia, now nearing completion, will contain the world's largest steam turbine. This set has a rating of 35,000 kw., and the turbine will weigh 600 tons. The generator is a 13,200-volt, 60-cycle, three-phase alternator, running at 1,200 revs. per min. There is also a 30,000-kw., 13,200-volt, three-phase, 25-cycle turbine set, which will run at 1,500 revs. per min. Separate duplicate sets of outdoor-installed high tension bus bars are arranged for each frequency, and the control of three of the turbo-generators of the adjoining plant, as well as the frequency-changer sets in the nearby sub-station, will be centralised in the new station. This will make possible the control of 69,000 kw. in 25-cycle apparatus, and 50,000 kw. in 60-cycle machines, or a total of

119,000 kw. from this station. Twenty Babcock & Wilcox boilers, each capable of evaporating 60,000 lb. of water per hour, will compose the boiler equipment of the new station.

Long-Distance Radiotelephony.—More details are now to hand regarding the remarkable achievements of the United States Navy Department in their experiments in wireless telephony. On the afternoon of Sept. 29th Mr. T. N. Vail, the president of the American Telephone & Telegraph Co., spoke from his office in New York to his chief engineer, Mr. John Carty, at Mare Island, California, which is near San Francisco and 3,000 miles away. Speech was transmitted by wire for 500 miles to Arlington, Virginia, and by radiotelephony the remaining 2,500 miles. This result is the outcome of experiments which have been carried on for the past few months by the American Telephone & Telegraph Co. and the Western Electric Co. in co-operation with Capt. Bullard, of the U.S. Navy. On the evening of the same day, wireless telephonic communication was accomplished between the naval station at Arlington, just outside Washington, to Honolulu, Hawaii, a distance of 4,600 miles, 2,500 of which are over the American continent and the remainder over the Pacific. The experiments leading up to this achievement were started in the spring, using stations at Montauk Point L.I. and Wilmington Del, 250 miles distant. Soon afterwards a 1,000-mile range was covered between the first named point and St. Simons Island, Ga., at which it was decided to make tests with stations at trans-atlantic distances.

Removing Car Bogies by their Own Power.—Writing in the "Electric Railway Journal," Mr. R. E. Hewitt, of the Southern Pacific Company Electric Lines, has described a convenient method of saving time and labour when it is required to remove a bogie from beneath a car for repairs. The shop crane has fitted to it in front of the cage a reel, from which can be paid out a four-conductor cable, the free end of which is taken to the motor on the bogie, and the conductors connected to the armature and field. The other ends of the conductors are connected by slip-rings on the reel to a throw-over switch, by which current is fed to them instead of to the crane motor. The crane controller can thus be used to bring out the bogie under its own power. In the equipment described the crane operated at 220 volts, and was therefore well-fitted for this arrangement.

Inauguration of New Plant at Stepney.—On Thursday, 14th inst., the installation of new plant at the Limehouse power station of the Stepney Borough Council was inaugurated by the starting up of one of the new 5,000 kw. turbo-generators by the Mayor, Mr. H. T. A. Chidgey, J.P. The additions to the plant consist of two of these sets, each running at 1,500 revs. per min. and generating three-phase current at 6,600 volts and 50 cycles, together with the necessary boilers and auxiliaries. The extensions to the building, however, are sufficient for a third set of the same capacity. The turbines of the new sets are of the "Zoelly" impulse type, and were made by Messrs. Escher, Wyss & Co., as were also the pumps and condensers, while the generators were constructed by Messrs. Brown, Boveri & Co. Heenan & Froude revolving air filters are used for the ventilating air. Ald. J. D. Kiley, J.P., chairman of the Electricity Supply Committee, presided at the ceremony, and spoke of the early days of the undertaking, when the only station was that at Osborn-street. The Limehouse station was opened in 1909, and in 1912 it was decided to make the additions, which would have been complete in 1914 had it not been for the war. Several munition works are being supplied by the station, and Mr. Kiley mentioned the fact that energy is being sold at less than 1d. per unit to manufacturers, and less than 2d. per unit for lighting. Councillor A. J. H. Prevost proposed a vote of thanks to the Mayor for the part he had taken in the ceremony, and Councillor H. H. Gordon, J.P. (L.C.C.), in seconding, paid a tribute to the borough engineer, Mr. W. C. P. Tapper and his staff, and also mentioned the fact that Stepney now had the largest municipal plant in London. On the motion of Councillor Barge (the chairman of the Poplar Electricity Committee), a vote of thanks was also accorded to Ald. Kiley. This was seconded by Ald. W. J. Barker.

OBITUARY.

Col. T. E. Vickers.—We regret to record the death of Col. T. E. Vickers, C.B., which took place in London on Tuesday last. He was born in 1833, and after his education at the Sheffield Collegiate School and Neuwied, Germany, he entered his father's business. At 21 years of age he had succeeded to the practical manufacturing control of the establishment. Shortly afterwards he introduced into this country the process for the manufacture of steel castings, bells, rings for railway rolling stock tyres and other productions. Later he invented his double rolling mill for rolling railway tyres from punched blooms, which proved a prolonged success. He was among the pioneers in the early 'seventies of the open-hearth process of smelting steel, and in this also he achieved a great success. The River Don Works, Sheffield, were inaugurated in 1866 in order to meet the increased demands upon the firm for their manufactures. Developments followed each other in rapid succession in connection with heavy forgings, gun making, armour manufacture, shipbuilding, electrical engineering, &c., and long before Col. Vickers's retirement in 1909 the firm had become one of the most renowned in the world. Col. Vickers was awarded the Howard quinquennial prize by the Institution of Civil Engineers "in recognition of the part taken during his career in developing and improving the production of steel for important engineering purposes." He was among the first to join the Volunteer movement and rose to be colonel of the Hallamshire Rifles. He retired at the age limit and became honorary colonel. In 1898 he was made a C.B. for his military services. In 1860 he married Frances Mary, only daughter of Dr. John Douglas, by whom he had two sons and four daughters.

Col. P. E. Huber-Werdmüller.—We regret to learn of the death, at the age of 78, of Colonel P. E. Huber-Werdmüller, of Zurich, for many years head of the Machinenfabrik Oerlikon.

Mr. Huber-Werdmüller was born in Zurich on Dec. 24, 1836. After a few years spent at City secondary schools of Zurich and at Neuchatel and Devrient Colleges, he entered the mechanical-technical section of the Federal Technical High School of Zurich in 1855, when this school was founded. He obtained his diploma as engineer in 1858, and started in his profession by obtaining practical experience during 1859-1861 at Messrs. Sulzer's works at Winterthur. He afterwards travelled, mainly in France, England and Belgium, for the purpose of studying foreign manufacturing methods and principles.

In 1863 he founded the firm of P. E. Huber & Cie., in Oerlikon, which existed until 1868. In 1878, after occupying posts of communal importance, he founded the Tool and Machine Works, Oerlikon (the present Maschinenfabrik Oerlikon), which he governed until 1911 as chairman, and he remained on the council of the company to the last. From Sept., 1878, to Dec., 1894, he was managing director, chiefly manufacturing tools and flour mill equipments, but from 1885 onwards the company engaged in the construction of electrical machines. Of the works and installations carried out by the Maschinenfabrik Oerlikon many were due to the enterprise and personal energy of Mr. Huber-Werdmüller. He was one of those mainly responsible for the first electric power transmission scheme of note, from Lauffen to Frankfort-on-Main, during the period of the electricity exhibition in that city in 1891.

Mr. Huber-Werdmüller was mainly instrumental in founding the Aluminium Company of Neuhausen and its sister works in 1888, and he remained from the first chairman of the company. He was one of the leaders of the Swiss National Exhibition of 1883, which date originated the Swiss Machines Industrielles, whose steps he guided as chairman. His intimacy with questions of transport and transit, customs and mercantile conventions, &c., were invaluable to his colleagues in all the undertakings with which he was associated.

We have only been able to briefly and inadequately mention a small number of the activities which Mr. Huber-Werdmüller's busy commercial and social career included. The Oerlikon Company and Switzerland have to mourn the loss of a notable administrator and citizen.

Killed in Action.—We regret to record the death of Lieut. Richard Newman Somerville, R.E., who was killed in France on Oct. 9th. He had graduated in arts and engineering at Trinity College, Dublin, and was a member of the University Officers' Training Corps before the war.

Lieut. John Gordon Hollingsworth, 10th Middlesex Regiment, was killed in a charge at the Dardanelles on Aug. 12th. He had been connected with the Territorial Force for a number of years, and on the outbreak of war he joined the 2/10th Middlesex Regiment. With the Mediterranean Expeditionary Force he took part in the landing at Suvla Bay, and in subsequent operations. Lieut. Hollingsworth was educated at University College, London, and was articled to Messrs. Plenty & Son (Ltd.), Newbury. Later he was in the works of Henry Bessemer & Co., and subsequently in those of Bechem & Keetman, Duisburg. Eventually he joined the staff of "Engineering."

Second Lieut. L. E. Schultz, of the 2nd Wiltshire Regiment, has been killed in action in France. He was educated in the Ipswich Middle School, and entering commercial life became secretary of George Schultz & Co. (Ltd.). He fell after the capture of an enemy trench, coming out to rescue wounded and to rally his men.

Captain George Crellin Cartwright, Royal Warwickshire Regiment, was killed whilst rallying a company in "The Great Advance." He was born in March, 1882, and graduated from the Central Technical College of the City and Guilds of London Institute. He served in the Boer War, and afterwards went to America where he worked for the General Electric Co. After completing the course in the shops, he took a position in the Foreign Department and was sent to Japan, and to Rio de Janeiro in Brazil. He returned to London in 1911 and was associated with the F. S. Pearson Engineering Corporation. In November, 1914, he was gazetted to a second lieutenancy and was promoted to lieutenant in April, 1915, and to Captain in July last. Shortly before his death he was attached to the staff of the 22nd Infantry Brigade as a machine-gun officer.

PERSONAL.

Dr. Michael I. Pupin, the inventor of the loading-coil for long-distance telephone lines, has been granted a year's absence from his post of Professor of Electromechanics in Columbia University, New York City, and will devote his time to the interests of his native country, Serbia, his work, however, not necessitating his return to that land.

The many friends of Mr. A. V. Gifkins, electrical engineer, of Westminster, and Bankipore, India, and late of Elstow Works, Bedford, will regret to hear that he was very severely injured in the recent raid. He is now in hospital in London, and is making slow but satisfactory progress. Needless to say, he will welcome any letters from old friends. They can be addressed to him at his office.

Mr. Alfred Perkins, district manager of the P.O. telephones at Bristol, has been presented by the local staff with some plate and other gifts on his retirement from the service under the age limit.

Mr. G. Wilson, assistant electrical engineer at Swinton and Pendlebury, has been authorised by the Council to join H.M. Forces.

Royal Engineers (T.F.)—The following appointments have been made:—

Tyne Electrical Engineers: Private J. A. Power (from London Regiment), W. G. Edwards and C. Russell to be second lieutenants.

APPOINTMENTS VACANT AND FILLED.

An assistant locomotive superintendent, with knowledge of electric train lighting, &c., is required by the Government of Hong Kong for the Kowloon Canton Railway. Salary £300. Applications to Sir John Wolfe Barry, Lyster & Partners, 2, Queen Anne's Gate, London, S.W.

Messrs. James Calder & Co. (Ltd.), distillers, Bo'ness, advertise for an electrician.

An engineer, with electrical and mechanical training, workshop experience, knowledge of wiring, motors, &c., is required for the Imperial Bacteriological Laboratory, Muktesar, India. Initial salary R.350 to R.400 per month, rising to R.500. Applications to Director-General of Stores, India Office, Whitehall, London, S.W., by Nov. 1.

Erith Council have appointed Mr. L. A. Sommersell mains superintendent in succession to Mr. Fowles resigned. Mr. H. A. Munday becomes chief clerk in succession to Mr. W. E. Deighton.

Mr. Stanley B. Jackson, electrical engineer, Wodonga, Victoria, has been appointed electrical engineer at the Pioneer tin mine, Bradshaw's Creek, Tasmania.

Mr. A. M. Fraser, electrical engineer, Sunbury, has been appointed electrical draughtsman and engineering assistant in the electrical engineers' branch of the Home Affairs Department, Melbourne.

Mr. J. S. Just, of the Sydney City Council's electrical engineers' staff, has accepted a position with the City Electric Light Co., Brisbane.

INSTITUTIONS AND SOCIETIES.

Birmingham Section of the Institution of Electrical Engineers.—At a recent committee meeting it was decided that it would not be possible under the existing circumstances to hold the usual number of meetings during the forthcoming Session, but it was agreed to hold one meeting in each month at least for the first half of the Session. It has not been possible to complete the programme for the first half of the Session, but certain provisional arrangements have been made. Col. J. F. Lister will deliver his Chairman's Address at the opening meeting to be held on Wednesday, the 27th inst. On Nov. 24 Prof. A. B. Field will read a Paper on "Difficulties of Design of High-speed Generators"; and on Dec. 15, Mr. J. D. Morgan will read a Paper on "The Ignition of Explosive Gas Mixtures by Electric Sparks."

Metropolitan Association of Electric Tramways Managers.—A meeting of the members was held on the 15th inst. at the Municipal and County Club, Whitehall, S.W., when the following were present: Messrs. Ullman (East Ham) (chairman), Schofield (Leyton) (vice-chairman), Moffet (West Ham), Mackinnon (London United), Hammond (Metropolitan Electric), Mason (South Metropolitan), and Goodyer (Croydon) (hon. secretary). Letters of inability to attend were received from Messrs. Fell (L.C.C.), Bruce (L.C.C.), Murray (Walthamstow) and Stokes (Bexley). Messrs. Ullman and Schofield were re-elected chairman and vice-chairman respectively, and Mr. Goodyer was re-elected hon. secretary. Various matters of interest were discussed.

Greenock Electrical Society.—The new session was opened on Friday last, when Mr. Frank H. Whysall read a Paper on "The Construction of Storage Batteries," in which he emphasised the conclusions he stated in his recent Paper to the Institution of Electrical Engineers, viz., that the use of storage batteries is a matter of increasing importance; that in connection with central station supplies a buffer-battery with a one-hour rating equal to the largest generating unit will effect an enormous saving; and that a peak load battery gives a considerable economy in capital and running charges. Mr. Whysall then described the construction of storage cells, and mentioned the improvements in design which had enabled makers to produce a battery of much smaller weight than was formerly possible. The small capacity plate with heavy weight had a longer life than the light plate with large capacity. Purity of materials was also an important consideration. The various methods of forming were described, and the merits of glass and wooden boxes dealt with. A description of the new Edison accumulator was also given.

British Association.—As a result of the recent discussion on fuel and smoke prevention at Manchester the Association has invited the following gentlemen to serve on a committee to consider and report upon this question from a national point of view: Prof. William A. Bone, F.R.S. (chairman); Mr. E. D. Simon, chairman of the Manchester Air Pollution Committee (secretary); Profs. P. P. Bedson, J. W. Cobb, J. B. Cohen, F.R.S., H. B. Dixon, F.R.S., Thomas Gray, H. S. Hele-Shaw, F.R.S., L. T. O'Shea, W. P. Wynne, F.R.S., and Richard Threlfall, F.R.S., together with Dr. G. T. Beilby, F.R.S., Mr. Ernest Bury and Dr. J. E. Stead, F.R.S. The committee, which is empowered to add if necessary to its members, has been selected so as to include representative chemists, engineers and technologists from all the principal industrial areas.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 22nd (to-day).

Junior Institution of Engineers.

8 p.m. Meeting at 39, Victoria-street. Paper on "Safety Precautions for Transmission Machinery," by Mr. W. V. H. Capps.

SATURDAY, Oct 23rd.

Birmingham and District Electrical Club.

6 p.m. Complimentary Dinner to the President at the Station Hotel, New-street, Birmingham. Presidential Address by Mr. W. G. L. Riddle.

MONDAY, Oct. 25th.

Western Section of the Institution of Electrical Engineers.

6.30 p.m. Meeting at Merchant Venturers' Technical College, Bristol. Chairman's Address, by Mr. D. C. Rogers.

WEDNESDAY, Oct. 27th.

Birmingham Section of the Institution of Electrical Engineers.

7 p.m. Meeting at University, Edmund-street, Birmingham. Chairman's Address by Col. J. F. Lister.

FRIDAY, Oct. 29th.

North East Coast Institution of Engineers and Shipbuilders.

Annual General Meeting at Bolbec Hall, Newcastle-upon-Tyne.

Junior Institution of Engineers.

8 p.m. Meeting at 39, Victoria-street. Paper on "Electric Clocks," by Mr. W. B. Prince.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing October 24, 1915:

Drills, 6.15 to 7.15; 7.15 to 8.15 p.m.

Monday, Oct. 25.—Section 1, technical; Section 3, squad or working party.

Tuesday, Oct. 26.—Section 2, technical; Section 4, shooting.

Thursday, Oct. 28.—Section 3, technical; Section 1, shooting.

Friday, Oct. 29.—Section 4, technical; Section 2, squad or working party.

Sections for technical drill will fall in at the Head quarters of London Electrical Engineers (T.F.), 46, Regency-street, S.W.

Sections for squad, signalling and working parties will fall in at the new Headquarters, Chester House, Eccleston place, S.W.

THE EFFECTIVE ILLUMINATION OF STREETS.*

BY PRESTON S. MILLAR.

Summary.—This Paper emphasises three considerations which are sometimes neglected in street lighting discussions—namely, the silhouette effect, specular reflection from street pavements and glare. The remainder of the Paper is given over to a presentation of the variables upon which the effectiveness of street illumination depends, and upon the influence which each feature of the installation exercises through these several variables.

Recent improvement in street lighting is due to (1) larger municipal appropriations; (2) more efficient lamps and accessories; (3) greater skill in application.

For the purpose of discussing the subject the following classification of streets is adopted :—

Class.	Description.
1*a*	Metropolitan thoroughfares of greatest distinction.
1*b*	Important city streets largely travelled at night.
2*a*	Business streets not largely traversed at night.
2*b*	City residential streets.
3*a*	Suburban residential streets.
3*b*	Suburban thoroughfares.

Class 1*a* is distinguished by a requirement for dignified, pleasing fixtures and for lamps and illumination which should be of fairly high intensity, lighting building fronts as well as street. Streets of the 1*b* class are likely to be characterised by much show-window and sign lighting which augments the street illumination during the hours of greatest traffic. Here intensities are likely to be highest. In streets of the 2*a* class a moderate intensity of illumination which lights building fronts as well as street is customary. Policing purposes and good seeing conditions for the occasional pedestrian are the principal desiderata. In streets of the 2*b* class it is usually desirable to keep the light upon the street surface, avoiding brilliant illumination of the upper stories of residence fronts and providing fairly good lighting for the low density vehicular and pedestrian traffic. In streets of the 3*a* class it is likewise desirable to keep the light upon the street, illuminating the side walks well to serve the purposes of pedestrians. In streets of the 3*b* class, which are the important automobile highways connecting populous centres, the principal requirement is that of the automobile driver. Here the most difficult problems of street illumination are encountered.

Considerations of first importance appear to fall within the comprehensive classification presented by the National Electric Light Association Street Lighting Committee in 1914, which is as follows :—

1. Discernment of large objects in the street and on the side walks.
2. Discernment of surface irregularities in the street and on the side walks.
3. Good general appearance of the lighted street.

It is possible to install at a low cost a system which will reveal large objects (purpose No. 1) while failing to serve the two other purposes. With increased appropriations, or more efficient illuminants, large objects may be revealed to better advantage, and surface irregularities (purpose No. 2) may also be revealed, although the third object may not be served. With still larger appropriations and still more efficient illuminants discernment may be improved and a pleasing appearance for the street (purpose No. 3) by day as well as by night may be had.

Processes of Seeing.

In streets at night objects are seen by reason of contour, relief, shadow or colour. We perceive the contour of objects when they are markedly different in brightness from their background. Since most large objects on the street at night are darker than their background, we perceive them usually as silhouettes. Contrasts in relief are perceived when the exposed surface of an adequately illuminated object presents areas of different reflecting powers or elements which are more or less favourably inclined with respect to incident light, or elements which lie in the shadow of other elements of the surface.

Photographs are reproduced in the original Paper showing test targets located successively in six representative positions between lamps in a street. The targets are substantially the same colour as the street surface, and it appears that those which are most clearly revealed receive the least light and are silhouetted against their background. Those least distinctly revealed receive on the observed surfaces about the same light as their background. Contrast perception is the ruling visual process with which street illuminations is concerned. To increase contrasts on surfaces to be seen is to better conditions for vision.

* Abstract of a paper read before the American Institute of Electrical Engineers.

Some Considerations which are Often Ignored.

In much of the literature of street illumination, curves of illumination intensity form the principal basis of judgment as to effectiveness. There is a tendency to over-emphasise the importance of horizontal light to the prejudice of other important considerations. Three of the principal considerations which are not emphasised directly by study of illumination intensity curves are presented in the following paragraphs.

Silhouette Effect.—When the writer directed attention to the silhouette effect in 1910* there existed but little appreciation of its importance. During the five years which have intervened there has gradually developed a greater appreciation of the extent to which it enters into conditions of visibility in street illumination. Yet its very general applicability, even now, is unrecognised by some engineers. There is an impression that only in lighting of very low intensity is it the prevailing method of discernment. As a matter of fact, the silhouette effect is pronounced whenever there are bright street or building backgrounds. A photographic under-exposure

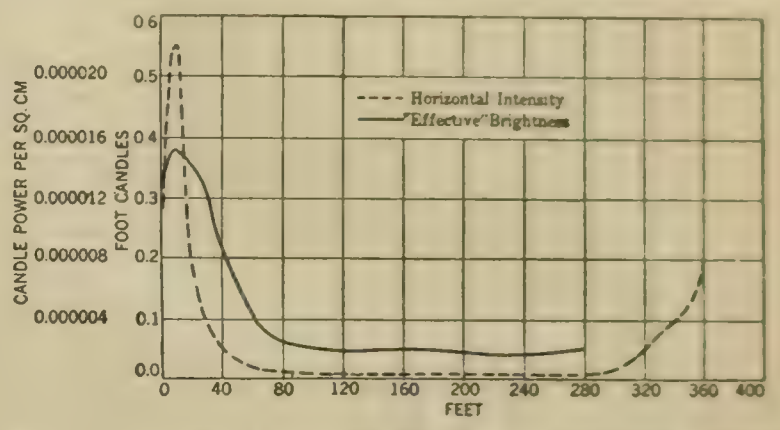


Fig. 1.—Curves of Brightness and Illumination Intensity.

of any street in the daytime shows objects as silhouettes. The casual glance of an automobile driver corresponds roughly with such an under-exposure. The majority of observations of large objects on the streets in our more intensely lighted thoroughfares, especially in the practice of automobile drivers, falls under this heading, because a driver is concerned primarily with avoiding obstacles, and usually looks carefully enough only to detect the presence of pedestrians and other objects. Usually he sees these as dark objects silhouetted against the lighter street surface or building surfaces. The pedestrian, too, obtains distant views of large objects as silhouettes, but as he moves more slowly and approaches objects more closely he has opportunity for closer observation, and in the more brightly lighted streets supplements discernment by silhouette with actual observation of surfaces in relief.

Nature of Street Pavement.—Modern streets which require the greatest care in lighting are traversed by automobiles. The majority of them are paved with asphalt, asphalt block, wooden block, treated

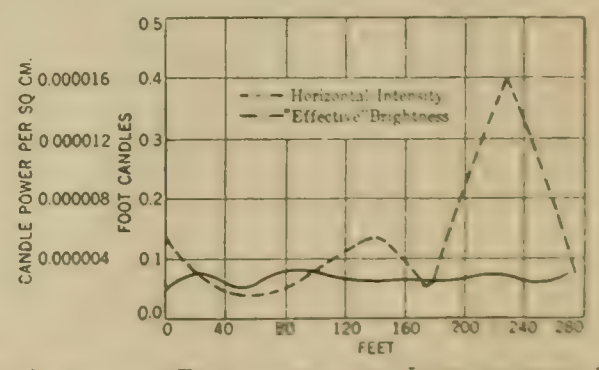


Fig. 2.—Curves of Brightness and Illumination Intensity.

macadam, &c. As a result of automobile traffic such pavements become oiled and polished. The high spots of the pavement then reflect specularly.

Fig. 1 shows measurements of horizontal illumination intensity and of brightness at the angle of an automobilist's view. The broken line shows horizontal foot-candles as measured on East 80th-street, New York City. This has an ordinary asphalt pavement, and is illuminated by multiple enclosed arc lamps 365 ft. apart. The continuous line shows brightness values. It will be noted that whereas the foot-candles vary in the ratio of 46 to 1, the brightness varies in the ratio of 8 to 1. This is a street in which automobile traffic forms but a small part of the total traffic.

Fig. 2 shows corresponding data for upper Seventh-avenue, New York City, which is a street largely traversed by automobiles. The

* "An Unrecognised Aspect of Street Illumination." Millar, "Transactions" I.E.S., 1910, p. 546.

street is paved with block asphalt; the horizontal foot-candles vary in the ratio of 10 to 1. The effective brightness varies in the ratio of 2 to 1. The impression of uniformity which one derives from a trip through the street is expressed by this brightness ratio rather than by the foot-candles ratio. On this street, which is of the boulevard, central parkway type, there are three lines of lamps. The linear spacing of the lamps is about 125 ft. As the street is fairly level, a great number of these lamps is within view at a given time. The street surface consists largely of small polished areas which reflect specularly. In driving through the street one sees reflected in these small polished areas imperfect images or part images of distant lamps. Notwithstanding the rather wide spacing and marked non-uniformity of illumination intensity, the effect is one of remarkable uniformity of lighting. In driving one looks at the street surface 200 ft. or more away, and the surface which he sees is rendered bright by lamps which may be one-quarter, one-half or even one mile away. Consequently, the surface between lamps viewed from this angle is almost, if not quite, as bright as is the surface near or directly under the lamps.

Any street which is largely traversed by automobiles, and which has pavement of the types named above, is likely to appear rather dark, because of the oil which is deposited upon it from automobiles. It is, however, a most favourable surface for street lighting pruposes, because of its tendency to reflect specularly. It was found that Seventh-avenue, New York City, described above, has three to four times the effective brightness per lumen of incident light as another prominent thoroughfare which is paved with Belgian block.

Recognition of the fact that modern streets are likely to be characterised by more or less of this specular quality necessitates important alterations in some of the theories regarding street lighting which have prevailed in the past and which are held at the present time by some engineers.

Relation between Lamps and Street Surfaces.—The effect of glare in street illumination is dependent primarily upon (1) the extremes of contrast within view—that is, contrast in brightness between the light source and the illuminated surfaces; (2) the visual angle separating the glaring source from the observed surfaces; (3) the portion of the field of view which is illuminated.

Glare militates against good street illumination, first in decreasing ability to see, and second in rendering unpleasant the appearance of the installation and the street. Anything which reduces the contrast between the light source and the road surface, or which increases the illuminated area within view, or which separates the bright light source from the road surface, reduces the effect of glare.

Sweet, in 1910,* studied that part of the effect of glare, which is a measurable reduction in the ability to see, using a single light source in a dark room. He found under these exaggerated conditions that a large reduction in visual power could be traced to the presence of a bright light source close to the centre of the field of vision. In 1914,† working with others on the campus of the University of Wisconsin, he pursued his researches, and has given preliminary publication to some very interesting results. In this latter research he employed from two to four lamps mounted at various heights and with various spacing intervals over a dirt road about 350 ft. long. It is not proposed at this time to enter into a discussion of these tests, but it may be noted that the only conclusions which they can indicate are those which would apply to a short stretch of dirt road. The modifications introduced by street pavements of better reflecting qualities, by building along the street, and by a greater length of illuminated street, have no part in this research. This is a serious limitation, because the effect of glare in street lighting is very largely reduced by each of these three factors. The two researches make available valuable information which has its bearing upon street lighting principles. If, however, the data are considered without due regard to the limitations under which the tests were made, there is danger of forming an exaggerated idea of the importance of adopting measures which will reduce the effect of glare by decreasing the brightness of light sources to low values. Since the problem is really one of reducing contrast between the light source and the illuminated surfaces, the more constructive way of accomplishing the desired end is to increase the brightness of the illuminated surfaces rather than to dim the light sources unduly. Excessive brightness of light sources must, of course, be reduced. It is common experience that a simple diffusing globe accomplishes this reasonably well under most conditions. Too great reduction in the brightness of the light source is unsatisfactory psychologically. We like a bright light source—we are dissatisfied with illumination in which a bright light source is not visible. Therefore the thing to do is to eliminate glare by increasing the brightness of the street surface, and where desirable that of surroundings, and by reducing the brightness of the light sources moderately throughout the angles at which they are viewed.

With these considerations concerning the importance of the silhouette effect, specular reflection from pavements and glare well in mind, we may proceed to a discussion of the variables of street illumination and of the several factors which the engineer must study in planning a street lighting installation.

Illumination Variables.

The effectiveness of street illumination depends upon the following:—

Intensity of Light upon the Street.—There is no single measure of intensity which serves all purposes. The average horizontal intensity upon the street surface is most nearly satisfactory.

Brightness of Street Surface.—Adopting automobilist's view-point as to angle and direction.

Relation between Lamps and Street Surface.—Visual angle between the two, and extremes of contrast encountered.

Contrasts Produced on the Street Surface and on Objects on the Street.—This is largely a function of the direction of the light.

Portion of Total Field of View Illuminated.—This may be affected either by the number of lighted lamps within view or by the area of surface which is illuminated.

Appearance of Installation and of Street by Day and by Night.—Lamps, fixtures, light distribution, &c.

Installation Factors.

Each of the foregoing variables upon which street lighting effectiveness depends is affected by four or more principal installation factors. Consider, for example, street surface brightness as a variable in street illumination. This depends upon the power of the lighting units, the number of lighting units per mile, the kind of lighting accessories employed, the location of lighting units, the nature of the street pavement and the nature of the surroundings. Alteration in any one of these conditions may influence the brightness of the street and therefore the effectiveness of the street illumination. An engineer who considers any one installation condition must appreciate that his decision may be far-reaching in its influence upon the effectiveness of the lighting, since every installation factor influences a number of these variables. In attempting to discuss these several elements of the problem it is necessary to generalise.

Size of Lighting Units and Spacing Intervals.

Power of Lighting Unit.—There is now a general tendency toward the adoption of more powerful lamps of one of the three types listed in the Table. These data are available through the courtesy of the Lamp Committee of the Association of Edison Illuminating Companies; in large measure they are authoritative for lamps of the period stated and equipped as indicated. Of the above illuminants the flame arc lamp and the multiple Mazda C lamp depreciate in candle-power 20 to 25 per cent. throughout life. The magnetite lamp and the series Mazda C lamps do not change materially throughout life.

Large versus Small Illuminants.—The cluster of lamps employed so largely in "ornamental or white way" lighting during the past five years has yielded favour in most recent installations to the single illuminant or less frequently to twin illuminants on one post.

The effectiveness of the light, other things being equal, is dependent upon the choice as between many small lighting units and few large lighting units. In favour of the small illuminants it is urged that greater uniformity results from their use; that they may be mounted lower, thus avoiding shadows from trees, &c.; and it is added that when small illuminants are mounted low, a larger percentage of their total flux is distributed over the street surface. On the other hand, it is argued in favour of large illuminants that they are relatively less costly per mile, and that usually the appearance of a street lighted by them is more pleasing.

There are two considerations not usually urged in this connection. The first is discussed in more detail under the subject of location of lighting units. Large illuminants are favoured from this viewpoint because they may be placed well out over the middle of the street, where the specular reflection from street surfaces allows the light to be applied in a more favourable direction than that from small illuminants which usually are mounted low over the curb. An example of ineffective use of small illuminants will occur to all who can visualise a wide, wet street with lamps over both curbs. The lighting of the street surface consists of a few bright streaks near the curbs, while the middle of the street is dark. As modern street pavements are extended, and automobile traffic increases, the advantages of mounting lamps well over the centre of the street tend to

* "An Analysis of Illumination Requirements in Street Lighting." Journal of Franklin Institute, 1910.

† "Electrical Review and Western Electrician," March 6, 1915.

Light Producing Efficiencies of Modern Street Illuminants. Association of Edison Illuminating Companies Lamp Committee Data on Street Illuminants.
(Arc Lamps Summer 1914—Mazda Lamps Winter 1914.)

Type.	Description of lamp and equipment.	Mean initial values. Bare. Total lumens*†	Bare. Terminal watts.	Bare. Lumens per watt.	Equip'd for street lgtg. ser. Total lumens*†	Equip'd for street lgtg. ser. Terminal watts.	Equip'd for street lgtg. ser. Lumens per watt.	Equip'd for street lgtg. ser. Power factor.	Approx. life.	Manufacturer's statement.
Average throughout life. Bare. Terminal watts.*†										
Flame arc...	G.E. 75/10 amp. a.-c. compensator, clear globes, white flame electrode	..	..	..	9,638	520	18·5	..	130 hr. per trim	G.E.C. appr. assignments of values; reports latest lamp with compensator consumes 500 w.; furnishes following data for new lamp of latest type without compens.; total lumens 11,190, watts 465, lumens pr. w. 24
(Various makes of carbon)	Westinghouse " "	..	..	..	8,557	480	17·8	..	80 "	Westinghouse Electric & Mfg. Co. reports for 1915 lamp electrode life of 130 hrs. and, without compens., higher efficiency as follows: lumens initial 9,676; throughout life (av.) 8,042; terminal watts, initial 445, av. throughout life 442; lumens per w. initial, 21·7, throughout life 8·2.
Magnetite and Metallic Flame (Stand. type—not the inverted "ornamental" type)	G.E. Magnetite 4 amp., stand. electrode, [clear globe	..	..	..	2,991	310	9·65	..	Data insufficient to permit assignment.	National Carbon Co. reports for flame arc lamp as a type, 16·9 lumens per watt throughout life, lamp equipped with light diffusing glassware.
	" 4 amp. high eff. electrode, clr. globe	..	..	..	4,649	323	14·4	..		G.E.C. appr. assignment of values. States electrode lives are for two
	" 5 " stand. electrode, clr. globe	..	..	..	5,768	390	14·8	..		[sizes resp. 230 & 350 hr.
	" 5 " high eff. electrode, clr. globe	..	..	..	7,655	371	20·6	..		Ditto, life is 180 hours.
	" 6·6 " stand. electrode, clr. globe	..	..	..	8,708	511	17·0	..		Ditto, lives are for two sizes respectively, 150 and 225 hours.
	" 6·6 " high eff. electrode, clr. globe	..	..	..	11,774	509	23·1	..		Ditto, lives are for two sizes respectively, 125 and 150 hours.
	Westg. Metallic fl. 4 amp., stand. elec. clr. globe	..	..	..	3,330	299	11·1	..	317 hr. per trim.	Ditto, life is 110 hours.
	Ditto, 4 amp. high eff. electrode clr. globe	..	..	..	4,100	306	13·4	..		Ditto, life is 75 hours.
Mazda C.....	100 watt multiple	1,176	100	11·7	Usual fixtures and containers absorb from 7 to 35 per cent. of the light given by the lamp					[type.
	300 "	3,767	300	12·5						Ditto states slightly higher c.p. and eff. obtained in inv. "ornamental"
	500 "	7,225	500	14·4						Westinghouse Elec. & Mfg. Co. approves assignment of values and
	1,000 "	16,335	1,000	16·3						claims 250 to 275 hours life.
	60 cp. 6·6 amp. series	574	44·4	12·9						Ditto, ditto.
	100 " 6·6 "	1,005	73	13·8						
	250 " 6·6 "	2,513	183	13·8						
	400 " 6·6 "	4,021	300	13·4						
	600 " 20 amp. series compensator..	6,031	321‡	18·8‡						
	1,000 " 20 " ..	10,053	504‡	19·9‡						

Initial lumens per watt. Approx. values for the summer 1915.	Approx. average life under correct operating conditions.
13·1	1,000 hours.
15·3	1,000 "
15·3	1,000 "
17·7	1,000 "
12·6	1,000 "
13·8	1,000 "
16·5	1,000 "
16·7	1,000 "
19·9‡	1,000 "
20·6‡	1,000 "

Mean initial values. Bare. Total lumens	Bare. Terminal watts.	Equip'd for street lgtg. Total lumens*†	Equip'd for street lgtg. Terminal watts.	Equip'd for street lgtg. Lumens per watt.	Average throughout life. Bare. Terminal watts.*†	Bare. Lumens per watt.	Equip'd for street lgtg. ser. Power factor.
1,176	100	2,991	310	9·65	98	10·8	..
3,767	300	4,649	323	14·4	294	11·5	..
7,225	500	5,768	390	14·8	490	13·3	..
16,335	1,000	7,655	371	20·6	980	15·0	..
574	44·4	8,708	511	17·0	45·3	12·7	..
1,005	73	11,774	509	23·1	74·5	13·1	..
2,513	183	3,330	299	11·1	187	13·2	..
4,021	300	4,100	306	13·4	306	12·9	..
6,031	321‡				331‡	16·8‡	..
10,053	504‡				520‡	17·4‡	..

No material change in c.p. throughout trim has been observed.

* Total lumens = s.c.p. × 4π. 1 lumen (L) = 0·08 s.c.p., approx. † Variations in average candle-power have been encountered ranging up to 20 per cent. of these values. ‡ Including compensator.

increase, and the disadvantages of small illuminants mounted low over the curbs tend to become more apparent.

The second consideration was brought out prominently last year by the Street Lighting Committees of the National Electric Light Association and the Association of Edison Illuminating Companies. It was shown that within reasonable limits, uni-directional light is to be preferred to multi-directional light because it enhances contrasts upon which discernment is dependent. Objects and surface irregularities are seen more surely by uni-directional light than by light coming from a number of directions. From this it follows that, other things being equal, the revealing power of a few large illuminants is greater than that of many small illuminants, especially if the latter are staggered along both curbs.

While these considerations do not clearly indicate the desirability of large units, they do add weight to the arguments in their favour.

Lighting Accessories.

Improved Distribution.—The most desirable distribution of light depends largely on the nature of the street surface and on the character of the street. Hence there is no such thing as a correct distribution characteristic for all street lighting. The prismatic refractor is successful in providing a distribution characteristic which for a vertical plane conforms to the theoretical requirements as laid down by some engineers. In other forms it will doubtless provide different distributions as required. It is an admirable device so far as redirection of light is concerned. However, it is objectionable in some forms because of excessive brightness, due to its small size. Also when combined with the casings with which it is usually employed, its appearance is not attractive. Probably in the evolution of this useful device these objections will be overcome.

The same considerations which underlie the design of the refractor, namely, the desire to increase the intensities on street surface at a distance from the lamps, would appear to favour the adoption of assymetrical horizontal distributions whereby light which normally is delivered upon surfaces lying along the sides of the street, is directed upon the street surface. Lighting accessories to accomplish this purpose have been devised, but thus far have not received the extensize trial which their theoretical advantages would appear to warrant.

Diffusing Globes.—The employment of diffusing globes to decrease brightness of light sources in the street has become more general in recent years. Perhaps the extreme example in the way of increased sizes of such globes is found in the Washington, D.C. installation of ornamental magnetite lamps, in which 28 in. built up alabaster globes of rather high density are employed. As compared with the use of a clear globe or of a lamp with no globe, a diffusing globe of fairly large size is usually desirable because it improves the appearance of the lighting unit, renders the appearance of the street more pleasing, and promotes good conditions of visibility.

It is desirable to secure the best possible balance between low light absorption and good diffusion when selecting diffusing globes. Test data on these two characteristics are of importance and should not be neglected. Because of neglect of simple and inexpensive tests of commercially available glassware, globes are being installed which do not accomplish the purposes in view so well as would other glassware. These either absorb a larger percentage of light than is necessary to secure the desired degree of diffusion, or else diffuse less well than need be, considering the amount of absorption.

Protection for the Eyes.—At first glance it would appear that street lighting purposes would be served admirably by a lighting accessory which would concentrate a large proportion of the light flux upon the street surface while directing but little light at those angles which fall near the centre of a field of vision in a given installation. However, certain difficulties operate against the success of such a scheme With practicable mounting heights, spacings have to be short if this is to be successful in illuminating the entire length of the street. The general direction of the light in such an installation is much more largely downward than is usually the case. Wherever there are sufficiently short-interval spacings to allow of such an installation, there usually exists a requirement for lighting the building fronts. In such installations the relatively high intensities on the street surface, together with the large areas of considerable brightness which present themselves to view, render the glare negligible when ordinary diffusing globes are used.

Location of Lighting Units.

Transverse of Street.—As between centre and kerb locations there is a considerable difference. In the first place with lamps located over each kerb, the street appears much wider.

In the lighting of important city streets this is usually a desirable condition. The lamps mounted over the kerbs likewise illuminate the sidewalks and the fronts of buildings better. When, however,

the lighting of the roadway becomes of first importance the best use may be made of the light by locating the lamp as nearly as practicable over the roadway so as to take full advantage of all specular reflection from the street surface.

Height.—In regard to heights of lamps there is also a wide difference in requirements, depending upon the character of the street. In some of the latest practice, powerful lamps are located 14 ft. to 18 ft. over the kerbs on business streets. These, however, are backed by light coloured buildings and the entire surrounding is so brightly lighted that the glare is not bad. With lamps over the middle of the street the background is usually the dark sky, and usually there are not light coloured buildings to relieve the general darkness. Under these conditions the opportunity for glare to become serious is considerable, and it is therefore necessary to locate the lamps rather high. The improvement realised in increasing the height of lamps of moderate power from 18 ft. to 20 ft. is considerable, while the improvement in increasing the height from, say, 27 ft. to 30 ft. is not very great. The curve of glare falls off rapidly with increasing separation when the separation between the light source and the observed surface is only a few degrees. Around a lamp which has a dark background there is a zone of halation within which objects tend to become invisible. Once outside this zone, the glare effect falls off less rapidly. It is very important to mount the lamps high enough to insure that the separation from the street surface is at least sufficient to avoid this zone of serious glare.

Power of Unit as Related to Glare.—Other things being equal, the objectionable effects of glare are greater when the lighting units are more powerful. Hence, it is approved practice to mount the more powerful units higher than less powerful units.

Spacing.—All features of an installation should be treated in such a way as to avoid dark areas between lamps, coupled with low mountings for very bright and powerful lamps. To avoid ineffective results due to multi-directional light which reduces contrasts, spacings need to be greater when the lamps are staggered along both kerbs than when they form a line along one side or over the middle of the street. The best spacing would appear to be contingent upon the kind of pavement employed and the nature of the surroundings. All the other factors should be so handled that in driving, one will not encounter the bad condition of a bright light source preventing an adequate view of the surface of the street beyond it. There is an excellent practice which is sometimes followed in the City of New York, in locating lamps for street lighting. Lamps which are temporarily installed may be raised and lowered; those mounted from the mast arm post may be placed nearer to or farther from the kerb, and those in the centre parkways may be moved about at will, the posts being mounted in rock-ballasted barrels. A crew of men locate the lamps in the trial installation as directed by the engineers in charge and the locations which appear to give the best illuminating effects are arrived at. Photometric tests are then made to show the results obtained and to afford a basis for the planning of other installations.

Theoretical Considerations which have not been Demonstrated.

Colour.—In street illumination where intensities are low, it is believed by some engineers that white light is more effective than yellow light. According to this view, objects are revealed with greater definition; smaller contrasts may be perceived, and there is less suggestion of haziness in the atmosphere when white light is employed. In accordance with the Purkinje effect there would appear to be some basis for this theory, since it is well known that at intensities of the order of 0·01 ft.-candles, we see almost exclusively by rod vision and the maximum of the ocular luminosity curve is removed toward the blue end of the spectrum. Whether or not this effect is present in street lighting is one of the interesting subjects of speculation at the present time.

Whether or not white light possesses advantage for low intensity street lighting due to ocular peculiarities, it is certain that it is preferred by many for high class street lighting on the ground that it is more suitable, pleasing and dignified than is yellow light. This is perhaps a matter of colour association, and is surely a matter of taste. It, therefore, hardly finds place in a discussion of this kind, and is merely mentioned in passing.

"Animation" of Light Source.—It has been suggested that the slight fluctuation of light which characterises arc lamps possesses some advantage for street lighting purposes over the steady glow of the incandescent lamp. So far as the writer knows, no demonstrations have been undertaken, and it has not been shown that this speculation has any basis in fact.

The original Paper is illustrated by numerous photographs.

ELECTRIC WELDING.*

BY C. B. AUEL.

(*Concluded from p.* 48.)

Summary.—In this Paper the author describes in detail the arc, incandescent and electro-percussive processes of electric welding. The arc process is subdivided into the Zerener, Benardos and Slavianoff systems, and the incandescent process into the La Grange-Hoho and Thomson systems. Several interesting tables showing cost of electric welds and smith welds are given, and the strength of welds is discussed at some length.

Incandescent Welding.

The incandescent or resistance processes of welding differ from the arc processes, not only in the method of obtaining the heating effect of the electric current, but in the further fact that pressure is also an essential factor. It is the introduction of resistance into the circuit, such as is caused by a poor contact (Thomson process) or by a poor conductor (La Grange-Hoho process) that produces the necessary heat for welding.

La Grange-Hoho Process.—In the La Grange-Hoho process an electrolytic bath is required. The two pieces of metal to be welded are joined in parallel to the negative terminal of a direct-current circuit of 125 to 150 volts, a large plate of lead, carbon or other conductor immersed in the bath forming the positive terminal. The bath consists of a mixture by weight of 44 parts of carbonate of potash and 56 parts of borax dissolved in water to a specific gravity of 1·24. The passage of the current through the bath causes decomposition of the electrolyte, bubbles of hydrogen being deposited on the metals to be welded, thus introducing a gaseous resistance in the region of contact between the metals and the electrolyte, with the consequent heating of the metals to incandescence. When the metals reach the proper fusing temperature, and while still continuing in the bath, they are forced together under heavy pressure, thus uniting, or they may be withdrawn from the bath after reaching the fusing temperature and welded together under a hammer in the usual manner. This process offers no advantage over the Thomson or resistance process, and the disadvantage of the bath is obvious.

Thomson Process.—In the Thomson process it will be noted that the welding is effected in the secondary circuit of a single-phase (25 to 60 cycle) transformer, which may have a capacity from 1 kw. to 100 kw. or more, the primary being wound for any suitable voltage, usually 110 or 220, the secondary for 0·5 to 7 volts. The terminals of the secondary circuit generally consist of comparatively large jaws, frequently water cooled, which clamp the metals to be welded. The power factor of a welding machine of this type will range from 50 to 85 per cent. In the making of a weld the ends of the two metals are butted together, first being filed flat if necessary, the lengths of each actually in the circuit being so adjusted as to make them equal in resistance, after which the primary circuit is closed. Current immediately flows through the metals, heating them very quickly at their point of contact to the temperature of fusion. They are then forced together by hand or automatically. The accompanying fin is easily eliminated either with a file after being taken from the welder or by means of an automatic hammer before being thus removed. Since the operation of welding is at all times under control, the weld may be made quickly or slowly, and there is, therefore, no waste of current; furthermore, the heat is self-contained—that is, it is generated within the metals themselves, and is, consequently, confined to the small portions between the jaws or electrodes.

From the preceding it is quite evident that the quality of the welds made by this process should be uniformly higher than those made by any of the arc processes or by the blacksmith, and it is, in fact, only exceeded by the electro-percussive process. It should, however, be equally evident that the Thomson process is best adapted for repetition work, while the arc processes are rather the reverse in this respect, so that there is little advantageous overlapping of these processes. The energy consumption involved in the making of a weld, and omitting all reference to the apparatus itself and the efficiency of operating it, is dependent upon the thermal and the electrical conductivity of the metals, their shapes, lengths, cross-sections, temperatures of fusion and time consumed in welding.

With reference to the curves shown in Fig. 5, Prof. Elihu Thomson states: "It will be seen that the energy increases more rapidly than the section of the pieces, doubtless because the large pieces take a longer time in welding, with the result of an increased loss by conduction of heat along the bars from the joint. If the time for welding

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

could be made the same for various sections, it is probable that the energy required would be more nearly in direct proportion to the area of section for any given metal. This rule would, however, only hold approximately, as there is a greater relative loss of heat by radiation and convection into the air from the pieces of smaller sections."

The Thomson process has a very great range as regards the metals as well as the shapes it is possible to weld. The Thomson Electric Welding Co., who were the pioneers in this process, and who have, therefore, had the greatest experience in this field, present the following as covering the metals and alloys which can be welded :—

Metals.—Wrought iron, cast iron, wrought copper, lead, tin, zinc, antimony, cobalt, nickel, bismuth, aluminium, silver, platinum, gold (pure), manganese.

Alloys.—Various grades of tool steel, various grades of mild steel, steel castings, chrome steel, mushet steel, stubs steel, crescent steel, bessemer steel, nickel steel, wrought brass, gunmetal, brass composition, fuse metal, type metal, solder metal, german silver, aluminium alloyed with iron, aluminium brass, aluminium bronze, phosphor bronze, silicon bronze, coin silver, various grades gold.

Combinations.—Copper to brass, copper to german silver, copper to gold, copper to silver, brass to wrought iron, tin to zinc, tin to brass, brass to german silver, brass to platinum, brass to tin, brass to mild steel, wrought iron to cast steel, wrought iron to mild steel, steel to platinum, wrought iron to tool steel, gold to german silver, gold to silver, gold to platinum, silver to platinum, wrought iron to mushet steel, wrought iron to stubs steel, wrought iron to crescent steel, wrought iron to cast brass, wrought iron to german silver, wrought iron to nickel, tin to lead, mild steel to tool steel, nickel steel to machine steel.

Wires as small as 0·0225 in. diameter can be butt-welded, the strengths of the joints, assuming the work to have been properly done, being dependent upon the composition of the materials welded, in general varying from 75 per cent. and upwards of the original stock, although certain investigators place the average as low as 63 per cent. Aluminium wires or rods can be successfully welded in the larger sizes; but in the smaller sizes the welds will be very unreliable, practically disintegrating if any attempt is made to work them as in rolling. This is probably due to the inability to rid the weld entirely of the oxide, which imperfection thus forms a greater percentage of the area of the weld in the smaller sizes, with consequent lower strength. At times there will be a brittle zone at either side and a little distance away from the weld, caused by the excessive rate of dissipation of heat when the current is withdrawn. Where this constitutes a disadvantage, as in high carbon steel, brittleness may be eliminated by passing current a second time through the welded piece, sufficient to heat the parts to a red heat, before removing them from the clamps, though it is rather better to loosen the clamps and move them further back so as to bring the brittle zones well within the circuit and further removed from the cooling influence of the clamps.

One of the most novel applications is the bonding of tram rails. As direct current is usually the only kind available, it must first be transformed to alternating current through the medium of a rotary converter. Instead of both portions of the clamps being of metal, as is usually the case, one part is of copper and one of carbon. About 2,000 amperes at 5 volts applied for approximately two to three minutes are required, and the usual operating force of three men can average 100 welds per day of 12 hours. Very similar to this application is that of rail welding, but on a much larger scale. In this, about 30,000 amperes at 5 to 7 volts are applied for two to three minutes with a pressure of 4,000 lb. per square inch on the weld. Two joint plates are necessary to each weld, one on either side of the rails being joined, and three welds are required to make a complete joint. With an operating force of six men 40 welds have been made per day of 12 hours. The accompanying table, taken from the report for 1910 of the Supervising Engineers, Chicago Traction, gives the results of several years' experience with electrically welded rail joints approximating 50,000 in number.

Later developments of the incandescent or resistance process of welding include what are known as spot, point, ridge, projection and button welding, much of it serving as a most desirable substitute for riveting. Briefly, it is the welding of materials in spots or at points and may be accomplished either by simply laying the flat material together and applying both heat and pressure through the medium of the electrodes, as in the case of thin sheets, or by first forming points, ridges or projections on the materials when thicker, then applying both heat and pressure, or by laying the materials together when still thicker and placing between or on either side a small flat metal button, then applying heat and pressure. A still further application of the incandescent process is in the lap welding of very thin ribbons, especially those of metals like nickel-chromium, on which an oxide forms which is not readily removed.

Electric brazing has received comparatively little attention, yet many materials can be effectively joined in this manner. A spot-welding machine can usually be employed with very little alteration, one or both terminals being of carbon or steel, as circumstances require. The "spelter" may for most purposes be either sheet brass or sheet silver from 0·005 in. to 0·015 in. in thickness, and the flux, when it is found necessary to use any, may be a saturated solution of borax water. The heat, as in welding, is so perfectly controlled that there is no danger of burning the materials. Furthermore, a spot-welding machine, when it reaches its maximum limit in welding, can do still larger work in brazing owing to the lower degree of heat required. The time for brazing a joint will naturally be rather longer than that required for welding, and care must be taken where brazed joints lie extremely close to one another that the heat from the joint being brazed does not react on the joint previously brazed and undo it, or does not extend to the next joint to be brazed and heat it sufficiently to cause an oxide to form, thus preventing brazing at all. Where there is any possibility of such conditions, dampened asbestos will prevent the former and borax water the latter.

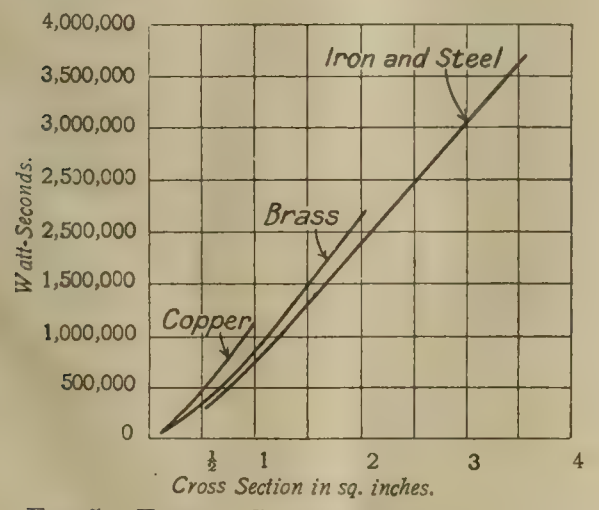


FIG. 5.—ENERGY CURVES, THOMSON PROCESS.

Summary Record of Electric-welded Rail Joints, by Yearly Groups.
From third annual report of the Board of Supervising Engineers, Chicago Traction. January 31, 1910.

Year.	No. joints welded	Total No. joints welded to Feb. 1.	Total failures		Failures 1907 welds.		Failures 1908 welds.		Failures 1909 welds.	
			No.	% failures to joints welded.	No.	% failures to joints welded 1907.	No.	% failures to joints welded 1908.	No.	% failures to joints welded 1909.
1907	8,299	...	417	5·04	417	5·04	...	...	...	...
1908	18,380	8,299	416	1·56	110	1·43	297	1·62	...	...
1909	21,716	26,679	287	0·59	92	1·11	91	0·50	104	0·48
Total to Feb. 1, 1910	48,395	48,395	1,120	2·31	628	7·57	388	2·12	104	0·48

Costs.—Costs could be given, but would mean little on account of the several variables involved, and for the further reason that certain manufacturers of welding apparatus sell their machines outright while others simply lease them. The quantity of welds possible to be made in one day may range from 100 to 200 in heavy or difficult work, to several thousand in semi-automatic work. The set-up time is frequently greater than the welding time, so that the cost of the current is usually a small item compared with that of labour, both direct and indirect. The fact, however, of the increasing use of apparatus of the kind under discussion over a period of 20 years is the best evidence that the process is an advantageous one to employ for many purposes.

ELECTRO-PERCUSSIVE WELDING.

As the electro-percussive method of welding is of more recent origin than any of the other methods, less is known of its ultimate possibilities, more especially with reference to its adaptability. It will weld together any two metals, whether alike or unlike as to their composition, melting point, conductance—in fact, quite regardless of their characteristics—though such combinations as silver and tin, or aluminium and tin, iron or lead will, of course, not be permanent, any more than they will be when welded by any other method, since their alloys disintegrate in time. Thus far this method has been largely confined to the welding of small wires or the equivalent, aluminium to aluminium or copper, platinum to nickel or copper, thermo-couples, spring steel, &c. The principle involved is that of

percussive contact between two metals with a condenser discharge occurring at the instant of such contact. The various items involved include voltage, velocity and force of impact, capacity of condenser, resistance and inductance of circuit, these being, of course, properly proportioned to one another.

Fig. 6 is a schematic diagram of the method. The welder is much on the order of a miniature pile-driver, two grips for holding the metals to be welded being provided, one of these located at the base and corresponding to the pile, except that it is stationary, the other corresponding to the driver and dropping upon the pile. G is a small direct-current generator, preferably of 250 volts and about 1 kw. capacity, which is used to charge a condenser (C) of the electrolytic type through a high resistance (R). Voltage control is secured through variation in the field of the generator, as well as by

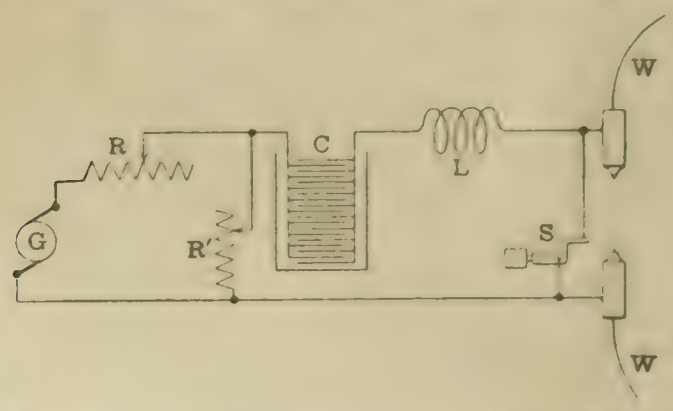


Fig. 6.—Diagram of Connections for Electro-Percussive Welding.

means of resistances R and R¹. The welding apparatus proper W-W is connected to the condenser through an inductance, L, long flexible leads being used to permit ready moving of the welder from place to place without the necessity of disturbing the auxiliaries. The terminals of the welder are bridged by the switch S, except in the actual making of a weld, when the switch is opened; thus no P.D. exists between the terminals while inserting or removing wires from the welder. The making of a weld is exceedingly simple. Either the metals to be welded, or if wires their ends, are placed in the grips; the switch S is then opened, charging the condenser. A catch is finally released, allowing the driver or hammer to fall, bringing the metals in so doing into percussive contact and making the weld, which only requires the removal of the burr to complete it.

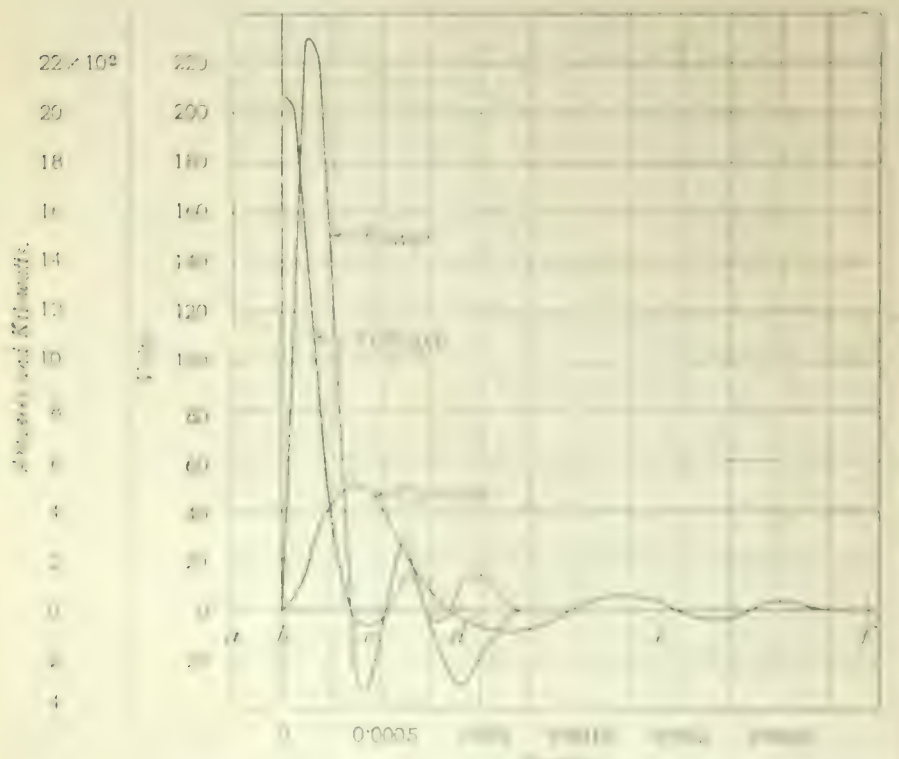


Fig. 7.—Oscillogram of Current and Voltage in Welding Circuit.

In explanation of the theory connected with the operation it may be said that, at the instant of contact, the condenser current is so heavy that the ends of the abutting metals are vaporised by the explosive discharge, and, due to the blow delivered by the falling mass, are forged together. The heat produced, though intense, is developed so quickly that it is confined to the extreme surfaces of the metals, and there is, therefore, no opportunity for general heating, with its possible deleterious effect on the welded materials. This generation of heat is dependent upon there being a certain resistance in circuit at the end of the metals being welded at the instant of their contact. It is, therefore, necessary to "V" them at right angles to each other with a pair of pliers. The condenser current vaporises the extremely small sections of the abutting metals and melts immediately thereafter the approaching surfaces of the two metals. This vaporisation must of necessity result in a separation of the metals for an instant, not, however, due to any reversal in the direction of travel of the falling metal, but simply because the rate of vaporisation is greater than the velocity of the approaching surfaces. Upon the metals coming together again the arc is extinguished and forging occurs.

The weld takes the form of a sharp dividing line between the two metals, and on each side of it the original materials are found with no change in their physical properties, such as brittleness for example, either at or near the weld, as sometimes occurs in the resistance or incandescent method of welding. Hard drawn materials are not softened, soft materials are not hardened, nor is the temper of springs affected. Several theories have been advanced to account for these apparently irreconcilable statements. The almost instantaneous heating and cooling may not give time for molecular changes, or if it does the amount of material affected may be inappreciable. Further, with certain metals like hard steel, the heat generated is so quickly transferred into the shanks of the metals being welded that the

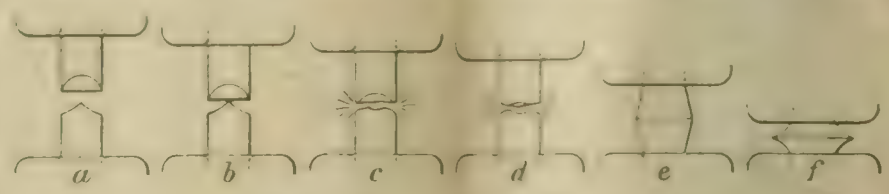


Fig. 8.—Stages of the Weld.

softened material is as quickly re-hardened. In the case of hard copper, silver, &c., it may be that the softened material is again hardened by the cold forge after cooling. Fig. 7 shows both current and voltage during the welding of a small wire (No. 18 B. & S. gauge), while Fig. 8 shows the several stages in the course of a weld. It will be observed that the time required for the actual weld is but 0·0012 second, the total power consumption being 0·00000123 kw.-hour. The oscillatory character of the power curve is due to the measurement of voltage having been made at points on the welder which included the two grips, and the oscillations are, therefore, due to the variations in the magnetic flux in them.

GREAT WESTERN RAILWAY'S ELECTRICAL MACHINERY.

In the "Great Western Railway Magazine" an interesting description has been given by Mr. R. T. Smith of some of the electrical machinery used for handling goods at the South Lambeth depot. The equipment contains a 35-ton gantry crane which runs parallel with the north side of the goods shed, and travels a length equal to that of the shed. The travelling gantry of the crane has a span of 51 ft. 6 in., covering two lines of rails and a cart road on either side. Two trains, amounting to 48 average-sized wagons can be dealt with without any marshalling or shunting. There are two hooks, one for a load of 35 tons, and the other for a load of 10 tons. All motions are electrically worked, and the crab can travel the width of the gantry in one minute, while the entire crane can travel the total length of the rails and roadway, which it covers, in 4½ minutes. The crane collects current from conductors in a conduit laid beneath the road level.

In the goods shed there are two one-ton underhung jib cranes of a type installed in several Great Western goods sheds, and consisting of a bridge travelling the whole length of the building, a crab traversing the bridge, and a revolving jib suspended from the crab. The driver, standing on a platform at the rear end of the revolving jib, is able to traverse the crab to any position inside the shed. By revolving the jib so that it points between two stanchions and traversing the crab to the end of the bridge, the load can be delivered into a lorry in the cart road outside the roof supports on the platforms. The depot also contains 13 "Clyde" type electric capstans, a 30-ton electrically operated wagon traverser, and a 3-cwt. electric travelling crane working over a large well-hole that extends the whole height of the building. There are, in addition three large lifts from the basement to the third floor, which are worked on the "full automatic" principle, enabling them to be despatched from any floor to any other by pressing appropriate buttons. Push-button control is also used for transporters at each end of the shed, which can raise goods from the ground and take them inside the building by any of the floors, slots being made in the floors to receive the rope.

ELECTRIFICATION ON THE LONDON & SOUTH-WESTERN RAILWAY.

(*Continued from p.* 61.)

The Power House.

One of the main features of the power house is the fact that it contains no conveyor plant for handling either coal or ash. In the case of the coal, this has been effected by the expedient of having a railway incline to the top of the building, which course has been rendered possible without any great difficulty, on account of the level of the ground in relation to the railway. Thus, the coal trucks are run on to the siding and up the incline into the top of the boiler house



Fig. 17.—View of Floor and Coal Bunkers above the Boilers.

above the coal bunkers, so that the contents can be simply dropped into the bunkers. There is a weighbridge on the siding at the bottom of the incline; otherwise the coal is not weighed for the individual boilers, though it passes through measuring hoppers on its way to the mechanical stokers. The bunkers have a capacity of about 1,400 tons, and in addition to this storage there is room for 10,000 tons of coal below the inclined track. The viaduct, for the greater part of its length, is provided with open decking, so that the coal can be discharged directly on to the storage space below. A view of the coal bunkers is seen in Fig. 17.

Generating Plant.

The present capacity of the plant is 25,000 kw., in units of 5,000 kw., with room for a sixth set; but there is space between the present building and the cooling towers for an extension to double this power. The general arrangement consists of a turbine house with switch galleries on one side and a [illegible] boiler house on the other, as shown in Fig. 19.

The turbine house, which is shown in Fig. 20, is 257 ft. long and 55 ft. wide. The main generators consist of Dick-Kerr turbo-alternators, each of 5,000 kw. The turbines are of the impulse type working at a pressure of 200 lb. per square inch, with 200°F. of superheat. They run at 1,500 revs. per min., and if the speed rises 15 per cent. above the normal an emergency governor cuts off the steam. Each turbine is provided with a settling tank, into which the hot oil from the bearings flows by gravity. It then passes through gauze strainers into a reservoir, from which it is drawn by an oil pump and forced through three water-cooled coolers in series to the bearings. Before starting up, the bearings can be flushed with oil by means of a steam-driven oil pump. This is connected in parallel with the other pump, and can also be used in an emergency. As may be found necessary, the oil can be treated by a Bowser oil filter connected to each set by pipes.

Each turbine is direct coupled to a three-phase alternator of a capacity of 5,555 k.v.a., or 5,000 kw., at a power factor of 0·9. These generate current at 25 cycles under a pressure of 11,000 to 11,500 volts. The alternators are two pole, and are excited by means of a direct-coupled dynamo on an extension of the shaft. The specification called for a temperature rise not exceeding 70°F. at full load.

Ventilation is secured by bringing air in from outside the building through a false floor, seen in Fig. 19, which communicates with the corridor containing the pipework carrying the circulating water for the condensers. In this corridor cloth air filters, by the Premier Cooler and Engineering [illegible] are

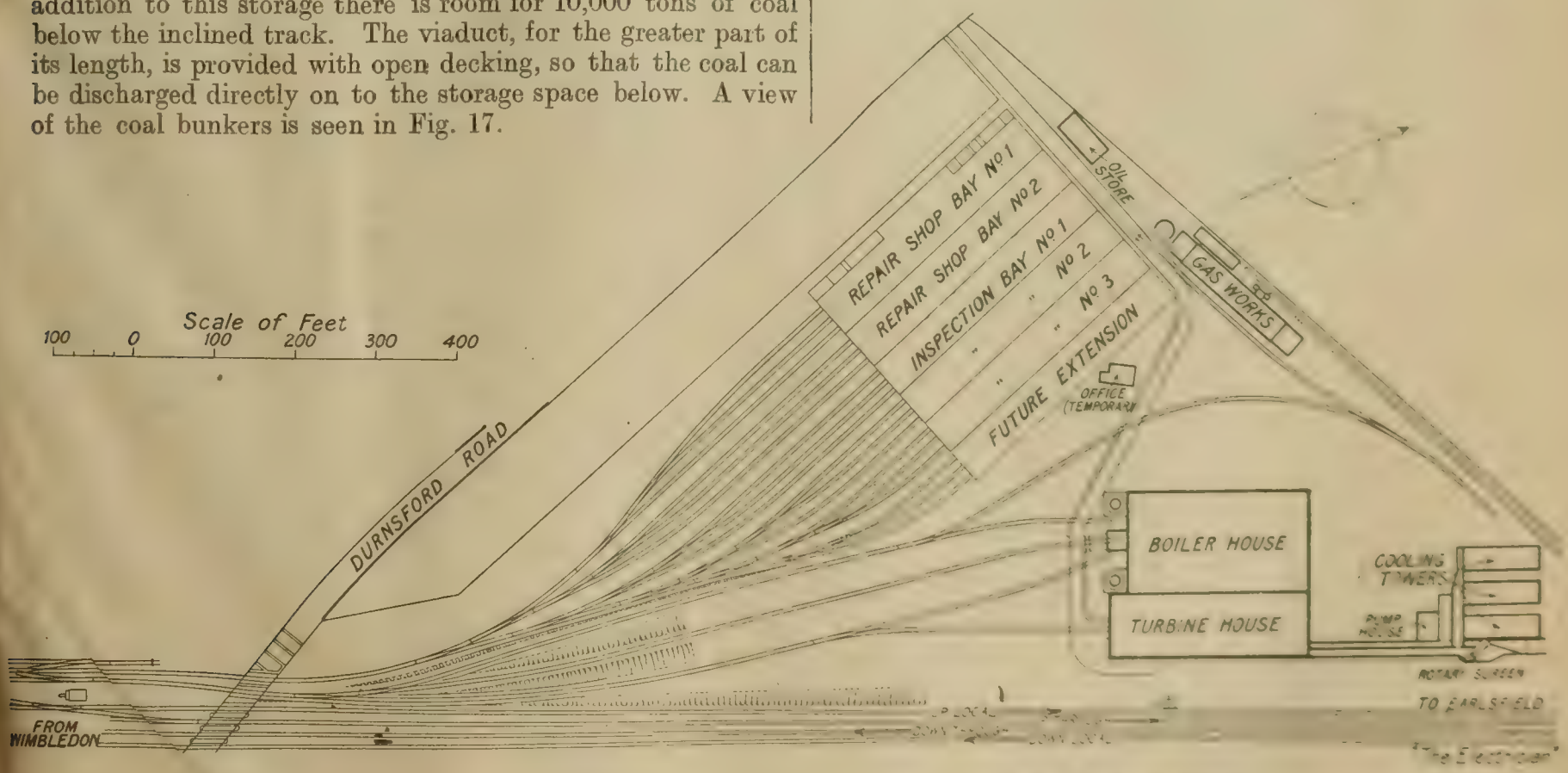


Fig. 18.—Plan showing Lay-out of the Power House and Car Repair Shops.

As will be seen by Fig. 18, the power house is in close proximity to the railway; and it is at no great distance from the river Wandle. The latter provides sufficient cooling water for the greater part of the year, and when the supply falls off the deficiency is made good by means of cooling towers.

fitted, one for each alternator, and the air is drawn through these by means of fans placed in the basement near the condensing plant, and is thence forced through the alternators, which are totally enclosed for the purpose. Each alternator is thus provided with its own air filter and fan, the view being

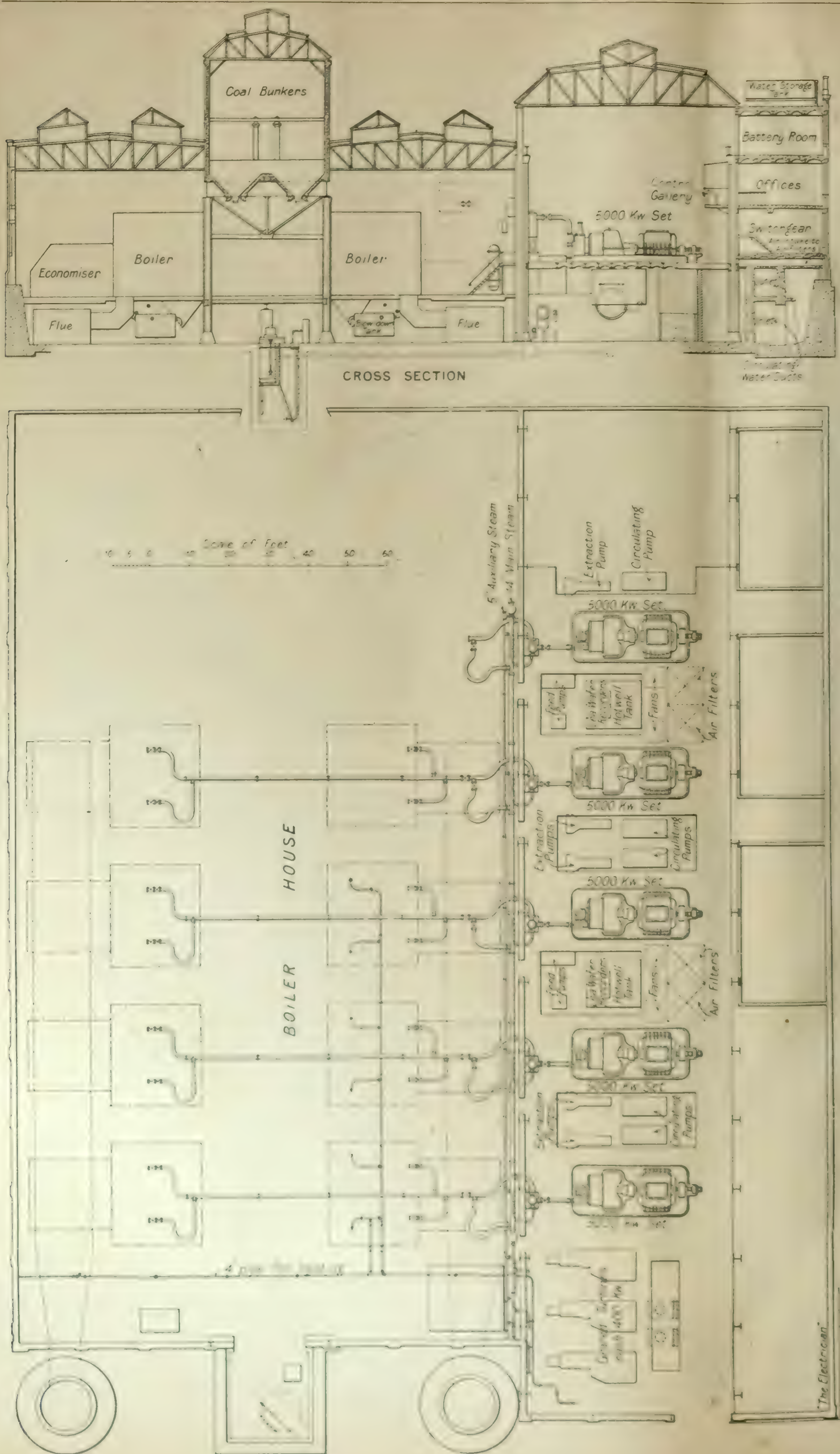


FIG. 19.—PLAN AND CROSS-SECTION OF POWER HOUSE.

that more efficient ventilation is secured in this way than by providing a fan on the alternator itself. After passing through the alternator the air is discharged into the turbine house.

In regard to excitation, it may be noted that the current supplied by the exciter is not regulated, but regulation is obtained by controlling the current in the field of the exciter.

seen in Fig. 23. The main exhaust pipes, as is usual, are provided with automatic valves, made by Alley & MacLellan, permitting the exhaust to pass to the atmosphere in the event of high back-pressure.

There are two hot well tanks, each being 14 ft. by 12 ft. by 9 ft. deep. These are placed between alternators 1 and 2 and

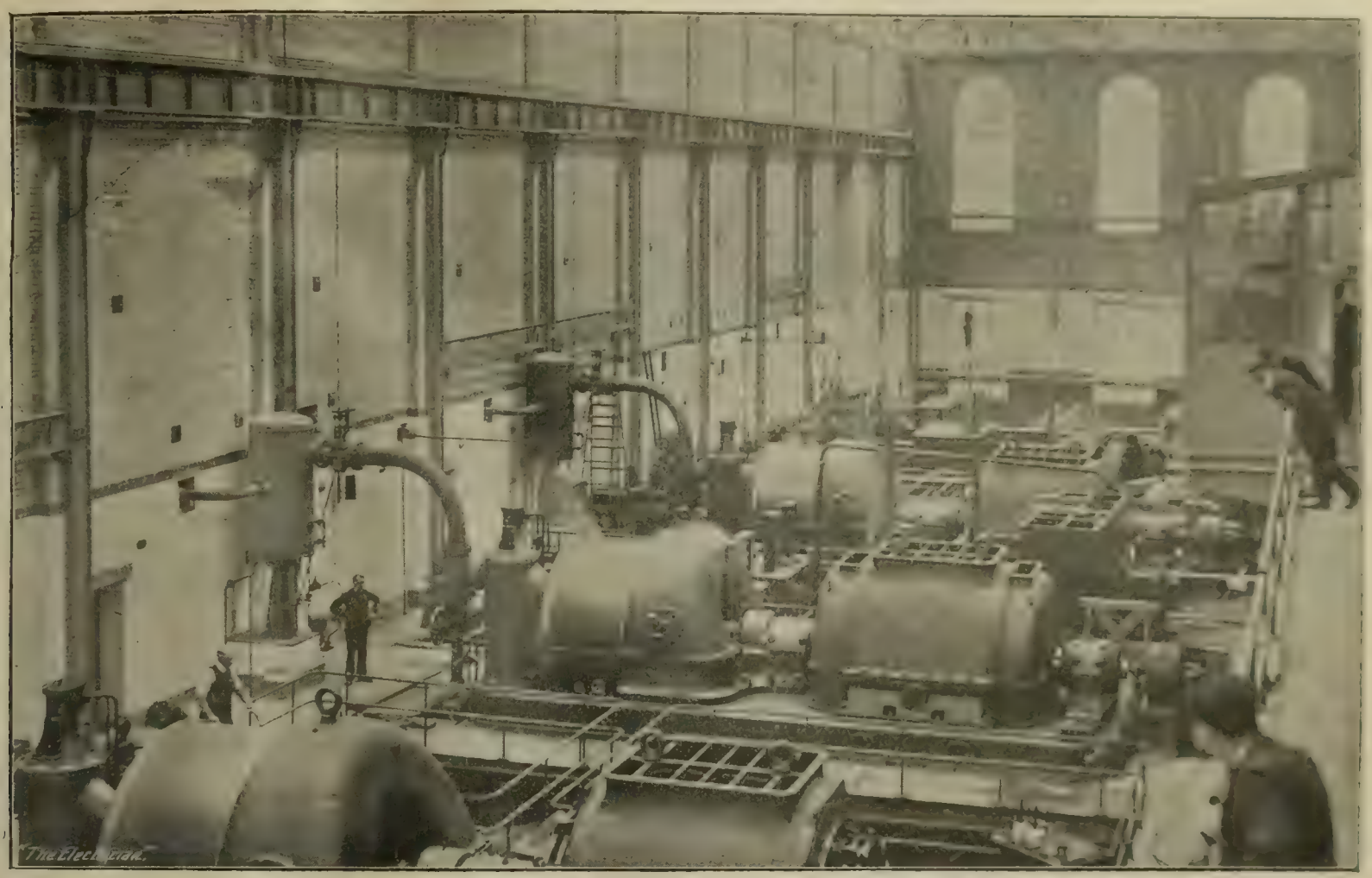


FIG. 20.—VIEW OF TURBINE HOUSE.

The general arrangement of the condensing plant for the main turbines is shown in Fig. 22. The condensers are of the surface condensing type, supplied by Willans & Robinson, the main condensers being of 7,740 sq. ft. surface. Each circulating pump is electrically driven. For maintaining the vacuum a small steam turbine running at 2,150 revs. per min. is employed to drive two pumps mounted on the same shaft; one of these extracts the condensed steam, the other takes water from the

between 3 and 4 respectively. The Lea recorders, one for each alternator, are mounted just above the hot wells, and are on the level of the turbine room floor.

Adjacent to the hot wells are the feed pumps, one electric and one steam pump to each. The two electric pumps are Rees-Roturbo three phase, and the steam pumps are by J. P. Hall & Sons. Each pump, both electric and steam, is capable of delivering 13,000 gallons of water per hour to the boilers.

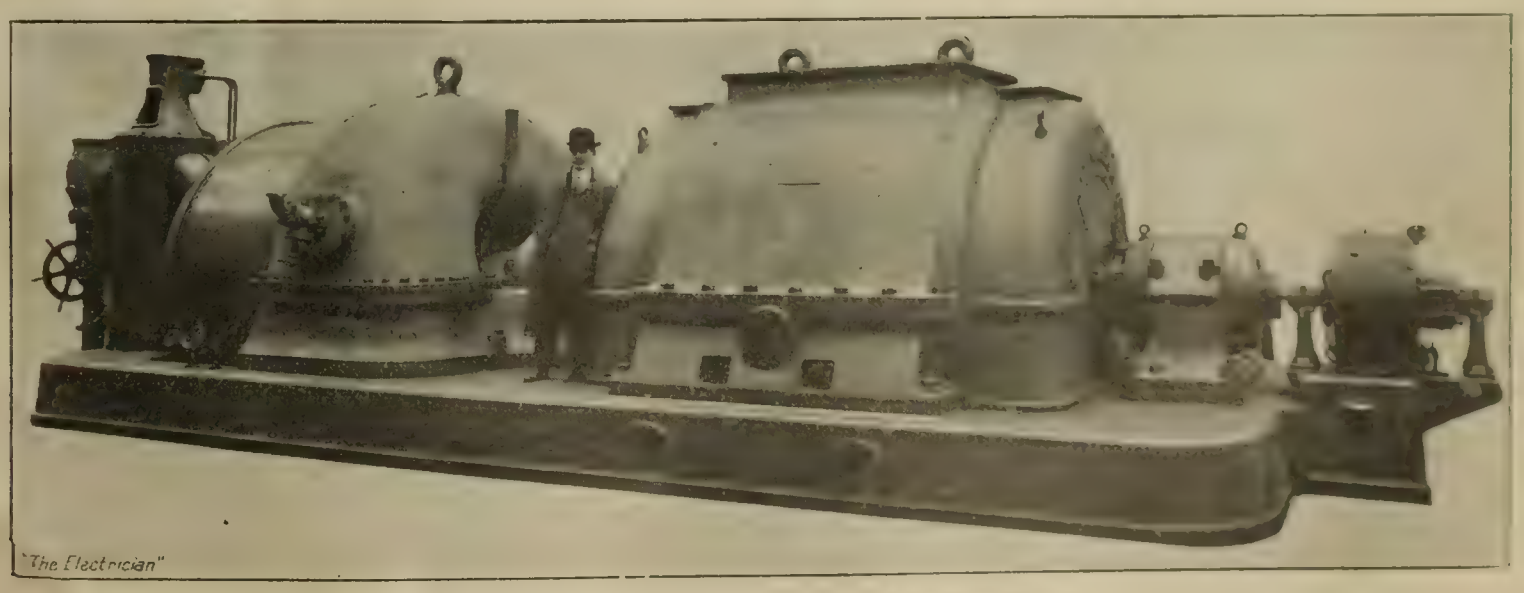


FIG. 21.—VIEW OF ONE OF THE 5,000 KW. SETS.

circulating water inlet aqueduct and forces it through an ejector, which removes the air from the condenser. The water is returned to the aqueduct. The condensed steam passes to a hot well tank via a Lea recorder. The exhaust from the small turbines on the condensers is taken direct to the hot wells through silencers. A view of this part of the plant is

The turbine house also contains three small Parsons steam turbines running at 5,000 revs. per min., each geared to a Dick, Kerr continuous-current generator running at 575 revs. per min., and giving 400 kw. at 220 volts. These generators, shown in Fig. 24, are used for supplying auxiliary power, which is mostly in the form of continuous-current motors; also light

for the power house and car repair shops. This plant is served by two condensing units in the basement, each of a size corresponding to one 400 kw. set, and having 895 sq. ft. of cooling surface.

The gearing of these sets, as shown in Fig. 25, is of the single reduction double helical type, and is totally enclosed in a substantial cast-iron casing. The pinion and shaft and the rim of the gear wheel are of steel, having teeth accurately cut by plant specially devised by Sir Charles Parsons, in which a supplementary creeping motion is introduced on the table carrying the gear wheel which is being cut. This creeping motion eliminates all errors in the cutting of the teeth, and thus removes objectionable noise and wear. Lubrication is effected by means of oil sprayed on to the teeth where they mesh. This oil is supplied under pressure from the main oil pump of the turbine. The pipework for the lubrication is seen in the foreground of Fig. 24.

The turbine house is spanned by a 40-ton three-motor overhead travelling crane, by the Chatteris Engineering Works Co., of which the following are the chief data :—

Working load of crane	40 tons
Test load	60 ,,
Span of crane	52 ft.
Total height of lift, from basement	43 ft. 6 in.
Speed—	
Hoisting, slow gear	40 tons at 5 ft. per min.
,, fast ,,	12 ,, 16 ft. ,,
,, ,, ,,	1 ton ,, 24 ft. ,,
Longitudinal travelling, 40 ton load	200 ft. per min.
,, ,, light	250 ft. ,,
Cross travel, 40 ton load	75 ft. ,,
,, ,, light	100 ft. ,,

The girders are of the built-lattice type and box section, with heavy bridge rails riveted on the top flanges for the crab to travel upon. The end carriages are built up of steel plates and angles and are of box section, fitted with cast steel travelling wheels which can be easily removed. The longitudinal travelling is actuated by a separate motor through double reduction gear, the motor being placed at the centre of the crane bridge and secured to the web plates. The first motion gears with a steel pinion on the motor spindle, and the shaft is provided with a steel pinion at each end, gearing with steel spur rings bolted to the travelling wheels. The crab frame is built up of steel H-sections and angles, arranged to receive the hoisting and cross-travelling motors, shafts, bearings and gearing. The crab is fitted with an automatic magnetic brake, which is capable of sustaining the full load. A secondary automatic mechanical brake is also fitted, capable of preventing the load being lowered at an excessive speed. The latter brake is totally enclosed, and runs in an oil bath. An improved overwinding switch is also fitted upon the crab ; this opens the lifting motor circuit when the crane hook is at the top of its travel, and it cannot be reset without first lowering the hook by hand to a safe position. A platform with double hand-rail is provided on both sides of the crane, with hatch on one side for access to the longitudinal travelling motor, and on the other for access

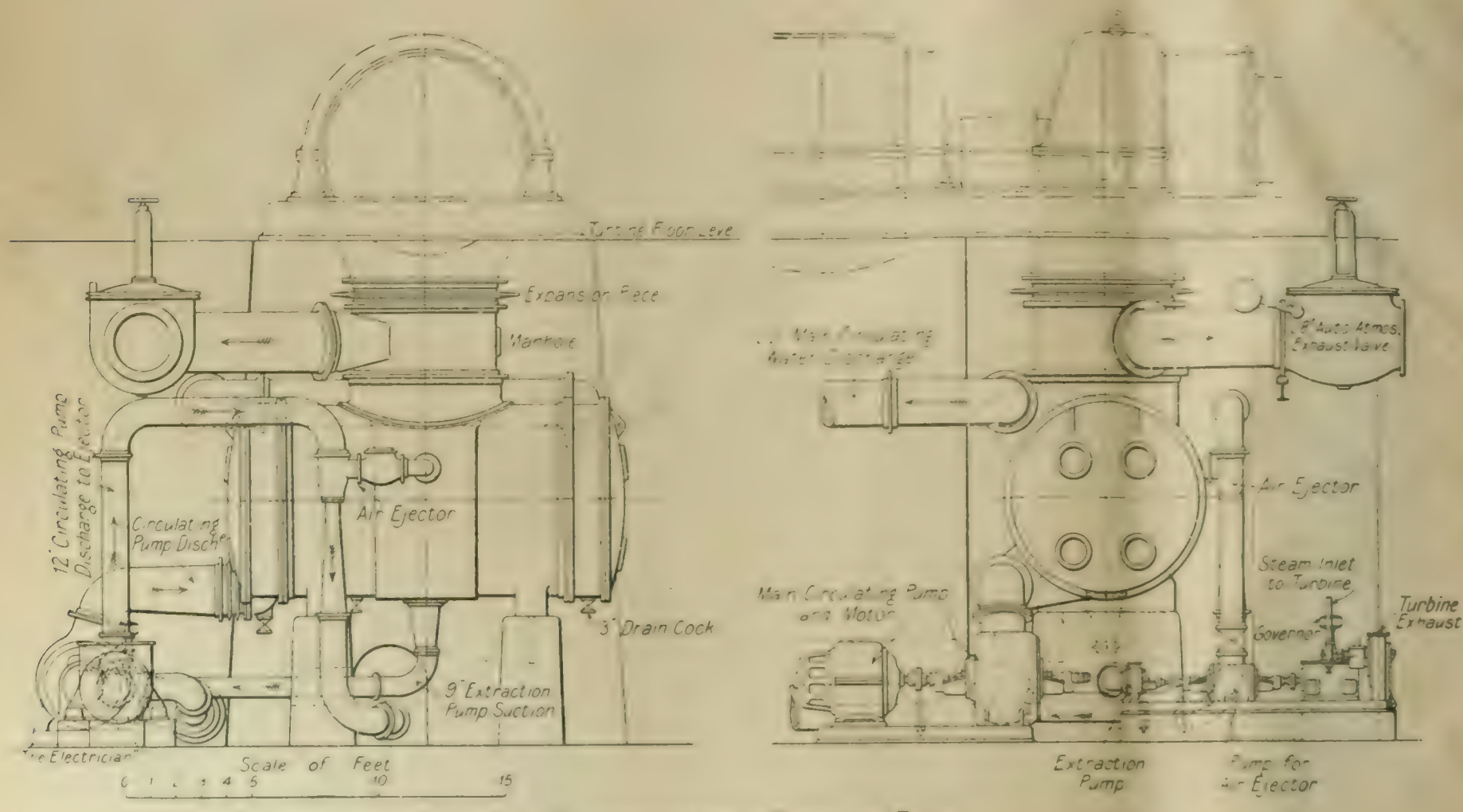


Fig. 22.—Arrangement of Condensing Plant.

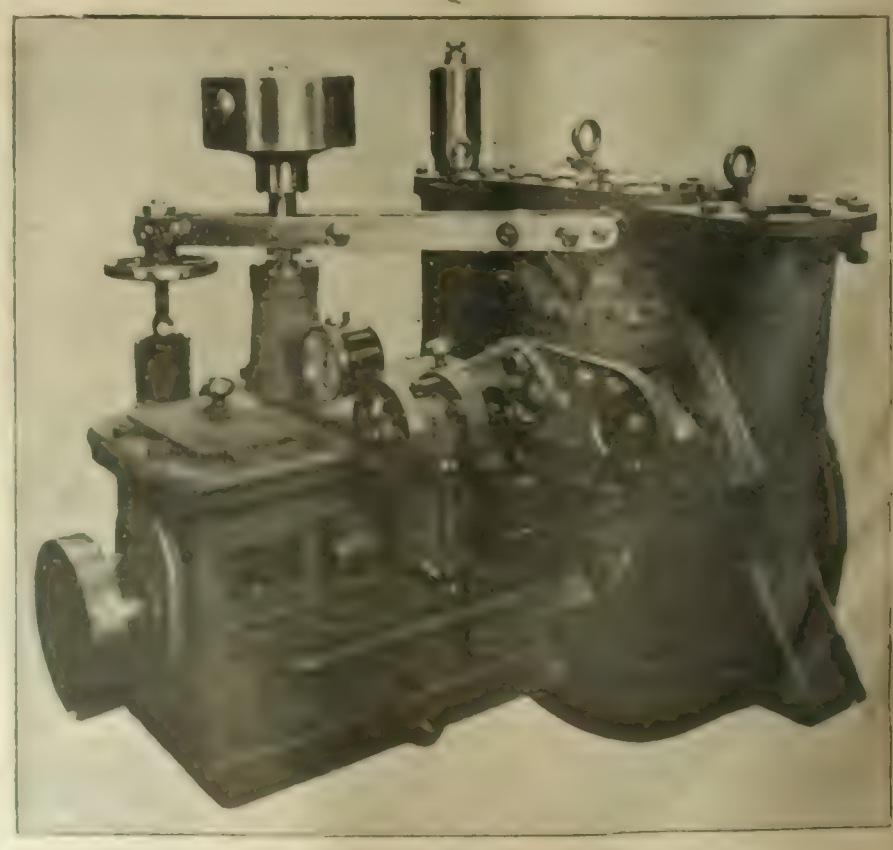


Fig. 23.—View of Small Steam Turbine Operating Condenser Pumps.

to the driver's cage. The crane is controlled from the driver's cage, which is placed below and at one end of the girders, and contains the controllers and switchgear. There are special contacts on the controller of the lifting motion for connecting resistance in parallel with the armature of the motor and giving dead slow lifting and lowering motions for overhauling purposes.

Boiler House.

The boiler house, which is 237 ft. in length and 130 ft. wide, contains on either side a range of boilers, each range having its own flue and chimney shaft. Either range at present consists

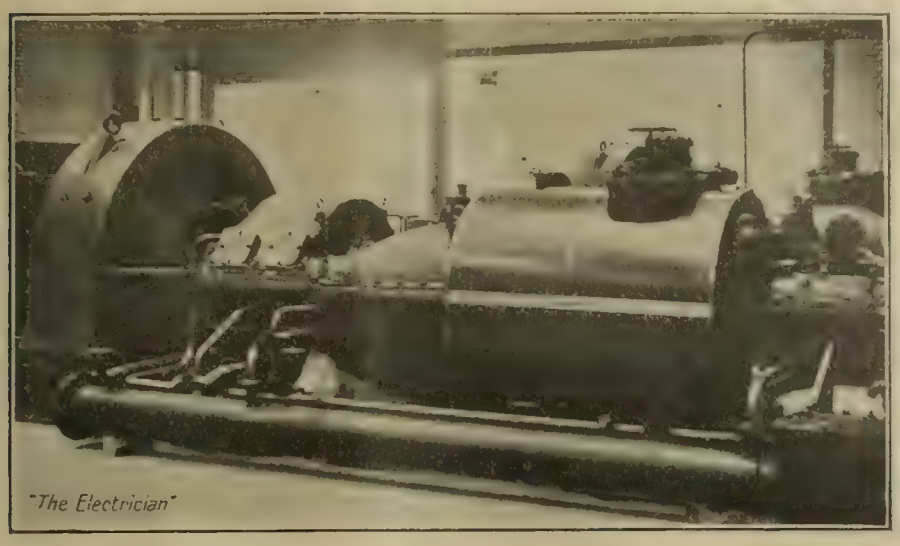


Fig. 24.—View of Parsons Geared Turbo-dynamo of 400 kw.

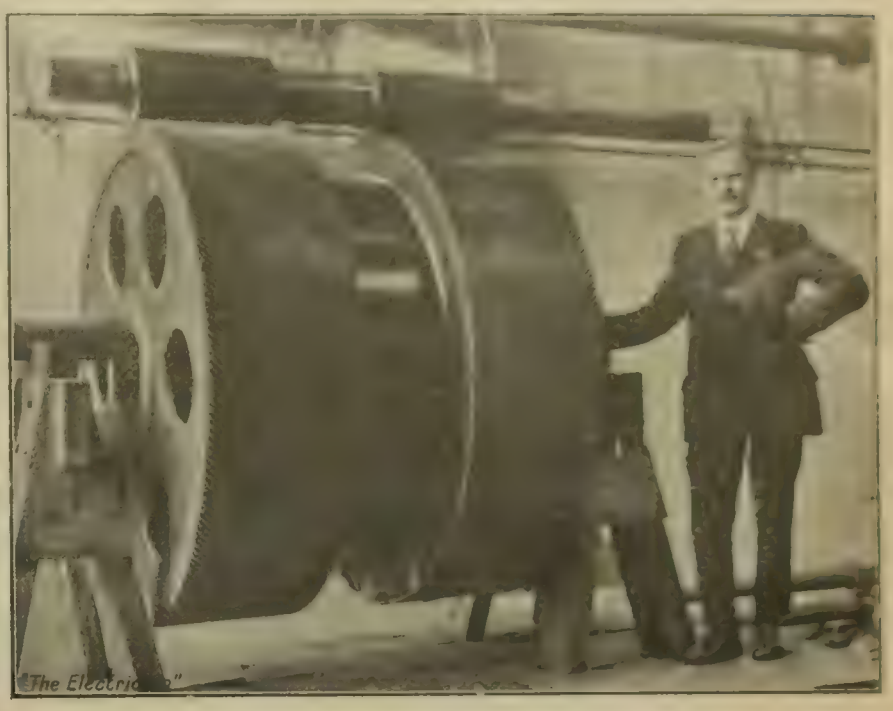


Fig. 25.—View of Gearing of 400 kw. Turbo Set.

of eight Babcock & Wilcox boilers, each having a heating surface of 5,760 sq. ft., a grate area of 123 sq. ft., and a normal evaporative capacity of 20,000 lb. of steam per hour. The boilers are fitted with superheaters to give a superheat of 200°F. They are equipped with chain-grate stokers, all the stokers on each range being worked by a counter-shaft driven by an electric motor. Each boiler is fitted at the back with its own Green's economiser, but these are not provided with the usual scrapers for the tubes. Scrapers have been dispensed with, as the cleaning of both boiler and economiser tubes is effected by

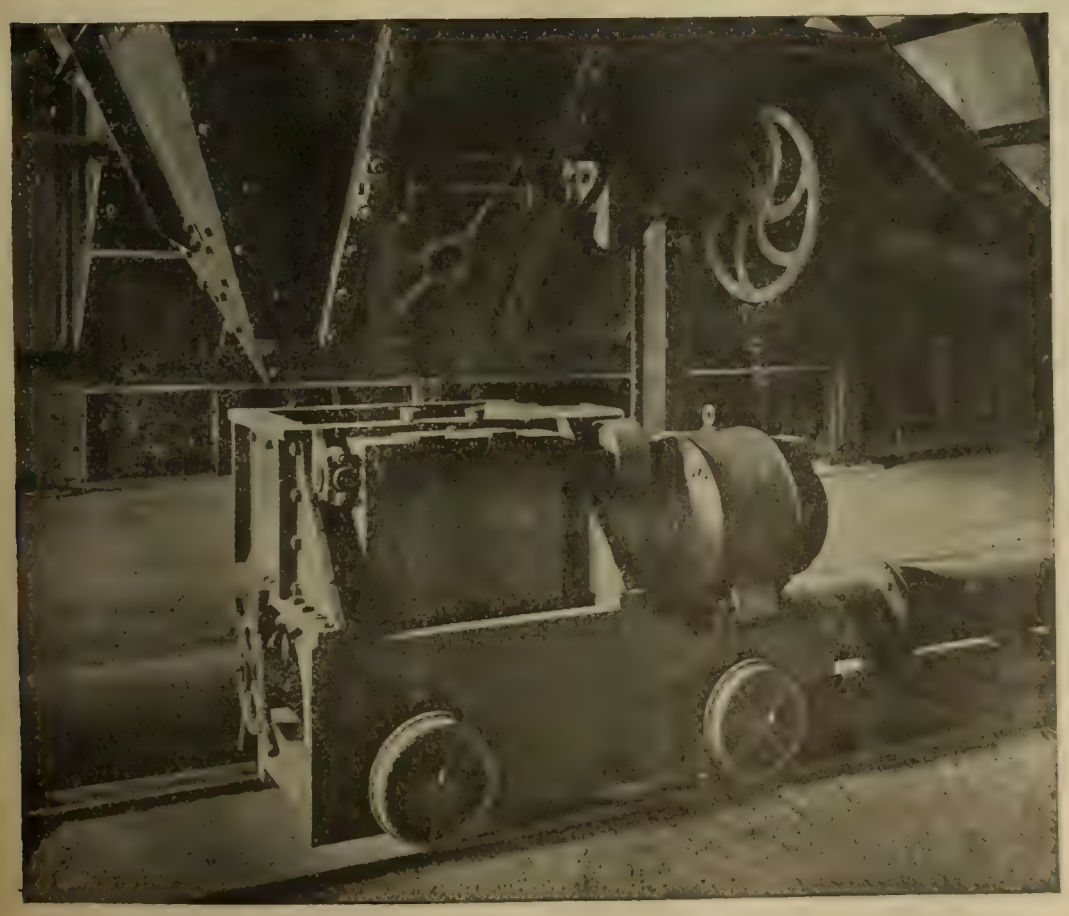


Fig. 26.—Crusher under Ash Chute.



Fig. 27.—Receiver of Suction Ash Plant.

means of compressed air. A two-stage electric compressor by Messrs. Alley & MacLellan is used for supplying air at 100 lb. per sq. in., to pipework in the basement, from which branches are brought up near the economisers. From these branches

the main flues consists of steel plate lined with 3 in. of fire-brick. Each chimney shaft is 230 ft. in height, 13 ft. 6 in. in internal diameter at the top, and is built on the Custodis principle.

One of the most interesting features of the power house is the ash handling plant. This consists of suction plant by Babcock & Wilcox (Ltd.), such as is already in use in one or two of our power stations. The ash from the boiler is received in an ash chute, which is seen in Fig. 26. When it is desired to dispose

of this ash an electrically operated crusher, which travels on a small track, is placed in position under the chute, as seen also in the illustration. The ash is then allowed to fall from the chute into the breaker, and thence into the suction pipe seen

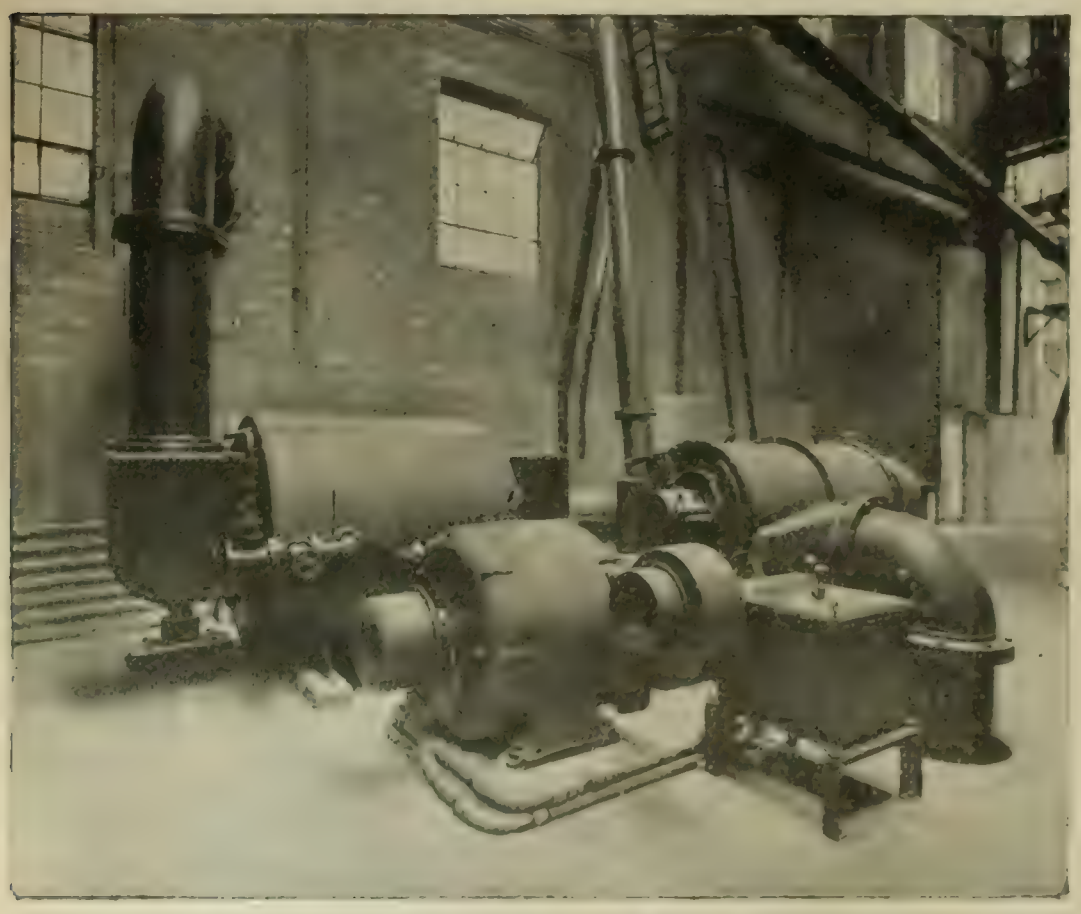


Fig. 28.—Spray Receiver and Blower of Ash Handling Plant.

behind the breaker. A pipe line is carried beneath each range of boilers to a receiver outside the building. This is seen in Fig. 27. Into this receiver the crushed ash is drawn by suction, and when the receiver is sufficiently full the ash is discharged into a railway truck below.

The remainder of the plant is seen in Fig. 28, and consists of an electrically-operated Sturtevant exhauster with the necessary adjuncts. In this illustration the suction pipe on the left-hand side is that from the receiver. As the air which is drawn from the receiver necessarily contains a certain amount of dust from the ash which is deposited in the receiver, it is treated by means of water sprays in a small receiver seen on the left in Fig. 28, the blower and its motor being on the right. Finally, the air is discharged into the flue. The pipes on the right of Fig. 28 are the main suction pipes rising from the two ranges of boilers to the receiver; they are noticeably smaller in diameter than the pipe returning from the receiver.

The general arrangement of the pipework under the boilers is well shown in Fig. 29. Here the open end of the suction pipe is seen at A. The air passes in at this end, and carries with it any ash that is allowed to drop into the pipe at any aperature which is being used for this purpose beneath any boiler. Only one aperture is open at a time, the others being closed by heavy iron doors. Any such open aperture does not make a joint with the discharge of the breaker, and it seems to be essential to the process to have a good flow of air into the free end at A.

Apart from ash conveying, the suction system can be used for removing soot from the boilers or the economisers. For this purpose a plate can be inserted to block the free end, and any of the branches to the boilers or economisers can be opened up. As seen in Fig. 29, there are two branches, B and C, to the two sections of each boiler and one branch, D, to the economiser E. The flue is seen at F. A branch of the suction pipe is taken to the foot of each chimney shaft, which is made conical, so that the soot will collect there, and can be removed in the same simple way.

The plant works with a suction equal to about $2\frac{1}{2}$ in. of mer- cury. If through a stoppage the suction rises to 6 in. a relief valve comes into operation. Among the advantages of such a plant are the removal of ash and clinker without dust, so that the working conditions are better. Moreover one labourer can dispose of 10 to 12 tons of ash and clinker from the furnaces to the ash tip in one hour. Apart from easy manipulation the cost of upkeep is low, and the plant is easily repaired.

The general arrangement of the steam piping, which is of solid drawn steel with screwed and riveted flanges, can be seen from Fig. 19, and is of some interest. Each set of four boilers across the boiler house practically forms one unit to supply one 5,000 kw. turbine, the steam being taken from each boiler by a 7 in. branch, which leads into an 8 in. pipe, the latter being increased to 10 in. after taking in the branches from the second pair of boilers. The latter then forms two branches, one of which feeds into a main 14 in. header running the whole length of the boiler house, and carried on hangers suspended from brackets on the wall.

The other branch is taken direct to the steam separator of the corresponding main turbine. In this way each turbine can be supplied by steam from its own set of four boilers, or, if desired, these boilers can be shut down and the steam can be supplied from the main header. No valves are fitted in the latter. With regard to expansion, this is taken up by the various bends, and there is

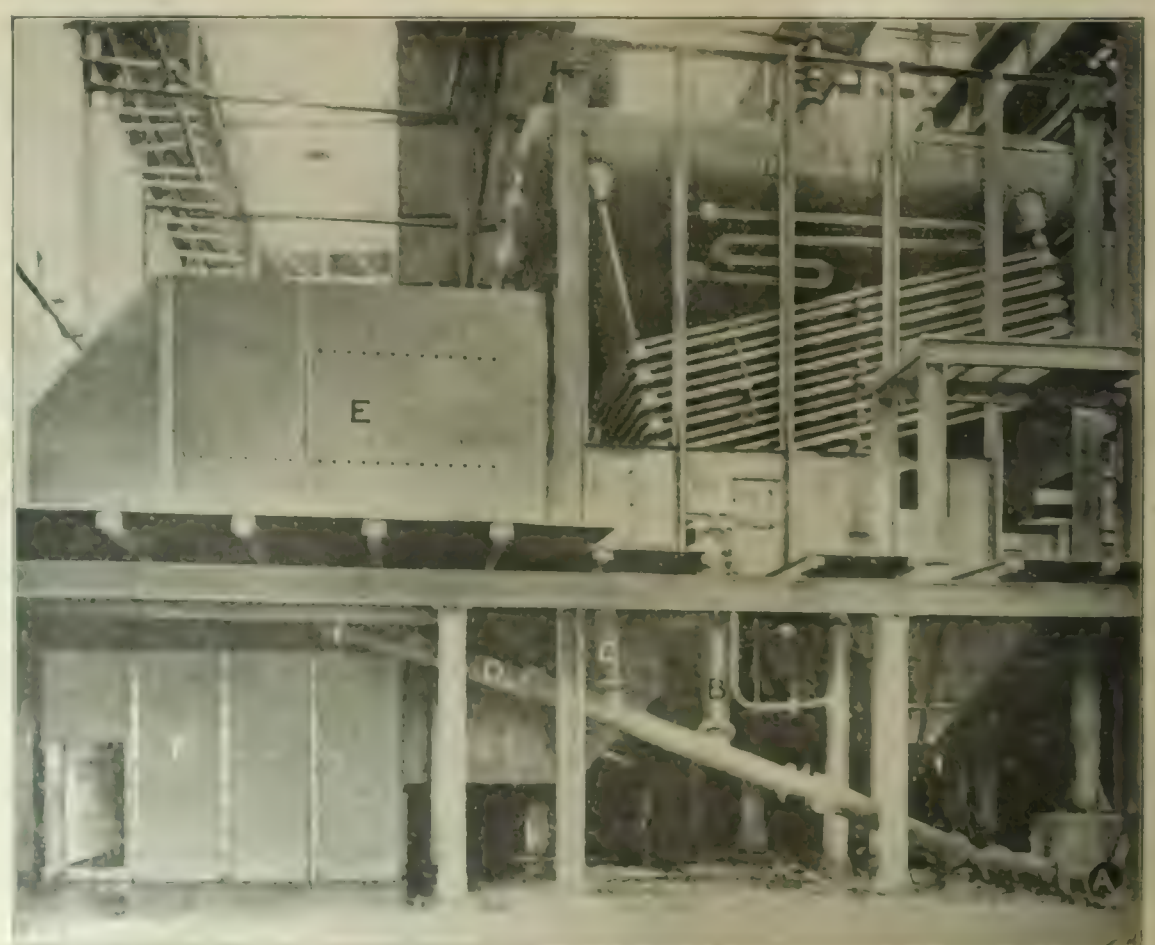


Fig. 29.—View of Pipework of Suction Ash Plant.

no expansion piece in the header itself: the latter will be anchored at the mid-point of the boiler house in the extended scheme. For the moment it will be noticed that the boilers

for the fifth turbine have not been put down, and consequently this one can only be supplied from the main header.

Condensed steam is removed by a steam separator at each turbine, and there is also a steam separator near each end of the main header. These are fitted with steam traps, as usual.

It will be noticed that there is also a 5 in. auxiliary steam pipe running the whole length of the boiler house; for its source of steam this is connected to each steam separator in the turbine room. This auxiliary main is used for supplying the 400 kw. sets, the feed pumps and other auxiliaries.

Lastly, there is a 4 in. saturated steam main which supplies steam for heating purposes to the power house offices and to the car-repair shops.

It was originally intended that the make up water should be taken from an artesian well, but owing to the geological formation of the ground the obtaining of water in this way proved to be impracticable.

The make-up water is therefore taken from the mains of the Metropolitan Water Board to a large tank of 100,000 gallons capacity at the top of the building. This tank is divided into two equal parts, and the make-up water taken from either of these passes through a Lea recorder. There is also a recorder to measure the water used for general purposes. From the tank the water is taken to a Boby water-softening plant, capable of dealing with 100 gallons per minute, and having a tank 19 ft. by 17 ft. by 9 ft. deep. The softened water is then taken through the turbine oil coolers if desired, and thence flows into the hot wells as "make-up." Thus the heat from the turbine oil is not wasted.

The only feed water heaters in the station are two small ones which receive the exhaust steam from the feed pumps. All the feed water passing from the hot wells to the boilers passes through one or other of these heaters.

Subsidiary Station Plant.

The motors used for the auxiliaries are partly three-phase at 440 volts and partly continuous current. The low-tension three-phase current is supplied through Berry oil-cooled single-phase transformers, four of these being provided (that is, one spare), each giving 780 amperes at 440 volts. They are connected in mesh on the primary and in star on the secondary to form a 600 k.v.a. set. Primary tappings are provided at $2\frac{1}{2}$ per cent. and 5 per cent. above and below the normal.

Continuous current is supplied by the smaller turbo-generators as already mentioned, and in connection with these there is a Tudor battery of 110 cells, the capacity being 1,150 ampere-hours at the three-hour rate. This battery supplies current for the control board, and for the lighting of the power house. It is situated on the top floor of the switchgear galleries, and in an adjacent compartment is a booster by the Electric Construction Co. for charging or discharging the battery.

In the switchgear bay, on the level of the turbine house and near the auxiliary transformers are two motor generator sets which are supplied with continuous current, and which generate single-phase current at 3,300 volts, and a frequency of 75, as distinct from the frequency of 25 at the power house. This current is transmitted for signalling and railway station lighting purposes, and we shall refer further to these sets in our description of the sub-stations.

(To be continued.)

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"A Treatise on Light." By R. A. Houston M.A. (London: Longmans, Green & Co.) Pp. xi.+478. 7s. 6d. net.

"A Course in Descriptive Geometry and Photogrammetry for the Mathematical Laboratory." By E. Lindsay Ince, M.A., B.Sc. (London: G. Bell & Sons.) Pp. 79. 2s. 6d. net.

"Relativity." By A. W. Conway, D.Sc., F.R.S. (London: G. Bell & Sons.) Pp. 43. 2s. net.

"A First Course in Engineering Science." By P. J. Haler, B.Sc., and A. H. Stuart, B.Sc. (London: University Tutorial Press.) Pp. vii.+191. 2s. 6d.

THERMAL CHARACTERISTICS AND INTERMITTENT RATING.

(Concluded from page 48.)

Summary.—Reference is made to the general theory of heating and cooling, and values are given of the heating time-constants of various machines. The load-factor method of rating intermittent machines is described and the principles are illustrated by means of examples. In conclusion, an account is given of the B.E.S.A. method of rating.

(*b*) *Intermittent Running on a Cycle of Long Duration.*—That the method of smoothing out the peaks (which was used above without appreciable error, for the short cycles) cannot be used for the long cycle is evident from equation (8). It is equally evident from Fig. 5 which has been drawn for a cycle of sufficient duration to allow the machine to reach a steady temperature during the running period, and to cool down to the temperature of the surrounding air during the idle period.

In a transformer the cycle is generally of long duration, and, in addition, the time-constants are equal to one another. Equation (8), therefore, becomes

$$\theta_1=\theta_f(\varepsilon^{(t_1+t_2)/T_h}-\varepsilon^{t_2/T_h})\div(\varepsilon^{t_1+t_2/T_h}-1).$$

We have also

$$W_1\div W=(\varepsilon^{(t_1+t_2)/T_h}-\varepsilon^{t_2/T_h})\div(\varepsilon^{t_1+t_2/T_h}-1),$$

from which $$W=W_1(\varepsilon^{(t_1+t_2)/T_h}-1)\div(\varepsilon^{t_1+t_2/T_h}-\varepsilon^{t_2/T_h}).* \quad (11)$$

This assumes that the primary switch of the transformer is opened during the period of rest, which means that during the period of rest there are no iron losses.

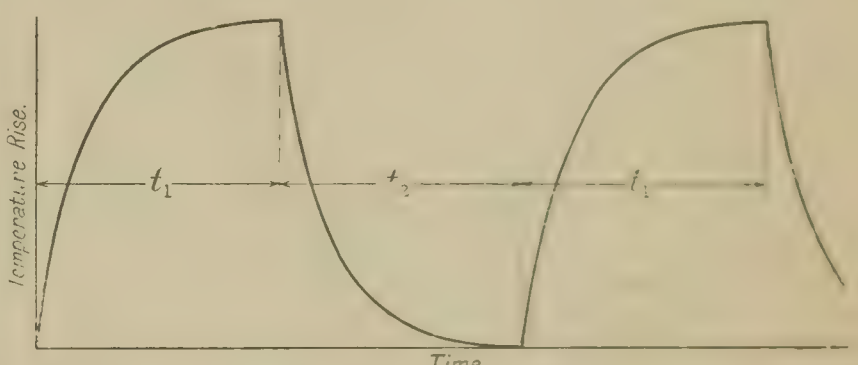


Fig. 5.—Heating and Cooling Curves for a Cycle of Long Duration.

In recent examinations several questions bearing on this subject have been set, and certain of these will now be answered.

Example 1.—A 100 kw. transformer has at full load an iron loss of 1 kw. and a copper loss of 1 kw., with a final temperature rise of 50°C. Its heating time-constant is 10 hours. What is the maximum permissible load for the same temperature-rise if the transformer is alternately worked for 12 hours and switched off for 12 hours?

In equation (11) substitute for $\varepsilon^{t_1+t_2/T_h}$ the value $2{\cdot}718^{24/10}=11$; for ε^{t_2/T_h} substitute the value $2{\cdot}718^{12/10}=3{\cdot}33$, and put $W_1=2{,}000$ watts. Then

$$W=2{,}000(11-1)\div(11-3{\cdot}33)$$
$$=2{,}610 \text{ watts},$$

and the allowable copper loss is thus equal to 2,610−1,000 =1,610 watts. Since copper loss is proportional to the square of the load, and remembering that a load of 100 kw. gives a copper loss of 1,000 watts, we at once write

$$\text{allowable load}=100(1{,}610\div1{,}000)^{\frac{1}{2}}$$
$$=127 \text{ kw.}$$

Example 2.—Two transformers A and B have the same permissible temperature-rise. Transformer A works daily on 100 kw. for 12 hours and is switched off for 12 hours. Transformer B works alternately at 100 kw. for one hour and is then switched off for one hour throughout the whole day. Give the

* In an article in the "E.T.Z." Dec. 20, 1909, E. Oelschläger considered from the thermal standpoint the case of intermittent running on a cycle of long duration, and deduced an expression for the rating.

output at which each transformer could be run continuously for the same permissible temperature rise.

Assume that the heating time-constant of each transformer =10 hours, also that the iron loss in each transformer=1,000 watts, and that the copper loss with a load of 100 kw.=1,000 watts.

$$W = W_1(\varepsilon^{(t_1+t_2)/T_h} - 1) \div (\varepsilon^{(t_1+t_2)/T_h} - \varepsilon^{t_2/T_h}).$$

Transformer A.—We have $\varepsilon^{(t_1+t_2)/T_h} = 2{\cdot}718^{24/10} = 11$; $\varepsilon^{t_2/T_h} = 2{\cdot}718^{12/10} = 3{\cdot}33$, and W=2,000 watts. Therefore

$$2{,}000 = W_1(11-1) \div (11-3{\cdot}33),$$

from which $W_1 = 1{,}534$ watts,

and the allowable copper loss=1,534—1,000=534 watts.

Therefore, load=100(534÷1,000)$^{\frac{1}{2}}$
=73 kw.

Transformer B.—In this transformer $\varepsilon^{(t_1+t_2)/T} = 2{\cdot}718^{22/10} = 1{\cdot}2$; $\varepsilon^{t_2/T_h} = 2{\cdot}718^{1/10} = 1{\cdot}1$, and W=2,000 watts. Therefore

$$2{,}000 = W_1(1{\cdot}2-1) \div (1{\cdot}2-1{\cdot}1),$$

from which $W_1 = 1{,}000$ watts,

and the allowable copper loss=1,000—1,000=0, which means that the transformer B unloaded, but left connected on the primary side, will attain the permissible temperature rise on account of the iron loss alone.

The same result can be obtained by a different line of reasoning. When transformer B is worked at a load-factor of $\frac{1}{2}$

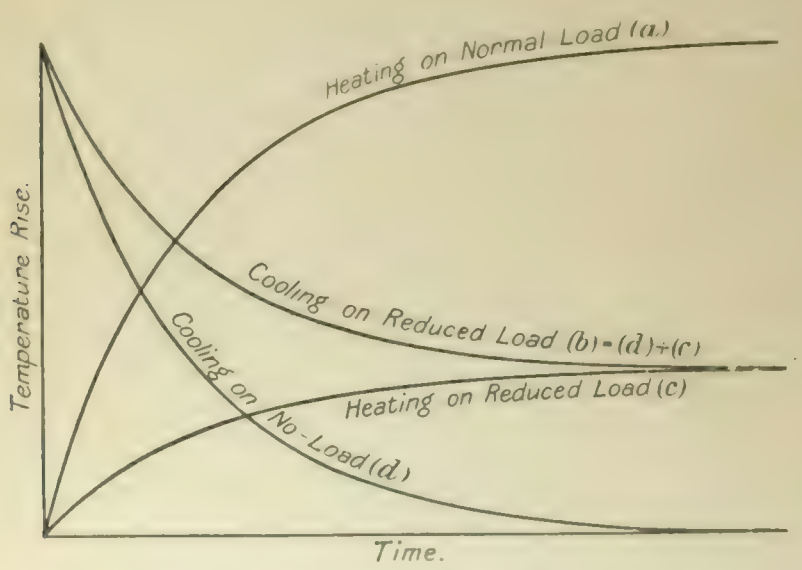


Fig. 6.—Thermal Characteristics on Reduced Load.

on a cycle of short duration, the thermal characteristic is similar to Fig. 3 and the peaks are negligibly small. On a load-factor of $\frac{1}{2}$, the temperature rise is θ_1 C. with a loss of 2,000 watts. Therefore, on a load factor of unity to keep the temperature rise θ_1°C., the loss must be reduced to 2,000/2=1,000 watts.

The very interesting fact brought to light in the last exercise tempts us to give one other problem, namely, a machine worked for a certain period on a certain load followed by another period on reduced load.

If the energy supply instead of being cut off entirely is merely reduced to W_0, the energy dissipated during the period of reduced load is now derived partly from the store $M s \theta_2$ and partly from the supply W_0. We thus have the equation,

$$\theta_2 A k\, dt = W_0 dt - M s\, d\theta_2,$$

which on solving gives

$$\theta = \theta_0 + e^{-kt/T}(\theta_{02} - \theta_0) \quad \ldots \quad (13)$$

where θ_0 is the maximum temperature rise on the reduced load W_0 (a result at once apparent from Fig. 6)

or $$t = T \log_e (\theta_1 - \theta_0)/(\theta_2 - \theta_0) \quad \ldots \quad (14)$$

We have put the heating and cooling time-constants alike and equal to T.

From equation (5) for the heating period

$$t_1 = T \log_e (\theta_1 - \theta_2)/(\theta_1 - \theta_1) \quad \ldots \quad (14)$$

and from equation (6) for the cooling period

$$t_2 = T \log_e (\theta_2 - \theta_0)/(\theta_2 - \theta_0) \quad \ldots \quad (15)$$

From these equations (14) and (15), by eliminating θ_2 and solving for θ_1, we get

$$\theta_1 = \theta_1(\varepsilon^{(t_1+t_2)/T} - \varepsilon^{t_2/T}) + \theta_0(\varepsilon^{t_2/T} - 1) \div (\varepsilon^{(t_1+t_2)/T} - 1),$$

and since temperature-rise and lost power are proportional,

$$W_1 = W(\varepsilon^{(t_1+t_2)/T} - \varepsilon^{t_2/T}) + W_0(\varepsilon^{t_2/T} - 1) \div (\varepsilon^{(t_1+t_2)/T} - 1),$$

from which

$$W = W_1(\varepsilon^{(t_1+t_2)/T} - 1) - W_0(\varepsilon^{t_2/T} - 1) \div (\varepsilon^{(t_1+t_2)/T} - \varepsilon^{t_2/T}). \quad (16)$$

Example 3.—In a 50 kw. transformer the iron loss is 800 watts and the copper loss is 600 watts. The heating time-constant is 10 hours. The transformer is worked intermittently for eight hours under load followed by a no-load period of 16 hours with the primary switch closed. Determine the permissible load.

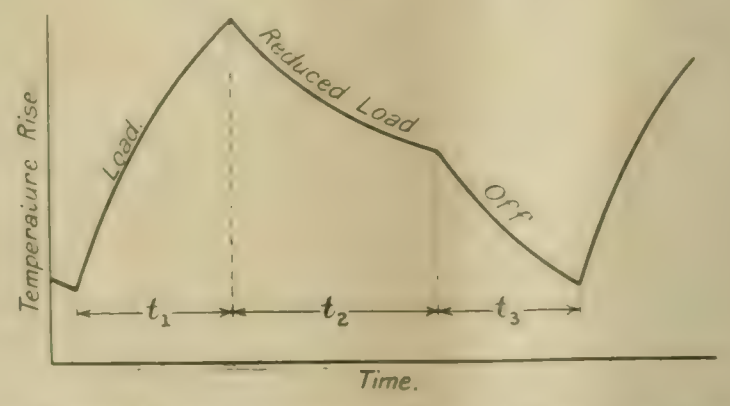


Fig. 7.—Thermal Characteristic of Machine Working on Complex Cycle.

We have $\varepsilon^{(t_1+t_2)/T} = 11$; $e^{t_2/T} = 4{\cdot}93$; $W_1 = 1{,}400$ watts and $W_0 = 800$ watts. Therefore, from equation (16)

$$W = \{1{,}400(11-1) - 800(4{\cdot}93-1)\} \div (11-4{\cdot}93)$$
$$= 1{,}780 \text{ watts.}$$

The allowable copper loss is thus 1,780—800=980 watts, and the permissible load=50 (980 ÷ 600)$^{\frac{1}{2}}$=64 kw.

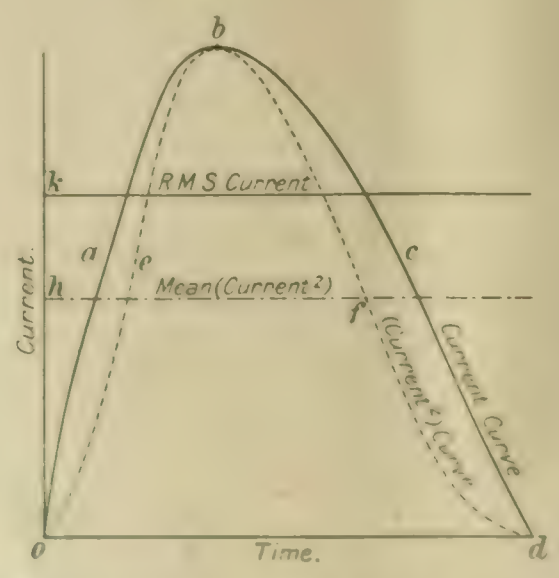


Fig. 8.—Determination of R.M.S. Current.

An extension of the above reasoning enables one to consider the cycle: load, reduced load and off, as shown in Fig. 7. This can well be left as an exercise for the interested reader to tackle at his leisure.

R.M.S. Rating.

When the cycle of operations is sufficiently well defined, the rating of an intermittent motor can be found by the root-mean-square (R.M.S.) method. The principle of the method is most easily explained by means of an elementary example. In Fig. 8 the current is represented by the curve *Oabcd*, and the curve *Oefd* found by squaring the ordinates of the current curve, gives the heating effect at every instant. The mean

height Oh of the curve $Oebfd$ therefore represents the average heating effect of the given current. By taking the square-root of Oh a steady current Ok is found, which, when continuously applied, will produce the same heating effect as the given varying current.

In applying the method, care must be taken to distinguish between heating effect and temperature rise. The heat is not carried away at the same rate all the time, for, at standstill and at the reduced speeds of acceleration and retardation, the ventilation is less than at full speed, and, in consequence, during these times the cooling surface is less efficient. To allow for this, Cheney* suggests that the R.M.S. value of the cycle, deter-

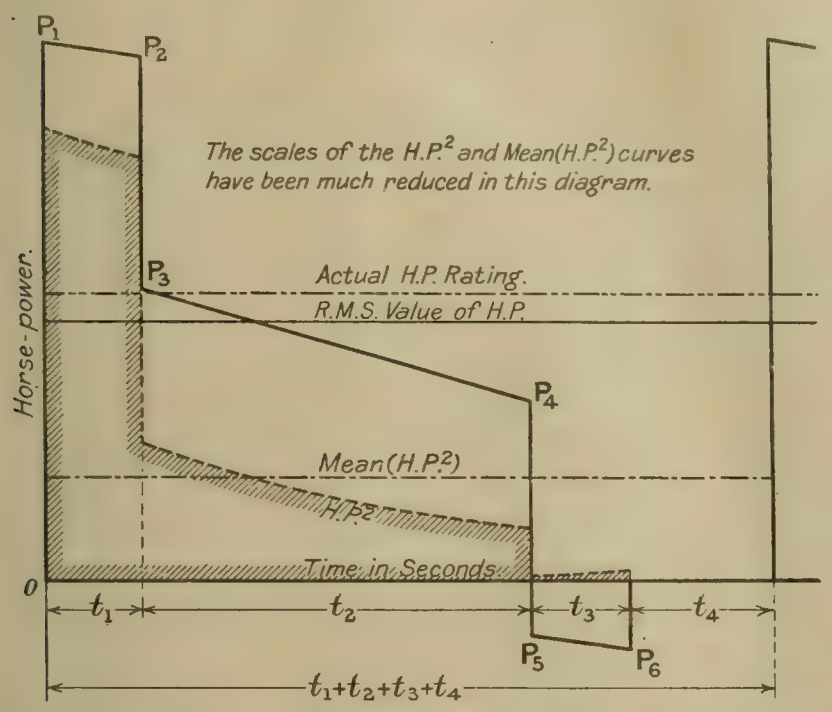


FIG. 9.—THE R.M.S. VALUE OF H.P. AND RATING OF WINDER-MOTOR,

mined in the manner described above, should be corrected by such a factor as shall represent the difference between the average dissipation of heat over the cycle and the dissipation at full speed. This factor depends upon the relative amount of time at reduced speeds and upon the speed and general design of the motor. The determination of the correcting factor falls outside the scope of the present article,

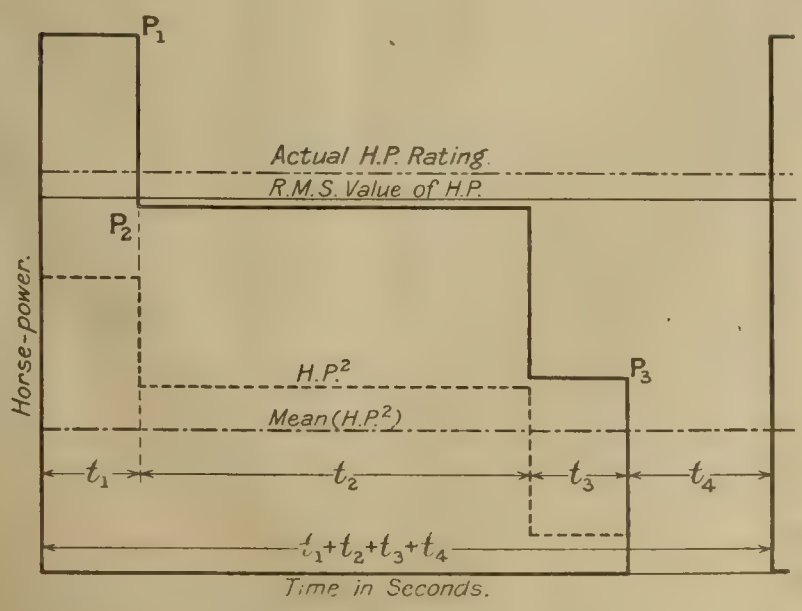


FIG. 10.—R.M.S. VALUE OF H.P., AND RATING FOR A SIMPLE CYCLE.

but, according to Cheney, for a general approximation it may be taken that the cooling during acceleration and retardation is 75 per cent., and during standstill is 50 per cent. of that at full speed. Hence, if the starting, full speed, stopping and standstill periods are t_1, t_2, t_3 and t_4 seconds respectively, the corresponding full-speed value of the cycle of operations will be $t_2+0{\cdot}75(t_1+t_3)+0{\cdot}5t_4$ seconds.

* "Transactions" Am. Inst. E.E., Vol. XXIX., p. 323, 1910.

For a power curve composed of [illegible] (Fig. 9) it can readily be shown that the R.M.S. value is

$$\text{H.P.}_{\text{rms}} = \sqrt{\frac{(P_1^2+P_2^2+P_1P_2)t_1+(P_2^2+P_3^2+P_2P_3)t_2+\ldots}{(P_5^2+P_6^2+P_5P_6)t_5+\ldots}} \quad \ldots \quad (17)$$

Applying the correcting factor, the actual H.P. required is

$$\text{H.P.} = \sqrt[2]{\frac{(P_1^2+P_2^2+P_1P_2)t_1+(P_3^2+P_4^2+P_3P_4)t_2+(P_5^2+P_6^2+P_5P_6)t_4}{t_2+0{\cdot}75(t_1+t_3)+0{\cdot}5t_4}} \quad \ldots \quad (18)$$

For cycles composed of horizontal lines, such as Fig. 10, the above expression for the actual H.P. rating simplifies to

$$\text{H.P.} = \sqrt[2]{\frac{P_1^2t_1+P_2^2t_2+P_3^2t_4}{t_2+0{\cdot}75(t_1+t_3)+0{\cdot}5t_4}} \quad \ldots \quad (19)$$

No matter which of these expressions is used the correct rating can quickly be determined.

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THE ILLUMINATION OF STREETS.

The question of the illumination of streets, which was marked by somewhat heated discussion in this country two years ago, seems now to be receiving less attention, and therefore it is interesting to have a survey of the subject by an American engineer, Mr. T. S. MILLAR. The Paper to which we refer was read before the American Institute of Electrical Engineers, and is reproduced in abstract in our present issue. The chief points to which Mr. MILLAR calls attention are, perhaps, the silhouette effect and the effect of specular reflection. Particular stress is laid upon the importance of objects appearing in silhouette form, and Mr. MILLAR is inclined to take the view that this is the principal way in which objects are seen at night. There is a good deal in this idea, though we do not think it should be pushed to an extreme; otherwise the tendency would be to have our sources of illumination at quite a low level so that everything would appear in silhouette. We cannot think, however, that this would be effective. Although the silhouette is undoubtedly important, the illumination is obviously better when the source of light is placed high. As an extreme case we may take the effect obtained in looking at traffic along a road with the setting sun immediately in front. The illumination in such a case is certainly not so satisfactory as when the sun is higher up, although the silhouette effect is very marked.

Mr. MILLAR calls attention to the fact that many streets now consist of fairly polished surfaces, and consequently artificial light is reflected specularly from them. Where

automobiles are largely used oil is often distributed and enhances this effect. Undoubtedly this specular reflection tends to increase the general illumination, though we doubt if this can be looked upon altogether as an advantage. In the present state of the London streets, with the illumination at a minimum, this specular reflection can be studied very easily. It is equivalent to secondary sources of light below the street surface, which is not an ideal condition, and it results in streaks of light with dark patches between. This renders the difficulty of seeing what is in the dark patches more pronounced. It would be better, of course, if the surface of the street were broken up so as to give diffused reflection rather than specular reflection. The advantage of reflection is that it increases the brightness. In this connection Mr. MILLAR points out that the effective brightness of a street is more important than the ratio of the maximum to minimum horizontal illumination. Undoubtedly the effect as a whole must be studied, but Mr. MILLAR does not define exactly what he means by the effective brightness, which, in the instance he mentions, varies from only 2 to 1, whereas the horizontal foot-candles vary from 10 to 1

The subject of glare is one on which opinions still differ materially. Illumination by reflected light is the only method which gives complete absence of glare, yet complaint is sometimes made that such illumination is unsatisfactory because a bright light source is not visible. This is difficult to understand when we remember that daylight illumination, without sunshine, usually gives less glare than any ordinary artificial lighting, and it is certainly considered satisfactory. No one complains of the monotony of good daylight illumination, even in the open, where shadows are reduced to a minimum. It seems to us, therefore, that where this complaint is made in the case of indirect illumination, either the intensity of the illumination must be too small or the reflecting surfaces must be so placed and so restricted as to give a sense of glare. A case in point will occur to many of our readers, namely, the lecture theatre of the Institution of Electrical Engineers. Here the reflecting surface is too restricted, and therefore gave a sense of glare until it was supplemented by increased top lighting of the direct kind. We do not doubt that if the whole of the top surface could have been used as a reflecting surface no glare would have been noticeable, and the lighting would have been regarded as satisfactory.

REVIEWS.

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Wireless Telegraphy. By A. B. ROLFE-MARTIN. Pp. vi.+256. (London: A. & C. BLACK.) 5s. net.

Of recent years a great number of small books have been published dealing in a popular, but at the same time scholarly way, with various arts and sciences; books which can be read in an armchair, but which require a serious effort for their comprehension by the student; books which, when they bear on branches of physical science, necessarily take much for granted, but do so with a frank statement such as—to quote our present author—"scientists are agreed to consider the effect as due to . . ."; which refrain from all lengthy mathematical analysis, while containing a healthy sprinkling of formulæ expressing the results of such analysis.

The present work departs somewhat from this classification in that a considerable proportion of it—nearly a third— is devoted to a description of the Marconi and Telefunken apparatus. The book no doubt thereby makes a stronger appeal to the operator, and perhaps to the amateur, to both of whom the author hopes it may be of service: but if the space thus occupied had been devoted to a rather deeper penetration into theory, the book would probably have been more suited to the "average student of electrical engineering," to whom the author mainly addresses himself.

The subject matter is well arranged in 15 chapters. A too brief reference to electromagnetic theory and the experiments of Hertz, is followed by a description of Marconi's early experiments, and then by a more or less theoretical exposition of resonance and coupling. A chapter on condensers and inductances, another on detecting devices, and another on receiving circuits come next, and will prove instructive. Probably neither Prof. Fleming nor Dr. de Forest would agree with the author that in America the Fleming valve "has sometimes gone by the name of an audion." The great inferiority in sensibility of the magnetic to the crystal detector is not mentioned.

In the chapter on spark-gaps, the Marconi fixed and rotating gaps and the Telefunken quenching gap are clearly described. But it should be stated that the impossibility of getting regular sparking with the first is due not to fluctuation of the charging voltage, as is suggested, but to inconstancy in the dielectric strength of the gap from moment to moment.

In a not very noteworthy chapter on aerials and earths the author makes a theoretical slip, of a kind of which examples are rare in this book, in saying that non-galvanised iron may not be used because of hysteresis loss. The galvanising removes excessive skin-effect, not hysteresis.

There is a short chapter on directive telegraphy, in which the Bellini-Marconi apparatus is well described and illustrated.

The chapter on continuous or undamped waves is, perhaps, the weakest in the book. There are two misprints; the tikker is wrongly treated as a mere interrupter, in which case it would require a crystal also for detecting sustained oscillation, and it is mistakenly stated to give a musical note, which, owing to haphazard direction of rectification, it does not. The common error is made of putting the key in a Poulsen transmitter at a point of high voltage on the inductance; the efficiency of the Poulsen generator is put at about 14 per cent., which, we believe, is much too low; the Goldschmidt alternator is said to have a hysteresis loss proper to each stage of frequency, whereas the inventor has shown that the last stage only is accompanied by iron loss; and, finally, in weighing continuous against spark systems, nothing is said of the modern heterodyne and other methods of reception.

There is a good chapter on damping and decrement.

There are two appendixes; one giving the Morse code, &c., the other on the electrical units, for which many readers of the book will be grateful.

The illustrations are numerous; of these the photographic reproductions are not very good—perhaps owing to the rough paper—but the line-drawings are quite clear. The book is well written from a literary point of view, and is very readable.

L. B. T.

The Standard Handbook for Electrical Engineers. Edited by F. F. FOWLE. Fourth edition. (New York: McGraw-Hill Book Co.) Pp. xvi.+1984. 21s. net.

The third edition of this well-known handbook was reviewed in these columns about four years ago. The present edition embodies so many changes and so much new matter that it is virtually a new book; but the general features and scheme of arrangement have been retained. That considerable additions have been made in the text is evident from the fact that the number of pages has been increased by about 500. From the list of contributors to the various sections it appears that the services of many eminent American engineers have been secured, and this gives one a feeling of confidence with regard to the vast amount of data in the book.

A brief outline of the changes and additions is given in the following note. Sections 1 to 5 inclusive cover the same general ground as in the third edition, but have been practically

re-written and considerably extended. Sections 6 to 9 inclusive, although embracing the same subjects as Sections 6 to 8 in the third edition, have been entirely re-written and amplified and made to conform to a revised classification. Section 10 covers the same general subject matter as the corresponding section in the last edition, but is entirely re-written and greatly enlarged. Sections 11 and 12 cover the same ground as Section 11 in the third edition, but are entirely new and much more comprehensive. Section 13 replaces Section 18 in the old edition, being entirely re-written; Section 14 replaces Section 12, with entirely new material; Section 15, on Industrial Motor Applications, is a new section with entirely new subject matter. Section 16 covers the ground of Section 13 in the third edition, and has been revised.

Electric vehicles and electric ship propulsion are dealt with in the two following sections, both being new. Section 19 replaces the old section 14, many portions of it being re-written. Section 20 takes the place of old Section 9 with new material, and Section 21 replaces old Sections 15 and 16, also re-written and altered somewhat in scope. Section 22 takes the place of the old Section 17 with practically new material throughout. Section 23 deals with mechanical matters and is new. Section 24 corresponds to Section 19 in the last edition, and the last section, on General Engineering Economics and Central Station Economics, is entirely new. Section 20 in the former edition has been abandoned and its contents, or their revised equivalents, have been distributed among other sections. The general get-up of the book leaves nothing to be desired. This and the excellence of the subject matter, together with the rational grouping and classification, makes the book worthy of its title.

Electric Railway Handbook. By A. S. Richey. (London: Hill Publishing Co., Ltd.) Pp. xi.+832. 17s. net.

In the preparation of this book the author has aimed at getting together information which the railway engineer frequently requires, and which hitherto has meant an extended search through engineers' handbooks or through the files of technical journals and proceedings of engineering societies. It is a great convenience to have such information in a single volume. At the same time, the requirements of the non-technical manager or operator have not been overlooked. The division of the matter into 12 sections will be appreciated by many readers. The ground covered in these sections includes road bed and track, buildings, train movement, railway motors, controlling apparatus, current-collecting devices, trucks, braking, rolling stock, transmission and distribution, and signals and communication.

The volume is not burdened with many of the subjects entering into electric railway engineering, and which are already well covered by existing books. For instance, it has not seemed wise to include detailed material relating to power plants, although such matters as the influence of amount and character of load on the capacity and location of power plants and sub-stations are given due consideration in connection with such subjects as power requirements, energy consumption, feeder lay-out and so forth. In the section devoted to buildings, the field of the architect has been entered practically only so far as electric railway building problems may differ from others. In our opinion, these and many other omissions increase the value of the work. Many fully dimensioned drawings are given, and although these relate to American practice they will nevertheless be helpful to British railway engineers, since main-line electrification on this side has not been sufficiently developed to enable engineers profitably to discuss such questions as standardisation of details. Much material has, with acknowledgment, been taken from standard books and publications. The quality of this material may be gauged from the fact that the sources include the American Electric Railway Engineering Association, the National Electric Light Association, and the files of the "Electric Railway Journal." In the next edition we should like to see an account of the practice of some of our own railways. The book is well got up and contains an excellent index.

THE USE OF ACCUMULATORS IN ALTERNATE-CURRENT STATIONS.*

BY L. SCHRÖDER.

The present Paper describes experiments made to test the uses of batteries in alternate-current work. The main ideas have been laid down in the German patent No. 161,805, and are shown diagrammatically in Fig. 1. Here G is the polyphase machine supplying power to the 'bus bars. D is a direct-current dynamo, forming a portion of the motor-generator set MD; the battery is connected up as shown. Naturally, such a simple arrangement without accessories does not allow the battery to produce a sufficient effect with a change of load on the 'bus bars. A series transformer is, therefore, introduced into the network, as shown at T, the secondary of which leads to the rotary R. The current from the rotary is nearly proportional to the current in the network, and is used for regulating the auxiliary machine Z by passing through its magnet windings *ab*. This auxiliary machine has also a second magnet winding which is fed from the battery. The two windings oppose one another; they exactly neutralise one another when the network carries its mean load. As the load in the network increases the winding *ab* gets the upper hand, so that the auxiliary machine Z enables the battery to discharge; thus the battery enables the dynamo D to drive the motor-generator set, so that the alternate-current machine M delivers current to the network. On the other hand, when the load in the network falls the battery is charged. A Danielson rotary is preferably used in the place of an ordinary rotary as a regulating machine; its action can be explained in the following way.

Let us suppose a polyphase current to be sent through a polyphase machine at rest, a rotating field is then produced in the armature. If the armature is synchronously rotated in the opposite direction, a fixed magnetic field will be present in the armature, *i.e.*, one that is fixed in space. The magnet poles will be opposed to this magnetism of the armature, and are so strongly excited that at mean load the two counterbalance one another. If the current in the network is increased the armature magnetism out-balances the

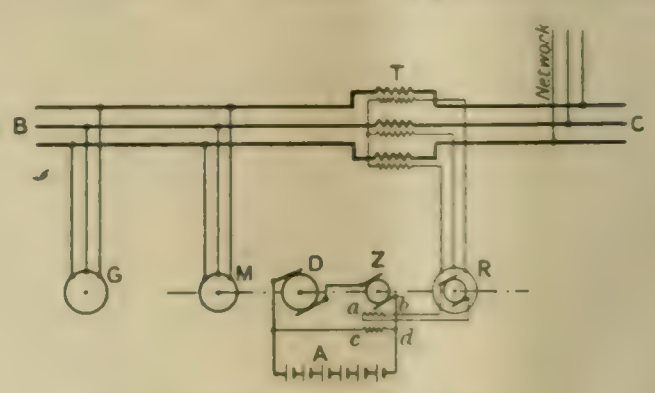


Fig. 1.—Connections to the Network.

other, the current from the auxiliary rotary flows in a definite direction, which is the opposite of that which results when the current in the network is below the mean. This current from the regulating machine R, which is nearly proportional to the change of the current in the network, is used for regulation purposes by exciting the machine Z. The machine Z is, therefore, excited in a manner which depends on the load on the 'bus bars and thus contributes to maintain the balance. The Danielson rotary has, therefore, certain advantages as compared with the ordinary rotary. For the working of the regulating machine Z it is only necessary to have one magnet winding in place of the two which would otherwise require to be used.

Fig. 2 shows a Danielson rotary and the necessary connections. Wooldridge has suggested that the effect of the Danielson rotary can be emphasised by using an extra pair of brushes *tu* in addition to the ordinary pair *ew*, the two sets being at right angles to one another. The ordinary brushes *ew* are short-circuited, as shown. The results may be described as follows: When there is a load, corresponding to the mean, on the network, the voltage of the Danielson rotary between the brushes *ew* is zero. As soon as there is a deviation from the mean there is a voltage between the brushes. Seeing, however, that they are short-circuited, a heavy current goes through the armature, producing a strong magnetic field, which is at right angles to the original one. This strong magnetic field produces a higher voltage, which produces an effect on the second pair of brushes. This results in the excitation of the auxiliary machine Z. This arrangement produces, therefore, a magnified effect on the output of the regulating machine. This effect is particularly marked if the series transformer is inserted, not in the network, as shown in Fig. 1, but in the modified way, shown in Fig. 2. In such a case

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 6 and 7, 1915.

there are far smaller fluctuations in the current. The second pair of brushes in this case produce very useful effects on the working of the Danielson rotary. The voltage of the direct-current machine D is thus so regular that one can in this way effect the normal excitation of the machines. Thus the machine G is excited by the winding *rs*, M by *pq*, D by *lm* and R by *ik*. The Danielson rotary has a compound winding besides the winding *ik*, as shown at *gh*. The direct-current machine D has also a compound winding *no*. The auxiliary machine Z is excited firstly by the winding *ab* from the regulating dynamo, secondly by the compound winding *ef*, and thirdly by the self-excitation *cd*. It has already been remarked in another publication that with a constant current the voltage of a battery falls quickly during the first instant of discharge, and it rises correspondingly during the first moments of charge. This results from polarisation effects. In Fig. 1 the regulating rotary R depends on the current in the network, and not on the change of voltage in the battery. It cannot, therefore, oppose the polarisation effect. For this purpose the self-exciting winding *cd* is added to the auxiliary machine Z. It is necessary to lay special stress on the value of this self exciting winding; cases have arisen in which there has been some defect in the working of an installation, and this has been found to be due to the lack of this winding. In the course of various tests the idea has suggested itself to apply the principle of the Lancashire machine to the problem of alternate-current battery buffers; this had hitherto never been done in practice. By means of the self-exciting winding in the present problem one has the same advantages as the Lancashire machine has as compared with that of the Pirani type.

The Paper also contains a considerable series of tests with arrangements of the kind already described, from which the following results are extracted. The test shown in Fig. 3 relates to a battery consisting of 106 cells with a discharge rate of 259 amperes for one hour. The network had an inductive load with a power factor of 0·85. The normal load of the network was 35 kw., as is shown at the beginning

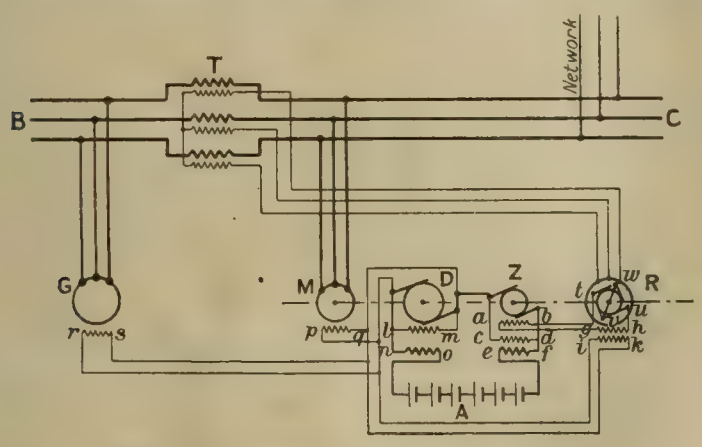


FIG. 2.—ALTERNATIVE CONNECTIONS.

of the curve in Fig. 3. The output of the polyphase machine was 43 kw., showing that the battery set took 8 kw. The load on the network is shown by the curve to increase to 108 kw., which is more than three times the normal load. At first readings were taken every five minutes, but towards the end at intervals of 20 seconds. It shows that the battery cut in and out in a very satisfactory manner. The output and voltage of the polyphase machine remain constant even after the battery has been charged or discharged for five minutes; this is to be ascribed to the important effect produced by the self-exciting winding *cd* on the auxiliary machine Z. At the beginning the buffer tests were ordinarily carried out with an unloaded network, with a normal load, and with a maximum load, *i.e.*, under the most variable conditions for the battery. But it was found that even if these tests went off satisfactorily there were intervening stages in which there were other phenomena not so satisfactory, such as a kind of hunting, or perhaps sparking. A different plan was, therefore, adopted, in which there was a steady change of load by gradual degrees, the changes of load being, therefore, relatively small and either up or down. Such a test is indicated in Fig. 3 by the portion on the curve of the load in the network between the points *a* and *b*. Let us consider the output of the polyphase machine and the voltage of the network. With a variation of the load on the network for five minutes between zero and 84 kw. the output of the polyphase machine varied from the mean by 7·25 per cent., and the voltage of the network varied from the mean by 2·15 per cent. Similarly with a variation of the load on the network from zero to 108 kw. for 20 seconds, the output of the polyphase machine varied on both sides of the mean by 9·5 per cent. and the voltage of the network by 4·4 per cent. Smaller fluctuations than these seem in general to be impossible; if an attempt is made to get a steadier voltage on the network, then we get greater variations in the polyphase machine. Thus in another test with a variation of load on the network from zero to 80 kw., for five minutes, the output of the polyphase machine varied from the mean by 11·1 per cent., while the voltage on the network varied by 1·7 per cent. Again, with a variation of load on the network from zero to 121 kw. for 30 seconds, the output of the polyphase machine varied by 14 per cent., while the voltage on the network varied by 3·6 per cent. Thus we get worse results for the machine output, but a smaller voltage on the network. It may be mentioned that the proper discharge rate of the battery in these tests was greatly exceeded; but this was done for the purpose of taking an extreme case. Tests were also made with the motor-generator driven synchronously and asynchronously; in both cases the series transformer was inserted in the network, as shown in Fig. 1, as well as in the manner shown in Fig. 2. In all cases similar results were obtained and stable running was found in every case. But the tests with asychronous running were not carried to such extreme limits of load on the network, though it may safely be assumed that it could have been done if desired. But with asynchronous running it ought to be borne in mind that the Danielson rotary requires synchronous running. If an asynchronous machine is taken for the purposes of work of this character, the Danielson rotary ought not to be mounted as shown; a special synchronous motor would have to be used. In this case the three main machines, consisting of the motor-generator and the auxiliary machine, are mounted on one spindle; the regulating machines, consisting of the synchronous motor together with the Danielson rotary, are then mounted separately on another spindle.

Another figure (not here reproduced) shows how a rotary can be used instead of a motor-generator. The general arrangement is almost exactly similar to that already discussed. The direct-current voltage of the rotary is sufficiently uniform to be capable of being used for the excitation of the polyphase machine; thus the excitation takes place through the rotary and no special exciter is needed. Tests, for which figures are given, were carried out with this arrange

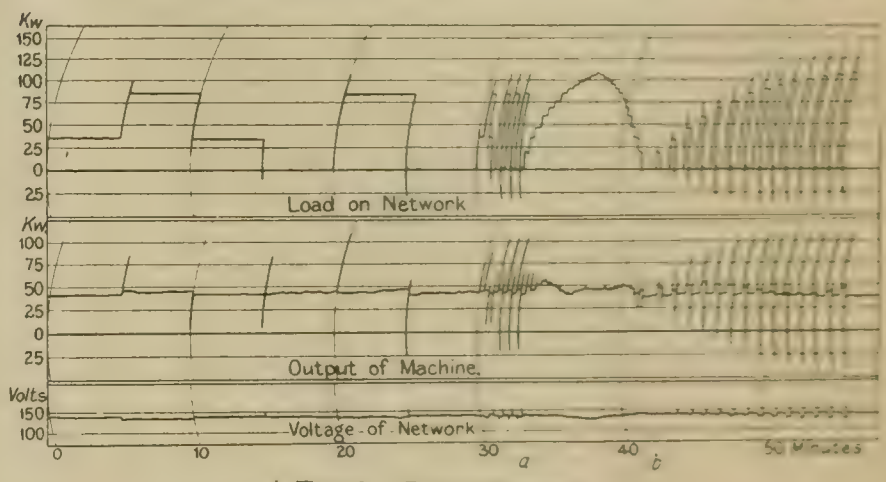


FIG. 3.—LOAD CURVES.

ment with satisfactory results; the discharge rate of the battery was taken to 1·78 times its proper value. Above this there was a danger of hunting. This was doubtless due to the Danielson rotary, because as soon as this was cut out and the regulation was done by hand all signs of the hunting ceased.

The various machines herein described were made specially for the tests, or rather were bought for that purpose. It is evident that they were not all equally suitable for the various nature of the conditions under which they were used; thus the results in practice might be better than here shown.

SUPERIMPOSED OR "PHANTOM" TELEPHONE CIRCUITS.

Summary.—The advantages and economies of superimposed or "phantom" telephone circuits are discussed in this article. The balancing of existing telephone circuits and the apparatus (retarding coils) required to obtain a successful working of "phantom" circuits are described in detail.

It is well known that increased transmission facilities may be obtained by superimposing on two existing telephone lines without providing additional wires, or, in other words, by making two telephone circuits do the work usually done by three such circuits. The economies possible by the use of superimposed circuits have made this a subject of considerable importance to telephone companies and telephone administrations. In the past, a coil of similar construction to the "hedgehog" type of transformer has been largely used for this purpose. With the increasing length of telephone lines and the public insistence on a high standard of efficiency, a demand has arisen for a coil, designed on scientific lines, which will admit of circuits

being superimposed without serious diminution of the efficiency of the original physical circuits. It is the purpose of this article briefly to outline the practical features of superimposed circuits, and to describe the apparatus which has been developed for use in such circuits.

Superimposed Circuits.—The superimposed circuit, in its simplest form for local battery working, is shown, diagrammatically, in Fig. 1. The two metallic circuits, M and N, are referred to as the physical (or side) circuits, the third circuit, resulting from their combination, is called the superimposed or "phantom" circuit. By means of the arrangement shown, three simultaneous telephone messages may be transmitted

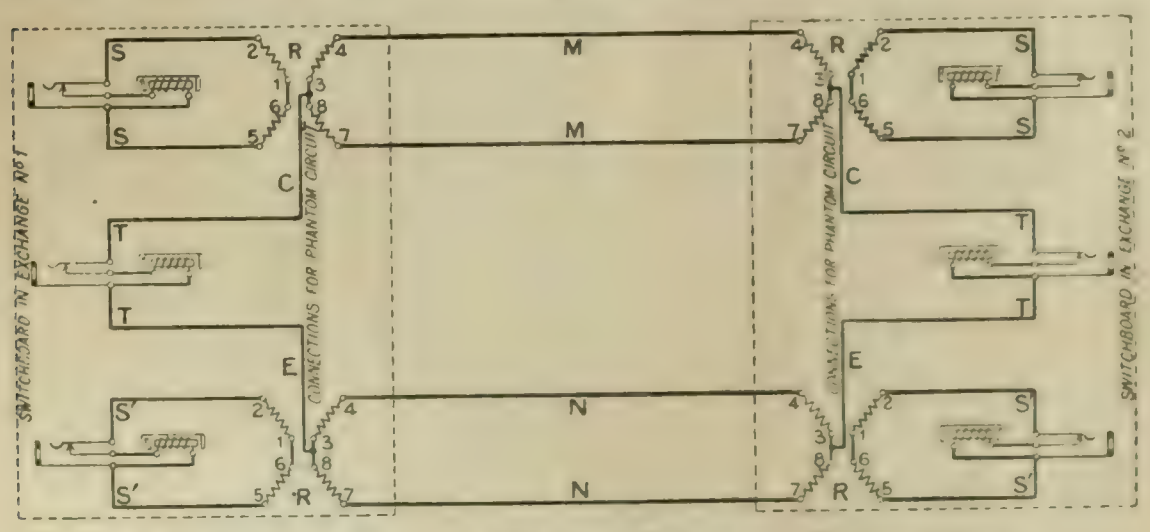


Fig. 1.—Outline Wiring of a Phantom Circuit for Magneto Lines Connecting Two Exchanges.

over the two physical (or side) circuits. One message may be sent over each of the physical circuits, and the third over the superimposed or combination of the two lines. The successful use of superimposed circuits necessitates, however, the introduction into the physical circuits of specially designed and well balanced repeating coils. Four of these repeating coils are required, one at each end of the two side circuits, the repeating coils being connected as shown in Fig. 1. The repeating coils R are shown connected to the switchboard terminals S and S′, on one side, and to the line terminals M and N on the other side. The connecting leads C and E join the middle points of the line windings to the switchboard terminals, T, of the superimposed circuit. It will be noted that the system is arranged symmetrically (as regards the various instruments and conductors involved) in such a manner that the terminal of each of the connecting lines to the superimposed circuit connects equi-potential points of the system with respect to all other terminals. This feature is essential to ensure the perfect balancing of the system. It is, however, equally important that the repeating coils introduced, should be so designed as to obviate the introduction of mutual disturbance between the regular subscriber's stations S and S_1, and the superimposed subscriber's station T. For common-battery working a somewhat similar circuit arrangement may be used.

For rural line circuits, where there are a number of telephone sets bridged across each physical circuit, the superimposed circuit may be formed by means of repeating coils and retardation coils, as shown in Fig. 2. Here the repeating coil R is connected as in Fig. 1, while a balanced retardation coil, D, is bridged across the line at the point from which the superimposed circuit is to be brought out.

It is commercially possible to utilise a superimposed telephone circuit for telegraph purposes, and one method of accomplishing this is shown, schematically, in Fig. 3. Intertelegraph between the telephone and telegraph is avoided by means of a system of balancing, using impedance coils and condensers in the combinations shown. The two telegraph circuits thus obtained may be worked duplex so that four telegraph messages may be transmitted simultaneously with three telephone messages. It may be mentioned here that, by a modification of the arrangement, shown in Fig. 3, placing the telegraph circuits on each metallic wire, it is possible to obtain four telegraph and three telephone circuits. As each telegraph circuit may be duplexed, a total of 11 simultaneous messages may be transmitted over the existing four wires.

Repeating Coils.—The first requisite, in order to establish well balanced and efficient superimposed circuits, is to have the metallic lines in perfect condition. The necessary precautions, which must be taken to secure this balance on existing lines (or on lines to be constructed) are dealt with under the heading of Line Construction. Having obtained the required balance in the telephone lines proper, it is equally important to insert repeating coils, which have been specially constructed for this purpose. A repeating coil, in order to be suitable for superimposed working must possess the following characteristics, enumerated in the order of their importance:—

(*a*) Perfect electrical balance.

(*b*) High efficiency, both for transmission and ringing.

(*c*) Low ohmic resistance.

(*d*) High insulation between the various windings.

The Western Electric Company a number of years ago produced a repeating coil, known as the No. 37—A, which was designed to embody all these characteristics. This coil was designed primarily with a view to obtaining a high ringing efficiency on long open wire and cable trunk lines, and it has been largely used for this purpose. In order to obtain the required ringing efficiency it was necessary (at the time when this coil was designed) to make the coil of somewhat large proportions. Recent development work has resulted in a substantial reduction in dimensions, and a repeating coil has been designed, which, although considerably smaller in bulk, is more efficient, in every respect, than the older pattern. It is known, commercially, as the No. 4006–A Repeating Coil. The two coils are shown in Fig. 4, the scale, placed alongside in this photographic reproduction showing the difference in dimensions.

Each coil is provided with the wiring diagram shown in Fig. 5. The numbering of terminals is related to the direction of each winding in accordance with the following simple and

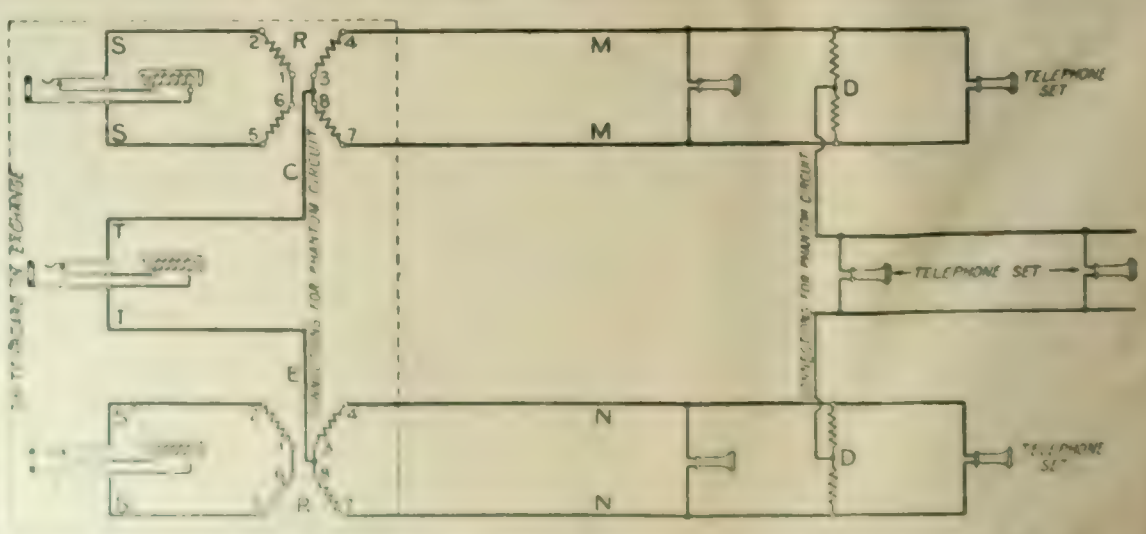


Fig. 2.—Outline Wiring of a Phantom Circuit for Long Magneto Subscriber Lines. (Limited to Code Ringing.)

specific rule. Connecting an *even*-numbered terminal of one winding to an *odd* numbered terminal of another winding, ensures that these two windings become connected *inductively* in series. It will be seen that there are four separate and accessible windings on this repeating coil. When connected for superimposed working these windings are joined, two and two, the middle point being brought out to form the line, leading to the superimposed circuit. The connections obtained are shown in Fig. 6. The winding designated 1, 2 in Fig. 6 is formed by connecting terminals 1 and 6 in Fig. 5, thereby

making one series winding 2, 1, 6, 5. By the joining up of terminals 3 and 8 in Fig. 5 a series winding 4, 3, 8, 7 is obtained, corresponding to the connection A, C, B in Fig. 6. It should be noted that terminals 1 and 2 in Fig. 5 are not the same as those designated 1 and 2 in Fig. 6. The nomenclature, shown in Fig. 6, is the one adopted by the Post Office, and as their

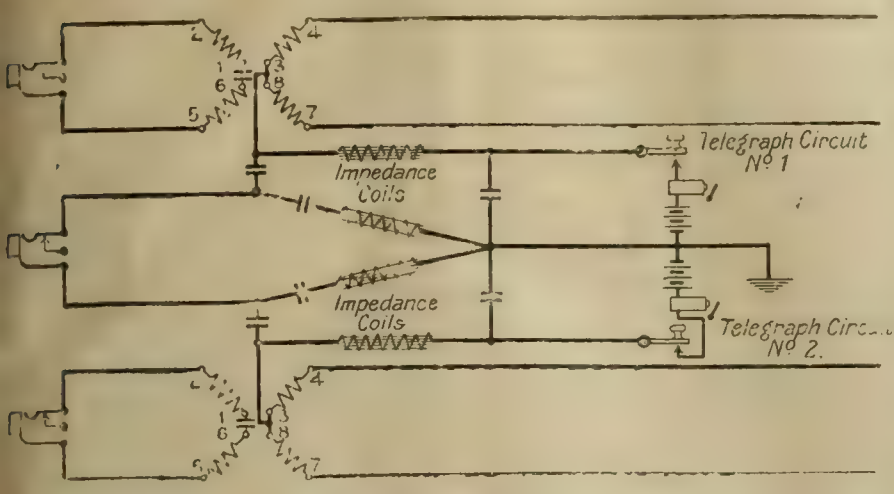


FIG. 3.—ARRANGEMENT FOR SENDING THREE TELEPHONE AND EIGHT TELEGRAPH MESSAGES SIMULTANEOUSLY OVER FOUR WIRES.

method of testing this repeating coil will now be described, it will simplify matters if we adhere to the Post Office notation.

In the "Post Office Electrical Engineers' Journal," July, 1915, the following description was given of the tests, specified by the Post Office for coils of this type which they use in connection with loaded superimposed circuits.

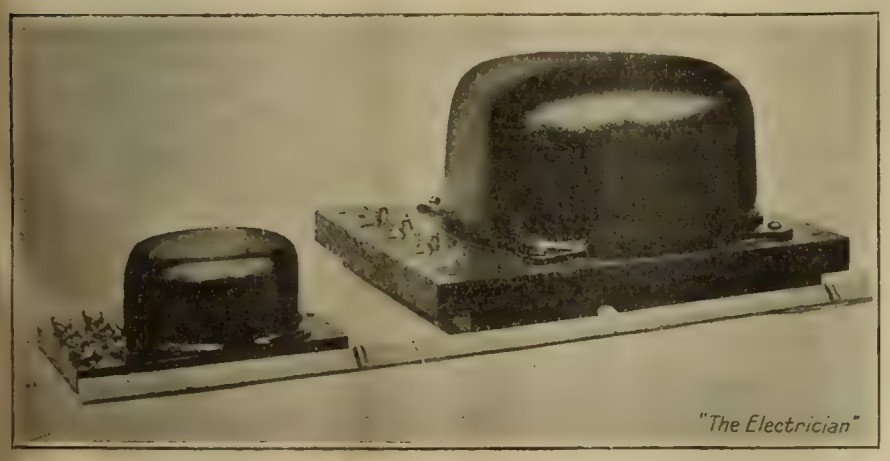


FIG. 4.—RELATIVE SIZES OF REPEATING COILS NO. 37-A AND NO. 4006-A.

No. 1.—*Test for Winding.*—The connections for this test are shown in Fig. 7. A single dry cell is connected, through a key, to terminals 1 and 2. Terminals A, C and B, C are connected in turn to a galvanometer "G," and on depressing the key the "throws" on the galvanometer should be in opposite directions for the coils compared. A similar test is made with terminals

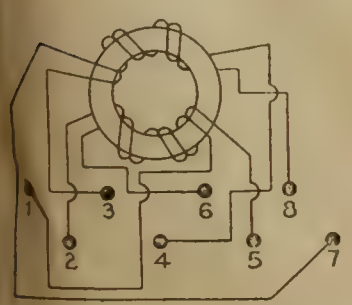


FIG. 5.—WIRING DIAGRAM OF No. 4006-A REPEATING COIL.

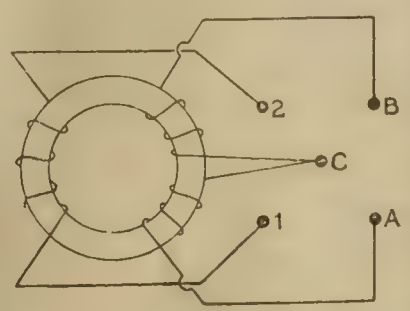


FIG. 6.—REPEATING COIL No. 4006-A, CONNECTED FOR "PHANTOM" WORKING.

A, C connected to the battery, and B, C and 1, 2 connected in turn to the galvanometer; 1 to the same terminal as B and 2 to the same terminal as C. The "throws" on the galvanometer should now also be in opposite directions for the coils compared

No. 2.—*Measurement of the Difference between the Capacities* of the two halves of the winding A, B to the winding 1, 2. The apparatus used is an alternating-current bridge consisting of 5,000 ohms non-reactive ratio arms, and two variable air condensers. Current is supplied to this bridge from a "buzzer" through a balanced and screened transformer. Before making

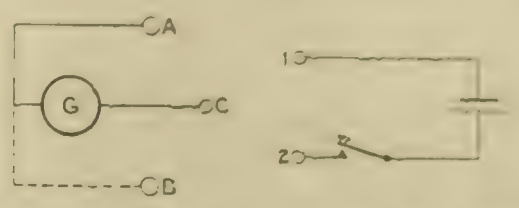


FIG. 7.—TEST FOR DIRECTION OF WINDINGS.

a measurement on the repeating coils it is necessary to balance the two variable air condensers, as shown in Fig. 8. Condenser No. 1 is set in the middle of the scale, and a balance is obtained by varying condenser No. 2 until absolute silence exists in the receiver. The bridge is then joined up, as shown in Fig. 9, and a balance is obtained by varying condenser No. 1. The

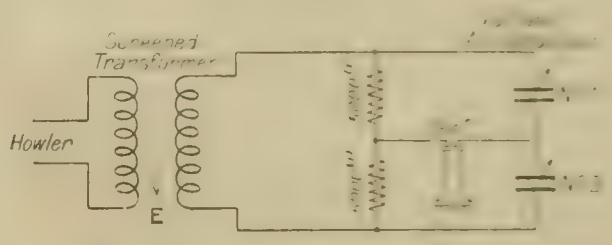


FIG. 8.—BRIDGE FOR MEASURING OUT-OF-BALANCE CAPACITY BETWEEN WINDINGS OF REPEATING COIL.

reading on condenser No. 1 will then be a measure of the out-of-balance capacity between the two halves of the primary and secondary windings, and this should not exceed 10 micro-microfarads.

Note.—The requirement of an out-of-balance capacity not exceeding 10 micro-microfarads is only considered necessary where the superimposed circuit is loaded. For non-loaded

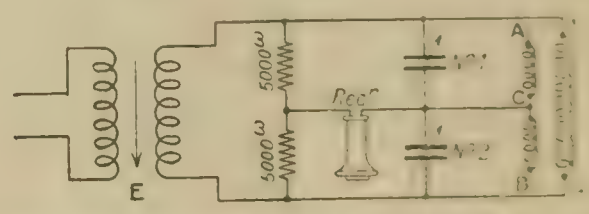


FIG. 9.—REPEATING COIL UNDER TEST FOR OUT-OF-BALANCE CAPACITY.

superimposed working the repeating coils used are allowed to show an out-of-balance capacity of 30 micro-microfarads.

No. 3.—*Effective-Resistance Balance.* For tests of effective resistance balance the terminals are connected as shown in Fig. 10. With 50·05Ω non-reactive ratio arms, balance must be obtained on the slide wire between two points 0·025Ω from the centre of the scale. This is equivalent to a ratio between the limits of 1·001 and 0·999.

No. 4.—*Impedance Balance.*—For the test of impedance balance the terminals are connected as shown in Fig. 11.

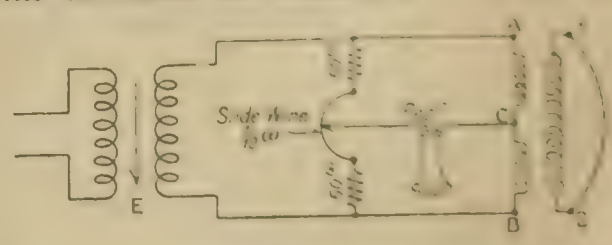


FIG. 10.—METHOD OF TESTING EFFECTIVE RESISTANCE BALANCE OF WINDINGS IN REPEATING COIL.

With 5,000·05Ω non-reactive ratio arms, balance must be obtained on the slide wire between the same limits as in Test 3. This is equivalent to a ratio between the limits of 1·00001 and 0·99999.

No. 5.—Power Efficiency.—The power efficiency is tested with a sine-form alternating current at two frequencies, such that $2\pi f$=100 and 5,000. The test at the lower frequency is made with 80 volts impressed upon either the winding A, B or

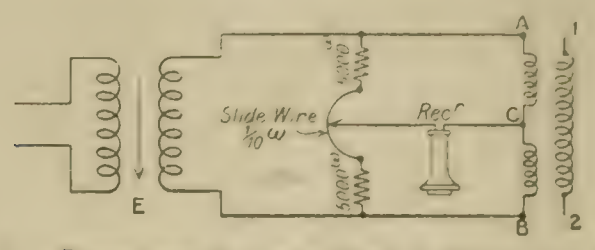


Fig. 11.—Impedance Balance Test of Repeating Coil.

1, 2, whilst a non-reactive load of 1,000 ohms is connected across the other winding. The efficiency under this condition, and when the windings are interchanged, must not be less than 55 per cent. The test at the higher frequency is made under

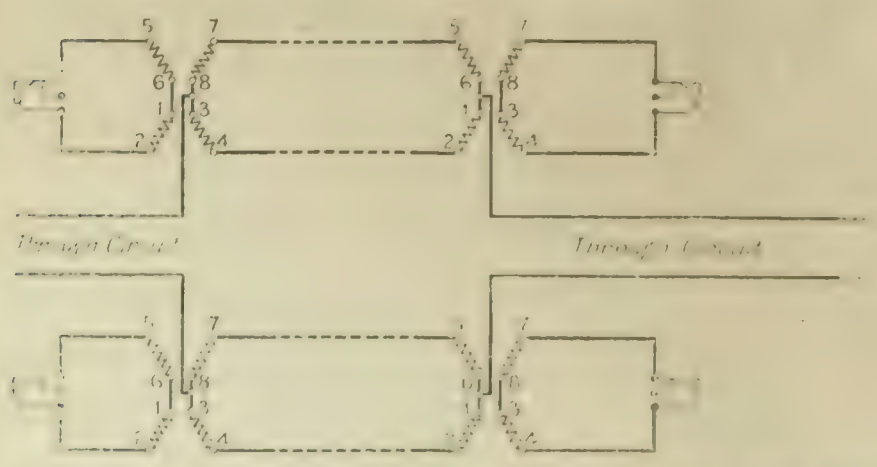


Fig. 12.—Portion of a Through Circuit, which has been made available for Superimposing for a short distance.

similar conditions, except that the testing current is 1 milliampere, and the efficiency must not be less than 80 per cent.

No. 6.—Insulation.—The direct-current insulation between the windings A, B and 1, 2, tested from the terminals of the

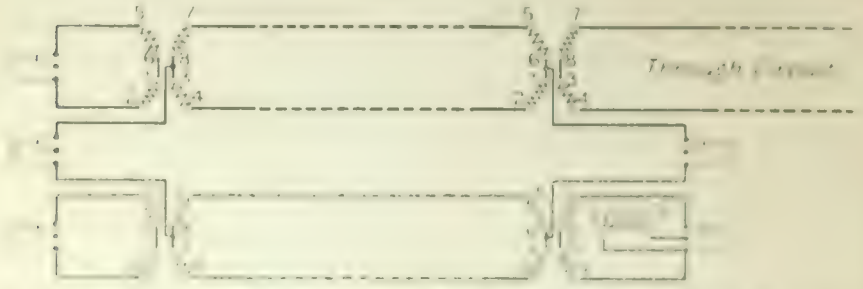


Fig. 13.—Through Circuit, partly Superimposed from one Terminus.

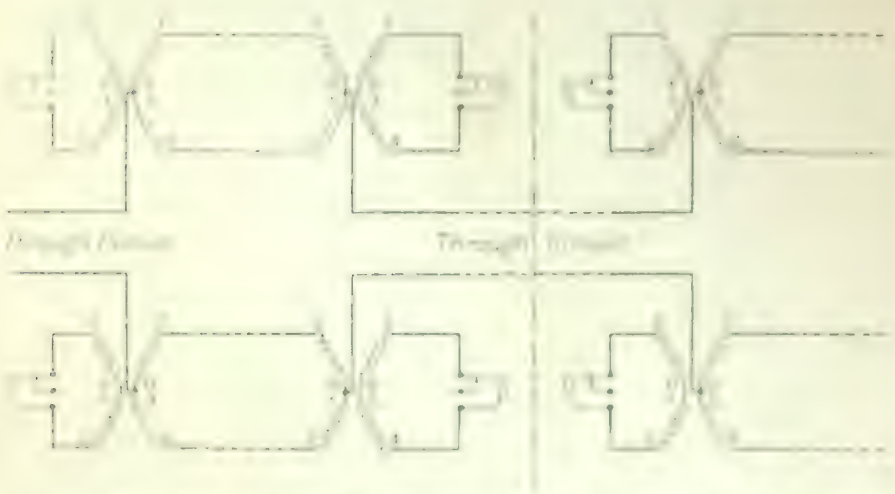


Fig. 14.—Long Through Circuit, which is available for several superimposed circuits, but leaves the intermediate points

completed instrument, must not be less than 100 megohms when tested with 100 volts.

Practical Applications.—It would be impossible to give a complete list of the numerous combinations which arise in the application of superimposed circuits, but a few typical examples are shown in Figs. 12 to 14. The principle of superimposed working is especially applicable to certain cases, such as for long distance work where the volume of business is such that two circuits usually suffice, but where there is an occasional demand for an extra circuit. In this case the superimposed circuit may be used as a call-wire circuit as occasion demands. Superimposing is also very advantageous for use in connection with a traffic in places where, for a short period each year, there is a much heavier demand than can be met with the maximum circuits warranted by the yearly traffic.

(To be concluded.)

CORRESPONDENCE.

THE DESIGN OF TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the article on "The Design of Stationary Transformers," by Messrs. Cabot and Cairns, published in your issue of the 1st inst., there are some errors which may be worth noting for the benefit of designers who wish to employ their method. The reference towards the bottom of the first column of page 945 to Fig. 2 should read Fig. 1; and, in this latter figure, in the last line but one under the heading "Punchings," 1·5D is in both cases a slip for 0·15D. Again, the core dimension 0·55D should be 0·53D in order to give (as is evidently intended) a symmetrical core section. Further, the figure in the yoke height should be 1·85 instead of 1·84. These corrections will involve changes in all the formulæ for the punchings. It may be noted, too, that by suitable arrangement it is easy to reduce the number of these formulæ from 12 to 8.

A point with which the authors of the Paper have not dealt is that the best result is obtained by using an *unsymmetrical* section for the core. With a yoke of double the area of the core the departure from symmetry should be greater than in the usual type.—I am, &c.,

Sunderland, Oct. 16. W. Tolme Maccall.

TRANSFORMER CORE LOSS AS AFFECTED BY TRIPLE HARMONICS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the issue of The Electrician for September 17th I notice that a Paper entitled "Transformer Core Loss as Affected by Triple Harmonics," was read before the British Association by Messrs. H. M. Lacey, B.Sc., and C. H. Stubbings, B.Sc. One would gather from a perusal of the Paper, as published, that the authors consider the experiments they describe to be novel, as they make little reference to previous work on the subject. I should like to point out, however, that the effects which they describe were first pointed out by me in an article entitled "Wave Shapes in Three Phase Transformers," published in The Electrician 10 years ago on November 19th, 1905. A further article appeared on January 5th, 1906, and some correspondence on May 18th of the same year. Since those dates there have been several Papers and articles published by others making reference to these effects and their practical bearing, both in English and American journals. It appears to me rather extraordinary that Messrs. Lacey and Stubbings did not, apparently, look up records of previous work on the subject before writing their Paper. If they will do so they will find, incidentally, that any advantage in pressure rise to lower iron loss in a star-to-star transformer may be more than offset by other disadvantages due to triple harmonic voltages existing between line wires and earth.—I am, &c.,

Chesterfield, Oct. 4. E. C. Cahill.

THE "DISCHARGE TUBE" USED AS A WIRELESS VALVE.

BY G. W. WHITE, M.SC.

All "gas valves" used up to the present utilise the electron emission from glowing filaments as the telephone current, this current being influenced by potential changes on a metal grid or gauze through which it must pass to the anode. The author has been successful in using the current set up when two ordinary electrodes are fixed opposite one another and maintained at a high P.D. in a rarefied gas. To obtain the necessary big current for convenient values of the P.D., a large vessel should be employed, and an intermediate electrode which does not introduce much resistance.

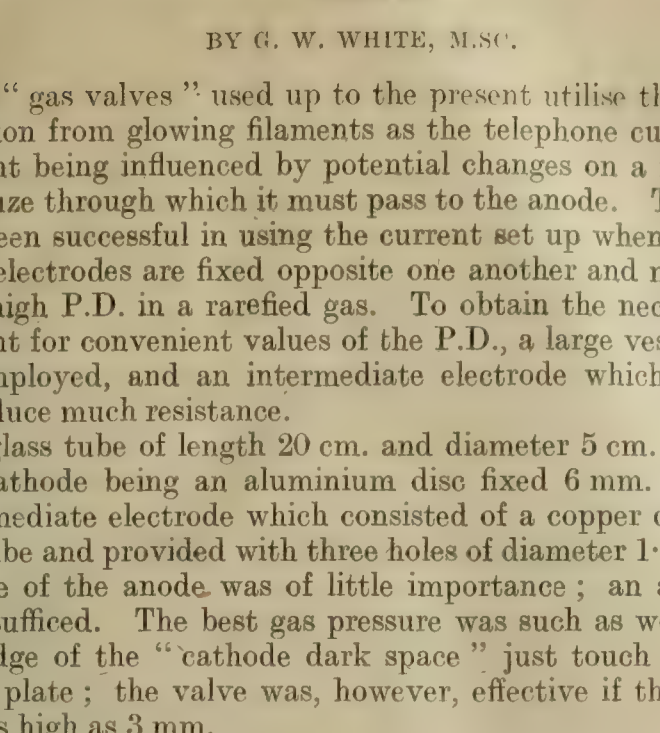
A glass tube of length 20 cm. and diameter 5 cm. was used, the cathode being an aluminium disc fixed 6 mm. below the intermediate electrode which consisted of a copper disc, filling the tube and provided with three holes of diameter 1·3 cm. The nature of the anode was of little importance; an aluminium wire sufficed. The best gas pressure was such as would make the edge of the "cathode dark space" just touch the perforated plate; the valve was, however, effective if the pressure was as high as 3 mm.

The conditions have not yet been determined which will yield a valve to compare in sensitiveness with the present ones employing a glowing cathode, and a higher potential (400 to 800 volts) is required to get the discharge in air; this potential can be considerably decreased by using the rarer gases.

A valve based on this principle has two advantages: It dispenses with the filament and heating battery, and is not sensitive to small pressure changes. It is only effective for "wireless" frequencies, and would be useful where long life is essential and the value of the magnification unimportant.

RELATION BETWEEN STEAM TURBINE RATING AND WATER RATE.

In a Paper presented at the recent convention of the Association of Iron and Steel Electrical Engineers, held at Detroit, U.S.A., Mr. P. M. Lincoln referred to the economy wrought by the units installed during the past year in the power house of the Interborough Rapid Transit Co. of New York as the high-water mark in steam-turbine



RELATION OF WATER RATES TO TURBINE RATING.

operation. Under specified conditions of operation—namely, 200 lb. boiler pressure, 120 deg. superheat and 29 in. vacuum—the economy is even better than the guarantee of 11·27 lb. of water per kilowatt-hour at the 'bus bars. Up to date this is the best water rate ever secured by any apparatus deriving its power from steam. Such high economy is due in considerable part to the large size of the particular unit. The normal rating of this unit is 30,000 kw., but in actual practice it has been found to be good for from 10 to 15 per cent. more than this.

The curves herewith show the relation between the output of steam-turbine units and the water rates at the best load, and give results for three conditions of steam supply. Under actual operating conditions, the slope of the water rate curve is much more than indicated in these curves, since steam conditions also vary with unit size. It is only in plants using units of the larger sizes that it pays to secure the higher vacua, superheats and boiler pressures that add so much to economy in water rate. A plant operating a 1,000 kw. unit, the author maintained, would not save enough in fuel to make it pay to instal the boiler and condenser equipment necessary to secure the highest possible superheat and vacuum, while in one using a 30,000 kw. unit the installation of such equipment would pay handsomely.

Economy in water rate is not the only advantage possessed by the large size unit. An increase in the amount of load brings economies in practically every direction. For instance, there is no inherent reason why a plant containing a given number of 30,000 kw. units should require a larger number of attendants for turbine and generator operation than one containing the same number of 1,000 kw. units. There usually are a larger number provided in the 30,000 kw. plant for the purpose of securing a higher degree of reliability rather than from any fundamental necessity.

A METHOD FOR MEASURING EARTH RESISTIVITY.*

BY FRANK WENNER.

A knowledge of earth resistivity may be of value in determining something of its composition, such, for example, as moisture content, whether or not it contains oil or ore of high conductivity, &c., or in the calculation of damages to pipe systems by the return current of street railway systems. For some of these or other reasons we may wish to determine the resistivity of limited portions of the earth.

For those cases in which we desire the resistivity of a fairly large portion of earth, extending to a considerable depth, or where there are reasons why the measurement should be made without disturbing the portion to be measured, the following method is suggested.

Four holes are made in the earth approximately uniformly spaced in a straight line. The diameter of the holes is not more than 10 per cent. of the distance between them and all extend to approximately the same depth, which is usually that at which we are most concerned with the resistivity. In each hole is placed an electrode which makes electrical contact with the earth only near the bottom. Two of these electrodes serve as current terminals and two as potential terminals in the measurement of the resistance.

Knowing the resistance, the depth of the holes and the distance between them we have data from which the effective resistivity in the vicinity can be calculated.

Where a is the distance between the holes, b is the depth of the holes, ρ is the resistivity, and R the measured resistance, then

$$\rho = \frac{4\pi a R}{2a\left(1 + \frac{2a}{\sqrt{a^2+4b^2}} - \frac{2a}{\sqrt{4a^2+4b^2}}\right)} \quad \text{. . . . . (1)}$$

where n varies between 1 and 2 according to the ratio of the depth of the electrodes to their distance apart. If the holes are not in a straight line or are not of a uniform depth or spacing the resistivity is easily calculated from the depth of each of the holes and the distance of each from each of the other three.

Concerning the resistance measurements there is in general no need for a high accuracy. There is, therefore, no reason why we may not use an ammeter for measuring the current and a voltmeter for measuring the resulting difference in potential between the potential terminals, providing no current is drawn from these terminals. As the voltage to be measured is low and the resistance between electrodes and earth high, errors would be introduced if the ammeter-voltmeter method were used in the ordinary way.

The following potentiometer arrangement, using alternating current to obviate the more serious difficulties which might arise on account of polarisation with direct current, seems to answer the purpose fairly well. The current terminals or electrodes are connected to a source of alternating voltage of suitable value, and across the line is connected a step-down transformer, the low voltage side of which is connected to the ends of a slide wire. One of the potential terminals is connected to one end of the slide wire and the

* From the "Journal" of the Washington Academy of Sciences.

other through a vibration galvanometer to the adjustable contact on the slide wire. An ammeter is connected into a lead to one of the current terminals and a voltometer across the ends of the slide wire. On account of the polarisation at the current electrodes a variable inductance is connected into one end of the leads, for the purpose of bringing the test current in phase with the voltage of the low side of the transformer.

If then adjustments are made so that no current flows through the galvanometer, the position of the sliding contact, the value of the test current, and the voltage across the slide wire are read, we have data from which the resistance R is readily calculated.

From the measured resistance, and the depth and distance between electrodes a value may be obtained for the effective resistivity as explained above. The value depends mainly upon the resistivity in the neighbourhood of and between the potential electrodes, and very little upon the resistivity at distances from either of these electrodes equal to half the distance between the current electrodes.

So far the method has been used only for determining resistivities in a region very close to the surface, a few metres or less in radius. To measure the effective resistance of a much larger portion of earth extending to a considerable depth, the electrodes would be placed much farther apart. Such a measurement might be of assistance in locating deposits of ore of high conductivity.

LEGAL INTELLIGENCE.

W. Sunderland v. Economisers (Ltd.).

On Tuesday Mr. Justice Ridley and a special jury heard this action for damages for alleged wrongful dismissal from the sole selling agency for Economisers for Yorks., Notts., and Derby and the city of Lincoln. The agency agreement was dated April 18, 1912 and defendants, while admitting that £10 commission was due on one order for a £200 economiser, contended that they were justified, under its terms, in determining the agreement, because plaintiff was not carrying out his work in the way they required.

Mr. McCall, K.C. (for plaintiff) said the correspondence between plaintiff and defendants discussed the possibility of introducing the economisers into various electricity supply undertakings. One of defendants' letters to plaintiff said: "We want to supply economisers in the West Riding to show Messrs. Green we can compete with them, so to speak, at their own back door." Mr. Sunderland, who was allotted shares in the new company, was appointed for five years on a commission of 5 per cent. on the net cash received by the firm for the business he introduced, with a proviso that in respect of all economisers sold to boiler makers and engineers the commission should be 2½ per cent. Mr. Sunderland's appointment was terminated after only 11 months, though a new economiser would naturally be somewhat difficult to place on the market and he was handicapped for several months by the absence of literature and catalogues.

Plaintiff (in his evidence) said there was delay in producing an economiser which would serve as sample, and it was December before he got fairly to work on the business. He travelled also in superheaters, but that did not prejudice his canvass for defendants. In cross-examination he admitted that defendants had written complaining that they could not get from him the information they wanted as to his calls upon various firms. They also wrote that such a district must not be fallow. His undertaking had been to notify defendants when there was anything to report.

As the next witness was being called the foreman of the jury notified that they had heard enough, and if the rest of the evidence did not add materially to plaintiff's case they should find against him.

His Lordship thereupon entered judgment for Economisers (Ltd.).

Electricity Works Valuation Appeals.

The Valuation Appeal Committee for the County of Roxburgh recently held a court to hear appeals, including that of the Electric Supply Corporation (Ltd.) against the assessment of their station at Melrose being entered at £65 and the mains at £25.

Mr. E. Howard Collins for the company) said that, unfortunately, his clients' undertaking showed no profit, and if the valuation was to be worked out in the ordinary method, the revenue or profit principle, the valuation would be nil. The Arbroath case decided that the best method of ascertaining the yearly value was the revenue or profits principle. His opinion was that there should not be any sum whatever entered in the valuation roll, but his clients would submit to be assessed in a sum of £20.

For respondents, Mr. Bensted said that in that case the revenue principle of valuation had broken down. The company had been working 12 years, and on the revenue basis, as far as he could ascertain, it had never shown any profits at all. Under these circumstances it might be expedient to abandon the revenue principle in favour of some other in order to arrive at the valuation. He submitted that circumstances had arisen which rendered it necessary to reconsider that basis. Whilst admitting that the undertaking showed no profits, he did think that the increase in its gross receipts ought to be taken into account.

Ultimately the parties agreed to a valuation of £21

At Dundalk Quarter Sessions last week the Urban Council appealed against the assessment of the electric supply works on account of the valuation being too high, while the gas company appealed on the ground that it was too low. The assessment commissioner placed the valuation at £440, but the Council thought it should not be higher than £255. After hearing evidence, the appeal was dismissed, as was an appeal by the gas company against the assessment of the gas works.

Baldock's Telegraph Instruments Co. (Ltd.) v. British Telegraph Instruments Co. (Ltd.)—Last week Mr. Justice Sargant made perpetual an ex parte injunction restraining the British Telegraph Instruments Co. (Ltd.) from presenting a petition to wind up plaintiff company. His Lordship said a consent brief on behalf of defendant company must be produced, and the injunction would apply so long as an alleged debt of £155 was in dispute.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.) The Court of Appeal will not hear the appeal of plaintiffs in this case from the judgment of Mr. Justice Joyce before Nov. 8.

Adnil Electric Co. (Ltd.)—On the petition of a creditor, a winding-up order was made against this company on Tuesday.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Fawcett, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

16,935 Soc. Anon des Etablissements L. Bleriot. Combined dynamo and accumulator electric systems. (24/9/13.)

16,936 Soc. Anon des Etablissements L. Bleriot. Control systems for electric installations. (24/9/13.)

20,130 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Rheostats.

20,551 Bruck. Magnetic separation. (4/10/13. Addition to 11,898/11.)

20,728 Collins & Collins. Electrical heating elements.

21,680 Shephard & McKechnie. Telegraph, submarine sound signalling, or similar systems.

21,861 Thearle. Machine for winding electromagnetic coils.

22,674 Taylor. Methods of using electric condensers for transformation of energy.

Refers to means for transforming electric energy by the use of a plurality of electric condensers which are charged through choking coils or otherwise, from a source of electric supply, and discharged in series, whereby a correspondingy increased voltage is obtainable during a transient period.

23,189 Joel. Apparatus for charging electric accumulators.

23,711 MacDonald. Electric [illegible] (Addition to 7,638/13.)

24,449 Smith. Means for [illegible] electric circuits.

24,475 Gardner. Electrical vibratory contact makers and breakers.

24,637 Hatton. Control devices for electric clock systems.

1915 Specifications.

347 Lindberg, Lindberg, Lundberg & Pehr. Electric switches.

1,119 O'Donnell. (Hodges & Smith.) Electrical alarm apparatus for mines and like [illegible].

7,934 Meyer-Jacobi. (Pieper.) Pocket electric flashlights. (Addition to 18,809/14.)

7,270 Fawssett. Electrical measuring instruments operating on the ferraris or induction principle.

Relates to instruments of the [illegible] type for the purpose of detecting and eliminating errors due to variations of temperature, and to the elimination of such [illegible] due to the [illegible] of the [illegible] of the driving flux [illegible] of a positive or negative coefficient of change of electrical resistance with change of temperature.

7,370 Wilson. Devices for [illegible] between conductors.

11,480 Rowley Bros. & Fawcett. Bicycle [illegible] electric pedal [illegible].

[illegible] 1914 Divided application of 2,230/14. Feb. 27.

APPLICATIONS FOR PATENTS

*Notes.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection as soon as they have been published. Names within parentheses are those of communicators of inventions. Where dates are given in square brackets they are those of foreign applications in respect of which an asterisk is affixed.*

October 4, 1915.

14,010 Wood. Screw-[illegible].

14,026 Lancaster Driving & Motor Co. & Hall. Electro-magnetically-[illegible].

October 5, 1915.

14,094 Wood. Reversing & Starting Electric [illegible].

14,111 Zeiss. [illegible] (Addition to 14,[illegible].)*

14,120 Lucas & Sanders. [illegible].

14,121 Ulbricht. [illegible].

October 6, 1915.

14,145 Bloomfield. Electric [illegible].

14,[illegible] [illegible].*

14,164 Chalmers. Electric [illegible].

October 7, 1915.

14,214 Fowler. Electric [illegible].

14,215 Wallace. [illegible].

14,[illegible] Hearne. [illegible] for preparing surfaces, as for [illegible], and removing the rust on [illegible].*

14,232 Ericsson (Ericsson Co. & Le Noir). Portable telephone and [illegible].

14,233 Ericsson (Ericsson Co. & Le Noir). Telephones.

October 8, 1915.

14,261 Bellamy. [illegible].

October 9, 1915.

14,[illegible] Lancaster & Kennedy. Electric [illegible] for [illegible] and indicating the [illegible].

14,[illegible] Smith. [illegible].

14,[illegible] Smith. [illegible]. (Addition to 17,911/15.)

14,[illegible] Hall. [illegible]. (Addition to 1,445/15.)

14,[illegible] Hall & Brake. Transmitting [illegible] and [illegible].

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	105	Wolsey Electric Vehicle. Illus.	2*
Imports and Exports of Electrical Manufactures	106	Electric Dust Vans. Illus.	2*
New Post and Telegraphs Bill	106	Two London Electric Vehicles. Illustrated	3*
Business Notices	106	From Buffalo to New York in an Electric Vehicle	4*
Bankruptcies, Liquidations, &c.	107	"Hitch Your Waggon to the Snow"	4*
Electricity Supply	107	Parking Service for Electric Vehicles	4*
Traction Notes	107	Electric Light Recommended for Use in Film Production.	4*
Empire Notes	108	Electric Vehicles in India	5*
Foreign Notes	108	Battery Exchange System Applied to Electric Passenger Vehicles	5*
The Round Table	17	The Wornout "Plug"	6*
The "Point Fives"	17	Mail Handling by Electric Trucks	6*
"Sun" Accessories. Illus.	18		
Advantages of the Electric Motor Drive	18	Miscellaneous Notes	109
Monometer Furnaces	19	Tenders Invited	109
Advertising Window Signs. Ill.	19	Tenders Received & Accepted	110
China Cover Switches	19	Companies' Meetings and Reports	111
Ironclad Switchgear. Illus.	20	Electrical Companies' Share List	111
Paraffin Lighting Set. Illus.	22		
Fish Fryers	22		
Electric Vehicle Progress Supplement—No. 21			
The Light Electric Delivery Van. Illustrated	1*		

COMMERCIAL TOPICS.

The Light Electric Delivery Van. We call attention in our Electric Vehicle Progress Supplement this month to the introduction into this country of an inexpensive battery-propelled delivery van for the use of tradesmen and others who require a simple and economical means of mechanical transport. The vehicle referred to is being imported from America, and the general design, coupled with the fact that the price is moderate, should encourage considerable sales. An analysis of the field of mechanical transport seems to indicate that there is an inherent prospective demand for this class of vehicle over here, and we trust that those who are in a position to encourage its use will make every effort to do so. Petrol vans in the hands of unskilled drivers are a costly means of trade transport, chiefly by reason of the high speeds at which they can be driven and the heavy repair and maintenance charges which result. These latter are an undue tax upon the trader, who, however, feels that to be up to date he must have mechanical rather than horse or hand delivery for his goods. The light battery-driven van, though at present higher in price than the petrol vehicle, can show better in running cost and maintenance and repair items, and on this account it should have a good future in trade delivery work, where it is a real necessity of the times.

* * * *

Non-Electrical Distributors. There are many trading organisations which deal directly with the public, and we have in mind particularly the ironmonger, the large store, the furnishing draper and the jeweller. These might with every advantage to the electrical industry handle certain lines of goods which are likely to appeal to the public taste. These goods include table utensils, fans, electrical novelties and electro-plated apparatus. The majority of these traders may be classed under the generic heading of "non-electrical distributors." The manufacturer or the factor is principally concerned with this class of trader, because of the exceptionally good and long-established connection which he has built up with the general public. As a rule these non-electrical trading firms are well organised from the selling point of view, and their showroom facilities are undoubtedly superior to those at the disposal of the average electrical contractor. There seems to be a tendency in the United States, at any rate, for the manufacturer to encourage these non-electrical houses to handle popular electrical lines, and in so doing they believe that their turnover will be enormously increased over the business which the electrical contractor pure and simple has shown himself capable of doing.

Hydro-electric Power in Canada. The abstract of the fourth annual report of the Toronto Hydro-electric System, which we gave in our last issue, is a good example of what can be done by a group of local authorities who combine to take advantage of a cheap supply of power in bulk. At the end of four years there are over 31,500 consumers connected to the system, with a load of over 88,000 H.P., and this, too, in a city with an electric supply company which has over 70,000 kw. connected to its mains. During the past year over 5,600 irons were sold, and the reduction in the price of electric current which has now been made should lead to a still greater development in the use of electricity for domestic purposes. During the past year the revenue from commercial power increased by 43·92 per cent. and from commercial lighting 40 per cent. The commercial income represented 63·9 of the total, compared with 36·1 per cent. from municipal sources. The total capital expended is over $5,650,000 and after paying interest and sinking fund and allowing for depreciation there was a surplus of $70,400.

* * * *

The Eternal Obstacle. Yet another startling case of "made in Germany." Mr. J. C. Sanderson, presiding at the annual meeting of the Djaboong (Java) Rubber Estates (Ltd.), said the company's coca crop had largely exceeeded the estimate. They anticipated the market would have been a fairly good one, as cocaine was manufactured from this shrub, but they had been unable to dispose of the produce, owing to all the large works making cocaine being situate in Germany. A scheme had been mooted in Java some two or three years ago for the establishment of a factory in that island, but the machinery required would have had to be made in Germany, so the scheme was dropped. He would not be surprised if the Japanese were commencing the manufacture of cocaine. It was astonishing to him that no large English chemists were taking up the manufacture. And so the tearful tale goes on.

* * * *

Automatic Telephony in Norway. From our "Tenders Invited" column it will be noticed that the Norwegian Government which owns and operates all telephones in Norway is preparing plans and specifications for the equipment of an automatic exchange in Christiania. This will be the first automatic exchange in Norway and is estimated to cost about £53,600. It is also reported that the Government proposes to spend over £270,000 on the State telephone system during the next six years.

* * * *

Dynamo Starters. The commercial prospects of the electric battery vehicle are in many ways being impaired by the fitment of dynamos, starting and lighting sets to petrol cars, especially to passenger vehicles. Half the sheer wretchedness of the petrol car is removed when it is possible to start the engine from the driving seat and also to turn on whatever lamps are needed from the same place. On a town passenger car, for example, this is not only a convenience, it is a positive luxury. The "electric" had, up to the time of the perfection of these starting and lighting accessories, a distinct fascination for the town habitué. Now by the expenditure of a tithe of the cost of an electric battery coupé—the town vehicle de luxe—a dynamo starting and lighting unit can be fitted to an existing car and, hey presto, it becomes an electric in its ease of getting off the mark. Apropos of these handy little units, in which there is now a flourishing section of electrical industry, Messrs. C. A. Vandervell wish it to be known that the rumour is entirely incorrect that their product in this regard has been taken over by the Government. Though actively engaged on munitions work, they are able to meet orders for their various standard productions.

* * * *

The Half-penny Post. The satisfaction generally felt and expressed by those who are concerned with the Halfpenny Postage question has been shortlived. If the subject were not a serious one for a vast number of traders, the terms of sec. 1 (*a*) of the new Post and Telegraphs Bill might be regarded as a joke. Immediately upon the issue of this Bill Mr. Powell, K.C., proprietor of the "Printers' Register," communicated with the Press, and pointed to the absence of any expression in the new Bill calculated to meet the objections to the proposal for the abolition of halfpenny postage. The text of the new Bill is set out on the next page of this issue of The Electrician, and should be

carefully perused by all who have this matter under consideration. It is clear from sec. 1 (*a*) of the new Bill that printed matter, inland book post packets above 2 oz. in weight will have to bear additional postage at letter rate, as no provision is made in this section for the continuance of the existing halfpenny postage rate for each 2 oz. beyond the first, as is provided for in sec. 2, sub-section (*b*, ii.) of the Post Office Act, 1908. It is not clear why the phraseology of the 1908 act should not have been followed in the new Act, and it is to be hoped that the agitation against this particular portion of the new Bill will be successful and put this point right; otherwise grievous injury will unquestionably be done to the printing and publishing trades, and to all other trades which depend largely for their success and development upon cheap postal facilities. Another aspect of the question appears to have been plainly stated by the assistant Postmaster-General (Mr. Pease) in closing the debate on the second reading of the new Bill. Mr. Pease said: "Under the proposed rate packages exceeding 2 oz. will still be liable to be charged at letter rate, and between 2 oz. and 3 oz. the charge will be 2½d." This is an alarming situation, and the Federation of Master Printers, who are taking very active steps in this matter, has pointed out that by this ruling a package of printed matter fractionally under 2 oz. in weight will cost d. for postage, but if fractionally over 2 oz. it will cost 2½d., or 2d. for the fraction of an ounce! Other fatuities are that 6 oz. will cost 3d. in one package, but if made up into three packets the cost will be 1½d.—that is, three times the trouble to the Post Office and only half the postage. Further, 4 oz. conveyed by post in Great Britain for a few yards will cost 2½d., but if posted from Japan to any part of the United Kingdom will cost 1d. only, while, moreover, the British Post Office will receive no part of the latter amount for carriage and delivery. It is obvious that the effect on the printing and publishing trades of these revolutionary changes in the postal rates will be ruinous; their effect upon many other trades (and, we would add, especially upon the electrical trades) will be strangulating. The issue of catalogues, price lists, showcards and the like in this country will be rendered impossible owing to their excessive postage cost, and the effect upon the mail order business must prove disastrous. Only our overseas competitors can possibly look with friendly feelings upon a departure which is almost an outrage upon the traders of the United Kingdom, just at a time when all classes of trading needs the fillip of ready and cheap distribution. The fact that the Treasury has powers under the Post Office Act, 1908, to fix, by warrant, the rates of postage and other sums to be charged in respect of postal packets, leaves us entirely at the mercy of the Postmaster-General for the time being, itself a condition of affairs that is not by any means satisfactory. We have moved rapidly since 1908, and the Post Office has become more than ever the handmaiden of the public. Strenuous agitation is necessary to save the situation.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Oct. 11, 1915, *to* Oct. 16, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (See also note at foot of Exports.)

IMPORTS.

[illegible]
£1[illegible]
[illegible]
56 pkgs. *Sweden:* Elec. lamps, £143; [illegible]
CANADA.—Unenumerated, £145.
[illegible]

EXPORTS.

[illegible]
material, £1,740;
machinery, £713;
cable, £4,752; elec. machinery, £1,040; unenumerated, £7,602. [illegible]
[illegible]
Wire and cable, £1,796;
[illegible]
[illegible]
cable, £1,033; unenumerated, £224. *Mossel Bay:* Unenumerated, £44.
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
SPAIN.
[illegible]

[illegible] Wire and cable, £5,691; unenumerated, £103.
INDIA, CEYLON, HONG-KONG AND STRAITS SETTLEMENTS. *Bombay:* Wire and cable, £425; elec. machinery, £438; unenumerated, £528. *Calcutta:* Wire and cable, £29; glow lamps, 8,200 (No.); unenumerated, £758. *Madras:* Elec. machinery, £429. *Ceylon:* Unenumerated, £29. *Singapore:* Unenumerated, £35. *Karachi:* Unenumerated, £[illegible]. [illegible]: Unenumerated, £68. *Penang:* Unenumerated, £47. *Kilindini:* Unenumerated, £10. *Penang:* Unenumerated, £25. *Batavia, Java:* Unenumerated, £52.
[illegible]: [illegible] Elec. machinery, £383; wire and cable, £1,471; unenumerated, £141; *Shanghai:* Unenumerated, £128.
[illegible] Unenumerated, £18.
MALTA.—Unenumerated, £73.
GIBRALTAR.—Unenumerated, £44.
PASOCREAU.—Wire and cable, £203.
FRANCE.—*Paris:* Unenumerated, £249. *Boulogne:* Unenumerated, £203. *Dieppe:* Unenumerated, £106.

FOREIGN GOODS (duty paid and free).

Europe: Unenumerated, £65. *New York:* Unenumerated, £530. *Hong Kong:* Unenumerated, £[illegible]. [illegible] Unenumerated, £64. *Buenos Ayres:* Unenumerated, £77. *Cape Town:* Unenumerated, £30. *Christiania:* Unenumerated, £107. *Ceylon:* Unenumerated, £19. *Lisbon:* Unenumerated, £87. *Port Elizabeth:* Unenumerated, £19. *Singapore:* Unenumerated, £42.

IN TRANSIT.

[illegible] Elec. [illegible], £350. *Montevideo:* Elec. [illegible], &c., £220. *Sydney:* Elec. lamps, &c., £1,060.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

NEW POST AND TELEGRAPHS BILL.

The Postal and Telegraph Rates (Statutory Limits) Bill, 1915, was issued last week, and following is its text:—

1.—For the purpose of enabling effect to be given to certain proposed changes of postal and telegraph rates the following variations shall have effect with respect to the statutory limits applicable to those rates:—

(*a*) The maximum rate for an inland book-packet under Sub-section (1) (*b*) of Section 2 of the Post Office Act, 1908, of a halfpenny for every two ounces or fractional part of two ounces shall cease to have effect except as respects inland book-packets which do not exceed two ounces in weight, and

(*b*) A maximum rate of a halfpenny for every six ounces in weight or for every fractional part of six ounces over and above the first or any additional six ounces up to such maximum weight as may be fixed by the Postmaster-General shall be substituted for the maximum rate of one halfpenny for each inland registered newspaper under Sub-section (1) (*b*) (3) of Section 2 of the Post Office Act, 1908, and

(*c*) A maximum rate of 9d. for the first twelve words of each ordinary-written telegram or for an ordinary-written telegram of less than twelve words shall be substituted for the maximum rate of sixpence under Section 2 of the Telegraphs Act, 1885, and

(*d*) The maximum rates for Press telegrams under Section 16 of the Telegraph Act, 1868, shall be varied as follows: "A rate of a shilling for every eighty words shall be substituted for the rate of a shilling for every hundred words transmitted between the hours of 6 p.m. and 9 a.m. to a single address, a rate of a shilling for every sixty words shall be substituted for the rate of a shilling for every seventy-five words transmitted between the hours of 9 a.m. and 6 to a single address. An additional charge of threepence for every eighty or sixty words, as the case may be, of the same telegraphic communication transmitted to an additional address shall be substituted for the rate of twopence for every hundred or seventy-five words, as the case may be, but the rates for Press telegrams shall not be raised above the limits existing immediately before the passing of this Act until after the 31st day of December, 1916.

2.—(1) Any contract for the supply or delivery to subscribers of newspapers, periodicals, or other publications at rates including postage so far as the contract includes the supply or delivery of publications, the rate of postage on which is increased after the passing of this Act, and before the first day of January, 1916, may be determined by any party to the contract as from the date on which the rate is raised by notice given to the other party to the contract not later than fourteen days after the increase of rate takes effect.

(2) In computing for the purposes of Sub-section (2) of Section 2 of the Post Office (Parcels) Act, 1882, the amount of the remuneration to railway companies for the carriage of parcels, there shall be excluded from the gross receipts of the Postmaster-General any increase in those receipts which is attributable to any increase in the rates of postage for parcels made after the passing of this Act, and during the continuance of the powers and a period of six months thereafter.

BUSINESS NOTICES.

Messrs. S. G. Leach & Co. (Ltd.) has been formed with a capital of £20,000 in £1 shares, and has taken over from the official receiver the business, goodwill and undertaking of the Admil Electric Co., (Ltd.) (in liquidation). We are informed that the new company has no foreign interests (enemy or otherwise), and that it will carry on business at the old address, 35, Artillery lane, E.C. All the directors and staff are British.

Plant Wanted.—An advertiser wants a 75 kw. dynamo and 20, 25, 30 and 35 B.H.P. 220 volt motors.

Patent Development.—The proprietor of patents Nos. 24,702/1908 and 24,708/1908, for "Improvements in seal fastenings," desires to

enter into arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Arthur F. Hawdon, electrical engineer, Yetholm, Elmfield Gardens, Gosforth, are to be sent to Mr. Chas. Woollett, 30, Mosley-street, Newcastle-on-Tyne, by Nov. 6.

A meeting to receive an account of the winding up of the British Drawn Wire Lamp Co. (Ltd.), will be held at 59, Chancery-lane, London, W.C., on Nov. 13.

Winding-up Petition.—A petition presented by the Sloan Electrical Co. (Ltd.) and Siemens Bros. Dynamo Works (Ltd.) for the winding-up of J. Whitehouse (Ltd.) (electrical engineers) will be heard at the County Court, Barnet, on Nov. 9.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bo'ness.—The Council have decided to apply to the Secretary for Scotland for sanction to a further loan of £7,000 to carry out extensions at the electricity works which are maintained by the National Construction Co.

Chesterfield.—The L.G. Board have sanctioned the borrowing of £5,000 for additional generating plant, &c.

Kettering.—An official inspection of the Ljungstrom turbine and other plant recently installed at the electricity works took place last week.

London County Council.—At the meeting on Tuesday sanction was given to the Shoreditch Borough Council to borrow £1,500 for their electricity undertaking.

Luton.—An inquiry will be held here on Wednesday next into the application of the Corporation for sanction to borrow £25,'50 for extensions of the electricity undertaking.

Manchester.—The secretary of the Ratepayers' Association (Mr. P. Percival) has sent a communication to the L.G. Board in opposition to the scheme of the Electricity Committee to erect a power station at Barton.

The greater part of the letter is an attack on what is called a "system of government by committees nominated for the political parties," and there is no serious attempt made to deal with the engineering and economic aspects of the question.

Nuneaton.—An official inquiry will be held on Tuesday into the Council's application for sanction to borrow £10,000 for the electric supply undertaking.

GENERAL.

Aylesbury.—The charge for electric current for heating purposes has been fixed at 1½d. per unit.

Bermondsey (London).—In regard to the recent alleged smoke nuisance at the generating station the Electricity Committee explains that the work of substituting chain grate stokers for the three underfeed stokers is, owing to war conditions, progressing very slowly, and that immediately the stokers are installed they will be able to reduce the smoke to a minimum.

Gravesend.—The Electric Supply Committee has been in negotiation with W. T. Henley's Telegraph Works Co. for a large increase in the supply of electric current.

The company offered to bear the capital cost involved and to maintain the cable if the Corporation would make an annual rebate of £80, the equivalent of the charges required to liquidate the capital outlay over a period of the life of the cable. The agreed discounts would be extended to meet the increased consumption, and a coal clause would be inserted in the agreement. These terms have now been approved.

Ilford.—The Electricity Committee has entered into an arrangement with Messrs. J. C. Fuller & Son for the supply of current. As the cable supplying the Isolation Hospital is at times heavily overloaded, it is proposed to put in hand the necessary extension of cable.

Mansfield.—It was announced at the Council meeting last week that the Electricity Committee was contributing £1,600 to relief of rates, out of a profit of £1,900 on the past year's working.

Newport (Mon).—The L.G. Board has sanctioned the raising of £8,327 for a refuse destructor.

The Electricity Committee has accepted the terms of the Tredegar Estate for the lease of a site for a sub-station in the Pillgwenlly district, and it is proposed to carry out the work by direct labour.

The borough electrical engineer (Mr. A. Nichols Moore) has reported that, owing to the shortage of staff in the distributing department, and the apparent impossibility of obtaining a suitable engineer to fill a vacancy, he proposed to make certain alterations and re-arrangement involving the transfer of an engineer in charge from the works to the distributing department, and to fill the vacancy thus created by the appointment of another assistant.

Oban.—A sub-committee has been appointed to consider and report on the charges for the supply of electrical energy for heating and cooking.

Southend-on-Sea.—The L.G. Board has consented to the completion of the Leigh sub-station, and has authorised the borrowing of the necessary money for this purpose, together with £500 in respect of material already purchased for the proposed sub-station at Thorpe Bay, which has been temporarily abandoned.

The Town Clerk has now been directed to inform the Board that the Corporation would be prepared to dispose for use for that purpose of the plant constructed for the Thorpe Bay sub-station, but that they would be glad to receive the sanction of the Board to the raising of the loan necessary for the plant for the Leigh sub-station.

Walsall.—At the meeting of the Council last week, Councillor Haywood (chairman of the Electricity Committee) appealed to users of electrical energy to be as economical in their consumption as possible, otherwise the works might not be able to meet the demand.

Councillor HAYWOOD explained that undertakings of that description had a line of safety, which was generally represented by two-thirds of the station load, and the load at their station was 2,400 kw. Last week they exceeded 1,700 kw., which was over the safety line. The maximum load for the 10 weeks ended Sept. 26 showed an increase in the maximum load of over 200 kw., compared with the same period of last year. It was going up rapidly, and they were approaching the safety line, and what would happen in eight or ten weeks' time he did not know, unless the users of current co-operated with the department and used as little as possible, particularly between the hours of four and six in the afternoon, when the demand reached its height. There was no spare plant available, and the only way to meet the situation was to put in a new generator, but as it would cost £1,000 and have to be parted with as soon as the new station was complete he could not support such a course. Unless the consumers helped the Committee in the way he had mentioned some restrictions would have to be put into operation.

Ald. COPE (chairman of the Tramways Committee) said that at the last meeting Councillor Haywood mentioned that the Tramway Committee might be asked to restrict their service, but he (Ald. Cope) would suggest that the Electricity Committee should not take on new customers.

Walton.—The Council have authorised the Urban Electric Supply Co. to extend their mains from the St. George's Hill Estate along Cobham-road to the Whiteley estate.

TRACTION NOTES.

Blackpool.—At the meeting of the Tramways Committee last week the engineer and manager (Mr. C. Furness) reported that the depression which set in after the outbreak of war had now been passed.

For the first time the total receipts from the commencement of the financial year were in excess of those for the corresponding period of last year. At the September meeting the total receipts showed a deficit of £470, but up to Oct. 7 the receipts were £60,433. 13s. 9d., against £59,392. 19s. 7d. for the corresponding period of 1914.

It has been decided to raise the price of annual contract tickets from £3 to £4. Mr. Furness was of opinion that the promotion of [illegible] the growth of annual contract tickets was becoming a serious factor as to revenue. In 1911 there were 922 contracts, bringing in £2,310; this year there had been 1,466 contracts with a revenue of £4,146. From a recent census during one week it was found out of 187,000 passengers, 37,000 (20 per cent.) were contract holders, the average fare per passenger being 0·52d. for the ordinary cash passenger 1·51d., and the average operating expenses per passenger 0·79d.

Bradford.—The outcome of a long discussion on 1d. fares at the meeting of the Council last week was a direction to the Tramways Committee to report fully on the whole question of tramway fares before April next.

Doncaster.—The Corporation have got over the difficulties in connection with the extension of the tramway system to the village of Woodlands, and to Brodsworth, and it is probable that construction work will be commenced shortly.

Southend-on-Sea.—With reference to the authority given for the purchase of bull's-eye lamps for conductors while collecting tram fares at night time, the electrical engineer (Mr. R. Birkett) now reports that on account of the difficulty of keeping the lamps in order, it is not desirable to adopt this method, and he has now been directed to make inquiries regarding small and low-priced accumulator lamps.

Women Conductors.—Leeds Tramways and Electricity Committee have now approved of the steps taken by the sub-committee towards the employment of women as tramcar conductors. A large number of women have applied to be engaged and over 130 have been approved as suitable.

The Chief Commissioner of Police has now removed the ban on the employment of women conductors in the London area.

Yorkshire Trolley Omn bus Scheme.—The trolley omnibus route from Guiseley to Burley-in-Wharfedale has been completed and trial runs have been made over the route. The section will be open for public traffic in a few days. The route from Guiseley to Otley has been open for some weeks.

EMPIRE NOTES.

Australasia.—The Commonwealth Government have made arrangements whereby the whole copper output of the Commonwealth suitable for electrolytic treatment will be treated in Australia. A British group of financiers have secured the Imperial Government's approval of their suggestion to treat in Great Britain the whole Australian concentrated zinc output.

The "Commonwealth Engineer" says Heidelberg (Victoria) Council has approved the plans and estimates of the proposed electric lighting extensions, at a cost of £4,000.

Automatic Telephony in India.—"Indian Engineering" reports that the automatic telephone system in Simla is a complete success, and Calcutta residents, who think their present telephone arrangements anything but perfect, are stated to be looking forward to the provision of an automatic exchange in that city.

Electricity in Indian Coal Mining.—According to the quinquennial review of the mineral production of India for the years 1909 to 1913 the output of coal has doubled in the past 10 years. The introduction of coal cutting machinery is not, however, making progress, although the "Colliery Guardian" states that when labour has been scarce and prices have been high, coal cutting plants have proved successful, but a return to normal conditions has proved that cost becomes relatively high, and they are then discarded. Only occasionally and under special conditions, is coal-cutting machinery now employed in the Bengal coal mines. The use of electricity for pumping, hauling and lighting is increasing, and several electric winding engines are said to be on order. The future for electric mining plant is indeed full of promise, and in the opinion of the department of Mines in India it is doubtful whether a modern colliery will be able to work successfully in the future unless it is electrically equipped.

India.—The "Colonial Journal" says the contract undertaken last year by the Central Engine Works (Ltd.) for the electric lighting of Johore Bahru township provides for public lighting and for the supply of light and power to government buildings and institutions in the town, and to the Sultan's residence at Pasir Plangga, about 2½ miles from the power station.

The generating plant will include two 150 kw. Westinghouse d.c. generators coupled to two 225 b.h.p. Westinghouse vertical tandem gas engines. It is proposed to use Rawang coal. Distribution will be on the three wire system at 500-250 volts over approximately 15 miles of streets. The capital expenditure is put at $204,100, and the company will maintain the plant and distributing system for three years.

South Africa.—H.M. Trade Commissioner for South Africa states in his report for 1914 that up to the outbreak of the war trade was below normal. The total trade for the year was £91,615,144, compared with £109,456,629 in 1913, of which £41,168,065 (£38,408,598) represented imports.

The imports included electrical material £874,627 (against £983,624 in 1913), mining material £1,662,060 (£1,709,758), and miscellaneous machinery and requisites therefor £1,673,709 (£1,949,839). Exports were valued at £53,496,076 (against £65,114,644). Imports from Germany were valued at £2,194,329 (£3,403,441). Amongst the German goods imported were electrical material £225,733 (against £390,670 in 1913, compared with £467,661 from the U.K. and £85,918 from U.S.A.), mining material £291,227 (against £161,191, U.K. £780,794, U.S.A. £161,191), miscellaneous machinery and requisites therefor £166,801 (against £199,792, U.K. £618,315, U.S.A. £114,491). A certain quantity of trash is imported into South Africa and bought under misapprehension, but in cheap grades of quality compatible with, and sometimes in advance of, a low price, Germany has met with great success.

Finance enters very largely into the matter. Subsidies have been granted by the German Government by means of exceptionally low transport rates upon certain goods for export, and there are German firms whose object is the establishment of a strong position in the world's markets. One advantage the combines gain is their oversea organisation. Instead of half-a-dozen travellers being appointed by as many firms, in competition with one another, the same number of men are appointed, but work together in the interests of the one combine. This staff is often controlled by a manager in the oversea market, through whom every order passes to the home organisation. German combines and firms send by each mail to their agent or agent-manager a list of orders executed during the week, showing works or f.o.b. cost; and price accepted by agent, the difference being the profit. This enables an agent to see how much he can abate his price to secure a special order. Cheap lines (not trashy goods, but cheaper grades of goods in many cases already manufactured by British firms) are the mainstay of the South African market. In the higher qualities British manufacturers have a position from which it would be difficult for foreign competitors to remove them, but their present position of security should not lead them into thinking they are entirely unassailable. Reputations in this market have been built up by German firms through the exploitation of cheap goods, and many of such firms are capable of turning out the better quality article as soon as it is demanded. If South Africa avoids careless investment of capital, overburdening of stores with stock and too heavy immediate borrowing, there is no adequate reason why the prosperity of the country should not be ensured, or why British firms should not secure a great share in the increasing import trade. South African importers are more sympathetic towards the British manufacturer than they have been for many years. The merchants there are aware of the difficulties found by the British manufacturer in effecting changes in methods of organisation that will meet the requirements of the market, but it is essential that the latter should give fresh evidence of his ability and of his business-like methods. In the Commercial Information Bureau established in connection with the office of H.M. Trade Commissioner at Cape Town there are about 1,500 catalogues of British firms on file. The bulk of these deal with machinery, although those covering smaller everyday requirements are in greater demand and more serviceable. There is no excuse for the omission of prices, &c., from the latter. Catalogues are sent without prices, discounts, weights, &c. Moreover, the price of an article in the United Kingdom is often a poor guide to its cost to the importer in South Africa. The attention of British firms is again, therefore, drawn to the need for furnishing H.M. Trade Commissioner with full information in this regard, since, through lack of the necessary information, not only do orders fail to eventuate, but possible buyers comment adversely upon British methods, comparing them unfavourably with those of the foreign manufacturer, who rarely fails in this respect. If necessary, special oversea catalogues should be produced. In not a few cases, as a result of the energy and activity of prospective agents whose interest has been aroused, orders have been sent to the United Kingdom and have proved to the firms concerned that direct representation is practicable and satisfactory. British firms should keep H.M. Trade Commissioner (Cape Town) informed as to the appointment of South African representatives and any change they may make in their representation.

FOREIGN NOTES.

China Trade.—Mr. T. W. Ainscough, of the Board of Trade, who, as previously announced, has recently returned from a business tour of China, stated, in an interview, that, generally speaking, trade in that country is in a state of transition owing to increased competition (mainly German and Austrian, and latterly Japanese). "The lines in which the Germans have penetrated the interior of China," he said, "have been in arms and munitions, general machinery (especially electrical), and aniline dyes."

Greece.—A consular report on the trade of the Piræus and district for 1914 says the present is a propitious moment to push trade which has hitherto been in the hands of our rivals in various kinds of machinery, steam, gas and oil engines, turbines, water wheels, electric motors and tools. Germany and Austria-Hungary have also done good business in c.i. pipes, bars, girders, sheets, wire, &c.

Germany has had the lead in tools and implements, not only on account of having sold much more cheaply than British manufacturers, but because the German travellers studied what was required locally to suit the buyers, whereas British designs were often found unsuitable. Austria-Hungary has been supplying Greece with more than double the quantity supplied by the United Kingdom of the following: Electrotechnical appliances, dynamos, motors, transformers, h.t. switches, fuses, electrical fittings, lamps, cable and transmission lines and electrolytic copper. Switzerland also supplies h.t. cables and wires; electrical instruments have generally been supplied by the United Kingdom, l.t. cable and wire by Sweden and transmission lines by Belgium.

New Telephone Lines.—It is reported that the Minister of Communications in Greece has laid a Bill before the Chamber for the extension of the lines in Old Greece and the new territories, and the adoption of the latest system. This change is expected to cost about £90,000.

Commercial Travellers.—The success of our rivals has been, to a great extent, due to their sending capable representatives to explain to buyers all they want to know about machines, &c., and also to their readiness to agree to alterations to meet local requirements. Representatives of British firms are seldom seen in Greece, and there have been many com-

plaints at the slackness of delivery on the part of British firms. It has been stated by a Greek factory manager that German agents visit prospective buyers daily, study their requirements, and provide exactly what they want. They inundate them with catalogues in French or German and in not a few cases even in Greek. The prices are quoted with delivery in Athens. Weights and prices are given in the metric system, and goods are delivered on easy terms, payable at 3, 6, 9 and even 12 months.

Russia.—The following, amongst other goods, have been added to the list of articles which, on importation into Russia, need not be accompanied by a certificate of origin :—

Leather belting for machinery ; wooden parts of machines and apparatus ; grinding and polishing substances ; graphite, carbons for electrotechnical purposes ; lubricating, polishing and adhesive compounds ; indiarubber (caoutchouc and gutta-percha), prepared and manufactured ; metallic ores and minerals ; cast-iron in pigs, scraps and filings, except ferro-manganese, ferro-silicon and ferrochrome ; copper, aluminium, nickel, cobalt, bismuth, cadmium and other unspecified metals ; chrysocolle, tombac, argentan (German silver), Britannia metal, anf all other unspecified metal alloys ; manufacturers of the foregoing metals and alloys, viz., articles nor ornamented in relief, not engraved, and stamped articles, even if combined with wood, iron, tinplate, leather or other common materials ; iron and steel manufactures, wrought, stamped, moulded—not specially mentioned in Customs Tariff ; forged rails ; steam boilers and similar apparatus, boilers, reservoirs, tanks, boxes, sections of bridges ; also all unspecified kinds of manufactures of sheet iron or steel ; iron and steel manufactures (unspecified), worked, turned, polished, ground, bronzed or otherwise elaborated, even with parts composed of wood or of copper or copper alloys ; wire of copper or copper alloys, aluminium, nickel, cobalt, bismuth, cadmium, &c., of chrysocolle, tombac, argentan, Britannia metal, &c. ; manufactures of wire of such metals and metal alloys ; electrical cables ; machines and apparatus, complete or incomplete, fitted together or in parts ; physical, chemical and mathematical and drawing instruments ; vacuo-meters, indicators and measuring apparatus ; electrical current interrupters, commutators, safety cut-outs ; holders for electrical incandescent lamps ; rheostats and commutators of all kinds, fitted together or in parts ; telegraphic and telephonic apparatus ; electrical and pneumatic bells and accessories for electrical signalling ; ammeters, wattmeters, voltmeters, and calculators ; machine belting of hemp or cotton.

MISCELLANEOUS NOTES.

Exports to China.—The " London Gazette " of Oct. 15 contains a further list of additions to the list of public bodies and persons in China (abstracted in our issues of Oct. 1 and 15), to whom articles sent from the United Kingdom may be consigned.

The following are amongst the additions : International Concession at Shanghai, North China Engineering Co. Works, Morgan Crucible Co., Japanese Posts and Telegraphs in Manchuria, British Manufacturers' Agency (Wang Chuan Yung), Shanghai, Compagnie Générale de Chemin de Fer and de Tramways en Chine, China Trading Co., Shanghai.

German-Dutch Telephony.—From Amsterdam it is reported that, from cause at present unascertained, telephonic communication between Holland and Western Germany is " greatly interrupted."

Munition Cases.—Recent decisions by the Metropolitan Munitions Tribunal include the following :—

A workman employed by the London General Omnibus Co. on the repair of electric light equipment in omnibuses was granted his discharge. He admitted receiving a war bonus of 4s. for 54 hours. The Chairman said he was not satisfied that the man was on war work and refused the certificate.

A workman employed by a firm of engineers asked for a certificate as he had only two jobs in three weeks. The firm stated that 40 per cent. of the man's work was war work, and the Chairman remarked that Government work was not necessarily munitions. The firm were the making of lifts for munition factories, ships, hospitals, &c., and the Munitions Department had recognised that as necessary work. Applicant was now shell making and earned on an average £3 5s. a week. The certificate was refused.

In another case a workman applied for a certificate of release from a firm of grinding wheel manufacturers. The employer admitted the man received a low wage ; he was paid 5d. an hour, plus war bonus. Other men were getting 7d. and 8d. and a bigger war bonus, but that was a special trade, and there was no recognised rate. If the man had kept better time he would have had better wages. The Chairman was not prepared to say that the man was not justified in leaving. It seemed a very low rate and the certificate would be granted.

Last week the South West Wales Munitions Court sat to decide a difference which had arisen between two electrical attendants and the management of a West Wales copper works at which they had been employed. The complainants, David J. Morgan and E. J. Griffiths, alleged that on their leaving their employment the certificates necessary for them to obtain employment elsewhere had been unreasonably withheld. They stated that they were paid 6s. per turn for six turns per week at the electrical sub-station at the works, and that as they could get employment elsewhere at £2. 2s. per week they decided to leave. They alleged that they were promised promotion, and that their wages were not sufficient to keep their homes going.

For the company, it was said that the men could not easily be replaced, and by their abstention from work there was a probability of that part of the works being stopped.

The Chairman said that the tribunal had come unanimously to the decision that the works in question was clearly a factory " whose business consisted wholly or mainly in the manufacture of substances for the production of arms and munitions generally." There was an opinion held that the provisions referred only to " controlled " establishments, but an Order issued by the Ministry of Munitions clearly showed that that was not so. It was thought by some that sec. 7 did not apply to any but controlled establishments, whereas, in fact it was equally applicable to all such establishments as were there described. The Court found that the certificates in both instances had not been unreasonably withheld.

Restriction of Exports.—The Privy Council on Oct. 19 approved recommendations by the Board of Trade that the Proclamation of July 28, as amended by subsequent Orders of Council, be further amended by the prohibition of the exportation of platinum to all destinations and of copper wire (insulated), electric light wires and cables and bare cables to all destinations, except British possessions and protectorates.

Wills.—Second-Lieut. H. G. Byng, of 32, Bryanston-square, London, W., third son of the late Mr. Gustav Byng (founder of the General Electric Co.), who was killed in action on May 18 last, left an estate of the gross value of £73,716. Lieut. Byng was only 25 years of age at the time of his death. He was an active member of the General Electric Co.'s engineering staff. £100 is left to Mr. C. A. Pearson's Fresh Air Fund, and £200 each to charities connected with Harrow School and Harvard University, where Lieut. Byng received his education.

The late Mr. Robert Hammond, consulting electrical engineer, left estate of the value of £7,828.

TENDERS INVITED.

House Service Boxes, Fuse Boxes and Fittings.

GRIMSBY Corporation invite tenders for the supply of House Service Boxes (lead) and Fittings and House Fuse Boxes and Fittings. Forms of tender and specification from the deputy electrical engineer (Mr. A. S. Channon), and tenders are to be sent to the Town Clerk, Municipal-buildings, Victoria-street, Grimsby, by first post Nov. 4. *See also an advertisement.*

Automatic Telephone Exchange.

Plans and forms of tender are being prepared for the installation of an automatic telephone system in CHRISTIANIA (Norway), at an estimated cost of about £53,600. Specifications, &c., from the Kristiania Telefonanlag, Toldbodgt, 30, Christiania.

Motor Generator.

RATHMINES (Co. DUBLIN) Urban Council require tenders by 10 a.m. Oct. 28 for the supply of a Motor Generator. Specifications, &c., from the Electrical Engineer.

Turbo-Alternator, Generating Plant, Boilers, &c.

The AUSTRALIAN COMMONWEALTH Department of Defence require tenders by noon Oct. 25 for Power-station Plant and Equipment for the Naval Dockyard Cockatoo Island, Sydney, N.S.W., and by noon Oct. 27 for Machine Tools. Specifications from Director of Navy Contracts, Navy Office, Melbourne.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for the supply and maintenance for 12 months of two Water-tube Boilers and Accessories at Newcastle, N.S.W. Specification, &c., from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

CAPE TOWN (South Africa) Corporation require tenders by noon Nov. 5 for a 4,000 kv.a. Steam-driven Alternator, with Condensing Plant, or a 1,000 kw. Converting Plant if delivered earlier. Specification, &c., can be seen at the office of Mr. H. D. Wilkinson, 4, Queen-street-place, London, E.C.

Telegraph and Railway Stores.

The directors of the NORTH EASTERN RAILWAY CO. are prepared to receive tenders for 6 or 12 months' supply (from Jan. 1, 1916) of Telegraph Apparatus, Wire and Line Stores. Forms of tender from the Telegraph Superintendent (Mr. C. H. Ellison), and tenders to the Secretary, Mr. R. F. Dunnell, York.

The directors of the NORTH EASTERN RAILWAY CO. also invite tenders for 6 or 12 months' supply of Arc Lamp Carbons, Electric Wires and Cables, Electric Lighting, Arc Lamp Globes, &c. Forms of tender from the Stores Superintendent, Gateshead. Tenders to the Secretary, York, by 9 a.m. Oct. 28.

Coal Conveyor, Coal Hopper, Water Cooler, Water and Feed Pumps.

The Electricity Committee of MANCHESTER Corporation invite tenders for the supply, delivery and erection of Coal-conveying Plant, New Coal Hopper, &c., Water Cooler, two Electrically-driven Circulating Water Pumps and Turbine-driven Boiler Feed Pump. Specifications, &c., from the Secretary of the Electricity Department (Mr. F. E. Hughes), and further particulars can be obtained from the chief electrical engineer (Mr. S. L. Pearce). Tenders to the Chairman of the Electricity Committee, Town Hall, Manchester, by 10 a.m. 27th inst.

Wiring Lamps Fittings &c.

LONDON County Council require tenders by 11 a.m. Nov. 3 for an Electrical Installation at Thornfield-road Elementary School, Coverdale-road, Hammersmith, W. (about 193 wiring points and 240 lighting points). Specification, form of tender, &c., from the Chief Engineer, Spring Gardens, S.W.

The GREAT NORTHERN RAILWAY CO. (IRELAND) require tenders by 10 a.m. Nov. 4 for 12 months' supply of Electric Cable and Wire, Electric Light Carbons, Electric Fittings, Lamps, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

GLASGOW Parish Council require tenders by 10 a.m. Oct. 25 for 12 months' supply of Electric Lamps and Fittings. Forms of tender, from Mr. J. R. Motion, 266, George-street, Glasgow.

The District Committee of the Middle Ward of LANARKSHIRE require tenders by 10 a.m. Nov. 1, for Electric Lighting Work at Hairmyres Colony, East Kilbride. Specifications from Mr. Wm. Arnot, 163, Hope st, Glasgow.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Sydney, invites tenders by 2:30 p.m. Nov. 4 for 100 miles Two twisted and 75 miles Three-twisted Rubber-insulated tinned Copper Wire for the AUSTRALIAN COMMONWEALTH. Postmaster-General's Department.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General requires tenders by 2:30 p.m. Nov. 4 for about 59 miles of Paper-insulated Lead-covered Cable (schedule 472, N.S.W.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Nov. 17 for Switchboard Parts and Accessories (schedule 343a), Telegraph Instruments (schedule 345), Protectors and Parts, &c. (schedule 346), and Ironwork (schedule 358) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), invites tenders by Nov. 10 for a Wheatstone Bridge (schedule 475 W.A.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Specifications, &c., for the above contracts can be obtained from the respective Deputy Postmasters-General.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zinc, Carbon and Manganese Powder, Manganese Chloride, Chlorides of Ammonia, Fibre Discs, Oliver Jars for Cells, Copper Blocks and Resistance Units (schedule No. 1,270). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited for the supply of 200 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus for the Australian Commonwealth Postmaster-General's Department. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders to the Deputy Postmaster-General, Perth (W. Australia), by 3 p.m. Dec. 8.

The Public Service Trades Board, Wellington, N.Z., invites tenders by 4 p.m. Oct. 27 for 10,000 Dry Cells and 4,000 yds. Telephone Cable. Particulars from the Controller of Stores, Post and Telegraph Department, Wellington, the District Storekeeper, Post and Telegraph Department, Christchurch, or the Telegraph Engineers, Auckland and Dunedin.

TENDERS RECEIVED AND ACCEPTED.

METROPOLITAN ASYLUMS BOARD.—It is proposed to extend for 10 years further the agreement with the Tudor Accumulator Co. for the maintenance (at £28 per annum) of the battery at the Northern Hospital. The tender of Toy & Winslow (at £72) has been accepted for wiring the medical superintendent's new house at Tooting Bec Asylum.

METROPOLITAN WATER BOARD.—The following tenders have been accepted :—

Edison & Swan United Electric Light Co., 5-ampere 250-volt four d.p. way and 20-ampere 250-volt eight d.p. way fuse boards, £32; Callender's Cable & Construction Co., cable, £116; Sterling Telephone & Electric Co., special stethoscope receiver cases, £83.

BARNES.—Tenders for a six months' supply of coal having been received, the Lighting Committee considers that none of the tenders is sufficiently attractive to warrant them recommending the Council to enter into a contract. They have, therefore, instructed the engineer to purchase supplies in the open market.

SCHOOL LIGHTING.—Nine tenders were received by the London Education Committee for wiring Winchester-street school (Finsbury), and the lowest, that of Napier, Kimber (Ltd.), at £103. 11s., was accepted. The other tenders ranged from £109. 11s. to £242. 4s. 6d.

The London Education Committee received claims from Defries & Goldberg for additional allowances on their contracts for wiring four schools, owing to the increase in the price of materials between the the acceptance of their tenders and the commencement of the work. During the recess, the chairman approved the undermentioned allowances: Woolmore-street (Poplar) 20 per cent., and Star-lane (Fulham), Senior-street (Paddington) and The "Victoria," Hammersmith, 10 per cent. A. Hawkins & Sons were allowed £13. 10s., and the Alpha Manufacturing Co. £12. 10s. extra on contracts for wiring the Ranelagh-road (St. George, Hanover-square) and Vernon-square (Finsbury) schools respectively.

LONDON COUNTY COUNCIL.—The tender of W. T. Henley's Telegraph Works Co. (at £114) has been accepted for the supply of an electric lighting main for lighting of refuges on the Victoria Embankment. One firm tendered at £115. 10s. and two others at £117. 10s.

SYDNEY (N.S.W.)—The tender of the Reason Mfg. Co. (Lewes) road, Brighton) for the annual supply of maximum demand indicators has been accepted by the Municipal Council.

BUENOS AIRES.—The tender of the Anglo-Argentine General Electric Co. for the supply of 40,000 carbons, at $4,475 m/n. (about £302), for the lighting of the Port of La Plata has been accepted by the Direccion General of the Port.

Government Contracts.—The following tenders were accepted by the British Government departments during September :—

War Office. Cable Accessories Co., Cranmer & Cheshire, Dermen & Smith, E. M. F. (1914) (Ltd.), Forward Electric Co., Galsworthy (Ltd.), General Electric Co., D. Hulet & Co., Ingram & Kemp, Kartrot Engineering Co., Ramsford & Lynes, Sun Electrical Co. and W. Whitehouse & Co., distribution boards, &c.; British Insulated & Helsby Cables, Cosmath Electric Cable Co., J. Frankenburg & Sons, A. Green (Ltd.), India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips, Liverpool Electric Cable Co., St. Helens Cable & Rubber Co., Severn Electrical Wire Co., H. W. Smith & Co., Wood & Goldstone and Yorkshire Cable Co., electric cable and wire; J. C. Fuller & Son and Siemens Bros. & Co., electric cells and parts; Bulpitt & Sons, Ellison & Swan United Electric Light Co., E. Griffith & Sons and A. Lyon & Wrench, electric lamps; C. Collins (Ltd.), General Electric Co., J. Hinks & Son, James & Foster, Keith Lamps Lighting Co., Lyon & Wrench, G. Polley (Ltd.), Pope's Electric Lamp Co., Rippingille's Albion Lamp Co. and Thorn-Smith (1914), lamps and lanterns; W. G. Heath & Co., electric lighting, H.M. Gunwharf, Devonport.

India Office. Chloride Electrical Storage Co., cells; Siemens Bros. & Co., wire and testing gears; Bullers (Ltd.), insulator caps; Post Office Telegraph Works, switchboard, &c.; Marconi's Wireless Telegraph Co., wireless telegraph apparatus.

Office of Works. Bowie Thomson Houston Co., D. G. Kerr & Co., Pope's Electric Lamp Co., Electric Lamp Mfg. Co. and Foster Engineering Co., supply of electric lamps until Aug. 31, 1916.

War Office. Walters Electrical Mfg. Co., protective apparatus; British Ever Ready Mfg. Co., Post Office Telegraph Works, Siemens Bros. & Co., and Western Electric Co., telephone apparatus; Eastern Telegraph Co., India Rubber, Gutta Percha & Telegraph Works Co. and Telegraph Construction & Maintenance Co., submarine cable; W. T. Henley's Telegraph Works Co., Johnson & Phillips, Siemens Bros. & Co., Telegraph Construction & Maintenance Co., and Union Cable Co., telephone cable; Siemens Bros. & Co., battery cells; London Electric Wire Co. & Smiths, Phoenix Telegraph & Electric Works and Siemens Bros. & Co., telephone cords; British Thomson-Houston Co., Edison & Swan United Electric Light Co., General Electric Co. and Siemens Bros. Dynamo Works, portable Miniest lamps; General Electric Co., telephone lamps.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

FERRANTI (LTD.)—The profit on trading for the year ended June 30 was £37,230. 17s. 9d., and after crediting discounts, interest and transfer fees, and deducting general establishment charges, repairs and renewals, legal expenses, income tax, bad debts, directors' and trustees' fees, there remains a balance of £16,739. 6s. 6d., making, with £2,050. 1s. 5d. brought forward, £18,789. 7s. 11d. Deducting interest on first mortgage debenture stock (£4,437. 15s. 3d.), on five-year notes (£2,052), on bank loans (£1,271. 7s. 4d.), and £10,000 for depreciation reserve, a sum of £1,028. 5s. 4d. remains to be carried forward. The results for the year show a falling off as compared with the previous year, but this is due in a considerable measure to the dislocation created by the war, and the heavy falling off in export business due to the same reason, and also to adverse monetary conditions. The company have entered into a contract with the Government for a supply of shells and fuses, and as considerable outlay will be necessary in buildings and plant, arrangements have been made with the Government, under which certain advances are made by them for this purpose, and the consent of the debenture-holders and shareholders has been duly obtained. The construction work is proceeding satisfactorily, and the directors hope that deliveries will commence shortly. The works of the company were declared a controlled establishment under the Munitions of War Act, 1915, on Sept. 6, 1915. During the year £3,046 first mortgage debentures were redeemed, and the loans against five-year notes and second mortgage debentures were further reduced.

FRASER & CHALMERS (LTD.)—The profit for the year to June 3 was £12,058, compared with £8,378 for the previous year and £4,604 for 1912-13. On Aug. 2 the company's works at Erith were made a controlled establishment under the Munitions of War Act, 1915. To meet special conditions which have arisen, a new and larger power station has been constructed at the works, and some additions have been made to plant and machinery. The expenditure under this head durng the year has been £23,507. The business in South Africa has shown improvement during the year. In order to compensate for the amount expended during the year in fixed plant and machinery at the works, £17,904 had been transferred from profit and loss to reserve account, making the total £80,000. The dividend of 7½ per cent. on the preference shares of the company was paid in July. The directors recommend that the balance be carried forward.

MONTEVIDEO TELEPHONE CO. (LTD.)—The directors' report for the year ended July 31 states that after providing for all charges in Montevideo and London, the net profit for that period is £25,776. 6s. 8d., against £28,524. 19s. 1d. for the previous year. This falling off in the profit is due to the diminution in the number of subscribers, owing to the depressed business conditions which prevailed during the year. The interim dividends paid in May absorbed £4,342. 14s., leaving £21,433. 12s. 8d., to which is added £5,303. 7s. 7d. brought forward, making an available balance of £26,737. 0s. 3d. After applying £8,000 to depreciation of property and plant, and transferring £9,000 to reserve for renewals, the directors recommend payment of final dividends of 2½ per cent. upon the preference shares and 3 per cent. upon the ordinary shares, making for the year 5 per cent. on the preference and 6 per cent. on the ordinary shares, leaving £5,394. 6s. 3d. to be carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

S. G. LEACH & CO. (LTD.)—Reg. Oct. 13, capital £20,000 (£19,500 £1 cumulative preference and 10,000 1s. ordinary), to carry on business as electricians, electrical, consulting, mechanical and sanitary engineers, ironmongers, makers of and dealers in electric tramcars, motor cars, flying machines, &c. Private company. Reg. office: 15-17, Artillery-lane, ishopsgate, E.C.

NOBLE ENGINEERING CO. (LTD.) (141,846).—Reg. Oct. 12, capital £5,000 in £1 shares (3,500 A and 1,500 B), to carry on the business of general, automobile, mechanical and electrical engineers, boiler and tool makers, machinists, &c., and to adopt an agreement with C. B. Heaton and W. A. Catherwood. Private company. First directors are C. B. Heaton and W. A. Catherwood (joint managers). Reg. office: 44-50, Hercules-road, Westminster Bridge-road, S.E.

MORTGAGES AND CHARGES.

ELECTRO-FLEX STEEL CO. (LTD.)—Issue on Sept. 28, 1915, of £4,900 pebentures, part of series of which particulars have already been filed.

ENFIELD ELECTRIC CABLE MFG. CO. (LTD.)—D[illegible] on certain [illegible] supplemental to mortgage dated Nov. 5, 1914, to secure £[illegible] Viscount [illegible], G. J. Ardilaun and [illegible]

CITY NOTES.

MEMORANDA (Oct. 20).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 65. Consols Pay Day Nov. 5. Stocks and Shares Taken Days Oct. 27 and Nov. 11. Pay Days Oct. 28 and Nov. 12. Price of silver, 23⅝d.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended Sept. 30 at [illegible] per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax), payable on Nov. 1.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—The [illegible] have declared a dividend of ½ per cent. on the [illegible] ordinary [illegible] stock, payable Dec. 1.

CALCUTTA TRAMWAYS CO. (LTD.)—An interim dividend of 3 per cent. (less tax) has been declared on the ordinary shares, payable Nov. 1.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The directors have declared an interim dividend at rate of 10 per cent. per annum (less tax) on the ordinary shares for the past half-year, payable Nov. 1.

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment, by warrants, on Nov. 1, of interest for the half year ending 31st inst., on their 4 per cent. mortgage debenture stock. The transfer books of the debenture stock will be closed from 26th to 30th inst. inclusive.

HOLOPHANE (LIMITED AND REDUCED).—A petition for confirming the reduction of the capital of this company from £2[illegible] to £[illegible] will be heard by Mr. Justice Astbury on Nov. 2.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Oct. 20. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. Oct. 20.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s d	
10	7%	Bournemouth & Poole E.L. Ord.	9[illegible]	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	[illegible]	4 15 [illegible]	[illegible]
10	6%	Do. 6% Cum 2nd Pref.	[illegible]	[illegible]	Feb Aug
5	10%	Brompton & Kensington Ord.	5[illegible]	6 0 2	Mar, Sept
St.	4%	Central Elec. Supp. G. Deb. St	9[illegible]	4 5 5	..
St.	4%	Charing Cross West End & City Debs.	[illegible]	4 15 4	Jan, July
5	2/3	Do. 4½% Pref.	[illegible]	[illegible]	
5	5%	Do. Ord.	[illegible]	[illegible]	Aug Feb
10	9%	City of London Elec. Lt. Ord.	[illegible]	[illegible]	Feb Aug
10	6/0	Do. 6% Pref.	[illegible]	[illegible]	Mar Sept
St.	5%	Do. 5% Deb. St.	[illegible]	5 0 6	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar Sept
10	6%	Do. 6% Pref.	[illegible]	[illegible]	Feb Aug
St.	4½%	Do. 2nd Deb.	[illegible]	[illegible]	May Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	[illegible]	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	[illegible]	[illegible]	Feb Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	[illegible]	[illegible]	..
St.	4%	Do. 4% Mort. Debs.	[illegible]	4 11 11	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	[illegible]	7 7 4	Mar Aug
St.	4½%	Do. 1st Mort. Deb.	[illegible]	4 14 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	[illegible]	[illegible]	[illegible]
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	[illegible]	[illegible]	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	[illegible]	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	[illegible]	[illegible]	[illegible]
4	5%	South London E.S. Ord	[illegible]	[illegible]	[illegible]
St.	4½%	Urban Elec. Supp 4½% Db. St.	[illegible]	[illegible]	[illegible]
1	8%	Waste Heat & Gas Elec. Gen. Stations.	[illegible]	[illegible]	[illegible]
5	9%	Westminster E.S. Corp. Ord.	[illegible]	[illegible]	[illegible]
5	4½%	Do. 4½% Cum Pref.	[illegible]	[illegible]	[illegible]
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	[illegible]	[illegible]	Apl, Oct
St.	6%	Do 6% Cum Pref.	[illegible]	[illegible]	[illegible]
St.	4%	Central London Guar. Assented Ord.	[illegible]	5 19 [illegible]	..
St.	4%	Do. do. Assented Def Ord.	[illegible]	[illegible]	..
St.	4½%	Do. 4½% Pref.	[illegible]	[illegible]	[illegible]
St.	4%	Do. 4% Deb. St.	[illegible]	[illegible]	Jan, July
St.	4%	City & S. London Deb.	[illegible]	[illegible]	May, Nov
St.	5%	Do. Pref. Issue	[illegible]	[illegible]	[illegible]
10	5½%	Lanarkshire Tramways	[illegible]	5 17 11	[illegible]
10	1%	London Electric Ry. Ord.	[illegible]	[illegible]	Jan, July
St.	4%	Do. 4% Pref.	[illegible]	[illegible]	[illegible]
St.	4%	Do. 4% Debs.	[illegible]	[illegible]	[illegible]
St.	1%	Metropolitan Ry. Con. Ord.	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½% Pref.	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½% Convertible Pref.	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½% A Debs	[illegible]	[illegible]	[illegible]
St.	3½%	Do. 3½% Debs.	[illegible]	[illegible]	[illegible]
St.	..	Metropolitan Dist. Ry. Ord.	[illegible]	..	[illegible]
St.	4%	Do. 4% Prior Lien	[illegible]	[illegible]	[illegible]
St.	4½%	Do. 4½% First Pref.	[illegible]	[illegible]	[illegible]
St.	6%	Do. 6% Perp. Debs.	[illegible]	[illegible]	[illegible]

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share.	Last Dividend	Name.	Price, Wed., Oct. 20	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways —*cont.*			
St	4%	Metropolitan Dist. Ry. 4% Debs.	66½	5 14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	68½	5 16 9	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1⅛	..	..
1/0	..	Do. A Ord.	⅛	..	..
St.	6%	Do. 6% Inc. Debs.	104	5 15 5	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 16	70½	8 11 1	Mar, Sept
..	4½%	Do. 4½% Bds.	98½	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	⅜	..	Marcn
5	6%	Do. Pref.	4⅛	6 15 3	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅝	6 9 10	Apl, Oct
1	6%	Do. 6% Pref.	1⅜	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 15 3	Mar
100	5%	Do. Prior Lien Debs.	93½	5 8 6	Jan, July
1	6%	Do. 6% Pref.	⅜	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞	7 5 5	Aug. Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 9 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1½	8 11 5	April
100	6%	Do. 6% Prior Lien Debs.	101⅝	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70⅛	5 13 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10¼	7 6 4	Jan, July
5	2/6	Do. 5% Pref.	4½	5 17 8	Feb, Aug
1	15%	Castner Kellner	3	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅛	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
1	6%	Elec. Construction Ord.	⅜	9 12 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10⅛	9 12 3	July
10	6%	Do. 6% Pref.	9⅞	6 9 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅝	7 16 1	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	¼	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7⅛	6 6 7	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	97½	4 2 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	31½	7 12 5	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅝	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82½	4 17 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0	Jun, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	102	5 17 7	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22⅛	6 12 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	60	6 1 3	Ja.Ap,Jly.O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	5⅝	6 16 2	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	120	5 16 8	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	65½	5 6 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81½	4 18 2	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11⅜	5 19 9	Ja, Ap, Jly.O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	5 19 5	Ja, My, Jly
25	13%	Indo-European	47½	6 16 10	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅝	5 6 8	April
1	7%	Do. 7% Pref.	1⅜	3 19 0	July
10	9d.	West India & Panama Ord.	1	10 0 0	May, Nov
10	6%	Do. 1st Pref.	8⅜	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 16 1	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79½	5 0 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	100	4 10 0	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	129½	6 3 7	Ja,Ap, Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	75	6 13 4	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅜	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101⅜	4 8 9	May, Nov
1	10%	Oriental Telephone Ord.	1⅜	5 2 7	Apl, Oct
St.	4%	Do. Db. St.	80	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	8⅛	7 0 8	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜	5 3 3	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	7⅛	6 3 1	Ja,Ap,My,Jn
10	6%	Do. 6% Pf.	7⅛	6 1 1	Ja,Ap,My,Jn
100	5%	Mackay Companies' Common	80	6 5 0	Ja, Apl, Jly.O
..	4%	Do. $100 Pref.	65½	6 12 9	Ja,Ap,Jly.O
100	6%	Submarine Cable Trust Certs.	121†	5 16 9	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	75	6 13 2	Jun, Dec
St.	4½%	Do. 4½% Debs.	70	6 8 7	Jan, July
St.	4%	Do. 4% Debs.	70½	5 13 10	Jan, July
5	2/9	Do. 5½% 1st Pref.	5⅜	5 2 1	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅝	5 1 1	Jan, July
100	..	Brazilian Traction Ord.	40½	7 8 4	Fb,My,Aug,N
100	£1	Do. 6% Pref.	90½	6 16 10	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 4 3	May
5	2/6	Do. 2½% Cum. Pref.	3⅛	3 19 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	60	7 10 0	..
5	7½%	Calcutta Elec. Trams. Ord.	8⅜	3 11 3	Mar, Sep
..	5%	Howrah Elec. Trams 5% Debs.	85½	5 13 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	6⅜	6 0 0	..
100	5%	Mexican Trams 5% Debs.	70	7 9 11	Jan, July
..	..	Mexico Tramway Company 5%	30	..	Fb,My,Aug,N.
..	5%	Do. Pref.	14½	6 18 11	May, Nov
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	78	5 15 10	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	91	5 9 10	Jun, Dec
100	4½%	Taubaté Funding Co. 4½% Bds.	90	4 17 11	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Electric Supply 6% Pref.	4⅜	6 17 1	Mar, Sept
St.	5%	Do. 5% Debs.	75	6 13 1	Jun, Dec
10	6%	Buenos Ayres Lt. & Pr. Pref.	13	5 18 ..	..
5	9%	Calcutta E. S. Corp. Ord.	6	7 10 ..	May, Nov
5	5%	Do. 5% Pref.	4½	5 11 ..	May, Nov
..	7%	Canadian Gen. Elec. Company (Can.)	113	6 16 ..	Ja,Ap,Jly,O
St.	3%	Mexican Electric Engineering, 1899 Mtg. Debs.	50½	5 1 ..	..
St.	5%	Do. 5% Cons. Deb. St.	94½	5 3 ..	Apl, Oct
..	5%	Shanghai Gas & Water Co. Bds.	102	4 18 0	Jan, July
..	6%	Do. Pref.	147	4 4 ..	Mar, Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	85	4 13 7	Ja,Jly
St.	4½%	Do. 4½% Cons. Mort. Debs.	90	5 1 ..	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf.	1⅜	..	Jan, July
..	5½%	Do. 5½% 1st Mort. Debs.	94½	..	Jan, July

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 20, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13½d.	English Lead	£25 10 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15½d.	**Old Metals:**	per ton.
Brass Wire	12½d.	Clean Scrap Copper	£70 0 0
Copper Wire	12½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	12½d.	Clean Scrap Brass	£52 0 0
Brass Sheets	13½d.	Old Lead	£21 10 0
	per ton.	Old Zinc	£35 0 0
Copper Sheets	£103 0 0	Hollow Pewter	£105 0 0
Spelter	£68 0 0	Black Pewter	£75 0 0
		Gun Metal	£60 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Oct. 19, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£85 0 0	Old Lead	£22 0 0
Clean Mixed Brass	£55 0 0	Tea Lead	£20 0 0
Clean Copper	£70 0 0	Old Zinc	£38 0 0
Brazlery Copper	£63 0 0	Hollow Pewter	£110 0 0
Gun Metal	£60 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £68; Commercial Tinman's Solder, £88; Blowpipe Solder, £98.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Oct. 13	1,673	+ 220	19	35,822	+ 1,517
Anglo-Argentine	,, 14	53,405	— 1,382	19	2,087,312	— 137,428
Ashton-under-Lyne	,, 16	482	+ 76	29	14,278	+ 905
Ayr Corporation	,, 16	276	+ 35	22	10,382	+ 533
Birkenhead Corporation	,, 17	1,408	+ 206	29	39,948	+ 3,067
Birmingham Corporation. Trams	,, 16	15,342	+ 3,917	29	399,010	+ 48,306
Birmingham Corporation. Buses	,, 16	891	+ 183	29	24,831	+ 17,117
Blackburn Corporation	..	..	..	..	..	..
Blackpool Corporation	,, 14	998	+ 126	29	61,432	+ 1,157
Blackpool and Fleetwood	,, 16	496	+ 7	41	35,548	— 226
Bolton Corporation	,, 17	2,098	+ 233	29§	78,455	— 2,651
Bournemouth Trams	,, 13	1,987	— 368	28	63,470	— 3,149
Bournemouth Buses	,, 13	8	+ 1	28	842	— 103
Bradford Corporation	,, 16	6,616	+ 58	28	191,155	+ 8,101
Brighton Corporation	,, 17	1,057	+ 141	29§	34,974	— 10
Bristol Trams Trams	,, 15	4,611	— 1,[illegible]	41	193,066	+ 738
Bristol Trams Buses, &c.	,, 15	4,671	+ 460	41	201,113	+ 35,253
Burmah E. Trams & Ltg.	,, 16	R4,146	— R[illegible]	41	R147,193	— R1,573
Burnley Corporation	,, 16	1,615	— 333	2	3,179	— 487
Burton Corporation	,, 17	274	— 6	29	8,487	— 353
Bury Corporation	,, 17	1,315	+ 84	29§	40,380	— 970
Calcutta Tramways Co.	,, 16	R70,697	— R[illegible]	..	..	..
Camborne-Redruth	,, 16	147	— 11	41	5,656	..
Cardiff Corporation	,, 9	2,667	+ 72	27	76,275	— 3,158
Cork Electric Trams Co.	,, 14	522	+ 44	41	20,853	— 12
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	..	..	..	..	..	..
Dover Corporation	,, 16	305	+ 30	28	9,440	+ 1,741
Dublin & Lucan Railway	,, 15	144	+ 22	15	2,561	— 76
Dublin United	,, 15	6,241	+ 540	41	252,981	+ 9,720
Dundee Corporation	,, 13	1,[illegible]	— [illegible]	28	30,076	+ 1,473
East Ham Council	,, 16	1,[illegible]	— [illegible]	28	38,080	+ 5,528
Exeter Corporation	,, 15	370	+ 35	28	11,341	+ 664
Glasgow Corporation	,, 16	22,[illegible]	— 2,[illegible]	29‡	432,802	+ 32,717
Glossop Trams	,, 16	133	+ 31	42	5,278	— 69
Gloucester Corpn.	,, 13	3[illegible]	+ [illegible]	28	9,783	— 81
Halifax Corpn. Trams	,, 12	2,132	— 8	28	65,456	+ 783
Halifax Corpn. Buses	,, 12	47	+ 1	28	1,463	— 7
Hastings Elec. Trams Co.	,, 14	[illegible]	[illegible]	41	41,421	— 21
Huddersfield Corpn.	,, [illegible]	2,[illegible]	— 121	27	76,275	— 12,075
Hull Corporation	,, 16	3,07[illegible]	— [illegible]	28	87,133	— 3,791
Ilford District Council	,, 16	656	+ 57	28	19,061	+ 2,816
Ilkeston Corporation	,, 13	136	+ 14	28	3,827	+ 85
Ipswich Corporation	,, 16	517	+ 121	27	16,545	+ 2,584
Isle of Thanet Co.	,, 16	330	— 75	28	786	— 347
Kilmarnock Corporation	,, 16	162	+ 14	22	3,846	— [illegible]
Lancashire Trams Co.	..	..	..	..	..	..
Lancashire United	,, 13	1,734	+ 191	41	72,213	+ 4,337
Leeds Corporation	,, 16	8,817	+ [illegible]	29	260,521	+ [illegible]
Leicester Corporation	,, 16	3,252	+ [illegible]	42	125,606	+ 6,420
Leith Corporation	,, 16	775	+ 118	22	17,511	+ 1,029
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	,, 9	13,544	+ [illegible]	40¶	534,505	+ 5,572
Llandudno & Colwyn Bay R.	,, 8	383	+ 77	41	15,793	+ 1,435
London County Council	..	..	..	..	..	..
Lowestoft Corporation	,, 16	122	— 69	2	239	— 158
Maidstone Corporation	,, 14	227	+ 42	28	6,582	+ 141
Manchester Corporation	,, 16	18,307	+ 1,[illegible]	28	517,787	+ 15,668
Newport Corporation	,, 16	182	+ 38	28	5,722	— 11
Newcastle-on-Tyne Corpn	,, 16	6,[illegible]	+ [illegible]	2[illegible]	182,602	+ 26,096
Newport (Mon.) Corpn.	..	..	..	..	..	..
North Staffordshire Corporation	,, 15	686	+ 102	28¶	21,532	+ 4,318
Nottingham Corporation	,, 14	3,773	+ [illegible]	28	[illegible]	+ 7,010
Oldham Corporation	,, 17	2,352	+ [illegible]	30	69,790	+ 2,132
Portsmouth Corporation	,, [illegible]	[illegible]	+ [illegible]	28	74,175	..
Preston Corporation	,, 13	[illegible]	+ [illegible]	28••	[illegible]	+ 455
Rhondda Corporation	..	..	..	..	..	..
Rotherham Corporation	,, 13	1,191	+ 82	28	32,723	+ 3,234
Salford Corporation	..	..	..	..	..	..
Sheffield Corporation	,, 17	9,331	+ 1,790	29§	262,866	+ 34,066
Southampton Corpn.	..	..	..	..	..	..
Southend Corporation	,, 13	699	— 37	28	26,084	— 7,280
South Shields	,, [illegible]	821	+ 123	29§	22,622	+ 657
Stockport Corporation	..	..	..	..	..	..
Southport Corporation	,, 17	1,[illegible]	+ 211	29	43,745	— 308
Sunderland District	,, 14	1,034	+ 4[illegible]	29	28,961	— 340
Swansea Corporation	,, 13	1[illegible]	— [illegible]	28	5,779	+ 612
Tynemouth Corporation	,, [illegible]	[illegible]	— [illegible]	14	6,[illegible]	— 284
Walsall Corporation	,, 17	1,190	+ 112	29§	38,[illegible]	+ 215
Warrington Corporation	,, 14	[illegible]	+ [illegible]	42	30,749	+ 4,530
Wallasey Corporation	,, 14	805	+ [illegible]	29	27,488	+ 3,199
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	,, 14	3,[illegible]	+ 357	29	89,718	+ 8,858
Wigan Corporation	,, 14	[illegible]	+ [illegible]	28	43,466	+ 1,501
Workington Corporation	,, 13	1,[illegible]	+ [illegible]	2	2,125	— 10
Yorkshire W. R. Trams	,, 17	1,[illegible]	+ [illegible]	42	66,870	+ 5,614

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Including [illegible] Buses &c. ‡ Minus 2 days. § Minus 3 days ‖ Plus 3 days ¶ Plus 2 days. •• Compared with one week more last year

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CONTENTS OF THE CURRENT NUMBER.

NOTES 113
Arrangements for the Week .. 116
Superimposed or "Phantom" Telephone Circuits. Illustrated. *Concluded* 117
Alternating-Current Ammeters and Voltmeters. Illus. 120
Turbo-Alternator Development 123
Electrification on the London & South-Western Railway. Illustrated. *Continued* 124
London-Birmingham Loaded Cable. Illustrated 128
THE PASSING OF THE SMALL TURBINE 130
REVIEWS 131
Specification and Design of Dynamo-Electric Machinery [Walker]: Reviewed by Gisbert Kapp.
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated. *Continued* 132
Bradford Electricity Supply .. 135
Method of Constructing Alternators to Obtain a Pure Sine Wave E.M.F. By W. Seemann. Illustrated 137
Hydro-Electric Developments in Norway 137
On the Distributed Capacity of Single-Layer Solenoids. By J. C. Hubbard 138
Engineering Students and the War 138
The "Electrician" Commercial and Industrial Section .. 139–150

NOTES.

Organised Research.

THREE months ago we commented upon the particulars issued by the Board of Education of a "Scheme for the Organisation and Development of Scientific and Industrial Research," and we suggested that men of note on the industrial side should be asked to serve on the Advisory Committee appointed by the Board. Beyond an attempt to ascertain the researches in progress in the various colleges little *real* work has been done in connection with the scheme. We now suggest to the Board the advisability of turning over their scheme to the several engineering and scientific institutions, giving to each definite instructions as to expenditure, and leaving the institutions a free hand as to the nature of any research contemplated. These people know what research is required in their own professions. The Board of Education does not and cannot know. Furthermore, we suggest to the Board that a Memorandum setting out the desirability, or otherwise, of teachers and senior students in technical institutions joining one of the branches of His Majesty's Forces. Should these men be compelled by another Department, or by public opinion, to enlist, such enlistment would indefinitely postpone all organised research and technical education. In both we are notoriously deficient, and we look to the Board to issue an instruction on the subject without delay.

FROM the brief reports of some typical colleges and institutions which we give on another page our readers will learn that the present position of affairs is serious. Most of the third and fourth year courses have been abandoned, as many of the 17 year and nearly all the 18 and 19 year-old students have joined H.M. Forces. We have nothing but praise for these patriotic young men who have answered their country's call, but it is questionable whether their energies and their abilities are being utilised to the best advantage. Another ominous sign is that the new enrolments are less than half the usual number, and the average age is also less. For a country whose existence is bound up with the maintenance of its supremacy in shipbuilding and engineering this is a vital matter which requires a speedy remedy. Every effort should be made to keep up the supply of skilled men, and perhaps the education authorities could devise a system of scholarships so as to encourage youths to enter the engineering profession. It might also be added that nearly all research work and all special courses of instruction have had to be abandoned for the time being. This latter branch of work requires every encouragement, and we regret that the inevitable war work has interfered so much with its continuation.

Electricity Supply at Bradford.

THE annual report of the Electricity Committee at Bradford shows a very satisfactory state of affairs. Although the undertaking has not grown to the same extent as hitherto, owing to war conditions, there has nevertheless been an increase of nearly three-quarters of a million units. As would be expected, the increase in power supply has been considerable, and bulk supply agreements have been entered into with a number of consumers, varying from 100 kw. up to 1,000 kw., or a total of 2,900 kw. It will be noticed from the figures we give elsewhere that the load-factor is very good, and is still rising, and that the total costs are low, amounting to only 1·07d., including capital charges. It is fortunate for this undertaking that contracts for new plant had been placed, and were well in hand, before the Government found it necessary to control the outputs of engineering establishments, or to adopt a policy of restricting capital expenditure. Even so, the sum which had been provisionally sanctioned in 1914 was somewhat reduced. As it is, the new turbo-generator of 5,000 kw. is so far completed that preliminary trials of this set have been made, and will, doubtless, be ready in the near future to take up its proportion of the new load obtained.

The Government and Extension Schemes.

IT is not every undertaking that is in the happy position of Bradford in regard to extensions. Quite recently the generating stations at Birmingham found it necessary to choose between the power consumers and the tramways, with the result that the tramways went short of power, much to the inconvenience of the public. In all industrial cities the demand for power is increasing rapidly as the work on munitions is extended. Walsall is another case of this kind. At Coventry also we notice that one of the consumers has intimated to the Electric Light Committee that a further supply of power will be required shortly, and the manager has reported that in order to give this supply extensions estimated to cost £30,000 will be necessary. While we agree that capital expenditure should be restricted as far as possible at the present time, we think that the Government should exercise rather more discrimination in the matter. What they probably do not realise

is that a power station cannot be enlarged in a few weeks. Even in normal times a long period elapses between the letting of a contract and getting the plant to work, and under present conditions such work is particularly slow, owing to the fact that all the large engineering works are Government controlled, and consequently cannot undertake the execution of orders without Government permission. Not only so, but it must be remembered that, if a generating station is loaded up so that there is very little spare plant, the risk of stoppage is materially greater, and this is a risk which should not be run in connection with munition work if it can in any way be avoided.

Sine-Wave Alternator.

Since the earliest days of alternating-current engineering the shape of the E.M.F. wave has given rise to considerable discussion. At the beginning it mattered little whether the wave was sinusoidal or not. In pre-oscillograph times the ingenious methods of determining the wave shape were for the most part complicated and unreliable, and were unsuitable for works testing. Nowadays a designer endeavours to arrange his machine to give a sinusoidal wave, and it is an easy matter for the buyer or his agent to determine the shape of the wave by means of an oscillograph. The factors determining the form of the E.M.F. wave are the distribution of the flux and the distribution of the winding. More than 10 years ago Mr. A. C. Eborall gave the E.M.F. curves under load of two three-phase alternators. Both machines were built by the same firm and were alike in all essential details, but in the one the slots were nearly closed and in the other entirely open. The ripples in the E.M.F. wave of the latter machine were clearly shown on the oscillogram. Mr. R. Rüdenberg, in 1904, discussed the question of suppressing all the more prominent harmonics by a suitable distribution of the winding, and gave as examples a number of windings as well as the oscillograms of the pressure waves obtained with various flux distributions. The work of Dr. C. P. Steinmetz on wave distortion is well known, and most of our readers will call to mind the important Paper on "The Shape of the Pressure Wave in Electrical Machinery," read earlier in the year by Dr. S. P. Smith and Mr. R. S. H. Boulding before the Institution of Electrical Engineers. Elsewhere in this issue we give an abstract of an article by Dr. W. Seemann, in which a method of constructing alternators to obtain a pure sine-wave E.M.F. is described. The author advocates the use of a drum-shaped rotor with the windings in radial slots uniformly spaced around its periphery, the slots being omitted at the poles. By cutting away the periphery of the rotor on a profiling machine the reluctance around the rotor is altered in such a way as to produce a sine wave. The method described admits of a sinusoidal E.M.F. wave being obtained on a definite load and phase displacement.

Alien Enemy Patents. A report on this subject has been issued by the Patents Tribunal of the Patent Office constituted to consider the question. We hope to deal with this in our next issue.

Marine Wireless Installations.—According to "The Steamship," the 7,000 wireless ship stations in the world require over 15,000 licensed men to operate them, while over 1,000 land stations with a working force of 4,200 men are required to handle the business which originates on board, or for, these vessels. The records of the United States show that about 2,000 amateurs have been licensed in the past few years to operate their own stations. A fair estimate of the number of warships so equipped in the navies now at war is: Great Britain 500, Germany 200, Italy 200, France 180, Russia 110, Japan 70, Austria 60. There are also a large number of small vessels under Colonial flags. The United States has over 300.

Electric Railway Development.—At the San Francisco Convention of the American Electric Railway Association, Mr. J. H. McGraw stated that the electric railway industry in the United States is now capitalised at more than £900,000,000, exclusive of the large amount of capital invested in the industries required to supply these railway companies with apparatus in the way of cars, electrical equipment, generating apparatus and rails. The number of passengers carried increased from 2,023,010,290 in 1890 to more than 12,000,000,000 in 1912.

Royal Engineer Commissions.—The University of London Officers' Training Corps, under the command of Lt.-Col. Capper, commences its eighth year of training this month. The contingent consists of Artillery, Engineer, Infantry and Medical Units.

The training is mainly of a continuous character, carried out in or near London. The number of commissions obtained up to August, 1915, is just short of 2,000. The Engineer Unit of the above contingent should appeal strongly to Engineers who are desirous of obtaining commissions in the Royal Engineers. Arrangements are made whereby training can be carried on continuously or for part time only for those men who cannot leave their civil posts until actually gazetted. Candidates for enrolment in the Engineer Unit should apply personally to the O.C. Engineer Unit at the University of London, South Kensington S.W., on Tuesday or Thursday evenings between 5:30 and 7:30 p.m.

The Coolidge Röntgen Ray Tube.—Profs. E. Rutherford and J. Barnes have recently contributed to the "Philosophical Magazine" two Papers giving the results of an extended experimental investigation of the Coolidge Röntgen-ray tube. The first Paper deals with maximum frequency of the Röntgen rays from the Coolidge tube for different voltages, the second part with the efficiency of production of Röntgen rays from the Coolidge tube. The authors found that the voltage required to excite the most penetrating rays in tungsten is about twice that to be expected on the quantum theory, indicating that about half of the energy of the exciting electron can be transformed into radiation. From the low value of the efficiency at high voltages (about 1/500) it is clear that, on the average, one electron only in 200 is efficient in producing radiation.

Transatlantic Wireless Telephony.—The transmission of speech by radio-telephony between America and Europe has now been successfully accomplished. This is the result of experiments commenced in June in America and France, conducted on this side by Lieut.-Commander Sayles, the American Naval Attaché, and Mr. H. L. Shreeve, of the American Bell Telephone Co. Col. Ferrié, the well-known wireless specialist of the French army, has also observed the experiments and made suggestions. The French Government greatly assisted the work by suspending all signals from the Eiffel Tower and other French stations when trials were being made. Within the last few days words transmitted from the American station at Arlington have been distinctly heard at the Eiffel Tower, though the clearness varied with the state of the atmosphere.

Automatic Telephony at Los Angeles.—In a Paper read before the American Institute of Electrical Engineers at San Francisco Mr. W. Lee Campbell described the present automatic switchboard telephone system in the city of Los Angeles. This system, which began to give service with one manual switchboard in the year 1902, has gradually been extended and transformed through several interesting stages of combined automatic and manual operation, until it now comprises 15 automatic offices and a traffic distributor switchboard which serve a total of 60,000 subscribers' stations—the largest automatic switchboard system in the world. The traffic distributor switchboard used for handling the out-going calls from a large number of private branch exchange switchboards is the largest board of the kind in operation; it includes 30 operators' positions and handles a heavy traffic. Uniformly good service is secured from the automatic apparatus scattered over this area of about 200 square miles, and handling from 500,000 to 600,000 calls each week-day.

Magnetic Properties of Iron Alloys Melted in Vacuo.—In an informative Paper presented last week at the American Institute of Electrical Engineers Mr. Trygve D. Yensen described further experiments on various alloys of the electrolytic iron melted in vacuo with other elements. The author

dealt briefly with the iron-boron and iron-carbon alloys, and presented results obtained with the iron-cobalt alloy Fe_2Co. He gave in greater detail the data in regard to iron-silicon alloys, from which the most remarkable results were obtained. The two best alloys were obtained with about 0·15 per cent. and 3·40 per cent. silicon, after annealing at 1,100°C. The values of maximum permeability for both of these alloys are above 50,000, and the values of hysteresis loss for $B_{max.}=10,000$ and 15,000 are about 300 and 1,000 ergs per cubic centimetre per cycle respectively. This hysteresis loss is one-eighth and one-third of the corresponding loss for commercial silicon steel. While both alloys have similar magnetic properties, the 3·40 per cent. silicon alloy has an electrical specific resistance nearly five times that of the 0·15 per cent. alloy, making it a particularly desirable material for use in electromagnetic machinery in places where a low eddy current loss is a requirement, in addition to high permeability and low hysteresis loss.

An Electrical Engineering Research Laboratory.—The electrical engineering laboratory of the Engineering Experiment Station of the University of Illinois is located in a two-story building, and has a floor area of 18,000 sq. ft. It receives continuous-current, two-phase and three-phase electrical energy from the 500 kw. power plant of the University. The laboratory contains 45 continuous-current dynamos with a total capacity of 400 kw., 25 alternating-current machines with a total capacity of 325 kw., and 45 transformers with a total capacity of 375 kw. The instrument room contains standards for the calibration of all types of commercial instruments, and also about 300 portable instruments for experimental work. There is available a 60-cell, 240 ampere-hour storage battery for work necessitating steady current. A 200,000-volt transformer affords opportunity for high-voltage alternating current testing. A set of 30 small continuous-current generators is installed with series electrical connection of the machines for high voltage continuous current experiments. From this set potentials up to 20,000 may be obtained. The current capacity of these machines is 0·5 ampere. The electrical furnace room contains a 30-kw. induction furnace, a 25-kw. arc furnace, two 20-kw. induction furnaces, a 15-kw. vacuum furnace for melting, a 30-kw. vacuum furnace for annealing and a 1·5-kw. muffle furnace. Four oscillographs are available for the study of transient electrical phenomena. A workshop in charge of a skilled mechanician is located in the basement of the electrical building, and in this shop is constructed a large part of the special apparatus needed in the electrical researches of the station.

The Navy's Need for Skilled Engineers.—Munition work as we understand it to-day, that is to say, work in the shop and the factory, forms by no means the only opportunity for skilled engineers to serve their country at the present time. The Navy is always glad of their services. Transference from munition work to the Navy is not encouraged, but amongst those skilled mechanics who are not at the present moment engaged on munition work there must be many who would be glad to find an outlet for their technical abilities by becoming a member of the Naval Service. It is felt that if the opportunities and the requirements, which exist in this respect were more fully known there would be no difficulty in keeping up the supply of electrical artificers and engine-room artificers who are needed by the Navy.

This branch of Naval Service has many attractions, not the least of which is the comparatively high pay received, which amounts on entry to nearly £2 per week, and which may be very considerably improved by good service. Thus with infinitely better pay and prospects than those of the ordinary seaman, they have the same opportunity for seeing the world and for leading a fine, healthy open-air life at the same time as driving their own trade, which usually keeps them so closely confined to the workshop. As they enter the Navy with the rating of chief petty officers they mess in the chief petty officers' mess and have the same opportunities for leave when they are in port. If they are sufficiently skilled they are drafted at once on to a battleship and come immediately to grips with their work. Their opportunities for advancement to commissioned rank are excellent.

During the period of the war, men are accepted between the ages of 21 and 45. For rating as engine-room artificers, men who have experience and are competent workmen in the trades of engine fitters and turners, copper smiths, boiler makers and engine smiths are required. An examination is usually held on entry, but in the case of [illegible] who holds a Board of Trade certificate as a first class or second class engineer and can produce certificates of character and ability from the works in which he has learnt his trade, exemption is granted. Engine-room artificers are entered as chief petty officers, a position which carries with it many privileges. A free kit is provided on entry, and this, of course, is not the ordinary blue-jacket's slacks and jumper, but what is known in the Navy as "fore and aft rig," that is to say, a peaked cap and reefer jacket.

Fitters, turners and instrument makers are required by the Navy as electrical artificers. Candidates for this rating are accepted for the period of the war between the ages of 21 and 45. The pay is also the same as engine-room artificers, and an examination in fitting and turning or instrument making is imposed. Electrical artificers may be recommended for a practical course of training which is carried out on board the "Vernon," which is moored at Portsmouth, or on board the "Defiance" at Devonport. During this period they may be accommodated either on board ship, or in the magnificent naval barracks which are situated in these two towns.

This avenue to naval life is certainly one not to be neglected by the skilled engineer. There is no quicker way of entering for actual service, and none which secures immediately better pay, prospects and position. Entering the Navy as a chief petty officer he immediately steps into a rank which takes the man who enters as ordinary seaman many years to achieve.

OBITUARY.

Sir Andrew Noble.—We regret to record the death of Sir Andrew Noble, Bart., K.C.B., chairman of Sir W. G. Armstrong, Whitworth & Co. He was born at Greenock in 1831, and after passing through the Royal Military Academy, Woolwich, entered the Royal Artillery in 1849, attaining the rank of captain in 1855. For some time he was employed in the Magnetic Survey at the Cape under Sir Edward Sabine, and on his return to this country he became secretary of the Royal Artillery Institution. In 1860 Captain Noble was induced to leave the public service and take up a position at Elswick, where he assumed the special direction of the ordnance department. While his administrative capacity and powers of work were of a high order, he also contributed in no small degree to that engineering and scientific reputation which his company has long enjoyed all over the world. In 1862 he carried out the first electroballistic investigations made in this country and was the inventor of the Noble chronoscope, an apparatus for determining the velocity of a projectile in the barrel of a gun. In conjunction with Sir Frederick Abel and collaterally with the Government Committee on Explosives, he carried out a long series of experiments on "Fired Gunpowder." He was president of the Mechanical Science Section of the British Association in 1890 when he delivered an address showing the indebtedness of naval and military services to mechanical science. In 1881 he was made a C.B., in 1893 K.C.B., and a baronet in 1902. He was also the wearer of many foreign orders. In 1904 Sir Andrew Noble gave evidence before the Royal Commission on Trade Disputes and Trade Combinations on behalf of the Engineering Trades Employers' Federation. He advocated leaving the settlement of trade disputes to the parties concerned or their authorised representatives. He did not think that any legislation could improve those matters, or that there was any demand for making such arrangements compulsory by law.

Prof. V. B. Lewes.—We regret to record the death of Prof. Vivian Byam Lewes, who died at Mold, Flintshire, on Saturday last from double pneumonia, at the age of 63. Last Tuesday week he gave a lecture at Mold, organised by the Educational Trust, on "The Explosives Used in the Great War." Afterwards, however, he was in a state of collapse, and was taken to the house of Mr. William Buckley, where he was to have stayed for his visit, and it was there that he died. Prof. Lewes was professor of chemistry at the Royal Naval College, Greenwich, and chief superintending gas examiner to the City of London. He has written several chemical works.

Mr. Leonard Potts.—The death is also announced of Mr. Leonard Potts, town clerk of Poplar. Mr. Potts, who had been 40 years in the service of the Borough Council and its predecessor (the district Board of Works), took a keen interest in all forms of municipal activity, and especially in the development of the municipal electricity department. He also took a prominent part in the conferences on the various London power schemes.

Mr. W. A. Luntley.—We have also to record the death, after a painful illness of over seven months, of Mr. W. A. Luntley, general manager of the Wolverhampton Corporation Tramways.

Killed in Action.—Capt. Sydney John Sankey, 1 6th South Staffordshire Regiment (T.F.), was killed in France on September 25th, aged 25. He was the eldest son of the late John W. Sankey, J.P., of Bromley, Wolverhampton, and a director of Joseph Sankey & Sons,

Bilston, the well-known manufacturers of transformer and armature stampings. He left for France with his battalion on March 2, 1915, and was very popular.

We also have to record the death of Lieut. Basil Erin Hicks, Royal Berkshire Regiment, 8th Battalion, a son of Prof. W. M. Hicks, F.R.S., of Sheffield University. He was 22 years of age.

Second Lieut. T. V. Dann, 1/6th South Staffordshire Regt. (T.F.), was killed in action on Oct. 13. He was formerly employed by the firm of B. Gibbons, jun., engineers, Dudley.

PERSONAL.

We learn that Temporary Lieut. Horace M. Taylor (borough electrical engineer of Middlesbrough) has been promoted to Temporary Captain in the Royal Marines Submarine Miners.

Royal Engineers (T.F.)—The following promotions have been made :—

London Electrical Engineers.—Sappers Wm. J. Rawlings and John D. Ross to be Second Lieutenants.

Kent (Fortress) Engineers : Corp. John O. Scott and Sapper Thos. H. Andrew (both from London Electrical Engineers) to be Second Lieutenants.

APPOINTMENTS VACANT AND FILLED.

Appointments will shortly be made in connection with a 1,000-kw. electric power installation at a large military camp in North Yorkshire, including an assistant engineer, junior shift engineers, station fitter, engine driver, stokers, stoker-trimmer, wireman and mate. Applicants must have had good experience of three-phase central station work, and the higher grades of the staff will be required to show a thorough knowledge of high-tension transmission. Applications from those engaged on munition work directly or indirectly will not be considered. Applications to the Commanding Royal Engineers, York District, 12, Wenlock-terrace, York. *See an advertisement.*

An electrician is wanted for the Gold Coast Government waterworks. Salary £300, rising by increments of £10 to £350, with free quarters, &c. Applications to Messrs. Hunter, Duff & Middleton, 17, Victoria-street, London, S.W. *See an advertisement.*

An engineer, with electrical and mechanical training, workshop experience, knowledge of wiring, motors, &c., is required for the Imperial Bacteriological Laboratory, Muktesar, India. Initial salary R.350 to R.400 per month, rising to R.500. Applications to Director-General of Stores, India Office, Whitehall, London, S.W., by Nov. 1.

Advertisers require jointers, accustomed to paper and vulcanised bitumen cables.

Mr. W. Dundas Fox has resigned his position with Bradford Corporation and has joined the staff of the British Westinghouse Co. at Manchester.

Mr. Fox was chief engineer and manager of the Penrith Electric Supply Co. between 1909 and 1912, and after a couple of years in Calgary, Canada, he returned to this country and became power representative of Bradford Corporation electricity department.

Mr. J. A. H. Clifford, junior engineer-in-charge, has been promoted to the position of senior engineer-in-charge at Belfast, and Mr. Girvan becomes junior engineer-in-charge.

INSTITUTIONS AND SOCIETIES.

Institution of Civil Engineers.—In addition to the awards announced in April for Papers read at the meetings, the Council of the Institution have made the following awards for Papers published in the "Proceedings" without discussion during the session 1914-15: A Telford Gold Medal to Mr. James Forge (New York); Telford premiums to Messrs. J. B. Mason (Dunedin, N.Z.), Harold Berridge (Aden), C. R. White (London), C. S. Churchill (Roanoke, Va.); and the Trevithick premiums to Mr. A. Poulsen (Lemvig, Denmark). The Indian premium for 1915 has been awarded to Mr. C. W. Anderson (Midnapore, India). These awards will be presented at the opening meeting of the new session on Tuesday, November 2nd, when Mr. Alexander Ross, President, will deliver an address.

National Illumination Committee of Great Britain.—A meeting of the National Illumination Committee of Great Britain was held at the Institution of Electrical Engineers on October 20, 1915, when it was reported that Mr. Jacques Abady, of London, had been nominated by the Institution of Gas Engineers as a member of the Committee to fill the vacancy caused by the death of Mr. Edward Allen, of Liverpool. The Committee elected Mr. W. Duddell, of London, to be its chairman in succession to the late Mr. Edward Allen, and Mr. John Bond, of Southport, to succeed Mr. Duddell as one of the vice-chairmen. Reports on observations carried out at the instance of the Committee at a number of technical laboratories on the height to which the flame of the Hefner amyl acetate lamp should be raised to afford a light of one international or English standard candle were discussed, and their further consideration was postponed until fuller details of some of the observations and other reports which had been promised had been obtained. A report prepared and sent by Dr. E. Ott, of Zürich, on researches which had been carried out in Switzerland on the effect of atmospheric pressure, humidity and vitiation on the light afforded by the Hefner standard lamp was considered, and it was decided, subject to Dr. Ott's consent being obtained, to prepare a translation of the report for communication to the English technical press.

Diesel Engine Users' Association.—At the October meeting several engineers having control of Diesel engine plants in Great Britain and abroad were elected members of the Association. The membership now includes engineers connected with Diesel plants in such distant parts as Oudtshoorn (S. Africa), Normanby (New Zealand), Delhi and Colombo. After reporting the progress made with the scheme for insurance at Lloyds against breakdown of Diesel engines, and in connection with the Association's efforts to obtain better terms from the Inland Revenue authorities for a reduction in regard to depreciation on the assessment of Diesel engine plant for income tax, the discussion on the question of lubrication of Diesel engines was resumed. The next meeting of the Association will be held on Nov. 24th, when the subject of cracked pistons is to be further discussed.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Oct. 29th (to-day).

University of London, University College.

5 p.m. Opening Lecture of course of Six Lectures on "Electric Heating and Electric Appliances," by Prof. J. A. Fleming, M.A., D.Sc.

North-East Coast Institution of Engineers and Shipbuilders.

7:30 p.m. Annual General Meeting at Bolbec Hall, Newcastle-upon-Tyne.

Institution of Mechanical Engineers.

8 p.m. Meeting at Institution of Civil Engineers, Great George-street, Westminster, S.W. "Thomas Hawksley" lecture by Dr. Dugald Clerk, F.R.S., on "The World's Sources of Fuel and Motive Power."

Junior Institution of Engineers.

8 p.m. Meeting at 39, Victoria-street. Paper on "Electric Clocks," by Mr. W. B. Prince.

SATURDAY, Oct. 30th.

Notts and Derbyshire Branch of the Association of Mining Electrical Engineers.

3:30 p.m. Meeting at University College, Nottingham. General business and Paper on "The Use and Abuse of Oils on Mining Plant," by Mr. T. C. Thompson.

TUESDAY, Nov. 2nd.

Institution of Civil Engineers.

8 p.m. Meeting at Great George-street, Westminster, S.W. Presidential Address by Mr. Alexander Ross, and Presentation of Awards for Papers during the past session.

Association of Supervising Electricians.

8 p.m. Meeting at St. Bride Institute, Bride-lane, Fleet-street, E.C. Paper by Mr. R. Rankin, M.I.E.E., on "Accumulators."

Röntgen Society.

8.15 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Presidential Address by Dr. J. H. Gardiner, F.C.S.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing Nov. 1, 1915 :—

Drills, 6.15 to 7:15; 7:15 to 8:15 p.m.

Monday, Nov. 1.—Section 1, technical; section 4, squad or working party.

Tuesday, Nov. 2.—Section 2, technical; section 3, shooting working party.

Thursday, Nov. 4.—Section 3, technical; section 2, shooting working party.

Friday, Nov. 5.—Section 4, technical; section 1, squad or working party.

Saturday, Nov. 6.—Company parade, 2:30 p.m.

Sections for technical drill will fall in at the Headquarters of London Electrical Engineers (T.F.), 46, Regency-street, S.W.

Sections for squad, signalling, shooting and working parties will fall in at the new headquarters, Chester House, Eccleston-place, S.W.

SUPERIMPOSED OR "PHANTOM" TELEPHONE CIRCUITS.

(*Concluded from page* 102.)

Summary.—The advantages and economies of superimposed or "phantom" telephone circuits are discussed in this article. The balancing of existing telephone circuits and the apparatus (repeating coils) required to obtain a successful working of "phantom" circuits are described in detail.

Line Construction.—Under this heading will be discussed the conditions, which must obtain in the metallic circuits in order to permit of the successful formation and operation of superimposed circuits. A few years ago the principle of superimposing on telephone circuits was applied in practice mainly to aerial circuits, the reason being that nearly all long-distance lines consisted of open-wire circuits. The introduction of loading coils, adapted for superimposed circuit working, together with improvements in cables for long distance superimposed working, have made possible the use of such cables for lines up to 500 miles in length. Submarine cables, which, owing to inherent construction difficulties, are limited to a few conductors are being designed so as to permit the full use of their superimposed circuits.

As the field of use for superimposing extends to aerial, underground and submarine circuits, it will be convenient to consider separately each type of circuit.

Aerial Lines.—The first and most essential condition, which must obtain in aerial lines in order to permit of successful superimposing, is that the circuits shall be well balanced; that is, the two lines selected to produce the superimposed circuit should be of equal resistance, insulation and capacity. For the best results, the physical circuits should be of the same size and kind of wire, and of the same length; but even with different sizes or kinds of wire—by using proper methods to secure perfect balance between the circuits—a fairly satisfactory superimposed circuit can be obtained. In such cases, it is necessary that each physical circuit shall contain equal lengths of the two types of wire. The two physical circuits will, therefore, after transposition, have the same efficiency with a transmission efficiency somewhere between the original efficiency values of the two circuits. It is essential that the line construction be the very best possible. Both metallic lines must be subjected to the same influence, which makes it practically essential that they run parallel. Besides being balanced in their relation to each other, the lines must be balanced in their relation to outside inductive influences by means of transpositions. There must be no poor insulation or poor joints, and in running the wires along wooded stretches, care must be taken to avoid tree grounds. The presence of any one of these will cause the line to become unbalanced, and the result will probably be a noisy circuit, instead of ordinarily quiet and satisfactory talking circuits. Superimposed circuit work does not require a higher grade of line construction than that needed for first-class results on regular metallic telephone circuits. Nevertheless, it is true that the ordinary metallic circuit will give fairly good results with line conditions so poor that a phantom circuit would not be possible.

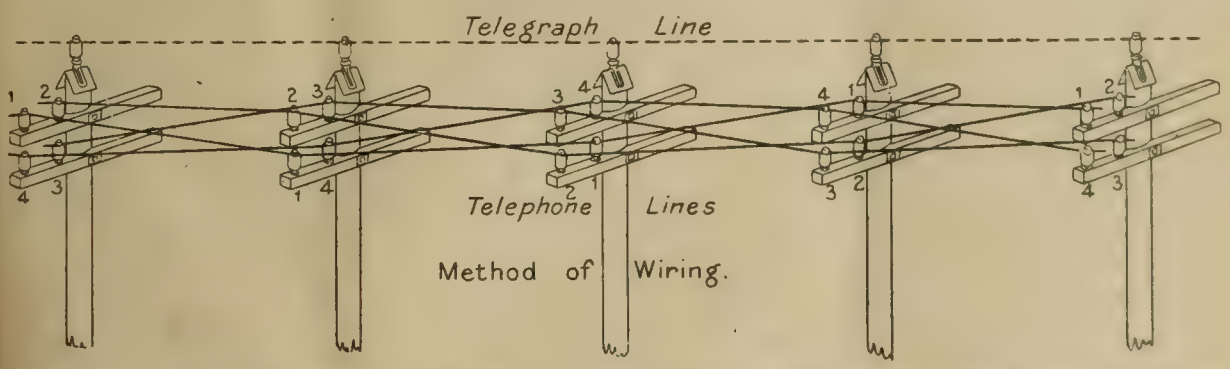


FIG. 15.—PERSPECTIVE VIEW OF AERIAL LINE TRANSPOSITION TO ELIMINATE INDUCTANCE ON TELEPHONE CIRCUITS.

Transposition of Aerial Lines.—When two or more telephone circuits are run side by side on the same poles, mutual disturbances are apt to arise. If, in addition, telegraph circuits are run on the same poles or high-tension circuits on poles in close proximity to the telephone line, the latter will be affected to the detriment of the telephone service, unless special precautions are taken to obviate the disturbing influences. The practices followed in various countries, to overcome mutual and external disturbances differ in some respects, but for convenience a summary of the methods in use may be brought together under two main headings: (*a*) Post Office practice and (*b*) American and Continental practice.

(*a*) *Post Office Practice.*—In order to overcome the disturbances caused by external influence (from telegraph and power

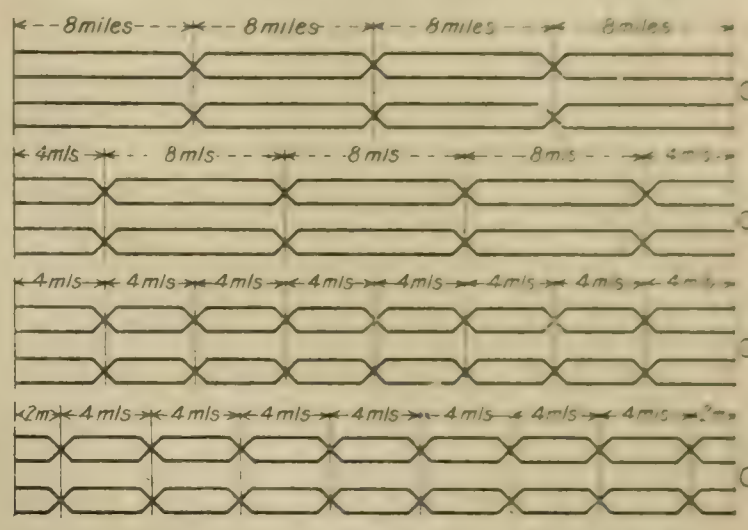


FIG. 16.—DIAGRAM SHOWING POST OFFICE METHOD OF AERIAL LINE TRANSPOSITIONS.

circuits) the telephone wires are so arranged on the pole line that they revolve in a right-hand direction, as shown in Fig. 15. Four spans of wire construction are shown in the illustration, and it will be noted that the wires make a complete revolution while passing these four spans. By this means the wires are kept at the same average distance from disturbances, caused by other circuits, such as, for example, a telegraph line running parallel to the telephone wires and strung on top of the poles in the manner shown by the illustration. The principle of this symmetrical twist system can readily be followed by tracing the numbers (1, 2, 3 and 4) marked on the insulators in the diagram. The mutual disturbances in telephone lines usually arise from dissymmetry of wiring arrangements, or else from lack of uniformity and balance of electrical conditions in the circuits. The result of such conditions is crosstalk, or the ability of persons listening on one circuit to overhear a conversation carried on over a neighbouring circuit. The conditions which should obtain to avoid crosstalk in telephone circuits have already been referred to above under the heading of Line Construction.

In accordance with the practice followed by the Post Office, the individual wires of each circuit are kept at a uniform average distance from each wire of any other circuit. In order to establish this condition the wires are arranged as the four corners of a square, of which the diagonally situated wires form a circuit. If this arrangement is consistently adhered to, so that at each pole along the route the four wires in diagonal pairs are exactly at the corners of a square, mutual disturbance is neutralised. When more than one such group of four wires exists on the same pole line, conditions become more complicated, as it is evident that some of the wires will necessarily be at varying distances from the two wires of a pair in an adjacent group. As each wire of one pair is not equidistant in each revolution from both wires of the other pair (in a neighbouring group), this condition gives rise to crosstalk.

To eliminate this interference between adjacent groups it is necessary to cross the two wires of each circuit of a group at

certain definite points. The crossing, or reversal of the relative positions of the wires of a circuit in alternate sections, equalises the inductive effect, and thus reduces the crosstalk.. The points, where the crossing of the wires occur, must be arranged symmetrically with respect to those in adjacent groups. Fig. 16 shows how the wires in four groups should be crossed in order that the mutual interference may be obviated. For reference the groups may be designated A, B, C and D. In group A the crosses occur at 8-mile intervals, the first crossing taking place 8 miles from the terminal pole. Group B also has the crosses placed at 8-mile intervals, but here the first cross-over occurs 4 miles from the terminus. Group C is arranged so that, beginning 4 miles from the terminal pole, the crosses occur every 4 miles along the route. Group D also has a 4-mile spacing of the crosses, but the first cross occurs 2 miles from the end pole. It is at once evident that by this arrangement the crosses in one group occur half-way between the crosses of the adjacent group, as a result of which crosstalk is eliminated.

(*b*) *American and Continental Practice.*—In the following discussion of methods of making superimposed transpositions, it is assumed that the metallic circuits before superimposing have already been transposed in accordance with what is known as "ABC" system. The simplest case will be that of two metallic circuits running side by side on a single cross-arm with no adjacent circuits, but arranged to take care of future growth, so that when additional circuits are placed on the same cross-arm or on other cross-arms on the same pole, the side circuits need not undergo any further transposition. In this case, shown in Fig. 17 beginning with the "Office" pole, the one nearest the Central Office, poles 1,300 ft. apart are selected as transposition poles. At the first transposition pole (A) wires "C" and "D" of Line 2 have been transposed, at the

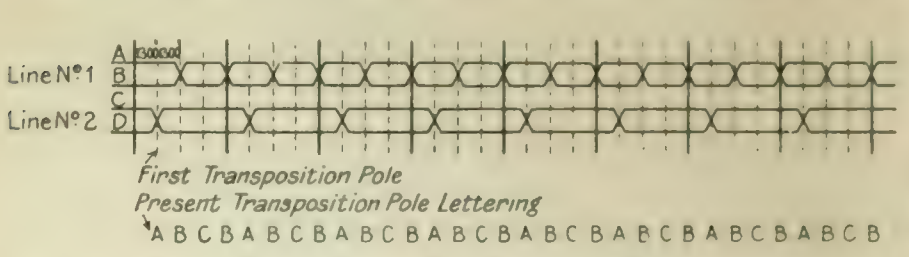


Fig. 17.—Transpositions on two Metallic Circuit Line before Cutting in Phantom.

second pole (B) wires "A" and "B" of Line 1 have been transposed, and again at the fourth pole (B). This scheme of transposition is carried on all along the line, none being cut in on the third pole (C). The transpositions before superimposing will, therefore, occur in the order A B C B A B C B A B C B, &c., to the end of the line.

In introducing superimposed circuits on a line already correctly transposed, the superimposed transpositions may come at points where side line transpositions have been made. Changes in the latter are, therefore, necessary at these points. There are in all four general types of superimposed transpositions, only one of which, however, is necessary for the case under discussion. These are known, for convenience as Type 1, Type 2, Type 3 and Type 4 (Fig. 18). In Type 1 transposition, the wires of both side circuits are transposed, in Type 2 the wires of the left-hand side circuit only are transposed, in Type 3 the wires of the right-hand side circuit only are transposed, and in Type 4 neither side circuit is transposed. Fig. 19 shows the superimposed transpositions cut in at the proper places on the two-circuit line. They occur 2 miles apart or at every eighth transposition pole. In effect, these transpositions, which are Type 4, simply change the positions of lines 1 and 2 with respect to each other without any actual transposition occurring in the lines themselves. This is the simplest form.

The working out of a more complex transposition problem is presented in Fig. 20, which shows a total of 10 side or physical circuits, five each on a 10-pin cross-arm. All four types of transposition are used in this case, wires 7, 8, 9 and 10 corresponding to A, B, C and D in the two-circuit case previously considered. Fig. 20 may, therefore, be taken to show how the growth from a two-circuit to a 10-circuit pole line can best be handled to introduce superimposed circuits. It will be noted in Fig. 20 that, in this case, the pole pairs are not used for the superimposed circuits.

This arrangement of the superimposed circuit is preferable; as it eliminates the extra care required in transposing the wires on the pole pins, due to the presence of the pole between the wires, and gives a somewhat better balanced superimposed circuit. The pole pair may, however, be used in building up the superimposed circuit in case the circuits occupying the other positions cannot conveniently be used.

In installing an entirely new line which is to be superimposed, the various transpositions follow the general scheme already outlined, with the exception that at the superimposed transposition points, the actual wires may be shifted instead of being cut and spliced as must be done in the case of cutting in phantom on existing lines.

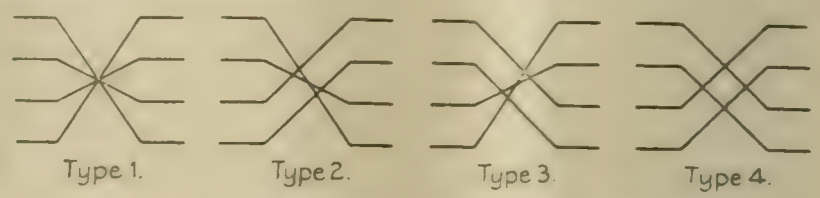


Fig. 18.—Types of Phantom Transpositions.

At the phantom transposition points, a drop bracket is used for the transposition insulator, so that the side circuits may cross over from one side of the cross-arm to the other side without any danger of interference. The drop bracket is equipped with a double-grooved transposition insulator, and attached to the cross-arm as shown in Fig. 21. Another double-grooved transposition insulator is also placed on the cross-arm on a transposition pin directly above the drop bracket. All transpositions should follow the same direction, in other words, facing in the direction in which the line is transposed, the right hand pair of wires should be run on top of the arms and attached to the insulators on the wooden pins. The left hand pair of wires should be run under the arm and attached to the insulators on the drop bracket. The wires after transposing should be tied to the outside of the insulators so that all strain is on the pins instead of on the tie-wires.

In order that service may not be interrupted when superimposed transpositions are cut in on existing lines, a combination of relays, keys and jumpers can be used. This has the

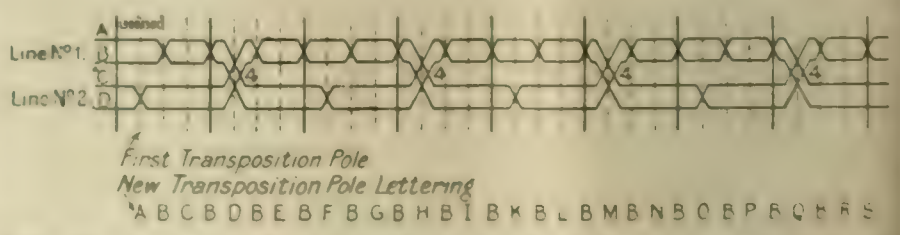


Fig. 19.—Phantom Transpositions for Two Metallic Circuits on One Cross-Arm.

effect of making an artificial transposition of the drops or relays in which the lines terminate. Assuming that the poles were originally stencilled in accordance with the ABC system, to denote where the side line transpositions occurred before cutting in the superimposed circuits, it becomes advisable to re-stencil the poles in accordance with the new lettering indicated in Figs. 19 and 20, depending upon the number of superimposed transpositions. It is also recommended that numerals denoting the number of phantom circuits installed, be stencilled on the poles. Correct pole stencilling will be found a great aid in maintenance work.

Underground Cables.—The type of cable most commonly used for superimposed working, is the so-called multiple-twin cable. It has been adopted as the standard for trunk or long-distance working by the Post Office. In general construction the multiple twin cable consists of a number of cores of 2, 4, 8 or 16 wires, formed by successive twinning operations. A 2-wire

core is the unit and is made up of two wires, separately insulated with similarly coloured paper, which may be red, white, blue or green. One wire of each pair is covered with red, and the other with white string for identification. The 4-wire core is made up of two such 2-wire cores, twisted together, the 4-wire core thus formed being covered with a spiral wrapping of paper of a particular colour, which may be red, white, blue or green. The 4-wire combinations is by far the most commonly used type of construction, 8-wire and 16-wire combinations rarely being called for. In fact the 4-wire unit construction is the standard, adopted by the Post Office. The rule as to colour combinations is to twist red with white, and to cover some with red and some with blue ; to twist blue with green and to cover some with white and some with green. In other words, either a red or a blue 4-wire unit may be made up of a red pair twisted with a white pair. Similarly a white or a green 4-wire unit may be made up of a blue pair twisted with a green pair. The lengths of twist vary, depending upon the colour of the 4-wire unit and upon the weight of the conductor. The table below shows the practice adopted by the Post Office in the choice of lengths of lay for various size conductors.

To take a specific example : A 4-wire core, in red covering, having a 16 in. twist (100-lb. conductor) would be made up of a red pair (8 in. twist), and a white pair (12 in. twist) ; similarly a blue-covered 4-wire unit with an 18 in. twist, would be made up of a blue pair (10 in. twist), and a green pair (14 in. twist). The 4-wire cores to the number desired are stranded into a large core, which is then treated, and covered with a lead sheath in the usual manner.

Submarine Cables.—Submarine cables of the type used for simultaneous telephone and telegraph working are designed in a manner which will permit of easy handling during the manufacture as well as during the laying of the cable. The insulating material generally used is gutta-percha, and in consequence the capacity of this type of cable is comparatively high. In order to cover distances of 75 to 100 nautical miles, it is necessary to use heavy copper conductors. This again means that the number of conductors is small (the usual number being four), in order that the overall diameter of the cable may be kept within commercial limits.

A short description of a typical telephone and telegraph cable may be of interest, and, as a representative case, the cable laid between England and Belgium in 1911, has been chosen. There are four copper conductors in this cable, the weight of each being 160 lb. per nautical mile. Each conductor is insulated with gutta-percha, to a thickness equivalent in weight to 150 lb. per nautical mile. The four conductors, thus insulated, are wormed with tanned jute into a 4-wire core, which is wrapped, successively, with a layer of ozokerited cotton tape, a thin brass tape and again a layer of ozokerited cotton tape. Over this insulation is placed a tanned jute serving, which forms the bed for an armouring of galvanised iron wires, 16 of which are laid around the cable at this stage of the manufacture. Finally a tarred jute serving is placed over the armouring. At intervals of 1 nautical mile loading coils are inserted for the improvement of speech transmission. The chief characteristics per nautical mile of this cable are : Resistance (including the loading coils), 27·8 ohms ; inductance, 100 millihenrys ; capacity, 0·162 microfarad ; leakance, 1·944 microhms ; and attenuation constant, 0·0185. This cable is arranged so that its superimposed circuit is loaded, the superimposed circuits being formed by the aid of the No. 4,006 repeating coils.

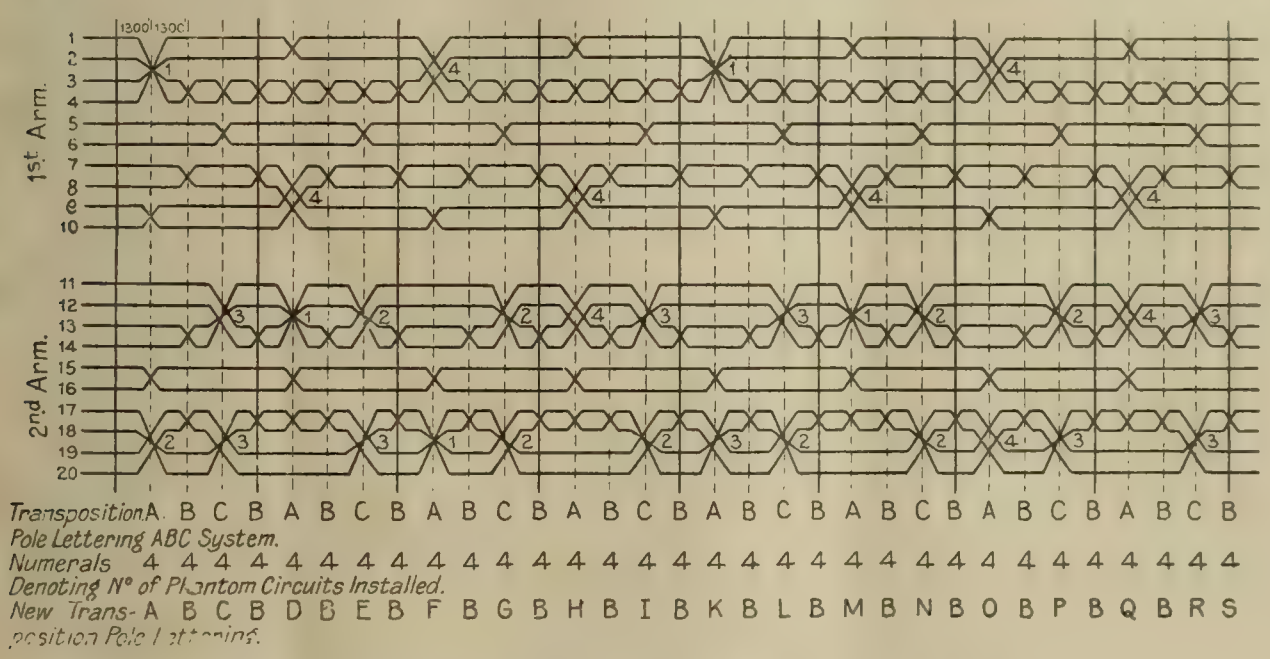


FIG. 20.—FOUR PHANTOM CIRCUITS CUT IN ON A 10-CIRCUIT POLE LINE.

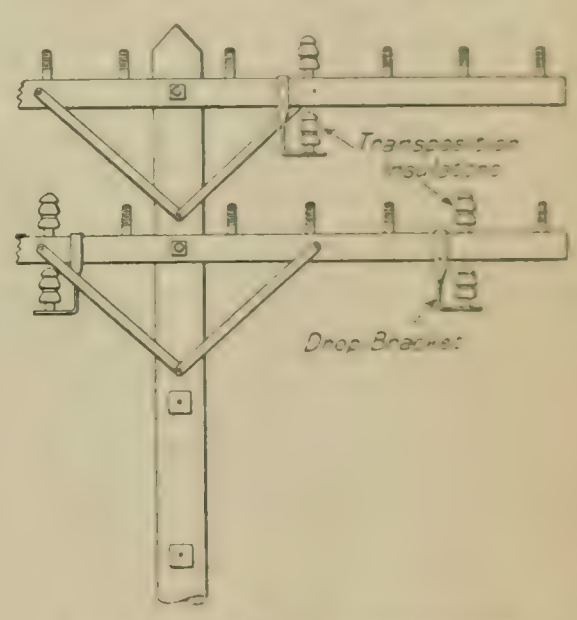


FIG. 21.—DROP BRACKET FITTED WITH DOUBLE-GROOVED INSULATOR.

Weight per mile of conductor. lbs.	Approx. length of lay in inches and colour of spiral wrapping.															
	2-wire cores.				4-wire cores.				8-wire cores.				16-wire cores.			
	Red.	Blue.	White.	Green.	Red.	Blue.	White.	Green.	Red.	Blue.	White.	Green.	Red.	Blue.	White.	Green.
10	2	3	4	5	6	8	10	12	10	14	18	22	18	22	26	30
12½																
20	4	5	6	7	8	10	12	14	12	16	20	24	20	24	28	32
40																
70	6	8	10	12	14	16	18	20	16	20	24	28	22	26	30	34
100	8	10	12	14	16	18	20	22	18	22	26	30	24	28	32	36
150																
200	12	14	16	18	20	22	24	26	22	26	30	34	28	32	36	40

NOTE.—The pilot core on each layer shall be covered with orange paper, and shall be similar in all other respects to a red core.

It is not surprising that the owners of such cables are constantly endeavouring to extend the use of the small number of conductors to the utmost. The only means of doing so in a practical manner has been found in superimposing upon the two metallic circuits, which can be formed of the four existing conductors. The latest proposal for increasing the traffic facilities of four-core submarine cables is described in the "Post Office Electrical Engineer's Journal," for July, 1914, in which an article appears, dealing with a method of obtaining a fourth telephone circuit over the four metallic conductors in parallel. In this article it is stated that the successful operation of such a "double" superimposing is possible only by virtue of perfectly balanced repeating coils.

Comparative Cost Figures.—The cost of establishing a superimposed circuit is so very small as to be practically negligible, especially when compared with that of installing a third metallic circuit. To take as an example a 20-mile metallic line of 150-lb. copper wire, the cost of the wire, exclusive of labour, and assuming that the poles and cross-arms are already placed and in use, is approximately £200. The cost of four repeating coils and accessories, which will give the equivalent of a third or phantom circuit from two metallic circuits, is about £5. This shows a saving of £195 for a 20-mile line, by employing a phantom circuit. If the line is constructed of No. 12 B.W.G. iron wire, the cost of a third metallic circuit would be about £80,

in which case there is a saving of £75 effected by the use of a phantom circuit. There is also a saving in labour, as the cutting in of the phantom circuits takes only a fraction of the time that would be required to tie in a pair of actual wires.

For rural subscribers superimposed circuits may be obtained by the application of repeating coils and retardation coils, as already shown in Fig. 2. The cost of the necessary apparatus is so low that in many cases a saving could be made by arranging for superimposing instead of stringing a third metallic circuit.

The excellent transmission and signalling qualities of a properly constructed superimposed circuit, and the enormous saving effected by its use, should be sufficient incentives for its use by telephone companies and administrations.

ALTERNATING-CURRENT AMMETERS AND VOLTMETERS.

[COMMUNICATED.]

In the selection of an instrument for use on alternating-current circuits there are a number of points which require consideration since there are five types of instrument available, each of which can claim some advantage. The five types are: Moving-iron; induction; hot wire; electrostatic; and dynamometer.

The *moving-iron type* is the most extensively used instrument, particularly for switchboard work, since it is considerably cheaper than any other type. A certain amount of prejudice exists against it, probably due to quality having been sacrificed in certain cases in order to cut down the cost of production. Thus, through inferior design and workmanship there are instruments on the market which are unreliable and inaccurate, and which have defects, such as unsuitable or insufficient insulation. Irregular and unevenly divided scales, and absence or insufficiency of damping arrangements are common. This has led some users to regard the type as generally unsatisfactory, but none of the defects mentioned are inherent, and instruments can be produced which are not only inexpensive, but are extremely accurate, robust and reliable, while errors due to variation of frequency, temperature or wave form, can be entirely eliminated. The moving iron instrument is, of course, suitable for use on continuous as well as alternating-current circuits. The chief objection to such use is the error due to hysteresis, but in a well-designed instrument this can be so reduced as to be negligible under ordinary circumstances.

The *induction type* has a very long, evenly divided scale and is exceedingly accurate when used at the frequency and temperature for which it is calibrated, but it is somewhat expensive, the temperature and frequency errors are rather high, and the moving parts are necessarily somewhat heavy.

The *hot-wire type* is perfectly dead-beat and equally suitable for use on alternating-current and continuous-current circuits, and no error is introduced by varying conditions except that due to temperature changes, but it is expensive and very delicate, the wire being liable either to fuse or to stretch on overloads. Other disadvantages of this type are that the scale is very cramped at the lower end and the power consumption is large.

The *electrostatic type* is not affected by variation of temperature, consumes no power and is equally suitable for use on alternating-current or continuous current circuits. Its use, however, is practically limited to the measurement of voltage. It is expensive and delicate, while the operating forces are very small.

The *dynamometer type* has no points of superiority over the moving-iron type for general use and is seldom adopted for ammeters or voltmeters as it is unnecessarily expensive and complicated.

A consideration of the advantages and disadvantages of various types will lead to the conclusion that, for switchboard work, a good moving iron instrument is sufficiently accurate and is not only the cheapest but is the most robust and reliable. In cases where exceptionally accurate readings are required the long and evenly divided scale of the induction type of instrument renders it preferable, and for a synchronising voltmeter, or where the load fluctuates rapidly, a hot wire instrument has certain advantages. But apart from these special cases, the instrument chosen will almost invariably be of the moving iron type. These conclusions may be opposed by some who have had experience of the different types, but, as has already been pointed out, some moving-iron instruments on the market are of inferior design and construction, and if an unsatisfactory instrument has been used and is taken as a basis for comparison it may easily be concluded that the type, as a whole, is unsatisfactory.

An exhaustive series of tests has recently been made which show that while some moving-iron instruments have errors which render them hardly suitable for use as anything more than current or potential indicators, others are quite accurate enough for all practical purposes under widely varying conditions. Particulars of the tests, with a description of the methods adopted and some of the good and bad features of the various instruments may not only be found interesting but may do something to remove any misapprehension which may exist with regard to the possibilities of the moving-iron type of instrument.

For the purposes of comparison and test nine similar ammeters, each by a different maker, were obtained and the following tests were carried out simultaneously on all the instruments. The results of all tests are given in Table I., the different instruments being lettered A to J.

The first series of tests related to the accuracy of the instruments under varying conditions, and was carried out as follows:—

TEST NO. 1. *Initial Accuracy.*—All the instruments were connected in series with a standard ammeter on a 50-cycle circuit, for which frequency they were calibrated. Readings were taken at five points between 1/5th full-scale and full-scale reading. The error given in Table I., is in each case the average error for the five readings.

TEST NO. 2. *Accuracy at 25 cycles.*

TEST NO. 3. *Accuracy at 100 cycles.*

TEST NO. 4. *Accuracy at 200 cycles.*

TEST NO. 5. *Accuracy on continuous current.*

The object of these four tests was to ascertain the frequency error and the adaptability of the instruments for use on different systems and frequencies without special calibration and were carried out in an exactly similar manner to Test No. 1.

The figures in Table I. give the additional errors due to change of frequency, &c., as compared with Test No. 1, not the actual errors as compared with the standard ammeter.

TEST NO. 6. *Hysteresis.*—The errors in a moving-iron instrument when used on continuous-current circuits are largely due to hysteresis in the iron, the magnetic condition of the iron lagging behind the magnetising force so that the reading taken on an ascending current is not the same as the reading taken on a descending current, although the actual current is the same for both readings. To keep the error within reasonable limits, the utmost care is necesary in the selection and annealing of the iron, and the mass of iron must be as small as possible. The error is expressed in Table I. as the percentage difference between readings taken on ascending and descending currents, not, as in Test No. 5, the error as compared with Test No. 1.

TEST NO. 7. *Wave-Form Error.*—This test was carried out in the same manner as Test No. 1, but the testing current was derived from a transformer with a saturated core, the wave-form being very peaky. The results are stated in terms of the percentage difference between the readings obtained on this test and those obtained on Test No. 1. The frequency of the supply during the test was 50 cycles per second.

TEST NO. 8. *Error due to Stray Magnetic Fields.*—Two conductors, each carrying 2,000 amperes, were placed 6 in. away from the instruments, and tests were carried out (*a*) with the conductors horizontal, and (*b*) with the conductors vertical. The percentage difference between the readings obtained and those obtained on Test No. 1 are given in Table I.

It may be mentioned that there are two distinct types of moving-iron instruments in general use, the attraction type, where a single piece of iron is attracted towards the centre of a solenoid, and the repulsion type, where two pieces of iron are placed in similar relation to the magnetic field inside a coil carrying current, and, being similarly magnetised, repel one another. Instruments C, G and H are of the attraction type, while all the others are of the repulsion type. It will be noticed that the attraction type of instrument is considerably less susceptible to external magnetic fields than the repulsion type, but the latter has several advantages which more than compensate for this, notably that the moving parts can be made much lighter and that considerably better scales can be obtained.

TEST NO. 9. *Temperature Effects.*—Theoretically a moving-iron instrument should not be affected to any appreciable extent by variations of temperature and this was borne out by the tests, as only instrument B was affected in any way, this being due to the expansion of the spindle causing the pointer to stick. It was found, however, that several of the instruments showed a permanent error when they cooled down again, and the magnitude of this error is given in Table I. In some cases the error was apparently due to the use of shellac for fixing the balance arms or balance weights, or to lock the pivot screws in position. Shellac softens at a moderate temperature, and in cooling the parts appear to move slightly. In instrument "A" the error was due to another cause, for no shellac was used.

Table I.—*Results of Tests on Nine Moving Iron Instruments.*

Test No.	Description of test.	Instrument. A.	B.	C.	D.	E.	F.	G.	H.	J.
1.	Initial accuracy	0·27%	0·95%	0·65%	6·92%	2·67%	1·45%	2·67	3·18	2·81
2.	Additional error on 25 cycles A.C.	None	None	None	None	0·21%	None	None	0·74%	
3.	Additional error on 100 cycles A.C.	0·41%	0·74%	1·1%	None	1·27%	0·42%	1·43	2·—	2·05
4.	Additional error on 200 cycles A.C.	0·85%	2·62%	5·75%	0·76%	4·46%	1·04	2·37%	3·0	3·—
5.	Additional error on D.C.	1·46%	2·58%	1·65%	2·12%	3·14%	3·01%	2·08	3·1	3·—
6.	Hysteresis error	2·29%	5·23%	3·33%	3·4%	2·24%	5·48%	5·5	6·—	7·97
7.	Wave-form error (additional)	0·98%	1·52%	0·98%	1·0%	2·05%	5·05%	1·0%	0·97	4·12
8.	Stray field error (additional)	3·49%	7·42%	0·36%	12·34%	9·4%	6·81%	1·45	1·—	2·—
9.	Error after heating to 170°F.	0·38%	1·58%	None	0·58%	None	1·04%	None	None	1·—
10.	Error after short-circuit	None	None	Pointer bent zero 5%	Pointer bent zero 5%	Pointer bent zero 3%	None	None	Damper damaged	Pointer bent zero 10
11.	Insulation, megohms	Inf.	Inf.	500	500	Inf.	180	30	Inf.	1
12.	Breakdown pressure, volts, A.C.	6,800	3,000	4,580	4,500	7,500	5,000	2,500	3,000	4,500
13.	Damping (*a*) percentage of full scale	71%	64%	98%	69%	85%	83%	93%	69%	90%
14.	Damping (*b*) swings	6	3	25	6	9	9	24	9	16
15.	Damping (*c*) seconds	3	2	12·5	3·5	3·5	4	11	3·5	6
16.	Weight of moving parts, grammes	2·3	1·86	3·98	2·31	3·86	4·97	5·34	9·2	2·81
17.	Ratio torque/weight	0·104	0·048	0·09	0·044	0·068	0·082	0·176	0·198	0·073
18.	Watts consumed	2·5	2·5	2·3	5·5	2·5	6·2	7·9	6·2	2·6

TEST No. 10. *Effect of Short-Circuit.*—A circuit breaker, set to open at 10 times the current corresponding to full scale reading, was put in series with the instruments, the current was suddenly switched on, the circuit being instantly interrupted by the circuit breaker. Four of the pointers were bent to an extent indicated in Table I. in terms of the percentage of full-scale deflection shown by the pointer with no current through the instrument. The damper vane of instrument H was badly damaged, and jammed against the walls of the damping chamber.

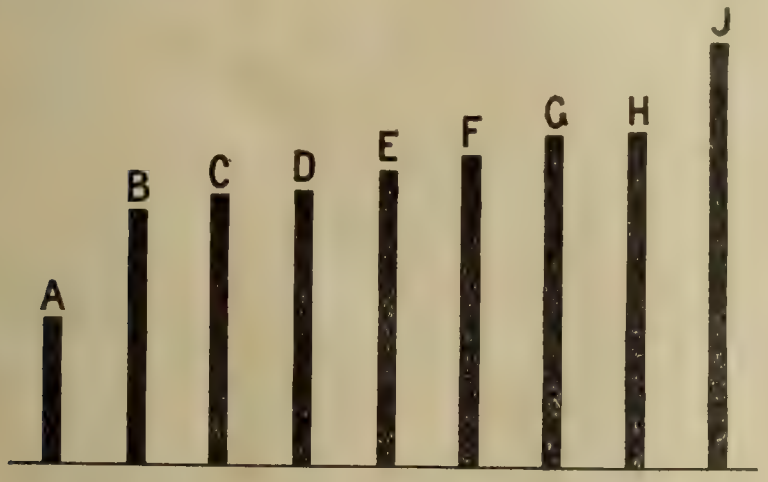


FIG. 1.—GRAPHICAL REPRESENTATION OF ERRORS.

TESTS Nos. 11 and 12. *Insulation.*—Table I. gives the insulation resistances of the instruments as measured by a 1,000-volt megger and the alternating-current voltages at which the insulation of the instruments broke down. The instruments were all dry when tested, and it is probable that several of them, in which porous insulating materials are used, would give worse results if used in a damp situation.

Table II.—*Positions of Instruments on Different Tests and Final Rating.*

Test No.	Description of Test.	Instrument. A.	B.	C.	D.	E.	F.	G.	H.	J.
1.	Initial accuracy	1	3	2	8	5	4	5	7	6
2.	Additional error on 25 cycles A.C.	1	1	1	1	2	1	1	3	4
3.	Additional error on 100 cycles A.C.	2	4	5	1	6	3	7	9	8
4.	Additional error on 200 cycles A.C.	2	5	8	1	6	3	4	7	9
5.	Additional error on D.C.	1	4	2	3	8	6	5	7	9
6.	Hysteresis error	2	5	3	4	1	5	7	8	9
7.	Wave-form error (additional)	2	4	2	3	5	7	3	1	6
8.	Stray field error (additional)	4	7	1	9	8	6	2	3	5
9.	Error after heating to 170°F.	2	6	1	3	1	4	1	1	5
10.	Error after short-circuit	1	1	3	3	2	1	1	5	4
11.	Insulation megohms	1	1	2	2	1	3	4	1	5
12.	Breakdown pressure	2	6	4	5	1	3	7	6	5
13.	Damping (*a*) percentage of full scale	3	1	7	2	5	4	6	2	6
14.	Damping (*b*) swings	2	1	6	2	3	3	5	3	4
15.	Damping (*c*) seconds	2	1	7	3	3	4	6	3	5
16.	Weight of moving parts	2	1	6	3	5	7	8	9	4
17.	Ratio torque/weight	3	8	4	9	7	5	2	1	6
18.	Watts consumed	2	2	1	4	2	5	6	5	3
Total of position Nos. in various tests		35	61	65	66	71	75	80	81	103
Rating No.		1	2	3	4	5	6	7	8	9

TESTS Nos. 13, 14 and 15. *Damping.*—All the instruments were fitted with air-dampers, and in order to enable a thorough comparison to be made of the efficacy of the different arrangements adopted, three tests were carried out. In each test a current equivalent to 60 per cent. of full-scale reading was suddenly switched on, the points noted being (*a*) the percentage of full-scale reading indicated by the pointer when at the end of its first swing, (*b*) the number of swings made by the pointer before coming to rest, and (*c*) the time which elapsed before the pointer came to rest. The results are given in Table I.



FIG. 2.—EXTERNAL VIEW OF INSTRUMENT.

It may be remarked that, in all instruments where air damping is adopted, it is possible to improve the damping by increasing the area of the air-vane, increasing the radius from the pivots to the air-vane, decreasing the clearance between the air-vane and the walls of the chamber in which it works, or decreasing the weight of the moving parts. Of these four alternatives, neither of the first two can be adopted beyond a certain point since, if the parts are to be made sufficiently strong, their weight, and therefore the moment of inertia of the instrument movement, will have to be increased to such an extent as to make the damping even more inefficient than before. The third alternative is not altogether desirable since with very small clearances the air-vane is more liable to foul its chamber and cause sticking. So long as the strength and robustness of the parts are ample the best method of improving the damping is to reduce the weight of the moving parts. It is generally recognised that, apart from the damping, one of the most desirable features an instrument can possess is lightness of the moving parts, since the life of the instrument is thereby increased, and it is not so likely to be damaged if it is roughly handled in transit or in use. It is most important that the ratio torque ÷ weight of moving parts should be large so as to ensure positive indications and prevent sticking; but if the ampere turns to operate an instrument are increased, to compensate for a heavy movement, the watts consumed are increased and a bad scale is produced. The weight of the moving parts, the ratio of torque to weight, and the watts consumed in the different instruments are given in Table I. as Tests Nos. 16, 17 and 18, and it will be seen that while instrument B gives the best results as regards damping, it has a very low torque, and, as has already been mentioned under the heading of "Temperature effects," this instrument is very liable to

stick, this being largely due to the low ratio of torque to weight. Instruments A, C, and H are approximately equal so far as damping is concerned, but instrument C has the same disadvantage as instrument B, and instrument H has an excessively heavy movement, the good damping being obtained by using a very large air-vane, which is mechanically weak, and the high ratio of torque to weight is obtained at the expense of a very bad scale and a heavy consumption of power. None of the others are particularly good so far as damping is concerned.

Resonant Effect.—Some of the instruments tested were found to have certain of the internal parts, generally the pointer and movement, set in vibration at critical frequencies between 20 and 100 periods. The best instruments were not affected in this way.

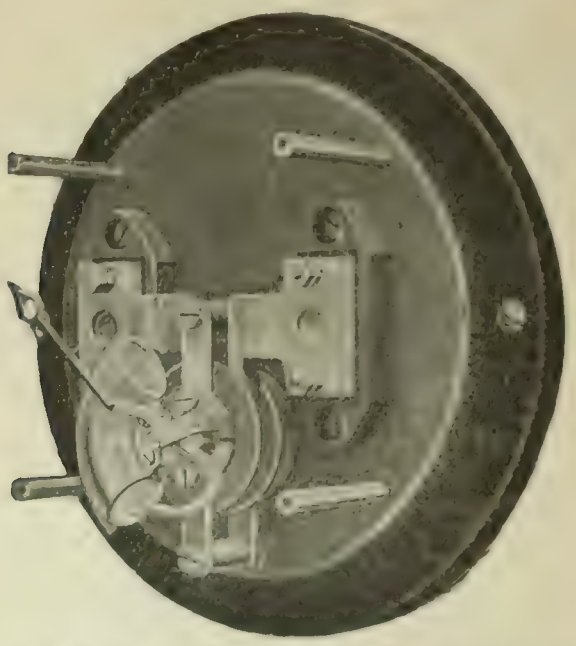


Fig. 3.—Internal Arrangement of Ammeter.

To enable the various features of the different instruments to be compared, their relative positions in each test are set out in Table II. The " position numbers " are totalled and the Tables used to ascertain the " rating number " or relative merit of each instrument. The relative positions of the several instruments are shown in Fig. 1. It will be seen that instrument A comes first with a total of 35 as against an average of 71. It is thought that a description of this instrument may be found interesting as it shows how modern manufacturing methods have been utilised in the production of a very satisfactory, and at the same time inexpensive, instrument. An external view of the instrument is shown in Fig. 2, and it will be seen that an open dial has been adopted instead of the more usual protected dial. The chief advantage of the open dial lies in the increased visibility obtained by its use, the whole length of the pointer being seen against

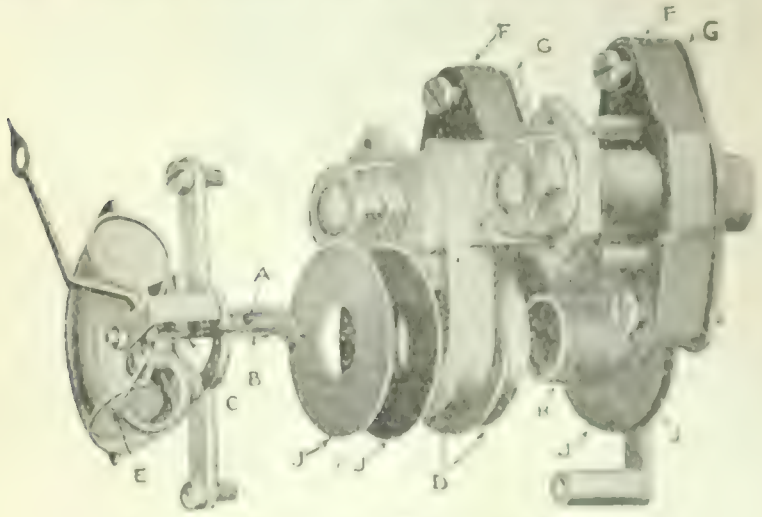


Fig. 4.—Details of Portable Ammeter.

the white dial instead of, as in the protected dial pattern, the tip only being seen against a dial more or less shaded from the light by the metal front.

Perhaps the most radical departure from general British practice is in the substitution of pressed steel for cast-iron in the construction of the base and cover of the instrument. A considerable saving in weight is effected without in any way decreasing the strength of the parts, and the finish, which is an important matter, is finer and lasts longer than when it is applied to cast-iron. The joint between the base and the cover is made without gaskets or cotton rope packing, the accuracy of the stampings being such that when the cover is pressed on to a projection on the base a perfectly dust and damp-proof, metal to metal, joint is obtained.

The bezel at the front of the cover is nickel plated, and is made of brass which takes and holds the plating very much better than cast-iron. This bezel is of thinner gauge metal than the cover, and yields slightly so as to bed down on the glass, which is held up behind it by the pressure of a strong steel spring. This method not only provides a perfectly tight joint, but as the fixing is not absolutely rigid there is no tendency for the glass to be broken by strains put on it when the screws holding the front are tightened up, or when the front expands or contracts with changes of temperature, as frequently happens where the glass is fixed by means of putty or flat metal clips. Clips are provided to prevent the glass from being forced back against the pointer.

For instrument dials the usual practice has been to use cardboard or paper stuck on a metal base, or metal with the surface either frosted or enamelled. Each of these methods has certain advantages and defects. The paper and cardboard dials have a good surface, but the paper is liable to become detached from its base, and the cardboard frequently warps, while neither of them can be cleaned satisfactorily if they become dirty. The chief defect of the metal dials has been that the surface has not been such as to show up the scale markings plainly, while some scales have been made of unstable alloys which warp badly.

The dial of the instrument we are describing has all the advantages mentioned above with none of the defects. It is made of metal, with the surface finished by a special process which renders it almost



Fig. 5.—Details of Ammeter Coil.

indistinguishable from pure white paper with a fine matt surface, and the scale is put on by hand with waterproof black ink. The dial may be washed repeatedly if it becomes dirty; it has no tendency whatever to warp, and has an appearance at least as good as that of any other kind of scale.

The flush pattern instrument has a case similar to that already described, with the exception that the front bezel is omitted. A special feature is that the flush ring is entirely separate from the instrument, so that it can be left in position on a switchboard for transit while the instrument itself is removed for special packing. In the case of switchboards of the cubicle type, with hinged doors, the flush ring may be fixed to the door, the instrument being independently mounted behind, so that there is no tendency to damage the instrument if the door is handled roughly, and there is no necessity for leads to be run on the door, with links or flexible connections to allow of the door being opened.

The internal arrangements of the instrument are shown in Fig. 3, and a more detailed view of an ammeter for heavier currents is shown in Fig. 4, with the parts " exploded " so as to show the construction more clearly.

The operation of the instrument is due to the mutual repulsion of two pieces of iron similarly placed in relation to a magnetic field. In Fig. 4 these pieces of iron are seen at A and B, the one marked A

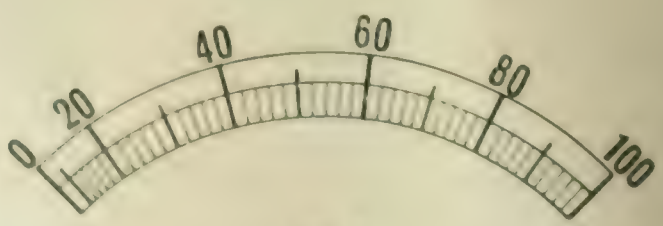


Fig. 6.

being fixed, while the one marked B is attached to the spindle C, which also carries the pointer, balance-weights and damping-vane. The spindle C is free to rotate between pivots. The current to be measured passes through the coil D, and the magnetic flux from the coil similarly affects the two pieces of iron A and B, which are placed inside it, causing them to repel one another, so that the piece B moves and carries the pointer away from the zero position.

The movement is gravity controlled, the balance-weight E being lifted up against the force of gravity when the pointer is moved away from the zero position. For conditions where gravity control is unsuitable, spring controlled instruments can be supplied. The balance-

weight E is removed and a helical spring is substituted for it. A device is added for adjusting the pointer at zero from outside the case. The current-carrying coil is extremely compact, and has ample sectional area. It is built up of soft drawn copper stampings, shaped as shown at K, Fig. 5, the number of stampings and the number of turns being varied to suit the current to be carried. Of the two finished coils shown in Fig. 4 one has two turns and the other has six turns. The terminal lugs are of soft drawn copper, and are riveted and sweated to the ends of the coil. The insulation of the live parts of the instruments has received special attention. Only those parts are alive which actually carry current, and substantial pieces of micanite are used to insulate them.

If reference is made to Fig. 3 it will be seen that the terminal stems are supported on blocks of moulded insulation, FF, between which and the base of the instrument are placed sheets of micanite, GG. The coil D is insulated by means of a micanite bush, H, and micanite washers, J. The instruments can, with perfect safety, be used with their cases earthed, and each instrument is tested with 2,000 volts alternating current between case and live parts. Great attention

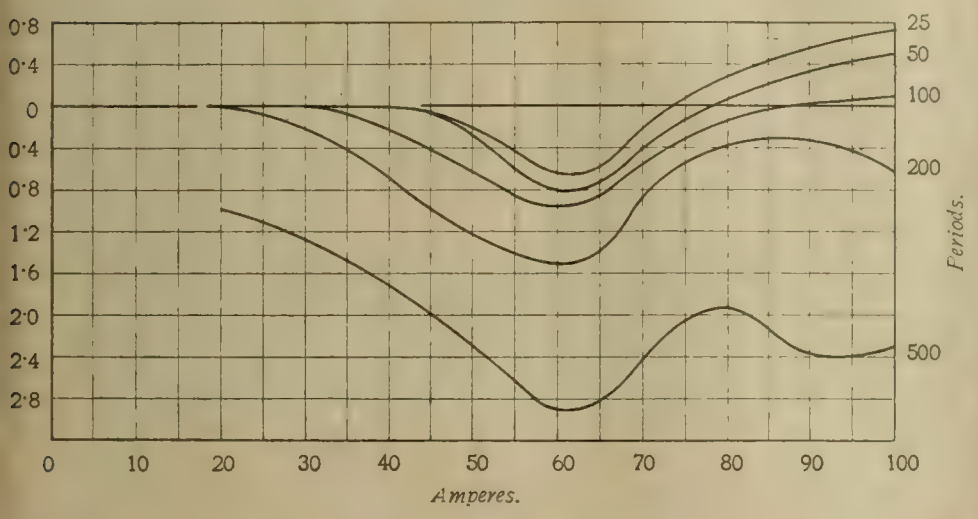


FIG. 7.—ERROR CURVES FOR AMMETER.

has been paid to the jewels and pivots, the jewels are the best sapphires obtainable and the steel points on the spindles are carefully hardened and polished. If a knife edge pointer and a mirror are fitted, the instrument will give sub-standard accuracy. A typical scale is shown in Fig. 6, and error curves for the ammeter when used on circuits of widely different frequencies are depicted in Fig. 7.

TURBO-ALTERNATOR DEVELOPMENT.

With the advent of the 20,000 kw. steam turbine many of the problems then confronting large modern generating stations were solved. However, the equipment soon proved to be too small to meet the rapidly advancing loads. The installation of 30,000 kw. and 35,000 kw. units since made has been another step forward, and now units of 50,000 kw. rating are being seriously considered. High economy and reliability are not the only desiderata in increasing the size of prime movers. Labour, real estate and other considerations depending upon loads, design and location of the plant in a large city are factors almost as important. Recently many of the large lighting companies in the United States have acquired huge railway loads, it being generally recognised by railway officials that this is advantageous to them. The following notes and opinions of eminent engineers taken from the "Electrical World" will be of interest to many of our readers.

In New York 30,000 kw. units are used to handle the elevated railway and subway demand of the Interborough Rapid Transit Co. Units of 20,000 kw. are used by the central stations of New York, Cleveland, Detroit and Chicago, and 30,000 kw. units in New York, Chicago and Philadelphia. Philadelphia has the distinction of possessing the largest steam turbine thus far installed, namely, the 35,000 kw. unit.

Further increase in size of turbo-generators beyond 35,000 kw., and even future operation of existing smaller units, suggest new problems in station design and operating practice. Higher steam pressures are certain, and these will introduce new problems in piping and fittings and possibly a further development in the methods of driving auxiliaries. In the discussion on economics of power station design at the recent International Engineering Congress at San Francisco, Mr. H. H. Barnes, jun., of the [illegible] of the tendencies in steam practice, intimating that boiler pressures much higher than 250 lb. would be [illegible] A pressure as high as 1,000 lb. was suggested as a possibility for turbo-generators of 40,000 kw. to 50,000 kw. rating. That these high pressures would not introduce operating difficulties is the opinion of Mr. C. W. E. Clarke. To a representative of the "Electrical World" Mr. Clarke said that it is entirely feasible to build steam boilers for 400 lb. pressure per square inch and that the use of high steam pressures rather than very high superheat, with its operating difficulties, is sure to mark decided gains in [illegible] Steam pressures of 500 lb. to 600 lb. per square inch are to be looked for in due course, and this means a gain of about 9 per cent. in turbine efficiency. The 50,000 kw. unit may be said to be on the horizon, and the whole problem of high-pressure operation is being opened up by the demands of large power engineering.

According to engineers of repute there are few serious mechanical difficulties in the way of constructing a steam turbo-generator of 50,000 kw. rating. Mr. P. M. Lincoln in a recent Paper said: "It is astonishing how rapidly we have advanced of late years in our ideas on this matter of size." He cited the first 6,000 kw. units installed in 1898 in the Manhattan Railway station, which were driven by reciprocating engines. That station now contains three 30,000 kw. units, but in physical dimensions and in weight the reciprocating units still hold the record. However, in ability to generate electricity they have been left far behind. "To-day," said Mr. Lincoln, "we talk of the coming 50,000 kw. turbo-generator with as much freedom as we did of those 6,000 kw. reciprocating engine-driven units 17 years ago. How much further this increase in size of units will go I make no attempt to predict, but it is safe to predict that the capacity of the future unit will be fixed by the demand for such units rather than by any inability to produce them."

On this same point, Prof. Edward F. Miller intimates that with the same steam pressure a 50,000 kw. unit should show slightly better economy than a 35,000 kw. unit in respect to water rates, and that noticeable gains in labour cost should result per unit of output when a machine of such capacity is operated at or near its rating. Prof. Miller is of the opinion that along with the design of such units, which can be improved in efficiency but slightly with existing steam pressures and superheats, are likely to come increases of steam pressure marking a new departure in power plant practice and raising the efficiency on the Rankine cycle considerably above the present maximum of about 73 per cent. These higher boiler pressures introduce some interesting problems in the design of auxiliaries and piping systems, and developments in this direction may be forecast with confidence.

Mr. H. G. Stott of the Interborough Rapid Transit Co., of New York, referring to the 30,000 kw. turbo-generators of that company, has stated that the large steam turbine has surpassed the gas engine in thermal efficiency, the figure of 26 to 28 per cent. for the former being only surpassed by the Diesel type of oil engine. The floor space occupied by the modern horizontal steam turbo-generator, moreover, is about 0·07 to 0·1 sq. ft. per kilowatt.

Mr. H. T. Herr of the Westinghouse Machine Co., in a recent address before the Railway Club of Pittsburgh, showed that each of 30,000 kw. units in the Interborough station replaced three 6,000 kw. reciprocating engines, and that while five times larger in rating the turbines only cost as much as the 6,000 kw. reciprocating units did 12 years ago. Moreover, the same hand-fired boilers used for the 6,000 kw. engines were equipped with underfeed stokers and their rating increased to 300 per cent. for peak-load operation.

While many engineers are confident that a 50,000 kw. unit will make its appearance shortly, they do not anticipate any operating difficulties. Mr. I. E. Moultrop, of the Edison Electric Illuminating Co. of Boston, believes that no more men would be likely to be required for operating such units, as compared with the 30,000 kw. size, and therefore the saving in labour should be attractive when figured on the kilowatt-hour basis. Without increasing the steam pressure or the superheat, marked gains in water rate can hardly be expected with the 50,000 kw. machine as compared with the 20,000 kw. and 30,000 kw. units. As yet the makers of auxiliaries are probably not fully prepared to meet the demands of such large units. Speaking on the investment, Mr. Moultrop said the value of plant in charge of the operator in the latter case might easily approach £150,000, the horizontal type being the settled standard. The cost of installing such large units is an important factor in relation to reserve capacity and the shape of the load curve. Where the load conditions permit virtually continuous operation at economical water rates, there is little doubt that the 50,000 kw. machine will find an immensely useful field. This will be true only in very large cities. In most cities the load at present is too small to warrant the installation of such a large unit.

ELECTRIFICATION ON THE LONDON & SOUTH-WESTERN RAILWAY.

(*Continued from p.* 93.)

Auxiliary Plant External to the Power House.

The circulating water is taken from the river Wandle. The water is brought through a ferro-concrete duct, 385 yds. long up to the power house, coarse strainers being provided at the entrance of this duct. Near the cooling towers it passes through a fine screen, by F. W. Brackett & Co., of Colchester. This screen is in the form of a rotating disc 20 ft. in diameter and capable of passing 2,000,000 gallons per hour. The general principle of the screen is shown in Figs. 31 and 32. The refuse, which is caught on the face of the screen, is brought up by this rotation above water level until it reaches a level at which cleaning jets on the reverse side throw off the refuse on to the catchboard seen in Fig. 32, and into a trough from which it can be removed. The screen is driven, through worm gearing, by an electric motor. It will be seen that this type of screen is not subject to a reversal of the flow of water. The screen is situated in a pit, and suitable hoisting gear is provided so that the skip containing the refuse may



Fig. 30.—View of Railway Incline for Delivering Coal into the Power House.

be raised periodically and its contents removed. Twelve thrust rollers are provided round the rim of the wheel to take up the water pressure on the face of the disc.

From this screen the water is taken through a ferro-concrete duct into the power house below the switch galleries, and after being pumped through the condensers it is discharged into a return duct at a higher level. From this it flows to a pump house near the cooling towers and onwards over a series of cascades direct to the river Wandle. The pump house is provided with three Rees Roturbo pumps, direct-coupled to motors by the Lancashire Dynamo Co., of 60 r.p.m. One of these is continuous current; the other two are three-phase.

During the greater part of the year the water available from the river Wandle will be sufficient for the needs of the power house. In dry weather, however, the water may be insufficient, and in that case three Klein cooling towers, each having a capacity of 200,000 gallons per hour, will be brought into use. These towers, if used exclusively, are insufficient to give the highest vacuum, but it was found that the cost of providing and maintaining towers sufficient for this purpose would not be justified, considering the limited use to which they would be put. The normal vacuum without the cooling towers in use is 28½ in., with barometer at 30 in., when the condensers are supplied with cooling water at a temperature of 65 deg. F.

Regulations have been made by the London County Council that the water shall not be returned to the Wandle above a

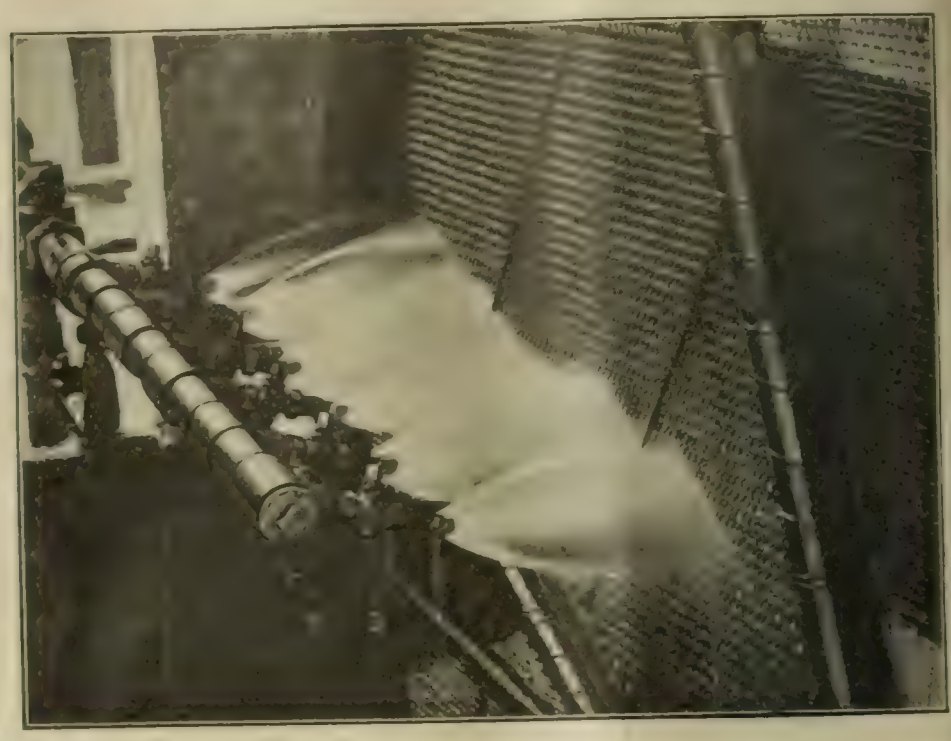


Fig. 31.—Water Jets on Brackett Strainer.

certain temperature and that the same quantity of water shall be returned to the river as is taken from it. Consequently, it is necessary to make up for the evaporation in the towers by drawing on the supply from the Metropolitan Water Board



Fig. 32.—Removal of Refuse from Screen.

when they are in use. In order to facilitate this, the evaporation has been agreed as a certain percentage of the water which is passed over the towers. When the towers are in use the cooled water is returned to the inlet duct and on its

way passes over a weir with a Lea recorder. This recorder not only measures the water that has passed over the cooling towers, but also acts upon a valve which permits the make-up water to flow into the cooled water in accordance with the agreed percentage. The whole thing is, therefore, automatic. The make-up water used in this way is measured by another Lea recorder.

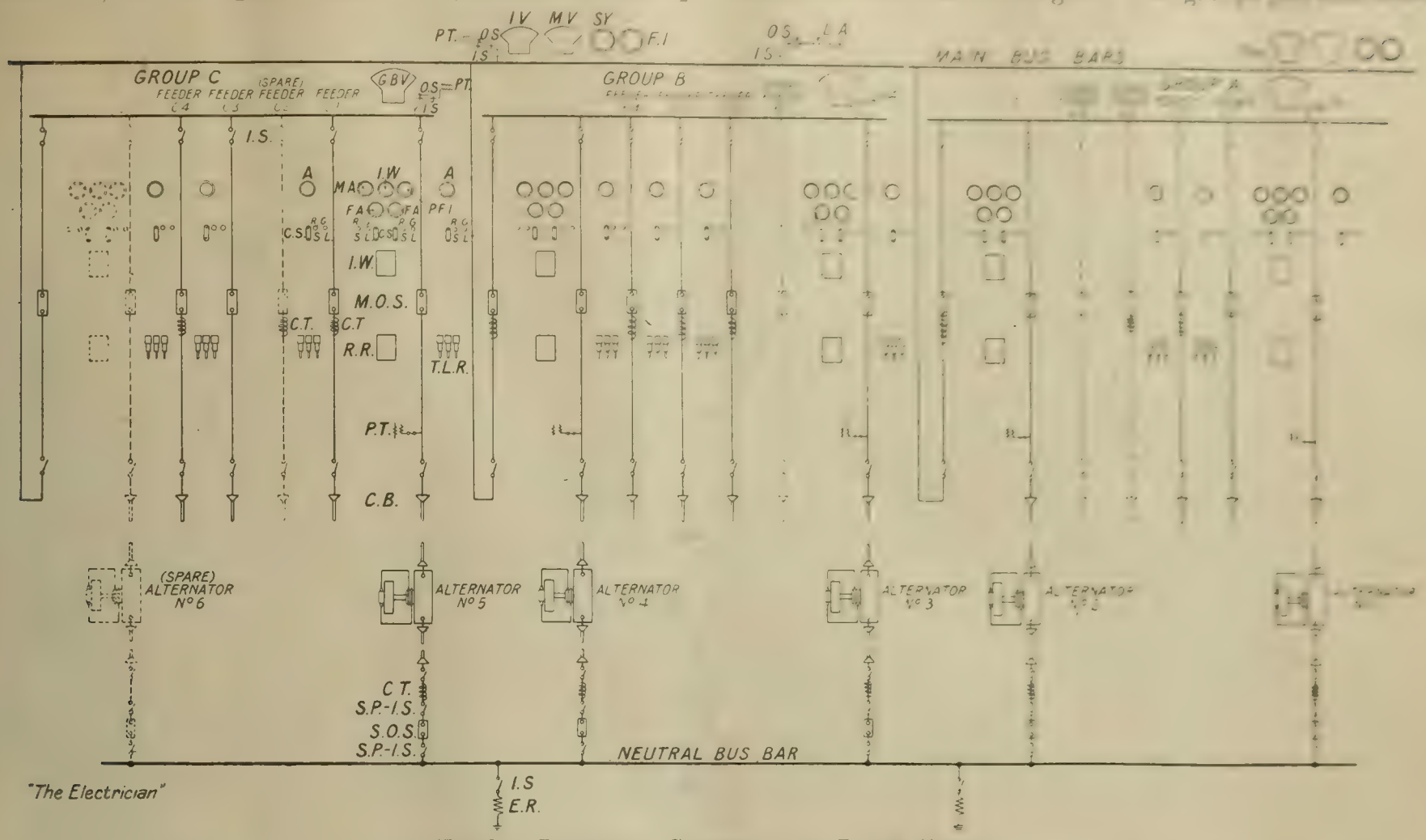


FIG. 33.—DIAGRAM OF CONNECTIONS IN POWER HOUSE.

P.T.=Potential transformer. O.S.=Oil switch. I.S.=Isolating switch. I.V.=Incoming voltmeter. M.V.=Machine voltmeter. SY.=Syncroscope. F.I.=Frequency indicator. L.A.=Lightning arresters. A.=Ammeter. I.W.=Indicating wattmeter. M.A.=Main ammeter. F.A.=Field ammeter. P.F.I.=Power factor indicator. S.L.=Signal lamp. R.=Red. G.=Green. C.S.=Control switch. M.O.S.=Motor operated oil switch. C.T.=Current transformer. R.R.=Reverse relay. T.L.R.=S.P. overload, time limit relays. C.B.=Cable box. S.P.I.S.=Single-phase isolating switch. S.O.S.=S.P. solenoid operated oil switch. E.R.=Earth resistance.

The switchgear is described over three floors, being arranged in the centre of the two first floors so as to enable access to be obtained to both sides of the gear. The groups [illegible] are separated from one another by moulded stone walls fitted with steel doors, the doors of each equipment having different locks to prevent access being obtained to the wrong compartment.

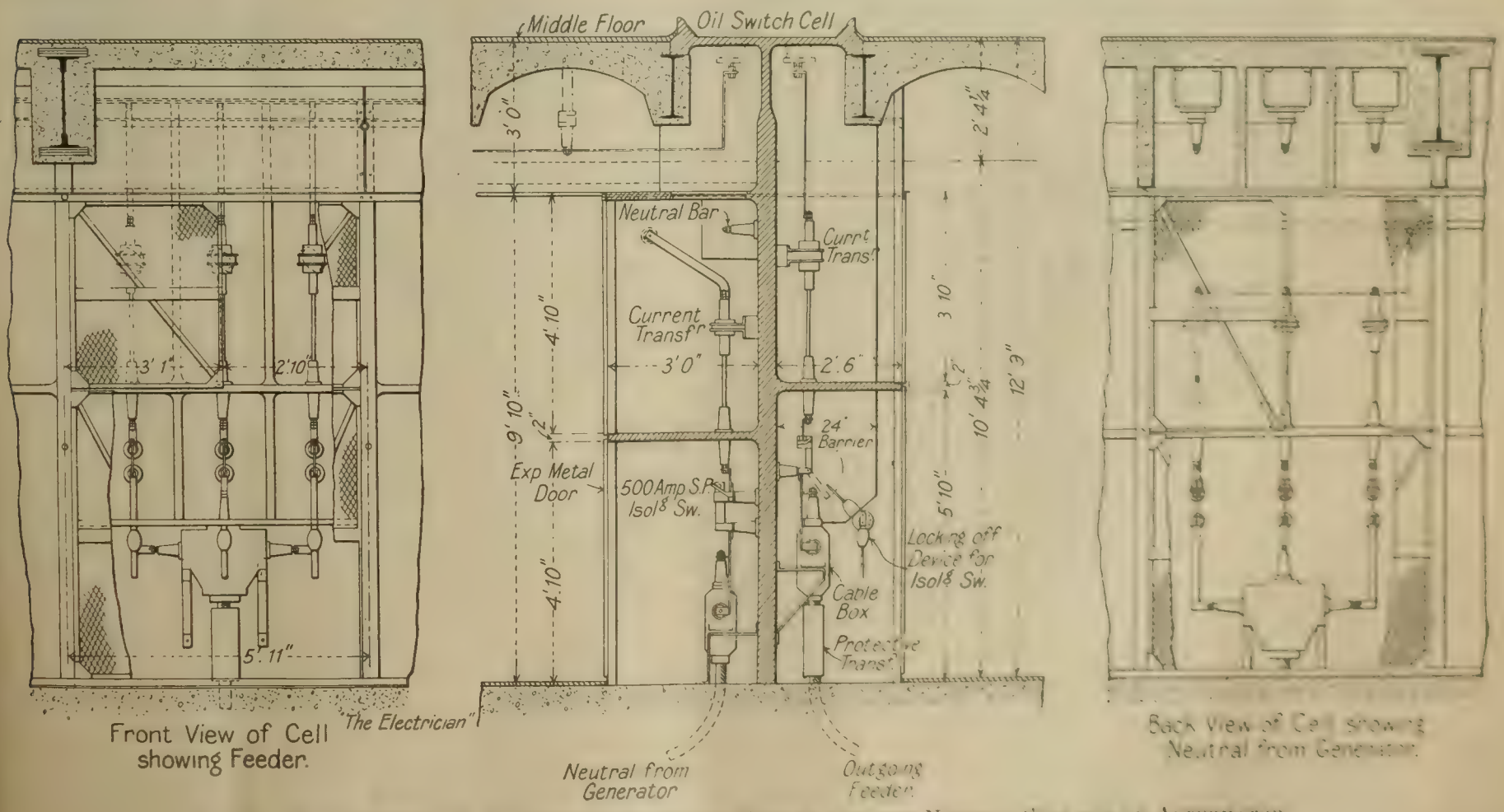


FIG. 34.—ARRANGEMENT OF SWITCHGEAR SHOWING A FEEDER AND THE NEUTRAL SIDE FOR AN ALTERNATOR.

THE SWITCHGEAR.

The power house switchgear is arranged in three groups, each group having two generators and four feeders connected to it as indicated in Fig. 33.

All the apparatus is contained in fireproof moulded stone cells, with barriers between the phases. The front of the cells is covered by expanded metal screens, except in the case of the oil switches, where sheet steel is employed. The connections

between the various pieces of apparatus are all of bare copper, carried on porcelain insulators.

Certain subsidiary gear is located on the ground floor. The control board and most of the oil switches are placed on the first floor and the group and main bus bars on the second floor. The general arrangement can be followed by referring to Figs. 33, 34 and 35.

We may first of all follow the neutral conductors of an alternator. In order to protect the alternators they are provided and then passes through isolating switches and the current transformers for the Merz-Price protection. The conductors are then united to a single conductor, which is taken into an adjacent cell (seen in Fig. 35) containing a remote-controlled oil switch with isolating switches on either side. Connection is then made to the neutral bar which runs through all the three group compartments. At two points connection is made from the neutral bar through an isolating link to a Brazil carbon resistance of 20 ohms, the other end of which is earthed to six

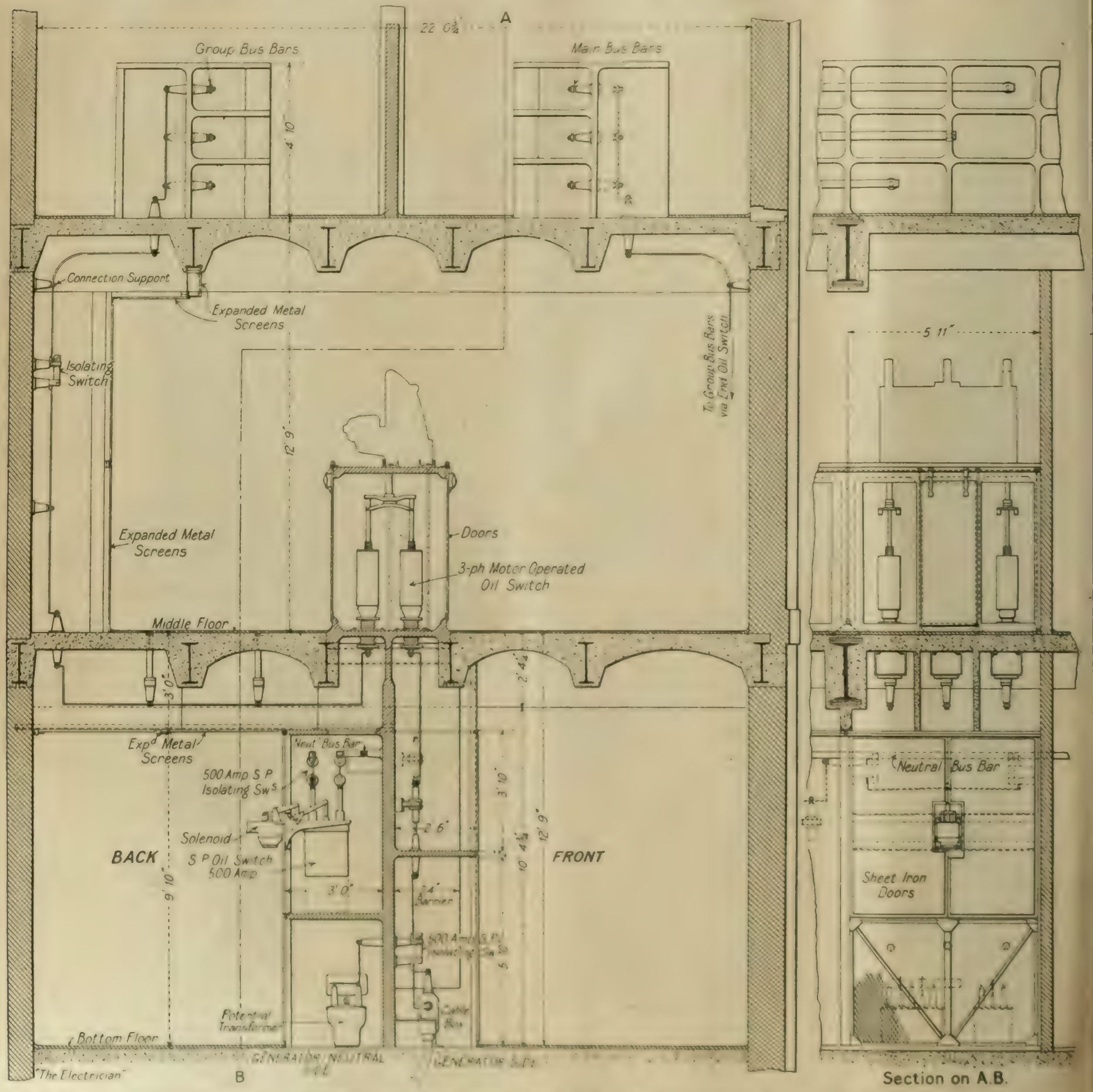


FIG. 35.—ARRANGEMENT OF SWITCHGEAR SHOWING THE HIGH TENSION SIDE FOR AN ALTERNATOR AND OIL SWITCH FOR THE NEUTRAL OF AN ALTERNATOR AND GENERAL ARRANGEMENT.

By "Back" is meant the side towards the turbine room. The control gallery is therefore an extension of the middle floor to the left.

with the balanced Merz-Price protective device, and in order to avoid having current transformers in a pit near the alternator where they are more or less inaccessible, a three core cable has been run from the neutral ends of the alternator windings and brought into the switchgear compartment on the ground floor in much the same way as the high tension cables. This neutral cable is seen in Fig. 34. It is brought into a trifurcating box

lengths of rail buried in the ground. Only one of these resistances is placed in circuit at one time. There is no trouble from triple harmonic circulating currents, as only one alternator is earthed at a time. This operation is carried out from the control board.

Passing, now, to the other side of the board, the three-core high-tension cable from the alternator can be followed (Fig. 35).

The cable is brought to a trifurcating box and thence through isolating links to another compartment of the cell containing current transformers for the Merz-Price protection and for instruments, and a current transformer on one of the phases for an ammeter. Going back to the lower cell, it will be noticed that connections are carried through the vertical partition to a potential transformer on the neutral side of the switchboard.

Returning to the feeder side, we see that the conductors are carried up from this group compartment to one of a group of oil switches on the first floor. This is of the remote-controlled motor operated type. Each phase is in a separate cell, and there are two oil vessels in each cell so as to give two breaks in series. There are contacts on the top of each oil vessel which are bridged by two switches in parallel, thus giving two paths in air to increase the conductance, but the final break takes place under oil. A view of one of the groups of oil switches is given in Fig. 36.

From Fig. 35 it will be seen that the conductors are taken from the oil switch down below the floor and up again to the group 'bus bars on the top floor. There are three compartments of group 'bus bars, corresponding with the three compartments of oil switches.

The protective and current transformers are all of the porcelain insulated type.

The arrangement of the feeders is practically the same as that of the high-tension cables from the alternators just described. They are brought down from the group 'bus bars



FIG. 36.—GROUP OF OIL SWITCHES.

through one of the oil switches just mentioned, and on the ground-floor compartment they are brought through current transformers, one on each phase, for supplying instruments, cut-outs, &c., to isolating switches and then to a trifurcating box. The three-core cable proceeding from this box is surrounded by a transformer for the Ferranti-Waters feeder protection. The feeders are taken out from the station through ducts; they then dip underground through troughing laid solid under a footway, and are brought up again on the adjacent railway embankment where they are carried on posts.

On the second floor are also situated the interconnecting 'bus bars running parallel with the group 'bus bars. Any set of group 'bus bars can be connected to the interconnecting 'bus bars by means of conductors which are taken down from the group 'bus bars through isolating switches to an oil switch and thence through isolating switches up to the interconnecting 'bus bars. The end oil switch of each of the groups is used for this purpose (Fig. 35).

The construction that is adopted for the 'bus bar board is cellular, as indicated by Figs. 35 and 37. The feeders or other conductors are brought up in vertical cells, one phase to each cell, and a connection is taken through a partition to the appropriate 'bus bar, each 'bus bar being housed in a horizontal cell running the full length of the group. Similarly the interconnecting 'bus bars run the full length of the switch

room, but there are only three sets of vertical cells for the three connections necessary to the three sets of group 'bus bars.

At one end of the interconnecting 'bus bars the bars are taken through isolating links and hand-operated oil switches (one to each phase); thence to a potential transformer for giving the voltage on the 'bus bars. Beyond these the conductors are taken to spark gaps of the horn type so as to protect the station from surges, the earthed side of the spark gap being each taken to

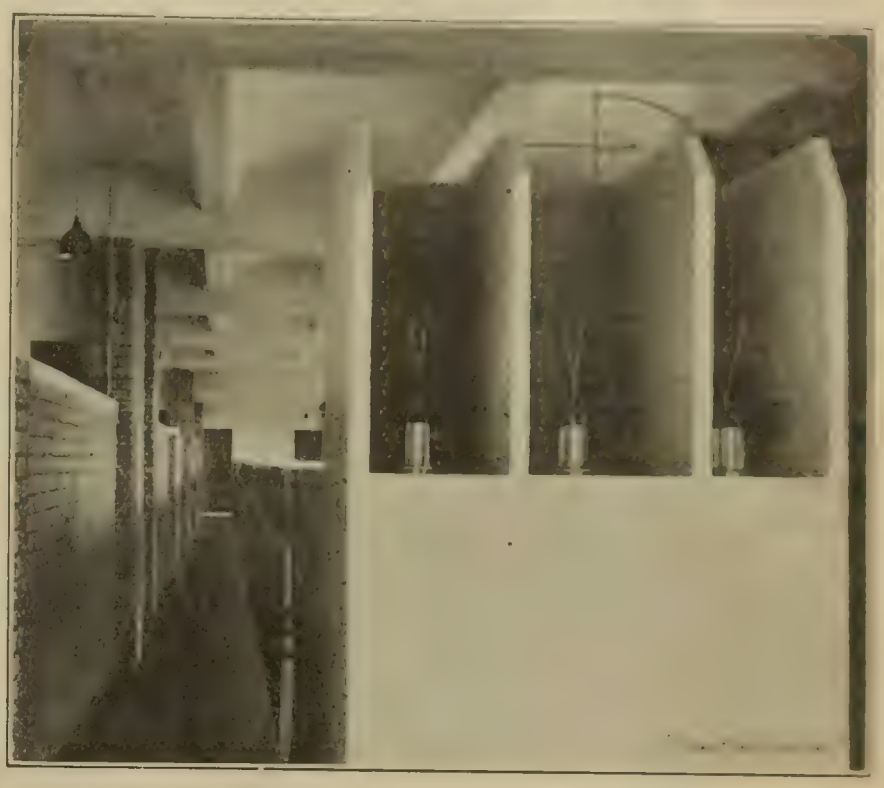


FIG. 37.—VIEW OF HORN SPARK GAPS AND CELLULAR CONSTRUCTION FOR INTERCONNECTING 'BUS BARS.

a Brazil resistance. The three phases are then connected together and taken through a fourth Brazil resistance to earth. A view of these spark gaps is seen in Fig. 37, which also shows the cellular construction adopted for the interconnecting 'bus bars.

A view of the control board, which is of the bench board type, giving the operator a clear view of the turbine house through a glass screen, and is situated on the first floor, is seen in Fig. 38. It is divided into three groups, in accordance with the rest of



FIG. 38.—VIEW OF CONTROL BOARD.

the scheme. Each alternator panel contains two small switches for operating the high-tension and neutral oil switches corresponding to the alternator. These oil switches are motor operated with continuous current at 220 volts, and have been referred to above. Each switch is worked by means of two plugs, one of which is pulled up to close the switch and the

other pulled up to open it. The closing plug can be padlocked so as to prevent interference.

There are red and green lamps to show when the circuit is closed or open, and also a small shutter which gives an indication by its colour. The panel also carries a switch which puts the exciter field on or off and an ammeter and voltmeter for the excitation. Sockets are provided into which plugs can be inserted for synchronising. One board is provided for each alternator at either end of the group. Above the panel is fixed a Brown-Boveri automatic pressure regulator, an ammeter, a wattmeter, a kilowatt-hour meter and a power-factor meter. Below the panel is a wheel for operating the field rheostat for the corresponding exciter; also a reverse relay which is put in circuit when synchronising and relays for the Merz-Price protection. To one side of the alternator panel is a device for giving signals to the turbine driver to run up, to go fast or slow, or to shut down. An electric hooter is provided in front of the gallery for calling the attention of a driver, and beneath this a numeral can be shown indicating the alternator to which the driver is to go. He can then see the signals on an indicator fixed on the wall near the alternator. A switch is also provided for controlling a small electric motor on the governor of the alternator so that the speed can be varied from the board. Consequently, when the alternator has been run up the complete synchronising operation is carried out at the board.

The feeder panels contain similar plug-operated switches for operating the oil switch and also indicating lamps. Above the panel is an ammeter; below it are the tripping devices for the Ferranti-Waters feeder protection.

At the end of the board are two voltmeters, one for the 'bus bars and one for the alternator that is being synchronised, a frequency indicator, a synchroniser and also synchronising lamps on each phase. In addition to the main switchboard there are two auxiliary boards, one for alternating and the other for continuous current.

Near the control board is a small telephone board by which communication can be obtained with the various sub-stations.

The auxiliary alternating-current board consists of four enamelled slate panels having the oil switches and 'bus bars mounted at the back, the whole of the back being enclosed by expanded metal screens. This board controls the supply from three 200 k.v.a. single-phase transformers by the British Electric Transformer Co., and three power circuits.

The auxiliary continuous-current board controls three 400 kw. auxiliary turbo-generators, an 800 ampere battery and booster, two 100 kw. motor alternators for the railway lighting and signalling supply, and 10 power circuits, and consists of enamelled slate panels, having the instruments and apparatus on the front and the bare copper 'bus bars on the back. Both the auxiliary boards are near the main control board.

All the switchgear was supplied by the British Thomson-Houston Company.

(To be continued.)

LONDON-BIRMINGHAM LOADED CABLE.*

The completion of the London–Birmingham cable marks the first stage in the realisation of the scheme for connecting London with Liverpool by means of an underground telephone cable. It may be mentioned that the Birmingham Liverpool section is also advancing towards completion. The following notes and tabulated results of actual tests on the completed cable will, no doubt, be of interest to many readers. The cable and loading scheme was designed by the Post Office engineers. The work between London and Birmingham was entrusted to the Western Electric Company, who provided and balanced the cable and supplied and fixed the loading coils. Further north the cable work is in the hands of the Helsby Cable Company. There are 52 telephone pairs in the cable along the entire route, divided as follows:—

2 direct circuits on 300 lb. conductors.
14 .. .. 200 ..
12 .. .. 150 ..
24 .. .. 100 ..

In addition, 12 of the 100-lb. and all the 150-lb. circuits, 12 in number, carry superimposed or phantom circuits (six phantom circuits in each of the two groups), and provision has been made by auxiliary stubs at the loading points for adding further phantom circuits as required.

The mean results of direct and alternating current tests which have been made on the entire cable are set out in Table I., and the table gives exact comparative values for the efficiency of the various circuits under the heading of the attenuation constant "β."

Table I.—*Direct and Alternating-current Tests. Mean Results.*
Cable Length 109·5 miles.

Weight, per mile, per wire (lb.).	Diameter.		Direct current tests.				Alternating current tests ($2\pi f=5{,}000$).
	Inches.	Mm.	Resistance, ohms per mile (loop).	Inductance henrys per mile (loop).	Insulation, megohms per mile (loop).	Capacity, mf. per mile (loop).	Attenuation, constant β per mile.
300	0·137	3·48	6·55	0·053	21,800	0·0568	0·00408
200	0·112	2·841	9·62	0·054	19,000	0·0655	0·00664
150	0·097	2·461	13·13	0·054	17,890	0·0697	0·00884
150	Phantom	Phantom	6·56	0·035	...	0·1057	0·00756
*100	0·079	2·009	18·38	0·053	20,600	0·0568	0·01074
100	Side	...	18·95	0·054	...	0·0575	0·01092
100	Phantom	Phantom	9·5	0·036	...	0·0905	0·00926
200	..	Not yet loaded	Not yet loaded	Not yet loaded	Not yet loaded	0·0823	...
300	..	Do.	Do.	Do.	Do.	0·0844	...

The mean measured characteristic impedance of the direct circuits is 900Ω. The measured values varied from 880Ω to 1,030Ω. The mean values for the phantom circuits is 586Ω.

The maximum resistance allowed in the loading coils at 800 periods per second is 50 ohms per henry ($R_1/L_1=50$), except in the case of the 300-lb. circuits, where the maximum resistance allowed is 35Ω per henry ($R_1/L_1=35$), R_1 being the effective resistance of the coil and L_1 its inductance in henyes. The maximum value of S/K is 20. These values were given by the contractors and verified by factory tests. The coil spacing distance of 2½ miles was adhered to throughout except at the cable ends, where it is 1¼ miles.

Having given the above data, it is of interest to compare the anticipated attenuation constants as calculated by the Post Office engineers with the measured values in the preceding table. For convenience of reference the figures are reproduced in Table II.

Table II.—*Measured and Calculated Values of the Attenuation Constant.*

Weight, per wire, per mile (lb.).	Calculated value of attenuation constant.	Measured value of attenuation constant.	Percentage difference from calculated value.
300	0·0048	0·00408	20% better.
200	0·00684	0·00664	3% better.
150	0·00875	0·00884	1% worse.
150 phantom	0·00759	0·00756	No difference.
100 direct cct.	0·01161	0·01092	7% better.
100 phantom	0·00926	Not calculated	...

It will be seen that, except in the case of the 300-lb. circuit, the differences are small. In the case of the 300-lb. circuit the capacity obtained was materially lower than anticipated (·055 mf. per mile instead of ·065 mf.) The only other difference in the treatment of this circuit is that a higher grade coil was used. It may be remarked that the same efficiency may be obtained by the combination of various proportions of copper and inductance per mile. Loading coils of various grades and prices are available for selection. The plan followed was to give the preference to a combination which secures a relatively large proportion of copper to inductance for a given efficiency and price, copper being a more stable asset than coils. This method also reduces to a minimum the effect of distortion caused by effective resistance in the coils, and secures a favourable characteristic impedance for working in connection with the general system. The grade of speech obtained is found to be satisfactory with the spacing named.

So far as any details are known to have been published it may be

* From the "Post Office Electrical Engineers' Journal," slightly abbreviated.

* Not phantomed

stated that the efficiency of the 300-lb. circuit, per unit length, is higher than that of any other existing underground circuit. This is principally because the copper used has a greater weight per mile than any other loaded circuit known. The result is also contributed to by the high-grade coils used, and the relatively low capacity of the circuit. It will be noticed that the phantom circuits are more efficient than the direct circuits on which they are superimposed. This is because of the favourable capacity of the phantom circuit, *i.e.*, its resistance is halved, but its capacity is not doubled, as compared with the direct circuits; this is advantageous from the transmission efficiency point of view.

Speech Tests.—It is generally assumed that the attenuation due to speech corresponds to that which is observed in telephone circuits, when an alternating current at a frequency of 800 periods per second

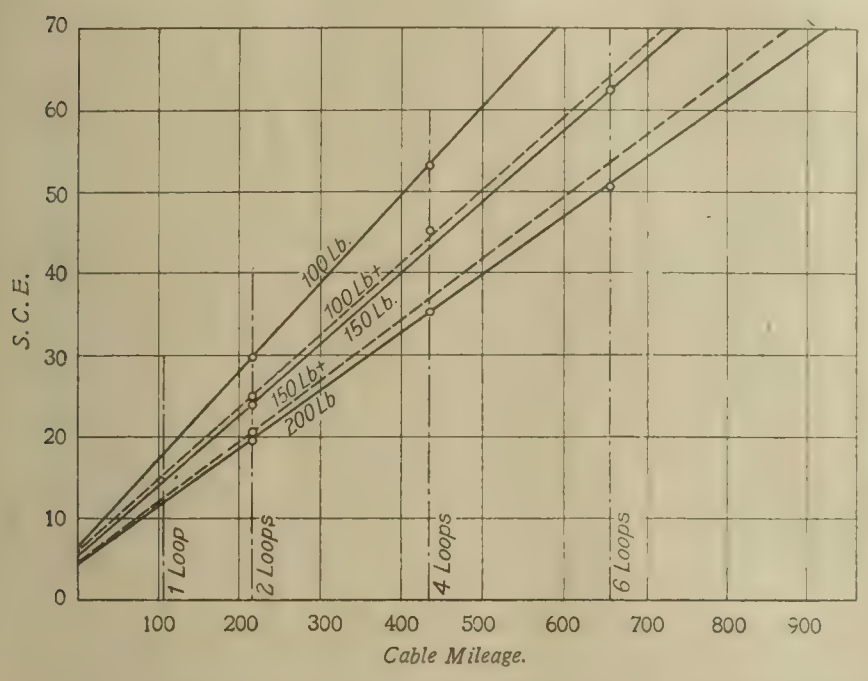


FIG. 1.—STANDARD CABLE EQUIVALENTS WITH C.B. TELEPHONES ON ZERO LOOP.

is transmitted along them. Table III. shows to what extent this was found to hold good in this case. The figures in the first line of the table are the results of speech tests made on the circuits in the cable, and compared with a standard cable. The results for each type of cable are expressed in terms of their standard cable equivalents (S.C.E.). The machine tests in Table II., which were made at a frequency of 800 periods per second, are reduced to "S.C.E.," and given for comparison on the second line of the table :—

Table III.—*Comparison of Speech Tests and Machine Tests (London-Birmingham).*

	Type of conductor.						
	300 lb.	200 lb.	150 lb.	150 lb. phantom	100 lb. *	100 lb. Side.	100 lb. phantom
S.C.E. of circuit deduced from speech tests.	4·7	7·4	9·5	7·9	11·3	11·6	9·4
S.C.E. of circuit deduced from machine tests.	4·25	6·92	9·22	7·89	11·21	11·39	9·88

If the difficulty and limits of error of standard cable tests are borne in mind the agreement is good.

Terminal Losses.—In order to investigate the terminal losses, the usual graphical method was resorted to, and the results are shown in Figs. 1 and 2. In Fig. 1 the result of speaking with the apparatus immediately at the ends of the loaded lines is seen, the terminal loss is the "S.C.E." value between the point where the graphed lines strike the vertical, and zero. Its average value is 6 miles of standard cable. Owing to the length of cable, it was not possible to obtain more than three points on the curve in any case. For this reason the values are somewhat approximate. The circuit used was the standard common battery circuit.

Fig. 2 shows the terminal loss in connection with the same local circuit, but with a subscriber's line of 350 ohms resistance. In the case of direct circuits the average loss is reduced to 0·8 miles of standard cable. In the case of the phantom circuit the result is 2 msc. With transformers for superimposing added the mean losses

*Not phantomed.

are increased by 1½ msc. It will be seen that the [illegible] tests give practical figures for commercial use.

Cross-talk Tests.—The tests were of two kinds: (a) Between all combinations of the direct circuits; (b) between the phantom and direct circuits, and *vice versa*.

In the first case the maximum cross-talk was no greater than would be observed when speaking through 50 miles of standard cable. In the second case the maximum [illegible] equal to 67 miles of standard cable.

Both these figures are far beyond the [illegible] of speech. The mean values are, however, very considerably better than these figures.

It may be mentioned that such results [illegible] without special care in the manufacture and balancing of the cable. In fact, the progress which this cable marks over others previously

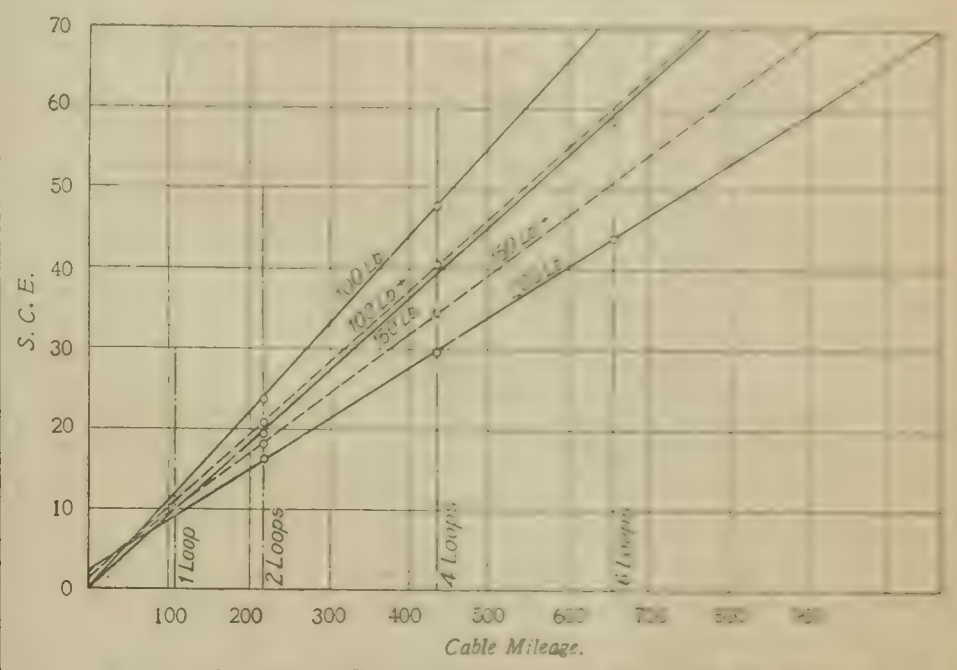


FIG. 2.—STANDARD CABLE EQUIVALENTS WITH C.B. TELEPHONES ON 4 S.M. LOOP.

laid in this country consists largely in the relatively small cross-talk and the reduction of leakance which have been obtained. The former has the important result of making phantom working possible, and the latter brings about decrease in the attenuation constant, with a corresponding increase in the possible range of telephonic speech. These results were foreseen and expected.

Substations of the Sydney Electrical Supply.—In a Paper read before the New South Wales section of the Electrical Association of Australia, Mr. J. S. Just gave a description of the substation apparatus of the Sydney Municipal Electric Supply Undertaking. High-tension three-phase alternating-current at 5,000 volts, is converted by rotary converters, motor converters and synchronous motor generators to direct current at 240 and 480 volts on the three-wire system. The two largest sets for this purpose are 15,000-kw. machines, one a motor converter and one a rotary converter. This variety in the kind of apparatus employed is largely due to the necessity of controlling the station power factor. The complete remote control of sub-stations may be put into operation by the tramway department. Batteries are also used, there being two of 4,000 and 6,000 ampere hours' capacity at the one hour rate. Great care has had to be taken in supporting the conductors for such large batteries, as great magnetic forces may be set up between them. The batteries are in halves between the outers and the neutral, and when charging the booster is connected in between the halves. The static transformers range from the large 33,000-volt apparatus in brick sub-stations to small exposed transformers on poles, the latter type running to 200 k.v.a. An interesting piece of apparatus in this connection is a special portable oil-drying and filtering outfit enabling the oil of a transformer to be dried out while the transformer is still in service, the oil being circulated through the filter and back to the transformer. The cost of drying in this way is about 26s. for a 100 k.v.a. transformer, containing 130 gallons of oil.

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THE PASSING OF THE SMALL TURBINE.

A table showing the results obtained with turbo-generators at different epochs is to be found in Sir CHAS. A. PARSONS' Rede lecture at Cambridge. The period covered by the table is from 1885 to 1910. During this time the output increased from 4 kw. to 5,000 kw., and the steam consumption of the latter machine is given at 13·2 lb. per kilowatt-hour with an absolute pressure in the condenser equivalent to 1·2 in., 120°F. superheat and a steam pressure of 200 lb. per square inch. In the first part of the next period, 1910 to 1915, designs followed the lines laid down at the close of the first period. A 25,000 kw. unit was built in 1913 by Messrs. Parsons & Co. for the Commonwealth Edison Co., of Chicago. The steam consumption of this unit marked an epoch in steam plant. With a pressure of 200 lb., 200°F. superheat, 29 in. vacuum, the steam consumption guaranteed at a load of 20,000 kw. was 11·25lb. per kilowatt-hour, and at half-load 12·5 lb.

Turbo-generators set to work during the present year in the United States are rated at 30,000 kw. and 35,000 kw. respectively. Three of the former size were ordered by the Interborough Co. of New York in 1913, and all have been in operation for some time. Provision has been made in the power station for eight of these units. The Philadelphia Electric Co. recently installed two large units, one of which is rated at 35,000 kw. and the other at 30,000 kw. The total rating of the two stations owned by this company is 151,000 kw., in nine generating units, and of this total the two new machines furnish no less than 65,000 kw., or approximately 43 per cent.

With this example before us we are in the mood fully to realise the significance of the editorial comment on the "Economics of Power Station Design" in the last issue of "Engineering." Our contemporary quotes the figures given by Messrs. MERZ and MCLELLAN, namely, that London is supplied with electricity upon 49 different systems, from

70 generating stations, by 65 authorities; and, further the MERZ and MCLELLAN figure of £170,000 a year for the saving on the working costs by modernising the electricity supply of Greater London is given. We agree that such figures form a fitting introduction to a consideration on general lines of the economy which may result from centralisation in the generation of electric energy. Our contemporary continues: "That such centralisation may result in economies of the first importance is now realised in all responsible quarters—the matter requires no preaching, except to town councillors and Members of Parliament—but figures such as those above bring dismal comfort even to the converted by suggesting that the folly of our present proceedings cannot go on for ever." Few of our readers will take exception to such plain speaking.

We would remind the layman that this wastage is not peculiar to London. The same appalling waste occurs in most of our towns and manufacturing districts, and experience shows that neighbouring towns will have their own power stations *at any cost*. In a Paper entitled "Economics of Electric Power Station Design," presented at the International Engineering Congress held in San Francisco last month, Mr. H. F. PARSHALL also gave figures for the London supply. A body of engineers of wide outlook should tackle the power supply problem, not of a single town, but of the entire country. An authoritative statement by such a body would surprise some of our economists, and would, in course of time, result in centralisation on a grand scale. This important work could be undertaken by a committee appointed by the Institution of Electrical Engineers.

As long as turbo units were of small size there was relatively little to be gained by building large generating stations, but the advent of the high-powered turbine puts the matter on a different footing and makes the centralisation of power a commercial proposition. The opinions given elsewhere in this issue of a number of American engineers of repute on the subject of increasing the size of turbo units may be regarded as an indication that serious attention is being devoted to the consideration of the many mechanical and electrical problems connected with the design, construction and operation of machines rated at 50,000 kw. The latter figure is in all likelihood the next increase in size. To those accustomed to look upon a 5,000 kw. unit as a large machine, the contemplated ten-fold increase will be little more than a dream, but it is not unlikely that the 50,000 kw. unit will itself be dwarfed when the question of centralisation is tackled in earnest. Since little improvement can be expected in the performance of larger turbines with existing steam pressures, it is evident that pressures will have to be increased to secure greater economy, and pressures of 500 lb. per square inch are being considered. An immediate gain of about 9 per cent. in turbine efficiency will follow the adoption of the higher pressure; and the higher pressures introduce a number of interesting problems in the design of auxiliaries and piping systems. Engineers best qualified to express an opinion on the subject do not anticipate any operating difficulties with the larger units, and by some it is believed that no more men will be likely to be required for operating such units, as compared with the 30,000 kw. size, and therefore the saving in labour should be attractive when worked out on the kilowatt-hour basis. Few inventors have shown greater tenacity in sticking to their subject than PARSONS has shown in all matters connected with the steam turbine and high-speed alternator, and few inventors have been privileged to witness such remarkable development of their invention during the short period of 30 years.

REVIEWS.

Copies of the books noticed under this heading can be had from The Electrician Office, post free, or may be ordered through any bookseller. Postage extra. Discount 10 per cent. for cash or to subscribers.

Specification and Design of Dynamo-Electric Machinery By MILLS WALKER, M.A., M.I.E.E. Pp. xii + 618. (London: Longmans, Green & Co.) 32s. net.

There is no lack of books on dynamo-electric machinery, but among all these there is none which treats the subject of design with such a wealth of detail and with such close attention to the question of manufacture as the work under review. The book will be found to be an indispensable vade mecum for the designing engineer, but the consulting engineer also will find a large part of it extremely useful. The author justly remarks in the introductory chapter that it is for the user or the consulting engineer, in the first place to decide what characteristics a machine shall have and how the specification shall be worded, whilst the most economical way of building the machine so that it shall comply with the specification is solely a question for the manufacturer. This strict distinction between the drawing up and the filling of a specification is the ideal condition both in the interest of purchaser and of the manufacturer; but this ideal can only be reached if the consulting engineer is careful to restrict his demands to what is really necessary and attainable. He must not specify unessential details or conditions which, however desirable they may appear to be on theoretical grounds, add nothing to the practical value of the machine, whilst at the same time increasing the cost of manufacture. In a word, the consulting engineer should know what conditions may be reasonably demanded in a given case; but such a knowledge can only be acquired by his studying the subject of dynamo electric machinery in a comprehensive way, including the technical and commercial aspects as they affect the manufacturer. Only then will he be able to safeguard the interests of his client, and it is for this reason that the consulting engineer also will find the book a very valuable guide in his branch of work. This point is illustrated by the general arrangement of the book. Part of it deals with general principles and such details which occur and demand attention in the design of any machine. The rest deals with specific cases. Here we find 18 examples of what may be termed model specifications, and the design to fill them worked out down to all essential details. These cases, roughly classified, are: Four three-phase generators (motive power: high-speed piston engine, slow-speed piston engine, gas engine and water turbine), two turbo-driven alternating-current generators, four induction motors, one continuous-current generator, two alternating to continuous-current generators, one continuous-current turbo-generator, two rotary converters, one rotary alternating-current booster, and one phase advancer. It will be seen from this list that the author has made a comprehensive selection of what may be termed the usual types of machinery. Special types, such as tramway and railway motors, machines required in mining and rolling-mill work, and other special types for use in various industries are not dealt with. In the preface the author says that it would take many years to compile a book covering the whole ground, and he considers the present book as a first instalment. He does not actually promise a second instalment, but as he is still a young man with great capacity for work every reader of his present book will wish and hope that a second instalment may appear in due course.

Although in the book under review the treatment is limited to the usual type of machine, the amount of work is prodigious. We have here a heavy tome of some 640 large pages containing, besides the letterpress of excellent type, 23 tables, 533 illustrations (many of them working drawings to scale), a very full index and five pages of symbols. The addition of these five pages to the letterpress will be appreciated by the reader when he has to look up quickly some point in a design and cannot spare the time to study the argument on which the formula he requires is based. The same symbols are used throughout; in most cases the author has adopted those recommended by

the I.E.C., but there are a few exceptions. The sum of all the fluxes in a magnet system he calls N instead of φ, though this symbol is used by him for the flux interlinking a coil; for frequency he puts n instead of f the international symbol; and W is used for power in watts, whilst the I.E.C. recommends this symbol for energy.

Part I., comprising "Short rules for use in the design of dynamo electric machinery," covers 264 pages; the rest of the book is devoted to Part II., "The specification and the design to meet the specification." The book is written on the assumption that the reader is familiar with the theory and operation of machines as given in the usual run of text books; yet the author departs from the usual method of treatment. In most text books we find a clear distinction between continuous current and alternating-current machines, and formulæ somewhat different in structure are given. The author treats all machines under one and the same comprehensive formula (following in this the lead given many years ago by Mr. B. G. Lamme), and introduces various coefficients to make the necessary distinction according to the type of machine. Another departure from the text-book custom, though not from shop practice, is that in the E.M.F. formula the flux from one pole does not appear, but instead of this the sum of all the fluxes taken with the same sign is used. There is a good reason for this, inasmuch as a single figure thus characterises the magnetic system or the "frame," as it is generally called. This single figure is given in "volt-lines," a unit introduced by the author, and which is equivalent to 100 megalines. There does not appear to be a very urgent need for this new unit. Whether we say that a certain frame is good for 2·89 volt-lines or for 289 megalines comes to the same thing; one figure is as easy to write as the other, but the megaline is a unit to which we are accustomed. The total flux defined by volt-lines is that which we get by multiplying the total armature surface by the maximum induction under the centre of the pole; it is, therefore, a fictitious figure, for at other places the induction is less and in some places zero. Nevertheless, the figure is a convenient standard for the magnetic loading of a machine, as the product of effective current per bar into the total number of bars is a convenient standard for the electric loading. These two figures are the bases of the design. The actual performance is predetermined by the introduction of coefficients, such as a flux coefficient, an E.M.F. coefficient, and various others taking account of fringing, shape and saturation of teeth, eddies and so on. There are several chapters on the magnetic circuit as applied to various types, and due weight is given to the question of economy, not only in showing how the number of poles affects it, but also by giving magnetisation curves and prices for the different materials and cost of machining.

Next we have several chapters on the electric circuit. These include windings and winding tables, chorded windings, eddy currents, moulds for winding the coils, insulating materials, their heat conductivity, dielectric strength, room taken up by insulation, the ventilation of windings, friction and windage losses, &c. Much space is rightly devoted to the question of temperature rise and its permissible limit. Here the author has largely drawn upon the results of experiments made by Mr. Skinner in America and Mr. Raynor at the N.P.L. All this information is, of course, accessible to the electrical engineer, but it is scattered in various journals, and by collecting and representing it in a systematic way the author has earned the gratitude of his colleagues. Table IX., on pp. 170 and 177, contains most valuable information on the mechanical, thermal and electrical qualities of 28 different materials, and the following 10 pages deserve careful study as they deal with the laws that govern temperature rise. After reading the author's clear exposition of this matter, which has been in controversy for the last few years, no one can fail to see how justified was the position taken up by the I.E.C. Committee on Standardising when it opposed the German attempt to lower the standard ambient temperature.

Certain matters of design are not treated in Part I., but are reserved for Part II. Thus the theory of commutation, the use of interpoles, the effect of phase swinging on the commutation of converters, the brush drop, heating of commutators and cognate subjects are dealt with at the appropriate place in connection with the details of design. The same remark applies to such matters at the parallel running of alternators, synchronising, mechanical effect of short-circuits, the staying of coils, use of dampers, phase advancing and many other details. In working out the design for each specification a calculation sheet as used in actual practice is added, with all the essential figures filled in. By the method adopted all machines are treated in the same way, and thus one form of calculation sheet serves for all cases, the only difference being that certain words are struck out and only those spaces filled in which are relevant to the job. The essential features of any design can thus be seen at a glance.

The publishers must be congratulated on the get up of the book; it is worthy of the excellent quality of the contents.

GISBERT KAPP.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Continued from page* 51.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

Determination of the Coefficient β_m.—This varies according to the relative positions of rotor and stator, and is the principal,

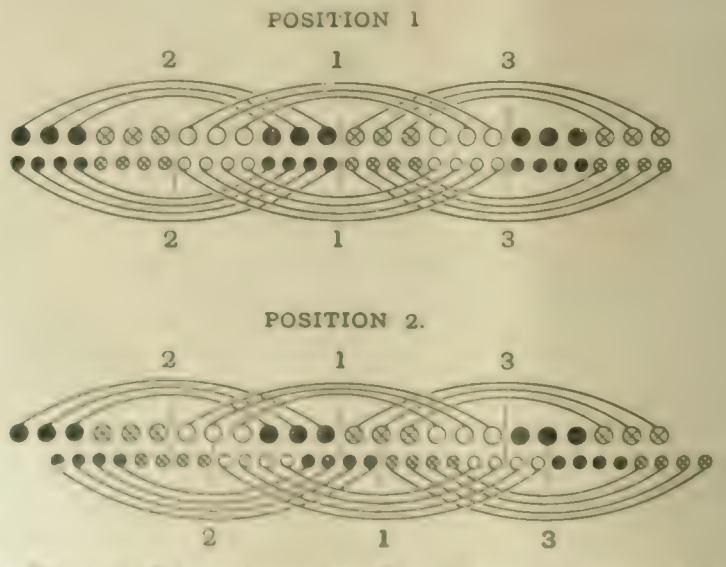


FIG. 6.—DIAGRAM ILLUSTRATING THE TWO SPECIAL POSITIONS OF ROTOR COILS RELATIVELY TO STATOR COILS.

if not the sole, reason, for the well-known variation of the short-circuit current according to the position in which the rotor is held during the test.

With different numbers of slots in stator and rotor it is not possible to obtain for *all* relative positions of rotor and stator a general formula for β_m as has been done above for β_s and β_r, so that each particular case must be calculated separately.

It will be shown later, however, that for *two particular positions* of the rotor relative to the stator, general formulæ exist which, with certain exceptions, express β_m exactly, and that

these *exact* formulæ lead to a general formula which expresses *approximately* in *all* cases the mean of the maximum and minimum values of σ_1.

The two particular positions will be referred to as position 1 and position 2.

Position 1 is the position in which the centres of stator and rotor coils coincide, while position 2 is the position in which the centres of stator and rotor coils are one-sixth of a pole-pitch apart, so that the middle point of a set of rotor coil-*sides* is midway between two adjacent sets of stator coil-sides. These two positions are shown in Fig. 6.

For these positions the general expression for β_m (in terms of $\beta_1, \beta_2, \beta_3$) reduces to simple forms.

In position 1, Fig. 6, it is evident by the symmetry of the positions of the rotor coils relative to the stator coils that $\beta_2=\beta_3$, where β_2, β_3 now represent the coefficients of the linkage with rotor coil 1 due to stator coils 2 and 3 respectively.

$\therefore \beta_m=(\beta_1-\beta_2)$ just as in the case of β_s, β_r. Moreover, $\beta_2=-\frac{1}{3}$ as before. $\therefore \beta_m=(\beta_1+\frac{1}{3})$, but β_1 will have a different value to that which it has in the case of either β_s or β_r, unless the numbers of stator and rotor slots are the same.

In position 2 the displacement of the rotor coils by one-sixth of the pole-pitch relatively to the stator coils causes rotor coil 1 to have a displacement of exactly half a pole-pitch relatively to stator coil 3. Consequently the linkage between these coils is zero, so that $\beta_3=0$. Again, the left-hand side of rotor coil 1 has the same displacement relative to the *right-hand* side of stator coil 2 as it has to the *left-hand* side of stator coil 1. This causes the linkage between stator coil 2 and rotor coil 1 to be the same in magnitude as, but opposite in sign to, that between stator coil 1 and rotor coil 1.

Therefore, $\beta_2=-\beta_1$.

$$\therefore \beta_m=\sqrt{\beta_1^2+\beta_2^2+\beta_3^2-\beta_1\beta_2-\beta_2\beta_3-\beta_3\beta_1},$$
$$=\sqrt{\beta_1^2+\beta_1^2+\beta_1^2}=\sqrt{3}\beta_1.$$

Calculation of σ_1 for a Particular Case.—Let us now calculate the value of β_m at positions 1 and 2 for a particular case; for example, $S_1=9$, $S_2=12$.

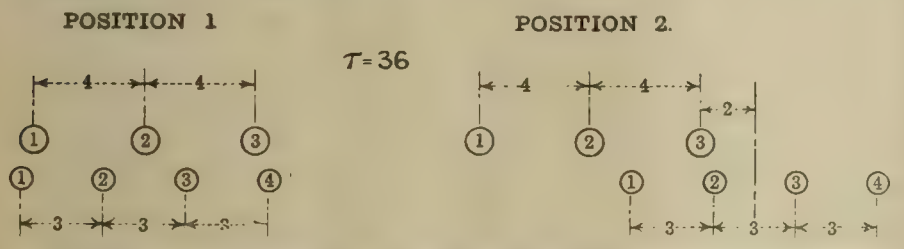


FIG. 7.—RELATIVE POSITIONS OF STATOR AND ROTOR SLOTS FOR CASE OF 9 STATOR AND 12 ROTOR SLOTS PER POLE.

Since we have only to calculate β_1 it is only necessary to deal with the relative positions of the slots of the coil-sides of phases 1 on stator and rotor. These are shown in Fig. 7.

In reckoning any coefficient β referring to linkage between stator and rotor it is convenient to take the pole-pitch equal to the least common multiple of S_1 and S_2, as this gives the smallest possible whole numbers to represent the stator and rotor slot pitches. In this case then let $\tau=36$, giving a stator slot pitch $w_1=4$ and a rotor slot pitch $w_2=3$.

In position 1 we have :—

For stator slot 1 $\Sigma x=(\frac{1}{2}+2\frac{1}{2}+5\frac{1}{2}+8\frac{1}{2})=17$,
For stator slot 2 $\Sigma x=(4\frac{1}{2}+1\frac{1}{2}+1\frac{1}{2}+4\frac{1}{2})=12$,
For stator slot 3 $\Sigma x=(8\frac{1}{2}+5\frac{1}{2}+2\frac{1}{2}+1\frac{1}{2})=17$.

$\therefore \Sigma x=46$. Also $\Sigma\tau=3\times4\times36$.

$$\therefore \beta_1=\left\{1-2\frac{\Sigma x}{\Sigma\tau}\right\}=\left(1-\frac{2\times46}{3\times4\times36}\right)=\left(1-\frac{23}{108}\right)=\frac{85}{108}.$$

$$\therefore \beta_m=\beta_1+\tfrac{1}{3}=\frac{85}{108}+\frac{36}{108}=\frac{121}{108}.$$

$$\frac{\beta_s+\beta_r}{2}=\frac{10}{9}+\frac{1}{9^2}+\frac{1}{12^2}=\frac{1,440+16+9}{9\times9\times16}=\frac{122{\cdot}0833}{108}.$$

$$\therefore \sigma_1=2\left\{\frac{\frac{\beta_s+\beta_r}{2}-\beta_m}{\frac{\beta_s+\beta_r}{2}}\right\}=2\left\{\frac{122{\cdot}0833-121}{122{\cdot}0833}\right\}=0{\cdot}0177.$$

In position 2 we have :—

For stator slot 1 $\Sigma x=(5\frac{1}{2}+8\frac{1}{2}+11\frac{1}{2}+14\frac{1}{2})=40$
For stator slot 2 $\Sigma x=(1\frac{1}{2}+4\frac{1}{2}+7\frac{1}{2}+10\frac{1}{2})=24$
For stator slot 3 $\Sigma x=(2\frac{1}{2}+5\frac{1}{2}+8\frac{1}{2}+11\frac{1}{2})=28$

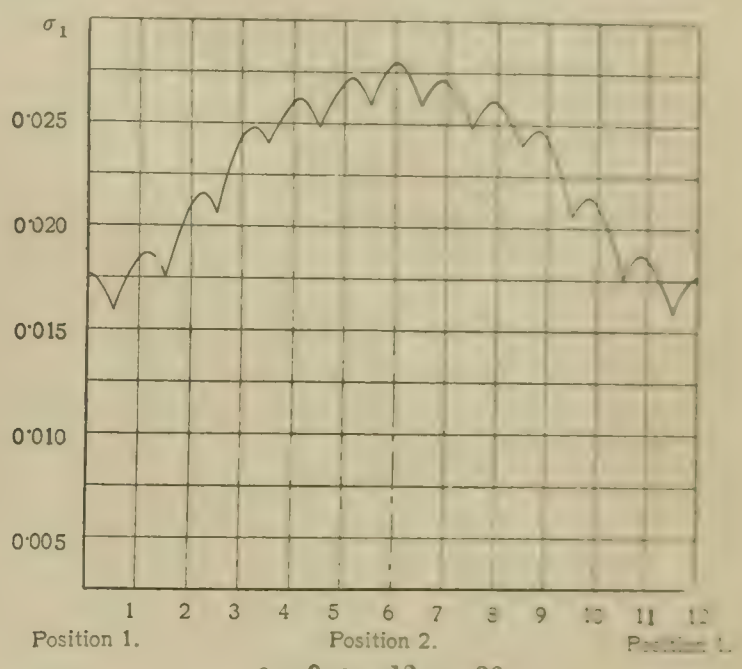
$$\therefore \Sigma x=77.$$

$$\therefore \beta_1=\left\{1-2\frac{\Sigma x}{\Sigma\tau}\right\}=\left\{1-\frac{2\times77}{3\times4\times36}\right\}$$
$$=\left(1-\frac{77}{216}\right)=\frac{139}{216}$$

$$\therefore \beta_m=\sqrt{3}\beta_1=\frac{139}{216}\sqrt{3}=\frac{120{\cdot}3775}{108}.$$

$$\therefore \sigma_1=2\frac{(122{\cdot}0833-120{\cdot}3775)}{122{\cdot}0833}=0{\cdot}0270.$$

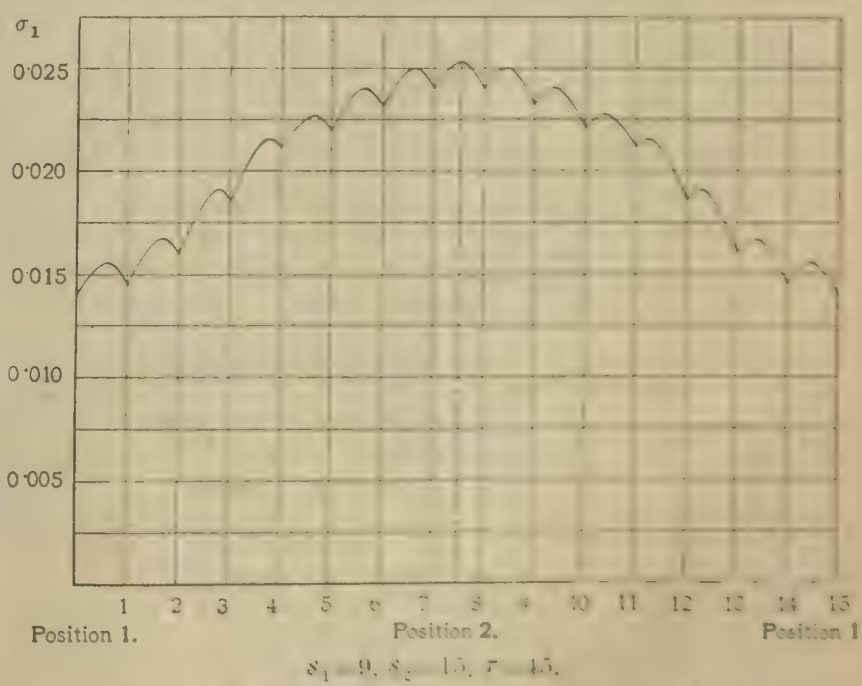
Variation of σ_1 with Position of Rotor.—Fig. 8 shows how σ_1 varies as the rotor is moved from position 1 through a sixth of a



$S_1=9$, $S_2=12$, $\tau=36$.

FIG. 8.—VARIATION OF σ_1 WITH POSITION OF ROTOR.

pole-pitch (=6) to position 2, and through a further sixth of a pole-pitch to the next position 1. It will be seen that there is a series of cusps on the curve at which occur what may be termed "local minima" in the value of σ_1. These local minima occur for displacements $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, &c., from position 1



$S_1=9$, $S_2=15$, $\tau=45$.

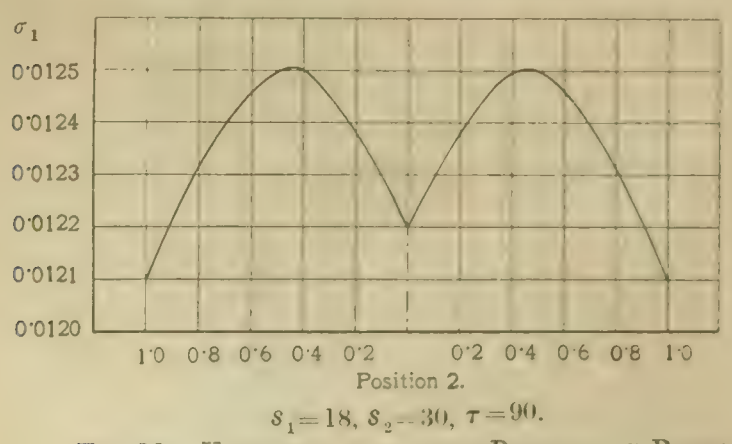
FIG. 9.—VARIATION OF σ_1 WITH POSITION OF ROTOR.

($\tau=36$). But these are the positions at which some rotor slot coincides with a stator slot. Whenever such a coincidence in position takes place a local minimum occurs. As a whole, the curve giving the value of σ_1 tends to a minimum at position 1 and a maximum at position 2, but the exact positions of the

maximum and minimum values depend on whether or no some rotor slot coincides with some stator slot at positions 1 and 2. In the example taken no slots coincide at position 1, and it is not, therefore, a position of true minimum σ_1, this occurring at the position nearest to position 1 where some slots do coincide. The true maximum does, however, occur at position 2, for no local minimum occurs here, since no slots coincide.

In Fig. 9 is shown the curve for σ_1 for the case of 9 stator slots and 15 rotor slots per pole. In this case, since some slots do coincide at position 1, this is the position of true minimum. The true maximum occurs again at position 2, since there is no slot coincidence in that position.

If we consider, however, the case of 18 and 30 slots per pole in stator and rotor respectively (*see* Fig. 10), we find that some



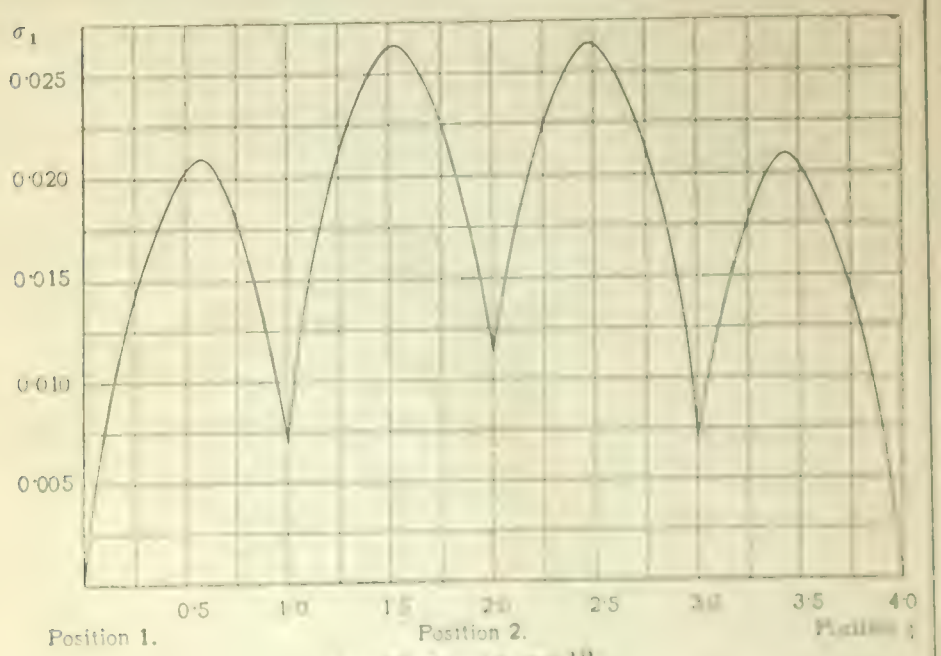
$s_1 = 18$, $s_2 = 30$, $\tau = 90$.

Fig. 10.—Variation of σ_1 with Position of Rotor.

slots coincide in position both at position 1 and position 2. Consequently, while position 1 is the position of true minimum, the true maximum does not occur at position 2. It occurs *approximately* midway between position 2 and the next position at which slot coincidence takes place. Only the part of the curve near position 2 is shown in this case.

Positions of Rotor for Maximum and Minimum σ_1.—The general rules governing the positions of true maximum and minimum may be stated as follows :—

1. The true minimum value of σ_1 occurs at position 1 if some slots coincide at that position. If no slots coincide there, then the position of true minimum is the nearest position at which some slots do coincide.



$s_1 = 12$, $s_2 = 12$, $\tau = 12$.

Fig. 11.—Variation of σ_1 with Position of Rotor.

2. The true maximum value of σ_1 occurs at position 2 if no slots coincide there. If some slots do coincide there, then the position of true maximum is approximately midway between position 2 and the nearest position at which slots again coincide.

Comparison of σ_1 *in Two Particular Cases.*—It is of interest to compare the curve for σ_1 shown in Fig. 9 with the corresponding curve for the case of 12 slots per pole in both stator and rotor, which is shown in Fig. 11. In both these cases the mean number of slots per pole is the same. The maximum values of σ_1 do not differ greatly, though that for 12—12 slots is slightly the larger. But whereas the minimum value for 12—12 slots is zero the minimum value for 9—15 slots is 0·014. The mean value of σ_1 (*i.e.*, the mean of the maximum and minimum values) for 12—12 slots is, therefore, considerably less than for 9—15 slots, but the *variation* in the value of σ_1 is more than double that for 9—15 slots. Not only is the *total* variation so much greater, but the *local* variation is also much greater, due to the fact that coincidences of stator and rotor slots, with the consequent cusps on the curve, do not occur nearly so frequently. There are only four such positions of coincidence, per third of a pole-pitch, in the case of 12 slots per pole in both stator and rotor, while with 9 and 15 stator and rotor slots per pole respectively there are no less than 15 such positions.

This comparison shows clearly how much less the dispersion coefficient varies with the position of the rotor when different numbers of slots in stator and rotor are employed, though the mean value of σ_1 is appreciably increased thereby, assuming the mean number of slots to be the same in both cases.

Table I. *Values of* σ_1.—*Whole Number of Slots per Pole per Phase.*

Stator slots per pole, S_1.	Rotor slots per pole, S_2.	$\sigma_{1\text{min.}}$	$\sigma_{1\text{max.}}$	$\sigma_{1\text{mean.}}$	$\sigma_{1\text{mean}}$ (from formula).
9	9	0	0·0420	0·0210	0·0213
9	12	0·0159	0·0280	0·0220	0·0217
9	15	0·0140	0·0253	0·0197	0·0196
9	18	0·0091	0·0259	0·0175	0·0172
12	12	0	0·0264	0·0132	0·0130
12	15	0·0097	0·0198	0·0148	0·0147
12	18	0·0078	0·0188	0·0133	0·0131
12	21	0·0080	0·0175	0·0128	0·0126
12	24	0·0051	0·0182	0·0117	0·0114
15	15	0	0·0204	0·0102	0·0102
15	18	0·0065	0·0158	0·0112	0·0111
15	21	0·0058	0·0150	0·0104	0·0103
15	24	0·0054	0·0144	0·0099	0·0098
15	27	0·0051	0·0141	0·0096	0·0095
15	30	0·0033	0·0147	0·0090	0·0087
18	18	0	0·0160	0·0080	0·0080
18	21	0·0047	0·0135	0·0091	0·0090
18	24	0·0040	0·0132	0·0086	0·0084
18	27	0·0035	0·0129	0·0082	0·0080
18	30	0·0035	0·0125	0·0080	0·0079
18	33	0·0036	0·0122	0·0079	0·0078
18	36	0·0023	0·0126	0·0075	0·0073
21	21	0	0·0145	0·0073	0·0072
21	24	0·0036	0·0122	0·0079	0·0078
21	27	0·0032	0·0118	0·0075	0·0075
21	30	0·0030	0·0116	0·0073	0·0072
21	33	0·0028	0·0114	0·0071	0·0070
21	36	0·0027	0·0112	0·0070	0·0068
21	39	0·0026	0·0111	0·0069	0·0067
21	42	0·0017	0·0115	0·0066	0·0064
24	24	0	0·0128	0·0064	0·0063
24	27	0·0028	0·0113	0·0071	0·0069
24	30	0·0025	0·0111	0·0068	0·0067
24	33	0·0024	0·0108	0·0066	0·0065
24	36	0·0020	0·0108	0·0064	0·0063
24	39	0·0021	0·0106	0·0064	0·0063
24	42	0·0020	0·0105	0·0063	0·0062
27	27	0	0·0120	0·0060	0·0059
27	30	0·0022	0·0106	0·0064	0·0063
27	33	0·0020	0·0104	0·0063	0·0062
27	36	0·0018	0·0104	0·0061	0·0060
27	39	0·0018	0·0102	0·0060	0·0059
27	42	0·0017	0·0101	0·0059	0·0058
30	30	0	0·0111	0·0056	0·0054
30	33	0·0018	0·0102	0·0060	0·0059
30	36	0·0016	0·0101	0·0059	0·0058
30	39	0·0016	0·0099	0·0058	0·0057
30	42	0·0014	0·0098	0·0056	0·0056

Values of σ_1.—In Table I. are given the minimum, maximum and mean values of σ_1 for various numbers of stator and rotor slots per pole, the numbers being all multiples of 3, so that there is in every case a whole number of slots per pole per phase.

(To be continued.)

BRADFORD ELECTRICITY SUPPLY.

The report of the Electricity Committee upon the work of the department during the year ended October, 1915, was approved at a meeting of the Committee last week, and is of more than usual interest.

The report states that, considering the abnormal conditions arising out of the war, the results of the year's working of the electricity undertaking cannot be regarded as other than satisfactory. In regard to the statement of accounts for the financial year ended March 31st last, although the output has not grown to anything like the same extent as in a number of previous years, an increase of nearly three-quarters of a million units was recorded, towards which all branches of the supply contributed, with the exception of the tramways section, the output for which showed a slight decrease on the previous year's figure. It is interesting to note that up to the end of November, 1914, the number of units sold for all purposes was lower than in the corresponding period of 1913. In view of the fact that at the end of the financial year the supply to the tramways department still showed a decrease, it will be gathered that the net increase recorded was solely due to the increased output to general supply consumers during the last four months of the year. The success attending the supply to domestic consumers who have adopted the rateable value system of charging is again an outstanding feature of the results, the units taken by such consumers representing an increase of practically 30 per cent. on the figure for 1913-14. The following statistics relating to this class of supply give some indication as to its popularity: At the end of March, 1915, the total number of domestic consumers was 1,333 (against 1,120 in 1914), the number charged on ordinary lighting rates was 526 (487), the number charged on special domestic rate 807, or 60·5 per cent. (633, or 56·52 per cent.), the units charged on special domestic rate was 797,303 (613,807), and the average units used per consumer were 988 (970). The income for the year from all sources was £147,584, an increase of £3,672 over 1914, and the net profit (£18,955) is the highest recorded in the history of the department. The adoption by the Finance and General Purposes Committee of the principle of accumulating sinking funds in connection with various Corporation undertakings reduced the percentage which the sinking fund contribution for he year bears to the capital to a figure more comparable with those obtaining in connection with the majority of the municipal electricity undertakings in the country. Out of the year's profits a sum of £5,000 has been appropriated in relief of rates, £6,910 expended on capital works and £115 applied to the depreciation of meters purchased for stock, the balance (£9,437) having been transferred to depreciation and renewals account.

Extension Schemes.—During the early months of the war municipalities were urged to put in hand at once various improvement and extension schemes, the object being to find employment for as large a number of workpeople as possible, as the general feeling then prevailing was that much distress would be caused by the dislocation of trade which the war would entail. The L.G. Board offered every facility for raising loans for such purposes and no difficulty whatever was experienced in obtaining sanction for borrowing money to defray the cost of all necessary extensions to the plant, &c., of electricity undertakings. Early this year, however, the Treasury having pointed out the necessity of severely curtailing all expenditure, both national and municipal, except that required for war purposes, and events having proved that the war had resulted in no serious lack of employment, but, on the contrary, had created a distinct shortage in the labour market, the policy of the L.G. Board was completely reversed, and in March last Mr. H. R. Hooper, one of the Board's inspectors, visited Bradford, and intimated that until after the war sanction for the raising of further loans would not be granted, except in respect of work rendered necessary for the production of goods and materials for war service. For this reason the provisional sanction which had been granted early in 1914 for raising £91,250 for carrying out extensions at the Valley-road electricity works buildings and plant was reduced to £79,683. Of the difference between these amounts the greater portion represented the estimated cost of certain works included in the scheme which up to the date of the inspector's visit had not been put in hand. The projected works comprised the installation of suction ash plant, a rotary feed pump, oil storage and filtration plant and switchgear for e.h.t. feeders, which items of plant, while being very desirable to conduce to the efficient and economical generation of electricity, could hardly at the time be regarded as absolutely necessary. The inspector's suggestion that these works should be deferred was, therefore, acceded to. An application made by the Council in October, 1914, for permission to borrow £52,000 for electricity mains, transformer chambers, &c., was also dealt with and the amount actually sanctioned was only £14,000, practically the whole of which had either been expended on work completed or [illegible] the cost of extensions then in hand. In July last the Board were requested to authorise the raising of a loan of £20,000, a portion of which was required to cover the cost of [illegible], for which the Council were already committed for the purpose of furnishing supplies of electricity to firms engaged on war work. It was the committee's intention that the balance applied for should be expended as and when required for the carrying out of urgent work of a similar character. The Board, however, intimated that they were not prepared to sanction a sum equivalent to the cost of the [illegible] tensions, transformer chambers, &c., regarding which definite information had been given them, and that in respect of future work application for sanction should be made as occasion arose, a course which has since been pursued.

Dealing with the question of the actual progress made with the extensions at the Valley-road works, it is stated considerable delay has been experienced in the delivery and erection of most of the plant on order, owing to the fact that practically all the firms capable of manufacturing such plant are engaged on war work. It is extremely fortunate that the contracts were placed and many well in hand before the Government found it necessary to exercise such complete control over the outputs of engineering establishments, otherwise it is doubtful whether much of the plant—practically the whole of which was expected to be in commission before the end of 1914—would have been ready in time to assist in coping with this winter's loads. The present state of affairs is that a number of firms will only accept orders for plant and materials required either directly or indirectly for war purposes, while firms which are prepared to execute general orders have week after week to postpone work on same so as to permit of the carrying out of urgent orders for the Admiralty and War Office. Of the Valley-road extensions, the induced draught plant was completed and put into operation on April 19th, since which date the installation has operated satisfactorily, and has, in addition to tending to the more economical operation of the steam raising plant, contributed to ease in the boiler house control and enabled the load to be carried on fewer boilers. The second cooling tower provided under the extension scheme now nearing completion was put into commission on May 20th, the use of the first tower having been commenced on October 17th last year. The storage battery, with its regulating boosters and switchgear, was placed in regular service on July 5th, and the results of its use have fully justified expectations. The boilers and generating sets can now be operated more economically by being kept loaded up to much nearer their full rated capacities for longer periods during the day than formerly, a much more uniform steam pressure can be maintained, and sudden demands caused by darkness or fog can be met with safety and certainty. The work in connection with the installation of the 5,000 kw. turbo-generator is so far completed that preliminary trials of the same have been made. A similar state of affairs exists as regards the two 1,500 kw. rotary converters. Unless the unexpected happens, practically the whole of the work in connection with the scheme will be completed before Christmas.

The whole of the plant and switchgear in the Valley-road works has been maintained in a high state of efficiency, and has given every satisfaction in operation.

As a result of experiments made during the year it has been found possible to run the sub-stations in parallel with the Valley-road works on the direct current, as well as on the alternating current, side, and the plant is now regularly operated in this manner. The consequence is that greater economy in running is obtained due to improvement in the load factors of the generating sets; immediate additions to the converting plant in the sub-stations have been rendered unnecessary; and the supply to the various tramway routes obtaining energy from these sub-stations has been considerably improved, a better pressure being maintained and the number and duration of the temporary interruptions of the supply by reason of the operation of circuit breakers under overload conditions being greatly reduced.

During the past 12 months great difficulty has been experienced in obtaining regular and full deliveries of coal, but the stocks are at present at a high level. The favourable contracts entered into prior to the outbreak of war expired in June and for the coal which is now being obtained under the new contracts (most of which are for 12 months) considerably enhanced prices are being paid.

There are 35 transformer chambers in commission, eight having been equipped during the past year. Work has also been commenced on two additional chambers, one of which is nearing completion, while in the other no gear has yet been installed. Fifty-two three-phase static transformers for effecting the reduction in pressure from 6,000 volts to 400 volts are now in commission in the various chambers. The total length of e.h.t. feeders now laid in the city is about 56½ miles. 133 extensions were made to the direct current and alter-

nating current general supply networks during the year ended March last, and 358 serivces laid into consumers' premises.

Publicity Department.—During the first few months of the year the staff of the publicity department was exceptionally busy on the work of stimulating the demand for electricity for various purposes, especially in view of the falling off in the output due to the slump in trade consequent upon the war. The efforts made were attended with considerable success, especially in the direction of increasing the use of electricity for motive power purposes on a small scale and for heating. On the trade of the city improving, due principally to the placing of large Government contracts in the vicinity, many firms found it necessary to obtain additional supplies of power, and as a result of negotiations entered into with a number of such firms, the department was successful in inducing them to take considerable supplies of electricity for power from the Corporation mains. Several of the concerns in question are included in the undermentioned list of consumers with whom bulk supply agreements have been entered into during the past year, the kilowatts demanded being as follows: Messrs. John Best & Sons, 800 kw.; Bradford Wool Extracting Co., 100 kw.; Mitchell Bros. (renewal), 350 kw.; Street Improvement Committee for Dumb Mills, 1,000 kw.; Shipley Tank Co., 200 kw.; Valley Combing Co., 100 kw.; H. Longbottom & Co., 150 kw.; and Hindle & Firth, 200 kw.; a total of 2,900 kw. The action taken by the L.G. Board in refusing sanction to loans for other than for war work, has resulted in the activities of the department being considerably curtailed and the staff has accordingly had to be reduced. As far as is permissible, however, publicity work is being proceeded with, and information with regard to the latest patterns and designs of various electrical consuming devices which are being placed on the market collected and distributed. The sales from the showroom have fallen off somewhat during the year, but the showroom continues to fulfil its primary object, namely, that of bringing the latest types of electrical apparatus to the notice of the general public.

H.M. Forces.—Of the employees of the department 58 are at present serving in H.M. Forces and no doubt many others would be willing to enlist but for the fact that it has been pointed out to them that the majority of the department's employees are serving their country in a more efficient manner by remaining at their present work, as it is absolutely necessary that the continuity of the electricity supply in Bradford should be maintained, in view of the fact that electrical energy is being taken from the department in large quantities by firms engaged on the manufacture of munitions of war. The Ministry of Munitions have given official recognition to the fact that the works are engaged on war service, by having supplied, for issue to the employees of the department whose services are regarded as being indispensable to the carrying on of the undertaking, badges exactly similar to those granted to munition workers. Increases have been made in the wages paid to nearly all grades of workmen employed in the department, either by the operation of the scheme of war bonuses adopted by the Council or by direct advances in their rates of pay.

Miscellaneous.—Additional consumers to the number of 421 have been connected during the year, bringing the total number of consumers on the supply at March 31st last to 4,510. In spite of the abnormal times through which the country is passing, the Committee are able to look forward with confidence to the future prospects of the department. The popularity of the use of electricity for power, lighting and domestic purposes continues to increase, and the new connections obtained during the past 12 months will undoubtedly lead to the output for the present financial year being considerably in excess of the figure recorded in any previous year. It is hardly to be expected, however, that the financial result will appear so favourable as that announced for the year ended March last, as the works costs will be inflated owing to the serious advances in the prices of coal and materials. Increases in wages and the allowances to dependents of employees serving with H.M. Forces will also add to the costs and the revenue will also be adversely affected by the lighting restrictions. Heavier capital charges will have to be borne, chiefly on account of the new plant and mains put down during the past year, and to some extent owing to the higher rate of interest which now has to be paid on loans. The item for rates will be greater, not only as a result of the increased rate levied but also by reason of the assessment having been advanced. On the other hand, it is hoped that considerable economies will be effected on the new works plant being put into regular service.

We give a Table showing the nature and extent of the load for the last three years.

The maximum recorded load occurred on Dec. 17, 1914, and was 11,745 kw. The capacity of the plant is 15,890 kw.

The following is an analysis of the accounts for the year ending March 31, 1915, together with the amount per unit sold for each item for the last two years:—

		Cost per unit sold.	
Generating Costs.	1914-15.	1914-15.	1913-14.
Fuel	£21,217	0·18d.	0·19d.
Oil, waste, water, &c.	2,319	0·02d.	0·02d.
Salaries and wages	6,312	0·05d.	0·05d.
Repairs and maintenance	9,874	0·08d.	0·07d.
Total Generating Costs	£39,722	0·33d.	0·33d.
Distribution Costs.			
Wages	£571	0·01d.	0·01d.
Repairs of general supply mains	3,011	0·02d.	0·04d.
Repairs to traction mains	1,049	0·01d.	0·00d.
Repairs to meters, fuses, &c.	1,711	0·01d.	0·00d.
Incandescent lamps	657	0·01d.	0·00d.
Total Distribution Costs	£6,999	0·06d.	0·05d.
Management Costs.			
Salaries and wages	£6,335	0·05d.	0·05d.
Proportion of administration, &c.	850	0·01d.	0·01d.
Insurance	337	0·00d.	0·00d.
Printing, stationery, &c.	590	0·00d.	0·00d.
Establishment charges	668	0·01d.	0·01d.
Bad debts	175	0·00d.	0·00d.
Total Management Costs	£8,955	0·07d.	0·07d.
Allowances to soldiers' dependents	£593	0·01d.	0·00d.
Public lamps	943	0·01d.	0·00d.
Rents and rates	8,010	0·07d.	0·07d.
Cost of hiring department	6,366	0·05d.	0·06d.
TOTAL COSTS (*ex.* Capital Charges)	**£71,588**	**0·60d.**	**0·58d**
Capital Charges.			
Interest	£24,182	0·20d.	0·19d.
Sinking fund	32,395	0·27d.	0·33d.
Miscellaneous	464	0·00d.	0·00d.
Total Capital Charges	£57,041	0·47d.	0·52d.
TOTAL COSTS (*inc.* Capital Charges)	**£128,629**	**1·07d.**	**1·10d.**
Revenue.			
Private and bulk supply	£88,833		
Tramway supply	48,215	1·45d.	1·45d.
Public lighting	1,132		
Rental of meters, &c.	3,441		
Rental of cables, &c.	522	0·03d.	0·03d.
Hiring department	5,435	0·05d.	0·05d.
Rents, &c.	6	0·00d.	0·00d.
TOTAL REVENUE	£147,584	1·23d.	1·23d.
Balance (surplus)	£18,955	0·16d.	0·13d.

To this surplus is added £1,146 from the stores account and £1,361 from the sinking fund account, this being the adjustment of contributions for the previous year. The total £21,462 is apportioned as mentioned above.

The total capital expenditure at March 31 last was £958,955 made up as follows:—

Land and buildings	£137,250
Machinery	279,469
Accumulators	16,917
Switchboards, &c.	18,837
Mains and services	158,825
Meters	32,922
Public lamps	3,926
Miscellaneous	10,819
	£958,955

£934,284 of this was obtained from loans and £24,671 contributed out of revenue.

	Year ended March 31		
	1915	1914	1913
Number of units sold for—			
Bulk supply	1,500,225	1,107,340	1,001,720
Private lighting	3,260,727	3,144,660	3,250,012
Domestic supply	797,203	811,815	464,767
Power and heating	4,012,148	4,181,303	4,000,341
Public lighting	171,138	124,413	127,344
Traction	11,044,076	11,471,091	10,013,207
TOTAL OUTPUT	20,785,517	20,904,622	19,118,391
Total units generated	24,844,021	24,795,000	22,987,341
Units lost in distribution, &c.	4,058,504	3,890,378	3,868,950
Percentage to total units generated	16·34	15·6	17·0
Load factor, per cent.	27·0	25·7	25·1
TOTAL NUMBER OF CONSUMERS	4,510	4,089	3,945
Total number of motors connected	2,915	2,658	2,478
Total horse-power of motors connected	18,160	16,441	14,845
TOTAL CONNECTIONS IN KW	25,151	23,251	21,062
Lamps			

METHOD OF CONSTRUCTING ALTERNATORS TO OBTAIN A PURE SINE WAVE E.M.F.*

BY W. SEEMANN.

This method permits a pure sine wave E.M.F. curve to be obtained for a definite load and phase displacement. A machine is preferably used the magnet of which consists of a drum-shaped rotor with the windings in radial slots of equal size uniformly spaced around its periphery, the slotting being omitted at the poles. The sine wave is obtained by altering the magnetic reluctance around the rotor, this

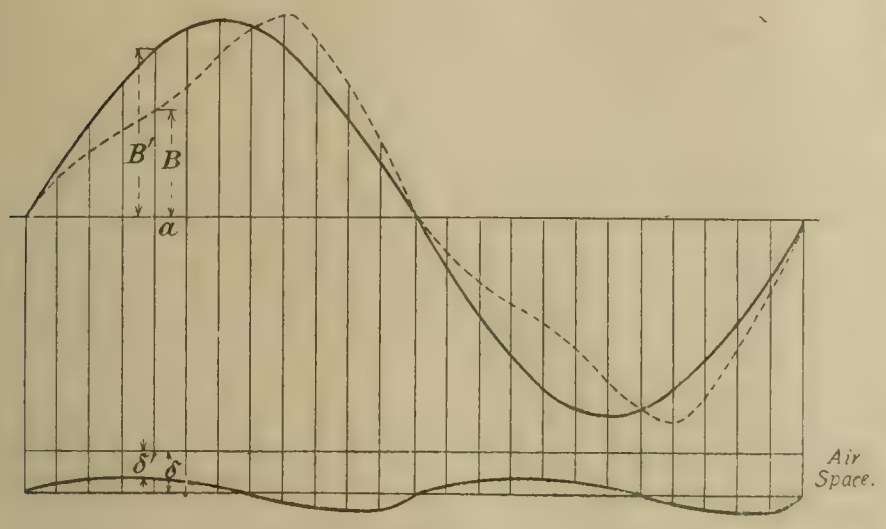


FIG. 1.

being effected by cutting away the periphery of the rotor at the required places. The dotted curve in Fig. 1 is the field or E.M.F. curve of an alternating-current dynamo obtained with a definite armature reaction. This curve is converted into an equivalent sine curve, *e.g.*, by the Fleming graphical method. There is thus obtained the field which is required to give a pure sine wave E.M.F. curve of equal effective value. At a definite point *a*, instead of the induction B, an induction B′ is required. This is obtained by reducing the magnetic reluctance at *a* in the proportion B/B′. If in

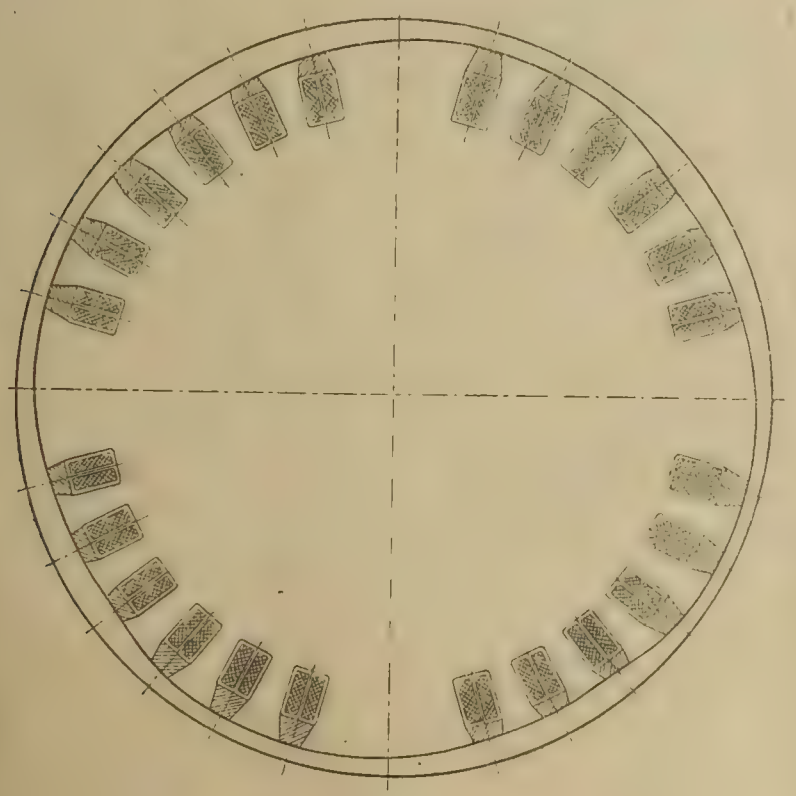


FIG. 2.

the first place the magnetic conductivity or permeance of the iron be taken at ∞, the above condition is fulfilled by altering the air gap from δ to $\delta' = \delta \frac{B}{B'}$. Taking into consideration the magnetic reluctance of the iron, the air gap is given more exactly as: $\delta' = (\delta + \chi)\delta \frac{B}{B'} - \chi$, where χ is an imaginary additional air gap which has the same permeance as the iron at the point *a* along the whole magnetic circuit. If this process be carried out all the way round the rotor the air gap of a constant value δ is converted into one δ' of a variable value (see the lower curve the diagram). The magnetic reluctance of the iron, from which χ is obtained, can be easily determined for the particular machine used. The cutting away of the periphery can be effected on a profiling machine, *e.g.*, a Pasig lathe, a one-pole template being first prepared. A section of a rotor having its periphery cut away in accordance with the above mentioned air-gap curve is given in Fig. 2.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., pp. 97-99.

HYDRO-ELECTRIC DEVELOPMENTS IN NORWAY.

The Royal Commission appointed in December, 1911, to report on the hydro-electric schemes in Norway, has now completed its investigations, an abstract of which has recently appeared in "Engineering." A list of the waterfalls owned by the State presented to the Storthing last year showed that the capacity of these amounted to 148,950 effective horse-power without regulation, or 743,480 H.P. after regulation. Since that time, however, more falls giving from 27,000 H.P. to 29,000 H.P. after regulation have been acquired by the State. The following are some of the largest State-owned falls:—

	Capacity.		
	Before regulation. H.P.		After regulation. H.P.
Nore Falls	24,240	...	164,000
Selfoss, Faldfoss, Stabfoss and Rundselvfoss	16,700	...	97,000
Ulla and Sandset	6,000	...	57,000
Bardu Falls	8,000	...	56,000
Indremofoss and Tusten Falls	7,700	...	46,000
Store Maalvand	7,100	...	44,000
Storfoss and Klöftemyrfoss	5,000	...	30,000
Vöringfoss	8,400	...	28,000
Falls in the Kvina River	—	...	27,000 29,000
Onilsavand	3,200	...	22,300
Mörkfoss	20,000	...	20,000

There are now 11 State plants, the largest of which is of 106,000 H.P. The chief purpose of the Commission was, however, to ascertain the demand for electrical energy with a view to its adequate supply. This demand has been growing rapidly in the towns for the various chemical industries and for ordinary purposes, and in the rural districts for lighting and for agricultural purposes. The probable requirements of the country for electrical energy are estimated at 0·2 H.P. per inhabitant, excluding that required for chemical works, this giving a total demand for 480,000 H.P., allowing for the estimated growth of population. This has been converted into kilowatts to be on the safe side. There are altogether 306 power stations in the country, the 20 largest being the following:—

	Kw.
Rjukan	105,000
Svälgfos	28,000
Glommen Wood Pulp Company	27,500
Tysse Falls Company	24,924
The Kellner-Partington Company	22,400
Gravfos Station	17,480
Lienfos, Notodden	15,840
Arendal Waterfall Company	14,750
Bergen Electricity Station	11,067
South Varanger Company	10,500
Drontheim town electric supply	
Upper Lerfos	4,650
Nether Lerfos	5,200
Christiania town electric station	2,047 and 4,400
Kykkelsrud power station	5,500
Tinfos	6,300
Drammen	5,500
Kragerö	5,250
Frederikshaold Saw Mills Union	4,894
Stavanger	4,410
Labro	4,240

The total capacity of all the stations is put down as about 396,000 kw. Deducting the power for chemical industries this only leaves 160,000 kw. to meet the above requirements of 480,000. The Commission, therefore, is of opinion that the State should, in order to meet this deficit, set about the exploitation of the waterfalls of the country which should, if properly developed, give the necessary power.

ON THE DISTRIBUTED CAPACITY OF SINGLE-LAYER SOLENOIDS.*

BY J. C. HUBBARD.

The periods of oscillation of circuits consisting of a single layer solenoid and an air condenser have been precisely measured by a method devised for the purpose by the author.† One of the objects of the measurements has been to determine the effective, or so-called distributed, capacity of solenoids, special attention being paid to the independent variation of all the factors upon which that quantity might depend. These are the diameter and axial length of the solenoid, the number of turns, the diameter of wire, and the dielectric effect of the insulation and of the core. The period of oscillation is given by

$$T=2\pi\sqrt{L(K+K_0)},$$

where K is the capacity of the air condenser and K_0 is the remaining capacity of the system, *i.e.*, the capacity of leads and connections and the distributed capacity of the coil. Six values of K, ranging from 200 cm. to 1,500 cm. were used with each solenoid. The periods were measured to one part in two thousand and were of the order of 10^{-5} sec. With all the solenoids used the relation between T^2 and K is found to be linear within the errors of measurement, and accordingly the variation of L with the period is negligible. Hence, for a given solenoid, we may write $T^2=Ka+b$,

where $a=4\pi^2L$, and $b=4\pi^2LK_0$, from which, $K_0=b/a$.

Since $K_0=K_1+K_2$, where K_1 is the capacity of the leads and K_2 is the distributed capacity of the coil, we have two independent means of finding K_2, once K_0 is determined for each solenoid. The first is by measuring the capacity of leads and connections, K_1, directly.‡ Whence $K_2=K_0-K_1$. The second is to make use of the fact that for geometrically similar electrical system, the electrical constants are in the ratio of the linear dimensions. Thus, if we take two coils, all the dimensions of one being n-fold greater than those of the other, we have, for one $K_0=K_1+K_2$,
and for the other, $K_0'=K_1+nK_2$.
Whence, $K_0'-K_0=(n-1)K_2$,
from which K_2 may be found. The results of the two methods are in close agreement. The values of K_2 for the coils used range from 5 cm. to 30 cm. of capacity. The distributed capacity of a single layer solenoid measured in electrostatic units is found to be a number of the same order of magnitude as the radius of the coil, measured in centimetres, but shows relatively very slight variation with the axial length, number of turns, and diameter of wire.

* Abstract of a Paper read before the American Physical Society.
† "Phys. Rev.," N. S., I., p. 247, March, 1913.
‡ *Loc. cit.*, p. 245.

ENGINEERING STUDENTS AND THE WAR.

The war appears to have had a very serious effect upon the engineering and science departments of the University Colleges and the leading technical schools of the country. Not only has there been a great drop in the number of third and fourth year students, who have nearly all joined H.M. Forces, but there has also been a considerable falling off in new enrolments, and the average age of first year students is lower than usual, while in not a few cases some of the advanced courses have had to be abandoned.

University College (University of London).—The faculty of engineering has no special features affecting electrical engineering this year. The two most important developments in connection with the scientific teaching at the college are the appointment of Prof. W. H. Bragg, M.A., D.Sc., F.R.S., as Quain professor of physics, in place of Prof. Frederick T. Trouton, resigned, and the opening of the new chemical laboratories which have been erected in Gower place. These laboratories, which have been erected at a total cost (including the purchase of the site) of over £100,000, are now probably the largest chemical laboratories in this country. They are fully equipped for undergraduate teaching and for post graduate work in chemical science. The entries in engineering have been very largely affected, and the entry for first year students is about 21, whereas the usual entry is about 70.

King's College (University of London).—There are no new features in the courses in engineering or physical science for 1915-16, but it has been found necessary to postpone the usual lectures in engineering usually given in the winter session owing to the war. The engineering department, under the direction of Prof. Jamieson, M.Inst.C.E., has been and is doing very useful work in connection with the war. Classes have been arranged for cadets who wish to have some preliminary training to enable them to enter munition works. The war has had a disastrous effect on the number of students, as more than a half have been absent. There is a falling off in the engineering classes of 48 since 1913, and in science of 51. Very valuable work has been done in the chemical laboratory in the re-discovery of formulæ for gun cotton, made in Germany and Austria by Prof. Jackson and Mr. Mestrey. The engineering department is also testing tar for toluene required for high explosives. The latter work is directly done for the War Office.

University of Bristol.—The faculty of engineering is provided and maintained in the Merchant Venturers' Technical College. There are no new developments in the electrical engineering department in the present session, for it has been seriously affected by the war. The reduction in the number of students in attendance has been considerable and some of the recognised teachers hold commissions in the Army. Research work is also making very slow progress as the members of the staff are busily occupied in teaching the classes which have been established to train unskilled men and women to help in munitions factories.

Armstrong College (Newcastle-on-Tyne).—There are no new features to report in the engineering, physics or electro-chemical departments. Since the beginning all the buildings of the college have been in use as a Military Hospital, and the college work, which is being carried on in different Institutions in the town, is necessarily handicapped for the time being. To show how the war has effected the college it may be stated that the number of students in all branches of engineering during the session before the war was 112, and the number now is 39.

Heriot-Watt College (Edinburgh).—The Board of Management of the South-East of Scotland area under the Ministry of Munitions have made the Heriot-Watt College the centre of their work, having taken over certain parts of the college, and have appointed Prof. Stanfield as their organising secretary and engineer, and Mr. J. M. Mackintosh, B.Sc., as their assistant secretary. They have also engaged the services of the whole of the engineering and part of the electrical engineering staff. The engineering staff is employed in training (free of charge) students for munitions work. The workshops of the college are being used for this purpose, and in addition a new workshop has been fitted up in the engineering department. Both day and evening classes for the training of munition workers are being carried on, and about 250 workers have already been trained who have obtained employment in Edinburgh, Glasgow and other munition centres. The engineering staff are also assisting in organising the development of the making of munitions in the south-east of Scotland, and some of the finer instruments wanted at the front are being made partly in the college, and partly in the workshops belonging to the Royal Scottish Museum, under the direction of the college. In order to facilitate this work, the governors have decided to close the second and third year day courses in engineering, the first year being carried on as usual. In addition, experimental work is being carried on in the electrical engineering, mining and mycology departments for some of the Scientific Committees employed by the Government. The chemistry department have just completed some experiments they were asked to undertake, and are shortly going to take up some new scientific work for the Government. Besides the first year engineering course, the day courses in the chemistry department are being carried on as usual, as also the whole of the evening classes in scientific, technical, trade, commercial and literary subjects. The total number of students is much less than in former years, a very large number both of day and evening students having enlisted in H.M. Forces.

Northampton Polytechnic Institute.—For the current session the courses of lectures by specialists which have been given in recent years in the electrical and mechanical engineering departments could not be continued because all the specialists qualified to give those courses were found to be too absorbed in war service work of one nature or another to devote the necessary time to such lectures. The only new feature is a glass-workers' course, for which it was anticipated that a demand would exist owing to the disturbance in the fine glass trade for chemical and other purposes which has been caused by the withdrawal of the German supplies. The effect of the war on enrolments has been more serious than in the preceding session, and both in the day and the evening courses it practically amounts to the withdrawal from the courses of students of 18 years of age and upwards, although the limit of age for enlistment is 19. The majority of the senior students of the engineering day courses have received commissions or have otherwise enrolled for some form of national service in connection with the war. The new enrolments of first year students have been seriously affected, as the applicants for admission were nearly all of 16 or 17 years of age, instead of having among their number, as in ordinary times, a large sprinkling of older men. In the evening courses, students of 18 and upwards who have not enlisted in the new armies or received commissions in them are working overtime in munition factories, and are quite unable to attend the evening classes. The consequence is that the senior classes are depleted, although the fall in the number of individuals enrolled as compared with the corresponding date of last year is only some 13 or 14 per cent. It is, however, anticipated that this percentage will increase as the session progresses. The engineering workshops are engaged in the manufacture of munitions, at which both the day and the evening students assist, and special war service work is also being done by the skilled staff of the Institute for more than one Government department. In fact, the whole resources of the Institute (in equipment and personnel) are practically at the service of the Government for any work which it is possible to undertake. Several hundreds of the public utility firms in the new armies have attended the special technical classes during the vacation months and new drafts are still being handled.

The Royal Technical College (Glasgow) reports that there are no new features to record this year so far as the courses in engineering and physical science are concerned. Over 1,700 students have joined the Army, and in addition, a large number are engaged on munitions work. From published lists it would appear that the number of members of the college on active service is exceeded only by the number from Cambridge and equalled only by the number from Oxford.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	139	"Belling" New Season Fires. Illustrated	25
Imports and Exports of Electrical Manufactures	140	Electric Light Fittings Accessories. Illustrated	28
LEGAL INTELLIGENCE	140	Ediswan Radiator Lamps. Illustrated	30
Business Notices	141	Osram Painting Books	30
Bankruptcies, &c.	141	Washing Paper Money	30
Electricity Supply	141		
Lighting and Power Notes	142	Miscellaneous Notes	145
Traction Notes	143	Tenders Invited	146
Telegraph & Telephone Notes	143	Tenders Received & Accepted	146
Empire Notes	143	Municipal Accounts	147
Foreign Notes	144	Companies' Meetings and Reports	148
The Round Table	23	New Companies, &c.	149
The "Point Fives"	23	City Notes	149
Electric Laboratory Furnaces. Illustrated	24	Electrical Companies' Share List	149

COMMERCIAL TOPICS.

Women Tram Conductors. The decision of the London Commissioner of Police to issue licences to women as conductors of stage carriages will be regarded by the Municipal Tramways Association as the direct result of its recommendations at the annual conference recently held in London. The fact that women have been for many months past acting as tram conductors upon the chief provincial tramway undertakings, and that they have given complete satisfaction in this capacity practically placed the London County Council in an anomalous position in the passive attitude which it had taken up with regard to female labour on its cars. We think we are right in stating that the majority of the provincial concerns are conducted upon more business lines than is the case in the Metropolitan area. Whether it is that the municipalities take a keener interest in the conduct of this particular branch of business we do not know, but they have since the outbreak of war taken steps to release men of military age by giving women opportunities of taking their places, at any rate as conductors. It seems to be argued that the conditions prevailing on the London cars at the present time, particularly as a restricted service is given and overcrowding is a daily occurrence, are totally unsuited to the employment of female labour in the capacity of conductors. In the initial stages it is proposed by the London County Council to engage women only for the trailer and single-deck cars. It will be interesting to note the results of this experiment. In any event, we imagine that in the present recruiting mood in which the public finds itself the men will get little or no sympathy if they make representations generally to oppose the employment of women as conductors throughout the service.

* * * *

China and Japan. More than ever our future trade with China has to be considered from the point of view of Japan's nearness to that country, and to the possibilities of Japan being in the position to enter the field for the supply of China's requirements on a sufficiently large scale to become a real competitor with Britain and the British Empire in filling China's orders on China's terms. Japan is in unquestionably a favoured position in regard to this trading, for besides the great value of proximity there is also the comparative similarity of race, religion and language which must have a favourable influence on the position. In this connection the remarks of Mr. W. G. L. Riddle, the new President of the Birmingham District Electric Club (given on another page) are of considerable interest, and the report of Mr. E. F. Crowe, H.M. commercial attaché at Tokyo, will be perused with interest, as will also the report from Mr. V. L. Savage, the British Consul at Changska, who deals with the development of the trade of Hunan, hitherto almost entirely in the hands of the Germans. The future importance of the China market gives increased interest to any statement from persons in the position of Mr. Riddle, who have gone over the ground and have made their deductions from the situation which existing conditions has created or intensified.

* * * *

Municipal War Allowances. A large number of the employees of Local Authorities serving with the Colours are recipients of allowances, and it is instructive to learn that certain L.G. Board auditors have challenged the validity of these allowances. On the outbreak of war many authorities decided to make liberal provision for those servants who patriotically responded to their country's call. As time progressed, more and more men joined H.M. Forces and increasingly large sums are being paid as war allowances by the Councils. Auditors who have been told off to investigate the matter seem to consider these heavier payments illegal. Acting upon the auditor's report, Shoreditch (London) Borough Council has adopted a revised scale and in future will pay combatants such an amount as will, together with the sum of 7s. and the wife's net separation allowance, make up the amount of the ordinary weekly wages paid to the combatant by the Council when he was in their employ. Other authorities have revised their scale of allowances, and Shoreditch may be taken as a typical example of what is regarded as correct practice in this important matter.

* * * *

Halfpenny Postage. It is with every satisfaction we are able to record that in the House of Commons on Thursday, almost before the ink was dry on our issue of the 22nd, the Postmaster-General accepted an amendment, proposed by Sir W. Byles, to the Postal and Telegraph Rates (Statutory Increase) Bill (set out in our last issue p. 106), that the rate of postage for packets of printed matter should remain as now, namely, 2 ozs. for ½d., with an additional ½d. for every 2 ozs. or fraction of 2 ozs. By securing the consent of the Chancellor of the Exchequer to this amendment the Postmaster-General has saved his Department from extreme ridicule. The anomalies set up by sec. 1 sub-sec. (*a*) of the original bill were of the most extraordinary kind, and it is almost inconceivable that a practical man, acquainted with the postal business, should have assumed for an instant that the State revenue would benefit by the proposal as originally set out. At very little trouble the exactions of this sub-section could have been avoided, itself a strong condemnation of the proposal, but the fact that the easiest way to overcome the principal anomaly would be to send the work to be printed and posted abroad shows how very little business acumen is brought by a British Minister of State to bear upon the consideration of such important questions. The Chancellor of the Exchequer assumed, we understand, that he would obtain a revenue of £400,000 as the result of his proposal. It must be obvious to the merest tyro in such matters that this is an entirely illusory figure, for which no legitimate justification exists, and this being so the Postmaster-General (with him the Chancellor of the Exchequer) has been well advised to accept the amendment of Sir W. Byles. It is to be regretted that another amendment from the same source could not be accepted, but this particular point we do not feel disposed to labour. It is sufficient to say that a larger number of trade and other journals will be seriously affected and handicapped by the new rate. This, however, will be avoided, it is to be feared, in many cases by curtailing the amount of expensive matter and illustrations which now go to make up many high-class educative trade publications. In this way the hands of the technical education clock are set back; but possibly the exigencies of the financial situation will be the Postmaster-General's justification in this particular instance. It is well at this stage to point out that as soon as the new Postal and Telegraph Rates Act comes into force the cost of letter postage must be carefully considered by traders. What can now be sent for 1d. may cost 4d., or 3d., or 2d., as the case may be, and it is essential that those who handle large quantities of correspondence should be drilled early into a knowledge of this change. We have come to regard the Post Office as the hand-maiden of enterprise, and we must, therefore, see that an eye is kept on the question of postage in its relation to trade

when the war ends and the Central Powers are once more free to engage in competitive trade with and against the British. As matters will stand when the new Act comes into force, a letter from Cornwall to Los Angeles will cost no more than a letter from Charing Cross to Westminster, or from one street to another in any town or village of the United Kingdom. Even places in Morocco where there are British Post Office agencies will be as well off, so far as the rates of postage are concerned, as the traders of London, Glasgow, Liverpool, Manchester, &c. We would ask whether it is not highly probable that some less pitiable and more statesmenlike method of obtaining revenue would not have been more to the nation's liking? No modification of the inland telegraph rate for messages has been made, and the 6d. telegram will, in due course, become the 9d. telegram without any regard to whether the use of the telegraph is imperative in some branches of trade where highly perishable produce is concerned or to the extent of the injury which this new impost will inflict upon certain sections of trade that are, without this staggering blow, in a parlous condition. Certainly trade and the trader have little for which to thank the Post Office Department, as at present constituted. The necessities of the case do not seem to us particularly to affect the matter. It is the duty of the statesman, worthy of the name, to encourage and not to impede the development of national industry. There was never a time in the history of the British nation when this encouragement was more needed than at present.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Oct. 18, 1915, *to* Oct. 23, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE. *France:* Unenumerated, 40 pkgs.
GRIMSBY. *France:* Carbon electrodes, 36 pkgs.; unenumerated, 7 pkgs.
LIVERPOOL.—*U.S.A.:* Unenumerated, 72 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £3,498; carbon candles, £70; elec. lamps, £1,925; telephone materials, £398; wire and cable, £258; unenumerated, £3,160—54 pkgs. *Holland:* Elec. lamps, £2,862—77 pkgs.; lamps parts, £75; elec. machinery, £54; unenumerated, £181. *France:* Elec. lamps, £696; carbon candles, £415; unenumerated, £74—6 pkgs. *Denmark:* Unenumerated, £493. *Italy:* Elec. machinery, £650; wire and cable, £880; elec. cables, 12 pkgs.; unenumerated, £219. *Sweden:* Elec. machinery, £36. *Spain:* Telephone materials, £10.
CANADA.—Wire and cable, £189.
SOUTHAMPTON.—*France:* Elec. lamps, 8 pkgs.; unenumerated, 38 pkgs.

EXPORTS.

[illegible] unenumerated, £27. [illegible] machinery, £28; unenumerated, £42. *Hobart:* Unenumerated, £200. *Lyttelton:* Unenumerated, £34. *Adelaide:* Elec. machinery, £383; unenumerated, £661. *Fremantle:* Wire and cable, £108; unenumerated, £83. *Launceston:* Unenumerated, £83.
[illegible] *Cape Town:* Unenumerated, £182.
EGYPT.—*Alexandria:* Unenumerated, £396. *Port Sudan:* Elec. machinery, £250 *Port Said:* Unenumerated, £230.
[illegible] Unenumerated, £116.
[illegible] £25.
[illegible], £72; unenumerated, £42.
[illegible]
SWEDEN.—*Stockholm:* Unen[illegible]
[illegible] enumerated, £55.
CHINA.
JAPAN.
[illegible], £190; Unenumerated, £60.

FOREIGN GOODS (duty paid and free)

[illegible] £21. *Sydney:* Unenumerated, £9. *Wellington:*

IN TRANSIT.

[illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Secret Process for Making Filaments.

A settlement was announced in Mr. Justice Darling's Court on Monday in the special jury case Harrison v. Ottley and others, relating to an agreement for the purchase of a secret process for the manufacture of metallic filaments for incandescent electric lamps.

When an application in the case was made recently it was stated that Mr. Harrison was suing Sir John Ottley and the other defendants for alleged breach of agreement, and that their principal defence was an allegation that plaintiff had not properly disclosed the process for the purpose of a test.

Counsel now announced that the case had been settled on terms that would be endorsed on their briefs, with a judge's order if necessary.

Diamond Coal Cutter Co. v. Mining Appliances Co.

On the 20th inst. the Court of Appeal (the Master of the Rolls and Lords Justices Bankes and Warrington) delivered judgment in an appeal by plaintiffs from the refusal of Mr. Justive Eve to restrain defendants from making threats of legal proceedings in respect of alleged infringement, under sec. 36 of the Patents and Designs Act. The Mining Appliances Co. had purchased the manufacturing and selling rights of a patent for a coal conveyor and single-stroke compressed air-driven motor and mechanical driving gear for electric power under an exclusive licence. The company had obtained the rights from one Eickhoff, a German patentee. Since the outbreak of war they had written to customers of the Diamond Coal Cutter Co. warning them to exercise caution if they were approached by any firm offering conveyors or motors similar to those of the writers, and saying that "under the special powers given by their licence" they would prosecute without hesitation all offenders. As a matter of fact no proceedings had been taken.

In giving judgment, the MASTER of the ROLLS said that the action was brought to assert and enforce not a common law but a statutory right. The Act conferred on a person aggrieved a right, where any person claiming to be a patentee of an invention threatened him with legal proceedings or liability in respect of an alleged infringement of a patent, to bring an action and obtain an injunction against the continuance of such threats. "Patentee" was defined as "the person for the time being entitled to the benefit of a patent." He thought it clear that a mere licensee was not a patentee within the meaning of sec. 36 of the Act. If he, not being a patentee, claimed to be a patentee, he might be within sec. 36, but not otherwise. The question in the case was whether defendants, who were not patentees, had by reason of two letters, brought themselves within sec. 36. On a fair construction of the letters defendants had told the truth—namely, that they were not the patentees, but were exclusive licensees—and the proceedings were expressly stated to be under their licence. That being so, they were not liable to an action under sec. 36, although, of course, they might be liable at common law, but only if malice could be proved.

The LORDS JUSTICES also delivered judgments to the same effect and the appeal was dismissed with costs.

Newhouse and others v. Northern Light, Power & Coal Co. (Ltd.)

Last week Mr. Justice Younger delivered judgment in this case, in which certain bondholders of the company sought an order to compel the company to call a meeting of the bondholders to deal with the question of the removal of the trustees. In the course of his judgment his Lordship said the directors asserted that their refusal to comply with the requisition was not wrongful, and while not admitting that the requisition was valid, they said that, whether valid or not, plaintiffs were not entitled to claim relief for the purpose of enforcing it. After reviewing the facts he was of opinion that plaintiffs throughout had been substantially right and defendants wrong. He could serve no useful purpose in ordering the meeting to be held now, but plaintiffs were entitled to a declaration that the company was bound to convene the meeting of bondholders in compliance with the requisition, and the company would have to pay the costs.

Beattie v. Barton-Wright.

Last week before Mr. Justice Bailey and a special jury, Mrs. E. Beattie was awarded £48 1s. as damages for injuries caused by negligent electrical treatment for rheumatism. Plaintiff alleged that she sustained burns which laid her up for several weeks. Defendant contended that if such an accident as was alleged occurred plaintiff did not take proper care.

Dr. [illegible] Gubbin[illegible]ough said there had never been a case of burning at St. Thomas' Hospital, where electrical treatment was used.

Defendant said he was the managing director of the Radium Electro [illegible] Co. (Ltd.). He had had 14 or 15 years' experience of electric treatment. Plaintiff was told if the heat became uncomfortably warm she was to say so, and then the current would be regulated. In the 14 years he had treated 9,000 patients, and about 120,000 treatments had been applied.

The jury returned a verdict for plaintiff for £48 1s., made up of £38 1s. for special damage and £10 for her suffering. Judgment was given accordingly, with costs.

BUSINESS NOTICES.

Mr. J. F. Avila, A.M.I.E.E., A.M.I.Mech.E., has been appointed works manager at the Birmingham works of Simplex Conduits (Ltd.). Some changes have recently been made, and the large amount of munition work the firm is engaged on necessitated Mr. Avila leaving London at short notice. For the last nine years he has acted as London manager to the company, and has been in touch with many electrical men in the London area. He regrets that his hurried departure prevented him taking leave of the majority of them.

Electricity Works for Sale.—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., advertise for sale an electricity supply station, with an output of about 3,000 k.v.a., three-phase, 50 cycles, 3,000 v., transforming to 1,400, 500 and 220 v.

Arc Lamps for Sale.—Messrs. John Barnes & Co. (Ltd.), 20, Finchley-road, London, N.W., have about 40 a.c. arc lamps for sale.

Patent Development.—The proprietor of patents Nos. 24,702/1908 and 24,708/1908, for "Improvements in seal fastenings," desires to enter into arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

The proprietor of patent No. 24,718/1905, relating to "Wireless telegraphy," desires to sell same or to grant licenses thereunder. Applications to Messrs. Boult, Wade & Tennant, Patent Agents, 111 & 112, Hatton Garden, London, E.C.

BANKRUPTCIES, &c.

Claims against Herbt. Page (trading as Smeeton & Page), electrical engineer, 63, Queen Victoria-street, London, E.C., are to be sent by Nov. 6 to Mr. E. S. Grey, Bankruptcy-buildings, London, W.C., preparatory to the payment of a dividend.

ELECTRICITY SUPPLY.

EXTENSIONS.

Coventry.—Although important extensions of the generating plant and mains have recently been carried out it was reported to the Council on Tuesday by the Electric Light Committee that further additions will be necessary very shortly.

The Manager (Mr. G. Tough) has received a letter from the Daimler Co. stating that, in the near future, the company would probably require a further supply of power beyond that for which they have already made application. To be able to accede to this application, it will be necessary (in the opinion of Mr. Tough) to carry out further extensions in addition to those in progress, and he estimates the additional cost at about £30,000.

The Chairman and Manager have been authorised to ascertain from the Ministry of Munitions whether, in the event of the Corporation undertaking the further extensions, the Government will make a similar financial arrangement to that made in reference to the extensions now in progress.

Gravesend.—Last week the Electrical Committee reported that they could not see their way to extend the mains so as to give a supply of electric current for X-ray apparatus at the hospital, on account of the cost of the extension and the uncertain duration of the supply. The matter was, however, referred back.

Leicester.—The Electrical Engineer recommends the installation of two additional water-tube boilers at the Lero generating station.

The estimated cost of the boilers and incidental work, including foundations, bunkers, telpher track, &c., amounts to £11,256, and the Tramways Committee recommends the Council to authorise the execution of the works and the payment of the cost thereof out of the tramways reserve fund,

The Electricity Committee has increased the wages of the shift engineers by 5s. per week.

London County Council.—On Tuesday sanction was given to the Poplar Borough Council borrowing £3,688 for electricity mains.

The County Council have made a new regulation providing for an annual inspection of the electrical and heating installations at garages in respect of which the Council has agreed to additional cubical extent under sec. 17 of the London County Council (General Powers) Act, 1908.

It is proposed to make arrangements for the use by electric lighting undertakers of the Council's subways, and the charges made in connection with such use, and also in respect of the use and supervision of pipes or wires existing in the subways on May 4, 1915, and in respect of the use and supervision of pipes or wires laid in the subways subsequently to May 4, 1915.

Plymouth.—Extensions of mains are to be made in order to supply prospective consumers in three streets.

Sheffield. The Electric Supply Committee has approved the action of the general manager (Mr. S. E. Fedden) in placing orders for materials and work in connection with the additions to Neepsend station and plant, amounting approximately to £111,013, and a further sum of £7,000 on existing contracts, to get the work completed in time for the new plant.

Mains are to be extended in various parts of the city, at a cost of £2,200. The committee has instructed Mr. Fedden to [illegible] increasing the accommodation for coal storage at Neepsend, and for coal handling plant, at a cost of £6,000.

The General Manager has experienced difficulties in obtaining supplies of coal, and he, together with the chairman of the committee, has been authorised to make inquiries regarding what motor lorries are available for quick delivery with power to purchase one or more if considered necessary.

Three guineas is to be contributed towards the expenses of the Electric Vehicle Committee of the Incorporated Municipal Electrical Association.

Walthamstow.—The Lighting Committee recommend the laying of an additional cable to the new works in Fulbourne-road of the Fuller Electrical Co., at a cost of £424.

The committee is considering the advisability of installing water softening plant at the electricity works, and it recommends the removal of the 10-ampere street arc lamps, and the substitution of special carbon filament lamps on the tramway routes.

The Finance Committee has approved the proposal of the Lighting Committee with regard to the wages of charge engineers being fixed at 45s. per week, rising to 55s. per week by annual increments of 2s. 6d., and to the wages of switchboard attendants being fixed at 35s. per week, rising to 40s. per week by annual increments of 2s. 6d.

West Ham.—The Corporation are recommended by the Electricity Committee to invite tenders for the supply of an additional boiler for the electricity works.

Willesden.—The L.G. Board has authorised the Council to raise £693 for mains and feeder pillar to afford an additional supply to Messrs. McVitie & Price.

GENERAL.

Aylesbury.—At the last meeting of the Council, the chairman of the Electricity Committee (Councillor Elliston) stated that the demand for electric current in the Bicester-road area was more than was at one time anticipated.

The Dominion Dairy Co. were in need of more power, and the receipts for electricity had already greatly increased in that area. It was proposed to lay a new cable at a cost of £362. They had a guarantee of £50 per year for five years from firms in the area, and that would more than meet the capital charges. If a cable were laid there would be a saving on the present system of street lighting in Bicester-road. It was possible the demand for power would be of a temporary character and that consumption would fall off, but even then the value of the cable would not be nullified, as the time might come when the question of other arrangements would be desirable at the sewage works.

Belfast.—A sub-committee of the Tramways and Electricity Committee has been formed to prepare a statement of the capital requirements for electricity services for the next two years.

Bidford-on-Avon.—Last week a public meeting was held in order to consider a projected electric supply scheme.

The promoters of the scheme (Messrs. Best & Pullen) were represented and the chairman (Mr. A. G. Phillips) explained that the meeting was called by the Parish Council at the request of Alcester Rural Council. Before the District Council would agree to support the scheme they desired to know whether there was amongst the parishioners at Bidford a demand for an electric lighting scheme.

After hearing an address by Mr. Best, there was some discussion, and a resolution in favour of the scheme was put by an amendment declining to support the proposal unless arrangements were made with the gas company by which electricity and gas could be purchased by consumers from one and the same company. There were 19 votes in favour of the amendment and 29 in support of the scheme.

Darwen.—The Corporation have authorised the electrical engineer (Mr. C. Garnett) to take an articled pupil.

Fakenham.—Mr. C. Pullen, of Bradford, has submitted to the Parish Council particulars of an electricity supply scheme for this district, and asking for official support.

Hammersmith (London).—The Electricity Committee has recently granted 85 applications for the supply of electricity (i.e. 3.8 c.s. 50 watt lamps), including one application for lighting and power at a flat rate of 1d. per unit, supply to be taken for five years.

The borough electrical engineer (Mr. G. Gilbert Bell) has reported that, owing to the increasing demand for current in the Hythe-road area, by factories engaged on munition work, the present feeders are unable to maintain the full pressure in that district. He has submitted a comprehensive scheme for meeting the present and future demands in the north of the borough, involving a considerable initial outlay, but, inasmuch as capital expenditure must be restricted to actual requirements at present,

the Committee has deferred the further consideration of the complete proposal. An essential detail of the scheme, which must be carried out immediately to meet the present demand, is for a new feeder to be drawn into the spare duct between the "North Pole" sub-station and Hythe-road, and if this is now laid as a three-core cable suitable for extra-high-pressure, it can at once be used for the single-phase work and afterwards connected up for higher pressure work under the larger scheme. A contract for carrying out the work has been let to Callender's Cable & Construction Co.

Hornsey.—The Council has decided that in cases where current is used for manufacturing purposes a special two-rate system should be adopted on the basis of 1d. per unit for use during daylight and 2½d. per unit after daylight, subject in every case to the borough electrical engineer being able to make suitable arrangements as to load, payment for special meter, &c.

Liverpool.—At the last meeting of the Tramways, Electric Power and Lighting Committee Mr. Russell Taylor gave a review of the past year's work.

He said that the capital expenditure up to the end of 1914 was close upon £2,250,000, and the revenue for 1914 was over £300,000, while the increased revenue for the six months ended June over the corresponding period last year was about £8,000. Out of the profits of the undertaking, from the time of its purchase in 1896, the sums of £862,128 had been set aside towards repayment of capital, £390,000 had been carried to reserve, depreciation and other contingencies, and £285,000 allotted to relief of rates, the contribution for the latter purpose for the current year being £25,000. There were about 11,500 consumers connected, compared with 10,800 in 1914. During the year 1914 over 48,000,000 units were supplied for lighting and power, and, during the first eight months of the current year an increased output of over 3,000,000 units had been supplied, or an increase of about 11 per cent. The demand for electrical energy for power this year had been most satisfactory, close on 6,000 H.P. having been connected during the past 12 months. That the economies and advantage of electric driving were receiving greater recognition was shown by several large and important manufacturing firms adopting this method during the last 12 months. In several cases three-phase alternating current was being supplied through sub-stations provided on the consumers' premises. To assist small power users to adopt electrical energy, motors were supplied on the hire-purchase system, and, to encourage the use of electrical energy for domestic and other purposes, suitable apparatus for heating and cooking was supplied on the same system. The demand for electric ovens, radiators and other heating apparatus had considerably developed during the past 12 months.

Mr. A. G. SMITH, city lighting engineer, reported that the lighting of the city was carried out by means of 15,843 lamps, of which 12,513 were incandescent gas, 2,677 flat flame, 551 electric and 93 oil. This is a large reduction on the numbers of last year, and is due to the decision of the Committee to fall in with the suggestion of the Government to curtail the street lighting. Electric lighting had been considerably curtailed, and the whole of the arc lighting had been discontinued at the request of the Mersey defence authority, the two incandescent lamps on the poles being lighted in lieu which was later further curtailed by the lighting of one lamp on each pole. The number of electric lamps had fallen from 1,129 to 551.

Loans to Local Authorities.—London County Council has notified the Metropolitan Borough Councils that the rate of interest to be charged on loans to local authorities has been increased from 4½ to 5 per cent.

Mexborough.—Last week the Electric Light Committee reported to the Council that they could not comply with an application from the Mexborough & Swinton Tramways Co. for a supply of electric current for the tramways, because it would involve a capital outlay which the Council could not at present undertake. The Council, however, instructed the Committee to re-consider the matter.

Pembroke (Dublin).—On p. 68 of our issue of the 15th inst. we referred to the breakdown of a Diesel engine at the electricity works.

We learn that there are two Diesel engines in the generating station, one of which was manufactured by Messrs. Willans & Robinson Victoria Works, Rugby, and the other was of foreign make. It was the latter that broke down. The Willans Diesel engine has performed and is performing its duty in a most satisfactory manner.

Poplar (London).—The Electricity Committee has again considered the question of enabling the public lighting staff to participate in the bonus scheme of the undertaking.

At present these men are on the Council's general staff, but the committee thinks the public lighting men could be placed on the electricity staff, and the rate of bonus on savings in public lighting maintenance might be increased from 5 to 10 per cent., this increase to be added to the proportion of bonus divisible amongst the junior officers and workmen of the electricity department.

After allowing for payment of certain charges on net revenue account there is a net surplus for the June quarter of £1,280, an increase of £415 over the corresponding period of 1914. The units sold increased by 1,076,456 units, or 31 per cent., notwithstanding a reduction in consumption for public lighting of 111,916 units. The net income from sales of current increased by £3,300, while the working expenditure increased by £2,300, of which £1,269 was due to the increased cost of coal. Owing to present abnormal conditions, private lighting, domestic supplies and public lighting dropped 125,330 units, but there was the large increase of 1,201,786 units in power and bulk supply, a net increase of 1,076,456 units.

Application was recently made to the L.C.C. for sanction to capital expenditure of £10,188, of which £6,500 was for machinery and £3,688 for mains. The Finance Committee recommended the County Council to sanction the amount subject (inter alia) to a condition that the period of an existing loan for £3,447 granted for 42 years at 3½ per cent. interest, in respect of machinery to be displaced, should be reduced to 15 years from the present time, a reduction of 12 years. The committee were advised that the L.C.C. had no power to enforce a reduction of the loan period sanctioned or the refund of unpaid balances in respect of obsolete plant, and that in view of the undertaking of the Borough Council to provide for all renewals and replacements during the currency of the loan out of revenue, such condition was unnecessary. After consultation between the chief officers of the Borough Council and the Comptroller of the County Council the Finance Committee of the L.C.C. recommend approval of the proposal of the Borough Council to meet otherwise than by loan the estimated cost (£6,500) of machinery, and to sanction the loan of £3,688 for mains.

Salford.—Application is to be made to the L.G. Board for sanction to borrow £734 to cover capital expenditure incurred and to be incurred in connection with the electricity undertaking, from Sept. 12 to Nov. 12, 1915, in respect of loans sanctioned prior to March 12 last.

The Electricity Committee has authorised agreements being entered into with five firms for the supply of electric current at tariff rates, and application is to be made to the L.G. Board for sanction to borrow £900 to cover cost of giving a supply of energy to the works of Isaac Bury (Ltd.). In the event of the application being refused, it is proposed to provide the money out of revenue. An additional feeder cable is to be laid from Trafford-road sub-station to the works of Edward Wood & Co.

LIGHTING & POWER NOTES.

Accrington.—The Electricity Committee will supply electrical energy to the Accrington and Church Joint Outfall Sewerage Board for power purposes, subject to the Board defraying the cost of laying the service cable from the nearest main.

Eccles.—The Electrical Engineer is endeavouring to arrange, in consultation with the military authorities, for an increase of public lighting.

A sub-committee is considering the expediency of applying for the electricity works to be deemed a controlled establishment under the Munitions of War Act.

Mr. F. A. Squire, shift engineer at the electricity works, has resigned his appointment.

Electric Cooking in Children's Hospital.—Sheffield Health Committee has decided to provide for electric cooking at King Edward VII. Hospital for Children.

Electricity in Quarry Working.—In the annual report of the Quarry Inspector (Mr. H. Walker) for the Scotland Division (No. 1) it is stated that electricity special rules were established at one metalliferous mine during the year. The aggregate horse-power derived from electricity in the mines of the district amounted to 321½ on the surface, and 250⅝ underground, the greater part being used in the counties of Edinburgh and Lanark.

Guernsey.—Holy Trinity Church is being wired for the electric light, and an electric motor is to be put in for blowing the organ.

Huddersfield.—At the last meeting of the Corporation the question of supplying the tramways with electrical energy was considered.

The Chairman and deputy chairman had interviewed the chairman and deputy chairman of the Tramways Committee thereon. The committee also considered an application from Mr. L. B. Holliday for a supply of electric power to some new explosive works, and the borough electrical engineer (Mr. A. B. Mountain) had reported thereon. The Ministry of Munitions intimated that the completion of the works was of national importance, and requested the use of such expedition as was possible in supplying electrical energy thereto. The chairman of the Tramways Committee undertook to advise his committee to forego for the present the supply by the electricity committee of current for tramways to enable the supply to be given to the new explosive works. It was, therefore, resolved to supply electrical energy to Mr. Holliday, subject to his entering into a formal agreement.

The War Office wrote asking for a supply of electrical energy to be taken to Arabia Mills if possible, but the committee were unable to grant the supply at present.

The Committee's report was adopted.

Oldham.—The electric supply department has been asked to give a supply of power to Messrs. Joynes Spencer & Co.

As the electric cables are already overladen in this district, the Electricity Committee have arranged with the Tramways Committee to supply the electricity from the overhead trolly wires. The firm will take all risks in connection with the extra supply.

Westminster.—The City Council is recommended to agree to the Westminster Electric Supply Corpn.'s proposal to increase on and after Jan. 1 next by 10 per cent. the rates of charges (3d. per unit for lighting and 1d. for power) for supply of electricity to the Municipal buildings.

Windsor.—The Council have made fresh agreements with the electric and gas lighting companies.

The Windsor Electrical Installation Co. will suspend the existing contract from September 17 last on condition that it is allowed to substitute for the existing high-candle-power lamps a lamp of the type recently fixed in the lower part of St. Leonard's-road, the annual charge to be reduced from £434 to £314, the company to have the option of extending the contract so that it should have four years on the conditions of old contract when normal lighting conditions are resumed.

TRACTION NOTES.

Bexley.—The Ministry of Munitions has asked for a through service of tramcars between Bexley Heath and Erith as it would facilitate the workers getting to and from their work.

The Board also asked the Council to consider whether they could arrange for such a service to be run at an early date.

As a result of the communication a conference has since been held at Whitehall between delegates of Erith and Bexley Councils and investigations are to be made into the matter by a representative of the Board of Trade.

Birmingham.—An appeal by the Tramways Committee for volunteers to take the places of employés who have enlisted has met with a satisfactory response.

During the first day nearly 200 applications were received, and altogether over 600 have now volunteered for the work. The committee point out that in consequence of so large a number of qualified motormen having joined the Colours they are finding extreme difficulty in maintaining the car services necessary for munition workers. To meet the difficulty they invite applications from professional and business men not qualified for military service who will be willing to learn the duties of a motorman with a view of their employment on Sundays and at such other times as they may be available.

L. & S.W. Railway.—The service of electrically-operated trains between Waterloo and Wimbledon, via East Putney, was inaugurated on Monday.

In the new service the compartment system of carriages is retained, but second-class coaches are abolished. As the result of electrification the number of trains run will be practically quadrupled. It is hoped that the section to Kingston will be opened towards the end of November, and the Hounslow section will follow shortly afterwards.

L.C.C. Tramways.—As the Treasury has refused sanction to the capital expenditure involved in the reconstruction of the horse lines between the West India Docks and Victoria Park and those in Grange-road and Southwark Park-road, the Council will have to make them safe for vehicular traffic at an estimated cost of £6,250.

Trailer Cars.—The Board of Trade has now agreed that passenger trailer cars may be run at all times of the day on the authorised routes.

Newcastle-on-Tyne.—Owing to the darkening of the streets the Corporation Tramways Committee has decided to stop the tramway service at 9:30 p.m., the conductors having complained of strain and danger.

Women Conductors.—Leicester Corporation have this week decided to engage women tramcar conductors.

Leeds Corporation have 50 women in training for the position of conductor.

London County Council also propose to employ women conductors, but at the outset they will work on trailer cars.

TELEGRAPH & TELEPHONE NOTES.

Brighton.—In view of the proposed increased telephone charges, the town clerk has been requested to report on the whole installation of telephones at the municipal establishments.

Post Office and Boy Labour.—The annual report of the Standing Committee on boy labour in the Post Office has been issued.

It is stated that the year 1914 was the first in which it was possible to absorb every boy messenger who was both willing and fit to enter the permanent service of the State. There was still a considerable number either not willing or not fit, but out of 5,183 boys, 2,728 were absorbed. The need for skilled telegraphists in the field and the consequent depletion of the staff made it imperative to increase the number of telegraph learners and the number of those passed through the training classes showed a marked increase.

Radiotelegraph Notes. It is announced that Mr. Clarence Eldridge (representing the Federal Building Co. of New York) has been granted by the Argentine Government a concession for the erection, near Buenos Ayres, of a high power wireless station which is designed shall communicate directly with a station to be erected at or near New York. The Poulsen system is, it is stated, to be employed. The period of 18 months is fixed in the concession for the completion of the service.

The concession is for 30 years, and provides that state telegrams and those of authorised national representatives shall be transmitted gratuitously and shall be charged only 50 per cent. of the ordinary tariff, the concessionaire company to transmit free of charge the official radio-grams of the Argentine Government and of its agents in foreign countries. The salaries and travelling expenses of the officials entrusted with the inspection of the station are to be paid by the concessionaires. The Government reserves the right to require that all employés of the station shall be Argentine citizens. The company is to afford facilities to the technical staff of the Argentine navy to practice at the station, and the concession does not imply any monopoly of radiographic communication, or any special privilege whatever, nor, without previously obtaining the consent of the Executive Power, may the concessionaire company transfer its authorisation nor enter into any arrangement with any other telegraphic, telephonic or radiographic company. Nine months is accorded the concessionaire to present plans and definite descriptions and commence work (excepting in case of force majeure due to the European war), and one year from commencement of work the station must be complete and in working order by effective normal direct communication between Buenos Ayres and New York. Otherwise the concession lapses at the expiry of the periods indicated (subject to the final decision of the Executive Power), the concessionaire in that case to have no claim for compensation.

It is announced from Washington that all commercial and amateur radio stations in the United States are about to be organised by the Intelligence Bureau of the Navy Department, in view of any emergency that may arise. It is further stated that a roof equipment similar to that employed by the Admiralty in London is about to be installed upon the roof of the U.S. Navy Building at Washington.

EMPIRE NOTES.

Adelaide (South Australia).—The accounts of the Adelaide Municipal Tramways Trust for the half-year ended July 31 show that the total amount advanced by the Government for construction (including Port Adelaide) is £1,516,224, and £155,305 has been repaid.

Revenue was £153,283 (compared with £157,149 in the corresponding half of 1914), including £408 (£110) from horse and £150,212 (£154,942) from electric cars, and £2,661 (£2,097) from other sources. Operating expenses were £95,488 (£96,581), gross profit being £58,204, equal to 8·315 per cent. of the capital cost. Interest on purchase money required £4,367 (£4,387), and an advance for construction £26,011 (£26,380), and sinking fund £23,333 (£22,976); and £8,678 (£8,680) was placed to renewal fund. Total revenue per car-mile was 15·254d. (15·020d.), and expenses were 9·447d. (9·220d.)

Australasia.—Kaponga (N.Z.) Town Board has installed hydro-electric plant, including a 70 B.H.P. medium pressure Francis turbine direct coupled to a General Electric (U.S.A.) 45-kw.230-volt compound d.c. generator, and a D.P. battery of 350 ampere-hours capacity.

Liddicombe (N.S.W.) Council has been authorised to enter into an agreement with the Sydney Council for the supply by the latter of current for electric lighting in Liddicombe.

South Brisbane (Queensland) Council has asked the Government to grant an order-in-council to Brisbane Electric Lighting Co. to supply electricity to the municipality.

Napier (N.Z.) Borough Council proposes to instal two 400 B.H.P. producer gas engines at their power house, to construct new electric tramways, purchase five cars and extend the electric lighting and power supply, &c. The total cost of these works is put at £55,500.

A proclamation, dated July 21, prohibits the importation of electric or magnetic belts, "or any belt which is alleged or intended to produce a therapeutic effect by electric or magnetic influences" into the Australian Commonwealth.

Egypt.—A consular report says the value of electrical machinery (including gas and petrol engines) imported into Alexandria in 1914 in £E(= £1. 0s. 6½d. sterling) was £53,328 (compared with £50,793 in 1913), of which £75,575 (£6,291) came from the United Kingdom, £3,764 (£20,417) from France, £18,133 (£7,594) from Germany and £34,921 (£1,024) from Switzerland. Imports of rolling stock for railways and tramways were valued at £91,204 (£41,949), including Austria-Hungary £35,652 (£1,520) and Belgium £15,532 (£19,489); steam engines, stationary and semi-stationary, total £92,380 (£134,447), U.K. £63,956 (£111,202), Germany £12,591 (£5,180), Italy £12,634 (£10,930).

Penang.—The following are abstracts of the reports of the electricity supply and tramways departments of George Town (Penang) municipality for the year 1914:—

Electricity Supply.—A 500 kw. steam dynamo with ejector condenser and a water-tube boiler were added to the plant. The number of consumers is 1,919, total connections are equal to 68,467 30-watt lamps (including 1,676 fans), and there are 19 motors (total 170 H.P.) connected. Capital expenditure is $964,516. Revenue was $281,597, compared with $257,647 in 1913. The reduction of power rate from 12 cts. to 10 cts. per unit accounted for a loss of $7,200 in revenue. Working expenses were $126,793 ($14,772 increase). Total costs per unit sold were 8·68 cts. (as in 1913) per unit sold. The gross profit was $154,804, which the engineer and manager (Mr. O. V. Thomas) points out is equal to 16 per cent. on the total capital expended. Interest required $41,492 and sinking fund $12,000, and $18,420 has been placed to depreciation and $25,000 to renewals and reserves fund.

Tramways.—Total capital expenditure $567,345 (increase $21,500). Revenue $152,014 (against $135,823), operating costs $92,616 (increase $5,846)=18·38 cts. per car-mile, gross profit $60,397 (against $49,052) =10·6 per cent. (9·1 per cent.). Passengers carried were 5,597,994 (4,895,132), car-miles run 503,923 (456,299), and units used 297,816 (264,867).

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a company at Las Perdices (Province of Cordoba) has been granted a concession for the electric lighting of the town for 20 years.

The public light and power installations belonging to a company at San Martin (Province of Mendoza) have been sold to O. Bromberg & Co., of Buenos Aires.

The movement recently started in Concordia (Entre Rios) for the formation of a local electric supply company is making progress. The proposed capital is $300,000 m. n. (about £26,100) which will be called up in monthly instalments in a series of 1,000 $50 shares at a time.

The Compania Industrial de Electricidad del Rio de la Plata has addressed a note to the Municipal Intendent of Buenos Aires, complaining of certain requirements specified in the schedule of conditions in a recent call for tenders for the supply of carbons for public arc lamps. The company state that they have supplied carbons to the municipality for the last five years, the material employed being of national manufacture and that the wording of the specification on this occasion prevented them from tendering.

Cuba.—A decree has been issued authorising the Havana Electric Railway, Light & Power Co. to construct a new double-track electric tramway in Havana.

Greece.—It is reported that the Ministry of Communications contemplates an extension of the telephone system, and the tender of the Western Electric Co. has been favourably considered in connection with the contract for telephone installations at Athens and Salonika. The value of the contract will be about £40,000.

Italy.—A consular report states that exports from Italy in 1914 included dynamos valued at £62,208, and scientific instruments £527,960. Imports of the same classes were valued at £103,247 and £2,560,270 respectively.

The United States and Germany continued to be the chief suppliers of agricultural machinery. Imports of dynamos from Germany were doubled, while the U.K. and Austria-Hungary lost much ground. The heavy fall in imports of scientific machinery was shared by Germany (the chief supplier), France and, to a lesser extent, by the U.K.

Madeira.—A consular report states that electric light fittings and appliances would command a ready sale there if offered at low prices.

St. Thomas (Danish W. Indies).—A consular report states that there have been installed on the new wharf of the Danish West Indian Co. at St. Thomas an electric lighting plant and two electrically-driven cranes (valued at about £10,000 each) for the rapid handling of coal.

Swiss Electricity Works.—We have received from the Schweizerische Elektrotechnischer Verein (Zurich) the annual tables of central electricity supply works "Statistik über Starkstromanlagen" for 1912, with a supplement, bringing the statistics up to Dec. 31, 1914.

The first table gives technical and financial details and information as to the system of supply, while the succeeding tables give particulars of the generating stations, transmission, transformation and distribution networks, lists of works using water power or internal combustion engines, undertakings worked solely by current taken in bulk, lamps, motors and current consuming devices connected, &c.; also supplementary lists are given of works of which full details were obtainable up to Dec., 1912, and of undertakings put into operation between Dec., 1912, and Dec., 1914. The book is carefully compiled and the statistics in the principal tables are very complete. The published price is 9 fr. (9s. post free in Britain).

United States.—*Manufactures and Export.*—A consular report states that electrolytic copper valued at $9,451,912 and iron ore $44,288,244 were exported from Duluth (Minn.) in 1914.

At Milwaukee some 4,000 fewer workmen were employed in the steel and iron trades than in 1913. The production of electric and telephone supplies, however, was valued at £3,134,160, compared with £2,554,460 in 1913.

Uruguay.—A project for establishing electric tramways in Paysandu has been included by the Uruguayan Government in the agenda for the present session of Parliament.

Electrical Engineering in China and Japan.

On Saturday a complimentary dinner was given to Mr. W. G. L. Riddle, the new president of the Birmingham and District Electrical Club. Mr. Riddle, who recently returned from a 12 months' business tour in **China**, referred in the course of his presidential address to the rapid growth of the municipal electricity undertaking in Shanghai, particulars of which have already appeared in the columns of THE ELECTRICIAN.

Mr. RIDDLE also said that the number of existing and proposed supply undertakings in China at present was legion. Perhaps the chief responsible factor was that the Chinese were essentially a commercial nation, and, as individuals, thoroughly alive to the potential value of electricity supply as an investment. Also the Chinese were rapidly becoming keenly alive to the manifold possibilities of electric driving for all industrial ventures requiring power. Another factor was the absence of a Board of Trade, L.G. Board, or, in fact, any form of administrative control which would tend to impose "capital-sinking restrictions" or discourage enterprise. It would, of course, be idle to underrate the useful and necessary functions which those departments exercised in this country, but it would be equally idle to ignore the impetus given to Chinese undertakings owing to the absence of inflexible restrictions and requirements of a conservative and enterprise-damping nature. However, China would ultimately benefit by the introduction and enforcement of temperate regulations drawn up with a view to ensuring a reasonable degree of safety, consistent with obtaining the maximum useful service for the minimum capital outlay. There were many undertakings in China which were stifling electrical progress in its infancy, and making the task of those interested in electrical plant importation a difficult and disheartening proposition. Those were cases which would occupy the attention of the responsible authorities with profit to the community, importers, and, in fact, all interested parties, including the short-sighted promoters of such concerns. Another very potent factor was undoubtedly the long credit and extended payment system adopted by Continental firms. Open to criticism as this system was, it was as certainly indirectly responsible for a large proportion of the engineering enterprises undertaken by the Chinese. While he was in China he was informed of a case of a 10,000-spindle electrically-driven cotton mill which was built and equipped without any expenditure upon the part of the nominal owners, the whole of the plant being supplied under an arrangement whereby its cost was to be met by the surplus revenue (if any) after payment of a fixed minimum dividend. Such was the faith of the factors of the plant in the possibilities of the cotton industry in China. Germans were the greatest competitors in the electrical engineering trade in China. They had practically ruined the Far Eastern business by the severe cutting of prices. Being subsidised by their Government and helped by their bankers, they had been in a position to secure many contracts which in the natural order of things might have been executed in Great Britain. Since the outbreak of hostilities neither Britain nor Germany had been able to take contracts, and in his opinion, when the war was over, Germany would be in the field again with renewed vigour. Before he left China in April last America and Japan were securing the bulk of the trade. Japan was already producing very creditable copies of the best European and American practice, and although their present production was insufficient to allow them to compete with advantage, it was certain that time would amend that and they would have the advantage of low freights and insurance, and also of quick deliveries. The British merchants in China did not receive the help from the British manufacturers that was desirable to secure their share of the trade. Very few large manufacturers had their own representatives on the spot. The majority of them employed [illegible] some firm of merchants, and if any help was desired by the merchants the manufacturers would not give it. Hence the success of the Germans.

A vote of thanks was accorded Mr. Riddle for his address.

A consular report from *Kiangchow* states that an electric light company was formed in Kiangchow by Chinese merchants in October, 1912, but financial difficulties led to a postponement of operations, and when the plant was finally installed it was on a smaller scale than originally intended.

The plant is British, and was supplied by a Hong Kong firm. The plant is capable of supplying current to 1,000 16-c.p. lights. Regular service began in May, 1914, and at present about 500 lamps are connected. The manager hopes in time to extend the plant so as to supply the whole town, though it is not expected that the extension will take place at any early date.

Mr. V. L. Savage, British Consul at *Chefoo*, states in his report for 1914:—

The overwhelming preponderance of British shipping is due to the

energy and enterprise of British shipping firms long established in China. Unfortunately, in other respects the lack of enterprise on the part of British merchants in general has left the development of the valuable trade of Hunan to be done almost entirely by Germans. The latter, it must be admitted, have done most of the pioneering work, and they have earned the profits they have made and the advantages they have acquired. On the other hand, the methods adopted by Germany cannot be reckoned as sound in all respects, and they are demoralising to the Chinese. But these methods are based to a great extent on economic factors and conditions which do not apply, on the whole, to British trade and manufactures, even of a parallel order. The engineering trade affords a good instance of the differing conditions and methods. The enormous output of the large German engineering works demands outlets in many markets in order to secure continuity of production. Temporary sacrifices may have to be made in the shape of low initial prices, long credits and loans to purchasers on the security of contracts under which the purchasers are more or less tied down to obtaining further any supplies of machinery from the same source, during a term of years; or to provide a quid pro quo for the loan in the shape of raw or partly manufactured products, delivered at profitable rates to the German purchasers. In the meantime the Chinese clients have to pay heavily for accessories and fittings, which, being especially adapted to the plant sold to them have to be obtained from the same or affiliated manufacturers. British manufacturers do not, as a general rule, produce on the same scale as the Germans, and they may not wish to cut down their profits or wait for them. These are reasons for the predominance of the German over the British engineering trade in China. The success obtained in recent years by a few younger British firms has clearly revealed the lines on which an import business should be carried on in these days of keen competition. These firms have realised the advantage of organising the distribution of the trade in the interior, and have met the problem by a system of native agencies under the close control and supervision of trained foreign agents, stationed at the nearest treaty port. In the case of official exactions and irregular taxation, the foreign agents at the inland treaty ports can promptly apply for, and obtain, Consular protection.

This system is a departure from the practice of the old-established merchants, who have hitherto preferred to centralise their trade at the few large importing centres and to deal only in large quantities of goods, and have been content to leave the distribution entirely in the hands of native middlemen. There is now no necessity for maintining this system, and there are good reasons for discarding it. A number of important trade marts have been opened to trade in the interior of China, where Europeans may both reside and trade in security. With improved communications now established, these places are accessible with comparative ease and comfort.

Electrical fittings already find a considerable sale in the Hunan market.

The report of Mr. E. E. Crowe, Commercial Attaché to H. M. Embassy, Tokio, on the trade of **Japan** for 1914, says :—

The total volume of trade (exclusive of Corea and Formosa) was £121,156,300 (decrease £17,870,159, compared with 1913). Imports were valued at £60,814,700 (£74,462,813) and exports at £60,341,600 (£64,563,646), excess of imports over exports £473,100 (£9,899,167). Even without the war there would have been a considerable decrease in the total volume of trade. Imports of submarine telegraph cable were £93,600 (increase £88,400), dynamos, motors, transformers, &c., £245,800 (decrease £127,700), gas, petroleum and hot-air engines £37,300 (decrease £86,900), insulated wire £139,900 (decrease £70,700). Imports of iron, pig and ingots were valued at £821,400 (decrease £442,900), bar and rod, &c., £1,007,200 (decrease £405,700), rails £191,800 (decrease £225,400), plate and sheet iron £714,100 (decrease £173,300), zinc, ingots and sheets £190,800 (decrease £155,300). Large orders were placed for metals in 1913, but the Government's retrenchment policy and postponement of industrial schemes upset the calculations of metal dealers. Many failures took place, but the declaration of war proved the salvation of many firms, as a speculative demand arose and prices rose 25 to 50 per cent. Machinery imports were valued at £2,546,200 (against £3,752,700 in 1913), of which the U.K. supplied £1,354,500 (£1,737,800), the U.S.A. £505,700 (£754,300) and Germany £556,100 (£873,600). Up to the outbreak of war Germany had 25½ per cent. of the machinery trade. There is a little to come from Tsingtao and from places where German ships have run for shelter, but when that has arrived imports from Germany will cease completely and British makers will have a fair chance of competing.

It should be borne in mind that Government departments place their orders in Japan whenever they can possibly do so. Another important point is that Japanese engineering works are increasing in number and capacity. Were it not for the heavy duties it would be impossible for them to compete in a great many lines, but the duty and the freight give them a big advantage which enable them to come fairly near British prices. Makers of certain types of heavy British machinery should consider whether it would not pay them to ship only the small, delicate parts and have the heavy castings made locally, thus saving duty and freight. Good castings are obtainable and there are a few works which could be relied on to do accurate machining. To many manufacturers, however, it might seem that there would be a danger that machinery constructed in this manner might not be exactly up to the high standard they maintain, and for their benefit another suggestion which has much to recommend it is that makers of small machinery in standard sizes, such as gas engines, electric motors, pneumatic drills, pumps, &c., should consign their goods to firms of high standing. A purchaser who can buy from stock will be more likely to go to the importer than if he has to wait for eight or nine months for delivery. The manufacture of machinery in Japan is making progress, and [illegible] problem we may lose a part of the [illegible] the ideas mentioned above have been tried during the past two or three years with considerable success in one or two cases.

Japan's total production of copper was [illegible] 1913), and the home consumption [illegible] Exports of copper were valued at £2,709,100 [illegible] £2,224,100 in 1913.

In regard to methods of [illegible] it is pointed out that the terms and conditions vary considerably according to the standing of the parties concerned, but as a rule German firms make a practice of giving longer credits than British firms, and the chief [illegible] and export business is that in the case of the former credit [illegible] days or more has to be allowed, while in the case of the latter cash [illegible] nearly always to be paid, and in some instances even an advance has to be made to dealers. No discount is allowed for cash in paying for goods. Payment in the import trade is generally made [illegible] due in 30, 60 or 90 days. The promissory notes can be discounted with Japanese banks but they are the source of much trouble and litigation, and a demand is frequently made for their renewal. Promissory notes can rarely be discounted without recourse. In these cases a higher rate has to be paid and the firm has to be of the best standing.

Of the Imperial Government railways about 175 miles of new railways and about 50 miles of light railways were opened to traffic during 1914. Two of the most interesting events of the year were the completion of the splendid new central station in Tokio and the opening of the new Government electric railway between Tokio and Yokohama. This railway, which runs side by side with the existing steam track, is 19 miles long, and connects the two above-mentioned towns. Between the two termini there are 14 stations and trains stop for 30 seconds at each. The power for driving the railway is derived from a gas [illegible] plant comprises four Lilleshall tandem double-acting gas engines direct coupled to 1,500 k.v.a. 11,000 volt three-phase 25 cycle alternators, three being in daily service and one in reserve. The gas for engines is produced in three Mond producing plants, two being in daily service and one spare. The whole of the steam required for gas production and for excitation is raised in boilers using the waste heat from gas engine exhaust. H.T. current is transmitted to four sub-stations and converted to 1,200 volts direct current. The car motors are designed for 600 volts, and pantograph overhead collectors are employed. Unfortunately, after the railway had been in operation a few days, at the end of the year it became necessary to discontinue the service. There was some trouble with the overhead equipment which at the time of opening to public service was in a somewhat unfinished state. It was found that the height of conductor from rail level varied considerably, especially under bridges, this proving troublesome when trains were in rapid motion, causing the pantograph collector to oscillate badly and thereby to stress the conductor unduly. It was also found that the conductor varied from the exact position between rails with the result that the conductor had a great tendency to creep along the collector and in many cases actually to slip entirely off. The conductor hangers from catenary wire gave trouble, owing to insufficient latitude or play being allowed in the loops encircling catenary, and in many places the thrust of pantograph deflected them badly, raising the height of conductor in these places.

A consular report states that the public works in Formosa in 1914 included the erection of electric power works at Dorowan.

MISCELLANEOUS NOTES.

British Trade Openings.—Since the outbreak of the war, applications have been received by the Commercial Intelligence Branch of the Board of Trade from a number of firms in all parts of the United Kingdom who wish to get into communication with United Kingdom manufacturers of various classes of goods which were previously obtained from Germany and Austria-Hungary.

These articles include metal filament electric lamps, packing materials (corrugated) for electric lamps, porcelain goods for electrical purposes, zinc sheets for dry batteries, &c. United Kingdom firms should write to the Director, 73, Basinghall-street, London, E.C.

Customs Duties. The following are rates of export duty with effect from Aug. 26, 1915, proposed by resolutions introduced into the New Zealand House of Representatives :—

Gas, oil and hot air engines, foreign 20 per cent. (as before), British, 10 per cent. (hitherto free); electric machinery and apparatus, viz., electric generators and electric motors, including slide rails therefor, electric transformers (this item previously included electric lamps, electric transformers (this item previously included globes for arc lamps), foreign, 20 per cent. (hitherto 15 per cent.), British, 10 per cent. (as before); motor vehicles, of bodies for same attached or unattached, foreign, 20 per cent. (as before), British, 10 per cent. (hitherto 20 per cent.), chassis for same, foreign, 20 per cent., British, 10 per cent. (both hitherto free).

Inquest.—An inquest was held on Monday upon Edgar M. Jackman, an electric lamp trimmer of the Islington Borough Council.

Evidence was given that on the evening of the 21st inst. deceased ascended an arc lamp standard in New North-road to trim and re-carbon

the arc lamp. After he got to the top he suddenly fell to the ground, and when picked up he was found to be dead.

Dr. B. H. SPILSBURY stated that death was due to coma, produced by fracture of the skull. There were blisters on both hands, which were caused by electric shock immediately before death.

The inquiry was adjourned for further evidence.

Municipal War Allowances.—Various local authorities have reconsidered and revised the allowances to their employees who are serving with the Colours.

Many authorities originally decided to grant full salaries (less the military pay) to those who joined H.M. Forces, but the L.G. Board auditors have been looking into the matter and in many cases it has been found that when the Government allowances for dependents were taken into account the employés were receiving much more than they earned before the war broke out. At Shoreditch (London) the auditor, Mr. A. Carson Roberts, has pointed out that the payments are much in excess of the usual Government and municipal scale, viz., such payments as make good the deficiency (if any) when military receipts are compared with civil receipts, promotion and proficiency pay and other special military emoluments, such as rations, &c., being left out of account. As it was submitted that these excess payments were illegal the Council have now adopted a revised scale to comply with the auditor's suggestions.

TENDERS INVITED.

Turbo-Alternator, Boilers, &c.

CAPE TOWN (South Africa) Corporation require tenders by noon Nov. 5 for a 4,000 kv.a. Steam-driven Alternator, with Condensing Plant, or a 1,000 kw. Converting Plant if delivered earlier. Specification, &c., can be seen at the office of Mr. H. D. Wilkinson, 4, Queen-street-place, London, E.C.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for the supply and maintenance for 12 months of two Water-tube Boilers and Accessories at Newcastle, Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Tramway Stores.

BRADFORD Corporation require tenders by Nov. 13 for 12 months' supply of General Stores for the tramways department, including Bolts, Nuts, &c., Lamp Fittings, Insulating Material and Tapes, Fuse Wire, Controller fingers, India Rubber, Insulating Paper, Paints, Iron, Castings, Oils, &c. Schedule, &c., from the General Manager, 7, Hall Ings, Bradford.

DUBLIN UNITED TRAMWAYS CO. (1896) require tenders by Nov. 15 for 12 months' supply of General Stores, including Car Fittings, Iron, Steel, Castings, Oils, Paints, Glass, Electric Supplies, &c. Forms of tender, &c., from the Secretary, 9, Upper Sackville-street, Dublin.

House Service Boxes, Fuse Boxes and Fittings.

GRIMSBY Corporation invite tenders for the supply of House Service Boxes (lead) and Fittings and House Fuse Boxes and Fittings. Forms of tender, &c., from the deputy electrical engineer (Mr. A. S. Channon), and tenders to the Town Clerk, Municipal-buildings, Victoria-street, Grimsby, by first post Nov. 4.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Nov. 17 for Switchboard Parts and Accessories (schedule 343), Telegraph Instruments (schedule 345), Protectors and Parts, &c. (schedule 346), and Ironwork (schedule 358) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Perth (W. Australia), invites tenders by Nov. 10 for a Wheatstone Bridge (schedule 475 W.A.) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Specifications, &c., for the above contracts can be obtained from the respective Deputy Postmasters General.

Tenders are invited for the supply of 294 Accumulators, each of 15 ampere hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms, &c., from the Commonwealth Offices, 72, Victoria street, London, S.W. Tenders to Deputy Postmaster-General, Perth (W. Australia), by 3 p.m. Dec. 8.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria street, London, S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically operated Railway Freight Car Transferrers (contract No. 30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Wiring, Lamps, Fittings, &c.

LONDON County Council require tenders by 11 a.m. Nov. 3 for an Electrical Installation at Thornfield-road Elementary School, Coverdale-road, Hammersmith, W. (about 193 wiring points and 240 lighting points). Specification, form of tender, &c., from the Chief Engineer, Spring Gardens, S.W.

The GREAT NORTHERN RAILWAY CO. (IRELAND) require tenders by 10 a.m. Nov. 4 for 12 months' supply of Electric Cable and Wire, Electric Light Carbons, Electric Fittings, Lamps, &c. Forms of tender from the Secretary, Amiens-street Terminus, Dublin.

The District Committee of the Middle Ward of LANARKSHIRE require tenders by 10 a.m. Nov. 1, for Electric Lighting Work at Hairmyres Colony, East Kilbride. Specifications from Mr. Wm. Arnot, 163, Hope-st, Glasgow.

Electric Cables, Transformers and Switchgear.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED.

LONDON COUNTY COUNCIL.—The Council have received the following tenders:—

Universal grinding machine for third section of central car repair depot: A. A. Jones & Shipman, £115; H. W. Ward & Co., £145; C. W. Burton, Griffiths & Co., £184; Pollock & Macnab, £187. 10s.; Selson Engineering Co., £192. 10s.; Charles Churchill & Co., £228; and Buck & Hickman, £231.

For measuring machine for third section of central car repair depot:—Buck & Hickman (*accepted*), £141. 15s., plus 2½ per cent.; C. W. Burton, Griffiths & Co., £26. 5s.

For nose pieces for Stirling boilers at Greenwich generating station, the tender of R. Hyde & Son (at £86. 13s. 4d.) has been accepted.

HAMMERSMITH (LONDON).—The Borough Council have accepted the tender of Callender's Cable & Construction Co. at £1,312 for the supply of a three-core extra-high-pressure cable at £1,312. There were eight tenders, varying from £1,285 to £1,400. 12s. 6d.

The Council have also extended the period of the contract with the British Electric Transformer Co. for three months for the supply of not more than seven transformers of 50, 100 and 200 kw. capacity, subject to an increase of 7½ per cent. for the 200 kw. transformers.

SHEFFIELD.—The tender of G. Longden & Son (at £3,169) has been accepted by the City Council to construct the foundations for four new boilers at Neepsend power house.

The Electric Supply Committee has also accepted the offer of the Staveley Coal & Iron Co. to supply a further 10,000 3 m. c.i. cable pipes; and the Health Committee has placed an order with Thomas A. Ashton (Ltd.) for the supply of certain electric light fittings for the King Edward VII. Hospital for Children.

BRADFORD.—The Guardians are recommended to accept the tender of C. Bell (at £89) for wiring the female infirmary.

SALFORD.—The Council has accepted the tender of E. Beal for 12 months' supply and delivery at the Ladywell Sanatorium of 500 Mazda electric lamps, at 8s. 6s. 8d. per 100. The Electricity Committee has also accepted the tender of W. Geipel & Co. for 20,000 parts flame arc lamp carbons at £130. 15s.

BATTERSEA (LONDON).—The Electricity Committee has accepted the offer of Robert Dempster & Sons to provide a runway at the electricity station for £135.

CHORLEY.—The Guardians have accepted the tender of the Turner-Dictograph Telephonic Co. for the installation of telephonic inter-communication throughout the workhouse for £140. 10s.

BRADFORD.—The Tramways Committee has accepted the following tenders :—

British Oxygen Co., for supply of oxygen for three months, 35s. per 1,000 cubic ft.; Scholey & Co., gear wheels and pinions for car motors (200 tool-steel gears £7. 9s. each, 200 tool-steel pinions £1. 5s. each).

PORTSMOUTH.—The Council have accepted the following tenders at schedule prices for six months' supplies to the tramways department :—

Pilkington Bros., glass; T. H. Harvey, creosote oil and pitch; Homelight Oil Co., paraffin oil; J. L. L. Duguid & Co., metal polish; Townson & Mercer, glass wool; G. P. Wilson & Sons, brake blocks; Pryke & Palmer, washers, nails, tools, screws, rubber and asbestos insertion, asbestos millboard, resin, trolley cord, &c.; Thermofelt (Ltd.), asbestos composition; Beldam Packing & Rubber Co., asbestos and piston packing; Stringer Bros., bolts and nuts, steel and iron; H. A. Evans, firebricks, screws, plumbers' metal and tinman's solder; Sheffield Hacksaw Co., hacksaw blades; Southey (Ltd.), fender bolts and nuts, hammer and pick shafts and glass-paper; J. W. Schofield & Sons, mild bessemer steel and spring steel; Engineering Supplies Co., controller fingers; Gabriel & Co., brake ratchets; F. W. Rowlands & Co., car gear wheels and car pinions; West Bromwich Spring Co., reverse barrel, controller, &c., springs; Dart Spring Co., trolley, sandhopper and brake pull-off springs; Fleming, Birkby & Goodall, trolley wheels and bushes, pull-offs, hangers, frogs, clamps, &c.; Marsh Bros. & Co., armature binding wire; Smith Bros. & Hill, sand tubes, spring washers and motor springs; Spicer Bros., fuller board, oiled cloth, sheet fibre, blackley tape and okonite tape; P. R. Jackson & Co., armature coils; Micanite & Insulators Co., mica; J. G. Ingram & Son, insulation sleeves and rubber tape; Cooper & Roberts, adhesive tape; British Thomson-Houston Co., incandescent lamps; Mica Mfg. Co., mica cloth and micanite; British Westinghouse & Mfg. Co., mica, mica paper and white tape; Carr Bros., small and large brooklyns, clevis insulators, insulating bolts and globe insulators; F. Smith & Co., span and guard wire; Solent District Engineering Agency, engine and cylinder oils; Burfield & Son, armature twine; Malleable Steel Castings Co., brake pull-off castings; Miller & Co., firebars; Antri-Attrition Metal Co., axle box bearings and key plates.

WEST HAM.—The Electricty Committee recommends the acceptance of the offer of the British Westinghouse Co. to supply a new motor of modern design for the 2,300 kw. turbo-alternator.

WEYMOUTH.—The Council have accepted the tender of Brooking & Co. for wiring the whole of the new municipal houses.

WARRINGTON.—The Guardians have accepted the tender of the General Electric Co. (Liverpool branch) for the supply of electrical goods.

CAPE TOWN (SOUTH AFRICA).—The Town Council have received the following tenders :—

For l.t. feeder cable and joint boxes, Siemens, Ltd. (*accepted*), £4,776; South African General Electric Co., £4,810; Telegraph Mfg. Co., £5,878. For two disconnecting pillars, Siemens, Ltd. (*accepted*), £172.

SYDNEY (N.S.W.)—The following tenders have been received by the City Council for the supply of a motor converter and rotary converter :—

British Westinghouse Co., 1,500 kw. set, £6,143; 2,000 kw. set (*rec. for acceptance*), £7,347. Guthridge (Ltd.), 100 kw. set, £4,716; 2,000 kw. set, £8,437. Dick, Kerr & Co., 1,500 kw. set, £7,316; 2,000 kw. set, £9,364. Siemens Bros. Dynamo Works, 1,500 kw. set, £7,121; 2,000 kw. set, £9,780. Australian General Electric Co., 1,500 kw. set, £6,975; 2,000 kw. set, £10,199.

Sydney Council are also recommended by the Electric Lighting Committee to accept the tender of the [illegible] oil dryer and filter, £395.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster General's Dept., Sydney.—Western Electric Co., Ltd., Morse sounders 7s. 9d. each, 70 ditto 9s. 3d. each, [illegible] Morse, and bonding clips 1s. 3d. each, 1,500 ditto 1s. 1d. each, Dayton & Reed, 500 ditto 1s. 7d. each, 350 ditto 1s. 9d. each.

Postmaster General's Dept., Melbourne.—[illegible] plants for wireless stations, Rookhaven and Flinders Island, 2½ and ditto, Mount Gambier £30, ditto, [illegible] booster set for Woodlark Island wireless station £240.

Victorian Railways.—W. T. Henley's Telegraph Works Co., Ltd., for Ballarat and Bendigo workshops at rates; R. W. Cameron & Co., for electric coaches at rates; R. W. Cameron & Co., [illegible] each; S. R. O. Allen, sulphate of copper for electrical purposes, at rates; British Insulated & Helsby Cables, Ltd., [illegible] £221 14s. 8d. per mile; Australian General Electric Co., [illegible] grinder, at rates; H. V. Duncan & Co., [illegible] rates; Miller & Co., Pty., second-hand l.t. cables, at rates; [illegible] O'Neill, electric freight lift for Toorak railway station £[illegible].

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published has been specially compiled by MESSRS. MEWBURN, ELLIS & PARTNERS, *Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the [illegible] at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

16,080 SOC. ANON DES ETABLISSEMENTS L. BLERIOT. [illegible] electric current. (7/7/13.)

20,176 KNIPE & READ. Method of and apparatus for [illegible] produced thereby.

Consists in bringing the parts or sheets to be [illegible] electric current to an annular contact area or areas [illegible] electrodes within which an unconfined gaseous [illegible] at all points of the joint and prevent pressure around the joint within [illegible] contact above and below the sheets.

20,238 SCHIESSLER. Electric current relays. [illegible] granted.)

A telephone relay wherein the [illegible] electric current is effected by varying the conductivit[illegible] electrodes, or preferably between condenser plates or [illegible] sifying circuit and the solid, liquid or gaseous dielectric which is ionised physically or chemically so that the ions thereof form the carrier of the intensifying current, the displacement currents produced by the superposition of the current to be intensified at the condenser, producing an undulating current of [illegible]

20,254 SMITH & OWEN. Attachment of electrical conduit tubes to junction pieces.

20,295 SCHMIDT. Electric switches for simultaneously [illegible] shutters.

20,458 LANDIS & GYR. S.A. Prepayment electric[illegible] 18,464/14.)

21,822 JONES. Electric arc soldering.

21,824 CURTIS & IGRANIC ELECTRIC CO. Electromagnetically-operated valves.

23,368 TRIER. Automatic regulating apparatus for dynamo-electric machines.

1915 SPECIFICATIONS.

4,987 WESSEL. Hot-wire alternating-current limiters.

A hot-wire alternating-current limiter having a main current electromagnetic relay in combination with a transformer which is brought into the working circuit by the said relay when the current limit for which the apparatus [illegible] secondary of said transformer supplying current to a hot [illegible] heated, effects an interruption of both the main current and the [illegible] of said transformer, thus causing a periodical interruption of the [illegible] been brought down below the said limit.

8,770 SOC. ANON DES ETABLISSEMENTS L. B[illegible] devices. (7/7/13. Divided application on 16,080/14. July 6.)

8,941 SCHIESSLER. Electric coupling transformers. (16/4/14. Divided application on 20,238/14. Sept. 26.)

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Ayr.—The revenue of the electricity department for the past year was £15,359 (a decrease of £448).

Working expenses were £8,160 and interest and sinking fund required £5,951, the net surplus being £1,248, which has been placed to reserve. Units used for power increased 57 per cent. and total units sold by 3·6 per cent. Coal cost £513 less, due to the use of low-grade fuel by means of the new stoking apparatus installed last year.

The tramway accounts show total capital expenditure £100,705 (increase £35), of which £21,935 has been redeemed. Revenue was £17,984, working expenses were £10,980, interest required £2,725 and sinking fund £1,819, net balance being £2,494. Average revenue per car-mile was 9·61d., and working expenses (including power) were 5·87d. Passengers carried were 4,019,771 (against 4,238,494 in previous year), car-miles run 448,725 (444,802), and units used 442,969 (421,844). The general manager (Mr. Wm. Grant) reports that the parcels carried were 24,023 (25,783). The average mileage obtained from the wheel [illegible] was 46,989, the lowest on record (against 88,829 last year). Mr. Grant is making inquiries into the cause of the decrease, which he was unable to account for at the time of writing. The maximum mileage was 92,928, and the minimum 21,276. Average mileage obtained from ordinary brake refils was 5,864, and from the new standard type 9,379. Average mileage obtained from pinion wheels was 56,708. Average mileage obtained from Welsh's patent trolley wheel centres was 3,388. Welsh's solid trolley wheels 3,503, Fleming & Birkby's 3,317 and B.T.-H. 3,479.

Bournemouth.—The accounts of the tramways department for the year ended March 31 show gross capital £467,073 (increase £24,067).

Revenue was £102,346, and working expenses were £55,066, leaving gross profit £47,279. Interest required £10,587, sinking fund and repayment £16,535, rent of leased lines £7,737, and allowances to dependants of employés on H.M. Service £2,352, the total of the net revenue charges being £37,964, and the net profit £10,270, from which £1,187 is deducted to cover loss on motor 'bus account. Total revenue per car-mile was

13·52d. and working expenses, including power, were 7·27d. Passengers carried were 16,967,210, car-miles run 1,815,632, and units used 3,072,169.

Maidstone.—The report of the engineer and manager accompanying the accounts of the electricity department for the year ended March 31 (which were abstracted in a recent issue) says the net surplus (£1,553) is the largest obtained since the works were started.

From the beginning of the financial year up till the outbreak of war things were running smoothly—the new engine started in March, 1914, was effecting economies in fuel and business was brisk; but when war broke out the Committee had to buy coal of inferior quality at greatly enhanced prices. Early in February anxiety was caused by inability to obtain coal, but the War Office, the Railway Commission and South-Eastern Railway Co. helped as much as they could, and removed the difficulty to a large extent. The department sold for Government purposes at satisfactory prices three 150 kw. sets which were out of date. The sale of the sets, which were wanted for wireless telegraphy, enabled the Committee to order from the Brush Electrical Engineering Co. a 1,250 kw. Ljungström turbine with rotary converter and switchgear, and it is hoped to have this set running by Christmas. Total revenue increased by £3,441, while the total costs went up by £2,043; gross profit was 8·4 per cent. on the total capital and 13·3 per cent. on the outstanding capital. All classes of demands for current show an increase except street lighting and tramways. Units sold for power form more than half the output, and increased by 31 per cent. The supply for lighting, although increasing, is becoming of less and less importance, due to the use of higher efficiency lamps and the ever-widening uses of electrical energy. These varying uses will bring down the cost of electricity and cheapen the supply all round. Average total cost per unit sold was 0·836d., or with capital charges 1·369d. To the dependents of the seven men in H.M. Forces allowances are made, and to the whole of the working staff a war bonus has been given in order to counteract the high prices of necessaries. Electric cooking is still throttled by the want of hiring powers, but the apparatus is greatly improved owing to extended use and experience. Mr. Hoadley says many hundreds of electric vehicles are now in use in this country with the most successful results, and he advises the Electricity Committee to do all in their power to further the use of electricity for cooking and heating, and to foster the use of electricity for charging electric vehicles by supplying at an inclusive charge per annum or per mile an electric vehicle for the Highways Committee. He also asks the Committee to consider a co-partnership or bonus scheme for the whole of the staff. The engineers of several electricity undertakings who have such schemes are unanimous in advocating it as a good investment from the Committee's point of view. Mr. Hoadley has a simple scheme which he proposes to submit to the Committee at an early date.

Tonbridge.—The electricity supply department's accounts for the year ended March 31 show gross capital expenditure £30,980 (increase £373), of which £10,816 has been repaid.

Revenue was £4,777, and working and general expenses were £2,495, leaving gross profit £2,281 (compared with £2,024 last year). Interest required £776, and instalments of loans £1,290 the net profit being £215 (compared with £110). Units generated were 463,619 (467,637) and sold 406,045 (394,511). Total maximum supply demanded was 198 kw. (200 kw.).

COMPANIES' MEETINGS AND REPORTS.

Montevideo Telephone Co. (Ltd.)

The twenty-seventh annual general meeting was held on Wednesday. Mr. Charles Lock presided.

The SECRETARY (Mr. R. H. Rees) read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN then said: The first item in the balance-sheet, the purchase price of property and additional outlay, was brought into the books at the commencement of the year as of the value of £180,000, and during the year we have added £5,945. Investments at cost show a substantial variation from last year, £49,289, against £41,452. During the year we have had considerable remittances from the other side, and have taken advantage of this to increase our investments by taking up some short notes of good class. Treasury notes and some War Loan, £5,000 of the latter. Our investments, as I have stated on previous occasions, are of quite good class and with one exception—a small amount of Austrian war loan, taken a couple of years ago—are all paying the interest expected when we acquired them. Bills receivable stand at £11,000, against £5,800, and cash figures at £10,798, against £14,847 last year. We thus have £21,798 of actual cash against £20,000—a strong cash position. The investments of £49,000 odd and our cash £21,700 put us in possession of actual liquid assets, realisable and available at very short notice, to the amount of £71,000 odd, our capital being £180,000, indicating an exceptionally strong position, and taking no account of assets of the real estate, £22,000, stores in Montevideo and sundry debtors. If we look at these figures above we have liquid assets, good realisable, solid assets of £194,000, the bulk of which probably every penny could be realised. The profit and loss account shows a slight diminution compared with last year, but I somewhat foreshadowed that result. We had intended but one month previously to last year's meeting a decrease in the number of our subscribers, and we said that that was likely to continue for a time. At the end of the financial year we had 1·6 fewer subscribers on our books than previously, but I am glad to say that business has been looking up of late in the Uruguayan Republic, and our last reports are that subscribers are commencing to show increases again. We show less gross revenue, £3,287, and only £2,748 less net revenue, which shows that we have been able to exercise substantial economies. Working expenses at Montevideo were substantially less than the previous year. Our net profit is £25,776, which amount will enable us to make the same appropriations to dividend account as we have done for the past seven or eight years, and will also enable us to make very substantial appropriations to depreciation and to the reserve for the renewal of plant. We apply £8,000 to depreciation as against £9,500 last year, and to reserve for renewal of plant we appropriate £9,000 against £9,500 a year ago. We carry forward £5,394 as against £5,303 brought in.

You will be glad to know that the new switchboard, when put into position, and when the operators had got thoroughly accustomed to its use, which took some little time, fulfilled all our expectations, and thoroughly justified the advice which Sir John Gavey gave us in recommending that particular type of switchboard. We are much indebted to him for his co-operation and for the close supervision he gave to the manufacture and erection of the board. With regard to the underground plant, having regard to the troublous times, we have not proceeded very energetically with the question of obtaining a concession to put the whole of our plant underground. We have not, however, lost sight of that idea or dropped it; on the contrary, our instructions to our local Board have been to keep the matter always before them, and, whenever a favourable opportunity occurs, to deal with it. We wish to give the public the benefit of a greatly improved system, and we shall be prepared to do so whenever we get the proper authorisation to proceed therewith. I now move the adoption of the report and accounts, and the declaration of the dividends set out therein.

Mr. J. G. LE MARCHANT seconded the resolution, which was carried unanimously.

The retiring director (Mr. J. G. Le Marchant), was then re-elected, as were the retiring auditors. A subscription of 50 guineas was voted to the British Red Cross Society, and a vote of thanks to the chairman and directors brought the meeting to a close.

BARBADOS ELECTRIC SUPPLY CORPN. (LTD.)—The profit for the year to June 30 was £2,230 (compared with £1,380 for the previous year), although there was a decrease in the profit from installation work and sales of electrical apparatus and stores. The war has reduced the number and size of new installations, and results have been affected by the increase in the cost of materials. £503 has been charged against trading for repairs and renewals, against £482 in previous year. This item again represents principally the cost of replacing poles, which expense is expected to continue for some time. The members of the advisory committee in Barbados have agreed to accept, as from the last date of payment (Dec. 31, 1912) half the fees previously paid. A moiety of the fees already charged in the accounts for the 18 months to June 30, 1914, has been credited to profit and loss account. No fees have been paid to the directors or to the members of the local advisory committee since the last report.

DICK, KERR & CO. (LTD.)—The chairman (Mr. Claud T. Cayley) stated at the meeting last week that the company's normal development had stopped, and their energies were transferred to the special requirements of the time. The profit on this year's trading was principally derived from orders and contracts taken before the war, and those were gradually falling in to a finish. Although they were busy now on abnormal work, there was bound to be a transition period occupied in re-establishing normal conditions, and it was because of that that the directors could not see their way to recommend a dividend on the ordinary shares. They were pleased because they believed that they, as a company, were assisting the Government to a material extent, but they were also hopeful that some reasonable profit proportionate to the efforts being made would be permitted—sufficient, at all events, to make it unnecessary next year to put such a large percentage of profit to reserve for contingencies. As to the Government's intention to absorb excess profits, especially if derived from work due directly to the war, no person could object to the principle, but at the same time no one could predict to what extent it would be applied, and it therefore behoved them to be ultra conservative in dealing with their accounts at present. Contracts were larger than they had been for some years. In the accounts they would observe that contracts figured at £460,365, which was larger than in many previous years.

INTERNATIONAL LIGHTING ASSOCIATION (LTD.)—The report for 1914 states that as the Para Gas Co. could not continue operations as an independent company unless additional funds were forthcoming, the directors of the gas company considered it advisable to approach the Para Electric Co., and as a result of their negotiations the electric company entered into an agreement to take over the gas undertaking on certain terms. After consideration the directors of the International Association decided to concur in the arrangement made with the Para Electric Co., and the transaction was duly completed on June 22 last, and in exchange for the association's holding of Para Gas Co. shares and debentures it has now received 820 6 per cent. cumulative preference shares of £5 each (fully paid) of the Para Electric Railways & Lighting Co., the sum of £1,031 5s. in cash, and £16,300 new 5 per cent. debentures of the Para Gas Co., containing the obligation of the Para Electric Co. for payment of principal, interest and sinking fund.

NORWICH ELECTRIC TRAMWAYS CO.—At the meeting on Tuesday the directors reported that the total receipts were £39,126 (against £39,121 in 1914) and the expenditure was £28,479 (against £28,044), leaving £10,647 (against £11,077). With £797, 7s. 8d. brought forward after paying the dividend and providing for reserve, the total is £11,444 8s. 1d. to be dealt with. The directors recommended that £2,500 be applied to

reserve, and £7,920 to payment of 3 per cent. dividend for the year ended June 30, leaving £1,024. 8s. 1d. to be carried forward. The number of car-miles run was 1,011,994 (against 1,048,275), and 9,471,883 passengers were carried (against 9,431,890).

SOUTH BRAZILIAN RAILWAYS CO. (LTD.)—At an extraordinary meeting last week resolutions approving a scheme of arrangement between the company and the holders of the first and second debentures were passed. Mr. Albert Mitchell, who presided, referred to the circumstances under which the company acquired the tramway system of Curityba as well as the electric light and power system of that city. He explained that, owing to the default of the contractor, it became necessary to take over the property in an incomplete state and to finish it for his account. To enable that to be done, he said, it had been necessary to obtain financial assistance, and, after negotiation, they were able to secure the assistance of their bankers in Paris and others, who made the necessary advances on the security of the company's bills, backed by the deposit of the unissued debentures. During the last two or three years the state of affairs in Brazil had been unsatisfactory from the financial and business point of view, and the inhabitants of Curityba had not used the tramways to the extent that it was undoubted they would do in normal times. Nevertheless, the tramway was just about paying its way and immediately normal times arrived they would be in a position to double the takings with little (if any) additional expenditure. The electric light and power department had shown most encouraging results, but it had also suffered from depression. Everything possible had been done to reduce the working expenses, which at present showed a satisfactory decrease compared with a year ago. It was proposed to create £240,000 of prior lien debentures in order to provide for the eventual liquidation of the floating debt and to give the company the necessary working capital.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ANGLO-AMERICAN METALS SYND. (LTD.) (141,904.)—Reg. Oct. 19, capital £3,000 in £1 shares (2,750 "A" and 250 "B"), to carry on the business of metal merchants, steam and other engine manufacturers, founders, galvanisers, electroplaters, cable makers, electrical engineers, &c., and to adopt an agreement with S. A. Yorks and J. O. Lawson-Johnston. Private company. First directors are J. O. Lawson-Johnston and S. A. Yorks (both permanent). Secretary, J. O. Lawson-Johnston. Reg. office, Trafalgar House, Waterloo-place, S.W.

MICA LUBRICANT CO. (LTD.) (141,895.)—Reg. Oct. 16, capital £5,000 in £1 shares, to take over the business carried on as the Mica Lubricant Co., to carry on the business of lubricant and packing manufacturers, manufacturers of and dealers in grease, asbestos and indiarubber goods, &c. Private company. First directors are A. Purvis, A. P. Purvis, W. W. Wilkin (manager), L. Bird and N. Sturrock. Reg. office: 63, King-street, South Shields.

UNITED TUBE CORPN. (LTD.) (141,902.)—Reg. Oct. 18, capital £150,000 in £100 shares, to carry on the business of manufacturers of and dealers in munitions of war and solid drawn, lapwelded and other tubes, wire drawers, smelters, engineers, metallurgists, aluminium coaters, stampers, tool makers, electrical and water supply engineers, &c. Private company. First directors are Col. J. R. Wright, S. Baldwin, M.P., J. C. Davies, G. Hethey, H. W. Dunn and A. Hethey.

STATUTORY RETURNS.

BLACKBURN, STARLING & CO. (LTD.)—Return to Aug. 5 gives capital as £12,000 in £1 shares. All shares taken up and £8,100 paid. £3,900 considered as paid. Mortgages and charges: Nil.

BRITISH ARC WELDING CO. (LTD.)—In return to July 15 capital is £15,000 in £10 shares. 657 shares taken up. £10 per share called up on 457 and £4,570 paid. £2,000 considered as paid on 200 shares. Mortgages and charges nil.

CHILI TELEPHONE CO. (LTD.)—In return to July 28 capital is £360,000 in £5 shares. 66,000 shares taken up. £220,000 paid and £110,000 considered as paid. Mortgages and charges, nil.

CHRISTY BROTHERS & CO. (LTD.)—Return to July 20 gives capital as £12,000 in £1 shares (3,000 deferred). 7,926 ordinary and 3,000 deferred shares taken up. £1,826 paid. £9,100 considered as paid. Mortgages and charges, £4,600.

CROMPTON & CO.† (LTD.)—Capital in return to July 19 is £221,007 in £1 shares (136,000 preference). 79,539 Ordinary and 136,000 preference shares taken up, of which 2,240 preference have been forfeited. £1 per share called up on seven ordinary and 7s. 6d. per share on 133,760 preference. £50,788. 2s. 8d. paid (including £621. 2s. 8d. paid on 2,240 preference shares forfeited). £163,132 considered as paid, being £1 per share on 219,532 ordinary and 12s. 6d. per share on 133,760 preference. Mortgages and charges, £100,000 first mortgage debentures.

MORTGAGES AND CHARGES.

HONG KONG TRAMWAY CO. (LTD.)—Memorandum of satisfaction to extent of £200 on Sept. 7 and £300 on Sept. 20, 1915, of trust deed dated July 1, 1903, securing £195,000, has been filed.

WEISS & BIHELLER (CANADA) (LTD.)—Memorandum of satisfaction in full on Oct. 12, 1915, of debentures dated Oct. 24, 1913, securing £12,000, has been filed.

CITY NOTES.

MEMORANDA (Oct. 27).—Bank rate 5 per cent. (since Aug. 9, 1914). Consols 65 ½. Consols Pay Day Nov. 1. Stocks and Shares Ticket Days Nov. 11 and 25. Pay Days Nov. 12 and 26. Price of silver [illegible].

BANK FÜR ELEKTRISCHE UNTERNEHMUNGEN ZURICH.—The profits for 1914-15 amounted to £[illegible], compared with £[illegible] in 1912-13, after writing off £62,[illegible] cost of issue of bonds this year and setting aside 250,000 f. for war tax. It is paying 8 per cent. against 10 per cent.

BRISBANE ELECTRIC TRAMS INVESTMENT CO. (LTD.)—The directors have declared a dividend of 4s. per share (less Income-tax) on the ordinary shares, payable Nov. 1.

COMPANIES TO BE STRUCK OFF THE REGISTER.—The following will be struck off the Register unless cause to the contrary is shown before Jan. 8: Budleigh Salterton Electric Light & Power Co., General Engineering Co., Liverpool Traction, Light & Power Investment Trust, Oil & Gas Turbine Synd., Power Synd. of South America, Russian Wireless Telegraph Trust, Telenews, Vacuum Electric & Gas Heating Appliances, Walker Reversible Turbine Co.

HUELVA GAS & ELECTRICITY CO. (LTD.)—The directors announce that it will be impossible to provide the interest due 11th prox. on the debenture stock.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a dividend of 1½ per cent. for at rate of 6 per cent. per annum on the common stock for the quarter to 31st inst.

LISBON ELECTRIC TRAMWAYS (LTD.)—The directors have declared an interim dividend of 2½ per cent. tax free, on account of earnings of current year, payable 12th prox.

NEW ST. HELENS & DISTRICT TRAMWAYS CO. (LTD.)—The directors have declared a dividend of 2½ per cent. (2s. 6d. per share) on the preference shares, £5,000 has been placed to reserve and £6,557 carried forward.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors recommend to the shareholders at the approaching meeting payment of the following dividends: 6s. per share on the first and second preference shares (for the six months to June 30, 1915) and 9d. per share on the ordinary shares (tax free).

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Oct. 27. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Wed. Oct. 27.	Rate per cent Yielded	Dividend Due
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 2 8	Mar. Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 6	Feb. Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅞	6 1 4	Feb. Aug
5	10%	Brompton & Kensington Ord.	3⅞	6 0 1	Mar. Sept
St.	4%	Central Elec. Supp. G. Deb. St.	92½	4 6 5	.. ..
St.	4%	Charing Cross West End & City Debs.	[illegible]	4 16 4	Jan. July
5	2/3	Do. 4½% Pref.	3[illegible]	[illegible]	.. ..
5	5%	Do. Ord.	4	2 [illegible] 0	Aug. Feb
10	9%	City of London Elec. Lt. Ord.	11[illegible]	7 11 [illegible]	Feb. Aug
10	6/0	Do. 6% Pref.	12[illegible]	4 17 0	Mar. Sept
St.	5%	Do. 5% Deb. St.	9[illegible]	5 0 [illegible]	[illegible]
10	7%	County of London Ord.	[illegible]	[illegible] 3 [illegible]	Mar. Sept
10	6%	Do. 6% Pref.	[illegible]	6 0 [illegible]	Feb. Aug
St.	4½%	Do. 2nd Deb.	97	4 12 [illegible]	May. Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	7[illegible]	5 17 6	Jan. [illegible]
5	9%	Kensington and Knightsbridge Ord.	[illegible]	7 5 [illegible]	Feb. Aug
St.	4%	Do. Deb. St.	8[illegible]	4 13 [illegible]	Jan. July
5	3/0	London Elec. Supp. 6% Pref.	[illegible]	[illegible] [illegible] [illegible]	.. ..
St.	4%	Do. 4% Mort. Debs.	8[illegible]	4 11 11	Jan. July
5	3½%	Metropolitan E. Supp. Ord.	[illegible]	[illegible] [illegible] [illegible]	Mar. Aug
St.	4½%	Do. 1st Mort. Deb.	9[illegible]	4 14 [illegible]	Jan. July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	[illegible]	5 [illegible] [illegible]	[illegible]
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs.	[illegible]	[illegible] [illegible] [illegible]	Mar. Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	10[illegible]	[illegible] [illegible] [illegible]	Mar. Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref.	[illegible]	[illegible] [illegible] [illegible]	Apl. Oct
4	5%	South London E.S. Ord.	[illegible]	[illegible] [illegible] [illegible]	Mar. Sept
St.	4½%	Urban Elec. Supp. 4½% Db. St.	[illegible]	[illegible] [illegible] [illegible]	Apl. Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	[illegible]	[illegible] [illegible] [illegible]	May. Nov
5	9%	Westminster E.S. Corp. Ord.	[illegible]	[illegible] [illegible] 0	May. Sept
5	4½%	Do. 4½% Cum. Pref.	[illegible]	[illegible] [illegible] [illegible]	Jan. July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	78	[illegible] [illegible] [illegible]	Apl. Oct
St.	6%	Do. 6% Cum. Pref.	[illegible]	[illegible] [illegible] 1	Feb. Aug
St.	4%	Central London Guar. Assented Ord.	[illegible]	[illegible] [illegible] [illegible]	.. ..
St.	4%	Do. do. Assented Def. Ord.	[illegible]	[illegible] [illegible] [illegible]	.. ..
St.	4½%	Do. 4½% Pref.	[illegible]	4 10 0	Jan. July
St.	4%	Do. 4% Deb. St.	[illegible]	4 [illegible] 9	[illegible]
St.	4%	City & S. London Deb.	[illegible]	4 15 3	Mar. Nov
St.	5%	Do. Pref. 1890	[illegible]	6 5 0	Feb. Aug
10	5½%	Lanarkshire Tramways	[illegible]	[illegible] 17 11	Jan. July
10	1%	London Electric Ry. Ord.	[illegible]	[illegible] [illegible] [illegible]	Jan. July
St.	4%	Do. 4% Pref.	[illegible]	[illegible] 2 10	Mar. Sept
St.	4%	Do. 4% Debs.	[illegible]	4 14 4	Jan. July
St.	1%	Metropolitan Ry. Con. Ord.	[illegible]	4 12 1	Feb. Aug
St.	3½%	Do. 3½% Pref.	[illegible]	4 10 [illegible]	Feb. Aug
St.	3½%	Do. 3½% Convertible Pref.	[illegible]	4 14 [illegible]	Feb. Aug
St.	3½%	Do. 3½% A Debs.	[illegible]	4 4 6	Jan. July
St.	3½%	Do. 3½% Debs.	[illegible]	4 4 1	Jan. July
St.	..	Metropolitan Dist. Ry. Ord.	[illegible]	.. ..	Feb. Aug
St.	4%	Do. 4% Prior Lien	[illegible]	4 7 0	May. Nov
St.	4½%	Do. 4½% First Pref.	[illegible]	[illegible] 15 0	Feb. Aug
St.	6%	Do. 6% Perp. Debs.	[illegible]	4 12 8	Jan. July

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Wed., Oct. 27	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways	—*cont.*		
St	4%	Metropolitan Dist. Ry. 4% Debs.	66½	5 14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	68½	5 16 9	Jan, July
St.	4%	Do. 4% Guar. Stock	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares	1½	..	..
1/0	..	Do. A Ord.	½	..	..
St.	6%	Do. 6% Inc. Debs.	103	5 16 6	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 16	70½	8 9 7	Mar, Sept
..	4½%	Do. 4½% Bds.	98	4 12 1	Jan, July
5	..	Yorkshire W. Riding Ord.	⅜	.	March
5	6%	Do. Pref.	4	6 15 3	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2½	6 11 9	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 11 9	Mar
100	5%	Do. Prior Lien Debs.	92½	5 8 1	Jan, July
1	6%	Do. 6% Pref.	⅞	6 13 4	Jan. July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 2 10	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5	6 0 0	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1⅛	7 14 10	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70½	5 13 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10½	7 6 4	Jan, July
5	2/6	Do. 5% Pref.	4½	5 17 8	Feb, Aug
1	15%	Castner Kellner	3	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
1	6%	Elec. Construction Ord.	⅝	9 12 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10⅜	9 12 3	July
10	6%	Do. 6% Pref.	9⅞	6 9 0	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅛	7 16 1	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7½	6 6 7	Feb, Aug
10	5%	Do. Pref.	8⅜	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	97½	4 2 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	32½	7 0 7	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅛	4 12 4	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82½	4 17 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100	4 10 0	Jan, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	102	5 17 7	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22½	6 11 2	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	66	6 1 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛†	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½†	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅞	6 8 8	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	122†	5 14 9	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	65½	5 6 6	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81½	4 18 2	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	76½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11⅛	5 19 2	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	5 19 5	Ja, My, Jly
25	13%	Indo-European	47½	6 16 10	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅝	5 3 3	April
1	7%	Do. 7% Pref.	1⅜	3 19 0	July
10	9d.	West India & Panama Ord.	1	10 0 0	May, Nov
10	6%	Do. 1st Pref.	8⅞	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 16 1	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	76½	5 0 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	100†	4 10 0	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	129½	6 3 7	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	75	6 13 4	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅝	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101½	4 7 9	May, Nov
1	10%	Oriental Telephone Ord.	11⅜	5 2 7	Apl, Oct
St.	4%	Do. Db. St.	80	5 0 0	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 5	Jan, July
5	8%	United River Plate Ord.	8⅛	7 0 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	12	6 0 0	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	9⅞	6 0 0	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80	6 5 0	Ja, Apl, Jly,O
..	4%	Do. $100 Pref.	68½	5 16 9	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	131	6 16 9	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams 5% Debs.	78½	6 7 9	Jun, Dec
St.	4½%	Do. 4½% Debs.	74½	6 1 1	Jan, July
St.	4%	Do. 4% Debs.	73½	5 9 1	Jan, July
5	2/9	Do. 5½% 1st Pref.	3⅞	7 14 5	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅜	7 10 5	Jan, July
100	2%	Brazilian Traction Ord.	84½	6 11 0	Fb,M,Aug,N
100	$1⅛	Do. 6% Pref.	24½	6 13 1	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6¼	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4⅜	5 5 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64½	7 5 5	..
5	9½%	Calcutta Elec. Trams. Ord.	8⅝	7	May, Sep
..	5%	Havana Elec. Ry. 5% Bds.	85½	11 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	..	6 0 0	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Tram. Common St.	19½	..	Fb,M,Aug,N
..	5%	Do. 5% Bds.	50	10 2 4	May, Nov
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	..	4 14 1	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 5% 1st Mt. Bds.	76½	6 11 0	Jan, July
100	4½%	Toronto Railway Co. 4½% Bds.	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅝	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	97	5 3 1	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10½	5 14 6	..
5	9%	Calcutta E. S. Corp. Ord.	6	6	May, Nov
5	5%	Do. 5% Pref.	4⅝	5 4 3	May, Nov
..	7%	Canadian Gen. Elec. Common St.	147½	5 2 11	Ja,Ap,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	94½	5 2 5	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	April, Oct
..	5%	Shawinigan Water & Power 5% Bds.	134½	4 17 4	Jan, July
..	6%	Do. Cons. Stock	142	4 4 3	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	88	4 13 5	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	86	5 1 2	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf.	⅜	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	92½	6 1 3	Jan, July

† Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Oct. 27, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13½d.	English Lead	£25 10 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15½d.	**Old Metals.**	per ton.
Brass Wire	12½d	Clean Scrap Copper	£70 0 0
Copper Wire	12½d.	Brazlery Copper Scrap	£59 0 0
Rolled Brass	12⅝d.	Clean Scrap Brass	£52 0 0
Brass Sheets	13⅛d.	Old Lead	£21 10 0
		Old Zinc	£35 0 0
	per ton.	Hollow Pewter	£105 0 0
Copper Sheets	£103 0 0	Black Pewter	£75 0 0
Spelter	£68 0 0	Gun Metal	£60 10 0

Mr A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Oct. 26, the following approximate prices of Scrap Metals:—

	per ton.		per ton
Aluminium Cuttings	£95 0 0	Old Lead	£22 0 0
Clean Mixed Brass	£54 0 0	Tea Lead	£20 0 0
Clean Copper	£70 0 0	Old Zinc	£42 0 0
Brazlery Copper	£63 0 0	Hollow Pewter	£110 0 0
Gun Metal	£62 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £68; Commercial Tinman's Solder, £33; Blowpipe Solder, £98.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Oct. 22	1,674	+ 209	20	37,497	+ 1,725
Anglo-Argentine	,, 21	50,754	+ 1,541	20	2,138,066	— 135,887
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	,, 23	254	+ 22	23	10,636	+ 555
Birkenhead Corporation	,, 24	1,282	+ 104	30	41,231	+ 3,171
Birmingham Corporation { Trams	..	..	..	..	..	..
Birmingham Corporation { Buses	..	..	..	..	..	..
Blackburn Corporation	,, 20	1,173	+ 51	30	40,048	— 525
Blackpool Corporation	,, 21	822	+ 112	30	62,254	+ 1,249
Blackpool and Fleetwood	,, 6	393	— 18	42	35,938	— 244
Bolton Corporation	,, 24	2,581	+ 240	30§	81,036	— 2,412
Bournemouth { Trams	,, 22	1,970	+ 313	29	65,440	+ 3,463
Bournemouth { Buses	,, 22	8	— 1	29	850	— 102
Bradford Corporation	,, 23	6,149	+ 332	29	197,304	+ 8,433
Brighton Corporation	,, 24	956	+ 40	30§	35,930	— 30
Bristol Trams { Trams	,, 22	4,722	+ 46	42	197,788	+ 1,146
Bristol Trams { Buses, &c.	,, 22	4,761	+ 1,394	42	205,875	+ 36,647
Burmah E. Trams & Ltg.	,, 23	R4,613	+ R1,181	42	R151,806	— R2,754
Burnley Corporation	,, 23	1,854	+ 226	3	4,733	+ 713
Burton Corporation	,, 24	263	— 21	30	8,749	— 332
Bury Corporation	,, 24	1,255	— 105	30§	41,636	— 865
Calcutta Tramways Co.	,, 23	R59,650	+ R4,192	..	..	..
Camborne-Redruth	,, 26	141	+ 10	42	5,827	+ 10
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 21	450	+ 19	42	21,353	+ 7
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	,, 26	992	+ 40	29¶	31,629	+ 803
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	,, 22	136	+ 7	16	2,697	+ 82
Dublin United	,, 22	6,062	+ 299	42	259,043	+ 10,007
Dundee Corporation	,, 20	1,344	+ 118	23§	31,421	+ 1,603
East Ham Council	,, 23	1,265	+ 79	29¶	39,345	+ 5,607
Exeter Corporation	,, 22	347	+ 16	29	11,688	+ 680
Glasgow Corporation	,, 23	21,965	+ 1,554	21‡	451,767	+ 34,416
Glossop Trams	,, 23	128	— 28	43	5,407	— 97
Gloucester Corpn.	,, 20	309	— 22	29	10,092	— 103
Halifax Corpn. { Trams	,, 19	2,167	— 84	29	67,653	+ 867
Halifax Corpn. { Buses	,, 19	47	+ 3	29	1,510	— 10
Hastings Elec. Trams Co.	,, 21	674	— 18	42	42,285	— 39
Huddersfield Corpn.	,, 23	2,513	— 178	29	81,314	— 12,400
Hull Corporation	,, 23	3,042	+ 130	29	90,176	— 3,661
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	,, 21	129	+ 14	29	3,957	+ 93
Ipswich Corporation	,, 23	511	+ 107	28	17,449	+ 2,695
Isle of Thanet Co.	,, 23	287	— 85	39	1,073	— 432
Kilmarnock Corporation	..	..	..	..	..	..
Lanarkshire Trams Co.	,, 21	2,318	+ 387	42	83,323	+ 3,689
Lancashire United	,, 20	1,718	+ 144	42	73,489	+ 4,951
Leeds Corporation	,, 23	5,000	+ 721	30	269,187	+ 21,201
Leicester Corporation	,, 23	3,[illegible]	+ 41	43	128,714	+ 6,837
Leith Corporation	,, 23	742	— 65	23	18,253	— 1,096
Lincoln Corporation	,, 23	128	+ 17	30	4,245	— 460
Liverpool Corporation	,, 16	13,[illegible]	+ 1,095	41¶	553,170	+ 6,667
Llandudno Colwyn Bay & Conway R.	,, 17	250	+ 73	42	16,319	+ 1,583
London County Council	..	..	..	..	..	..
Lowestoft Corporation	,, 23	1,[illegible]	— 54	30	428	— 228
Maidstone Corporation	,, 21	[illegible]	+ [illegible]	29	6,796	+ 154
Manchester Corporation	,, 23	17,892	+ 1,444	[illegible]	[illegible]	+ 17,048
Nelson Corporation	,, 23	[illegible]	+ 46	[illegible]	[illegible]	— 35
Newcastle-on-Tyne Corpn.	,, 23	6,365	+ 672	[illegible]	[illegible]	+ 26,768
Newport (Mon.) Corpn.	,, 16	[illegible]	+ [illegible]	29	[illegible]	+ 102
Northampton Corporation	,, 23	[illegible]	+ 97	29¶	23,142	+ 4,416
Nottingham Corporation	,, 21	3,689	+ 395	29	110,866	+ 7,406
Oldham Corporation	,, 24	2,240	+ 357	31	72,031	+ 2,484
Portsmouth Corporation	,, 16	2,361	+ [illegible]	[illegible]	76,537	..
Preston Corporation	,, [illegible]	[illegible]	+ 118	29••	28,425	+ 572
Rochdale	..	..	..	..	..	..
Rotherham Corporation	,, [illegible]	1,167	+ 92	29	33,690	+ 3,325
Salford Corporation	,, [illegible]	[illegible]	+ 487	[illegible]	[illegible]	+ 5,799
Sheffield Corporation	..	..	..	..	..	..
Southport Corpn.	,, [illegible]	1,459	— 321	[illegible]	44,928	+ 330
Southend Corporation	,, [illegible]	[illegible]	— 67	29	26,754	— 7,365
South Shields	,, [illegible]	775	+ 95	28¶	23,397	+ [illegible]
Stalybridge Hyde Mossley & Dukinfield	..	..	..	..	..	..
Stockport Corporation	,, [illegible]	1,425	+ [illegible]	[illegible]	45,171	— 217
Sunderland District	,, [illegible]	[illegible]	+ 47	[illegible]	[illegible]	— [illegible]
Swansea Corporation	,, 20	[illegible]	+ 19	29	[illegible]	— [illegible]
Tynemouth Tram Co.	,, [illegible]	[illegible]	— [illegible]	15	[illegible]	— [illegible]
Walsall Corporation	,, [illegible]	1,116	+ [illegible]	[illegible]	[illegible]	— [illegible]
Walsall Corporation	,, [illegible]	[illegible]	— 144	43	[illegible]	— [illegible]
Wigan Corporation	,, [illegible]	[illegible]	+ 42	30	[illegible]	+ 3,282
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	,, [illegible]	[illegible]	+ [illegible]	[illegible]	[illegible]	+ 9,124
Wigan Corporation	,, [illegible]	[illegible]	— [illegible]	29	[illegible]	+ 1,717
Wisbech & District	,, [illegible]	[illegible]	— 194	3	[illegible]	— 134
Yorkshire (W. Riding)	,, [illegible]	[illegible]	+ 114	43	[illegible]	+ [illegible]

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days ‖ Plus 3 days ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMEER.

NOTES 151
Arrangements for the Week .. 154
Control and Protection of Electric Systems. By C. P. Steinmetz 155
The Application of Electricity to the Heating of Metals. By F. L. Bishop. Illustrated 158
The Electric Furnace for Re-Heating, Heat Treating and Annealing. By T. F. Baily 159
On an Adjustable Prism-Shaped Multiple Spark-Gap. By B. Thieme 162
Electrification on the London & South-Western Railway. Illustrated. *Concluded* 163
Artificial Illuminants for Use in Practical Photography. By C. E. Kenneth Mees, D.Sc. 167
ELECTRICITY APPLIED TO THE HEATING OF METALS 168
Some Problems of Electro-magnetic Induction. By Prof. G. W. O. Howe, D.Sc. Illustrated 169
The Relation of Science to Practice in Engineering .. 172
CORRESPONDENCE 172
Sine Wave Alternators (Charles V. Drysdale).
Distributed Capacity of Solenoids (G. W. O. Howe).
Impregnated Stockingette.
Col. J. F. Lister's Address to the Birmingham Local Section of the I.E.E. 173
The Installation and Working of Storage Batteries 175
Educational Notes 175
PARLIAMENTARY INTELLIGENCE 176
The "Electrician" Commercial and Industrial Section .. 177–184

NOTES.

The Taxation of Excess Profits.

SOME little time ago it was announced that where the profits of a company amounted to more than the average of the last two or three years before the war the excess would be taxed at a high rate. This seemed to be a reasonable method of obtaining revenue. Now, however, it appears that the maximum profit to be permitted is to be 6 per cent. This is a much more serious proposition, more particularly in the case of electricity supply companies and tramway companies, which generally work under a limited tenure. Many such companies are paying dividends at the present time of about 8 per cent., and this is by no means too much when it is remembered that a large part of the capital must be repaid before the date of compulsory purchase, and that the dividends paid in the early years by such undertakings were very small—indeed in many cases no dividend was paid for some years. Apart from this, however, it appears that the profits are to be arrived at on the basis which is usually followed in assessments for income tax. In other words, the writing off of capital expenditure is not permitted, and an allowance for wear and tear or renewals is only allowed on a very modest scale, much more modest than would be considered reasonable in sound commercial working. This makes a very serious difference in arriving at a figure of profit, and leads to a result which may show a profit from the point of view of assessment when there is no true profit from the commercial standpoint. We fear, therefore, that if this method is to be followed, the profits paid by certain companies during the war will be reduced very heavily, below that which they have paid hitherto or during the last two or three years. Not only may this have a very baneful effect upon the future of an undertaking, but it will certainly cause considerable hardship to shareholders, more particularly those who have made investments within recent years, and have necessarily purchased at a price which assumes that a reasonable dividend will be maintained. An enforced reduction of profits would mean a serious reduction in the value of the securities affected. We trust, therefore, that the Government will look into the question further from the commercial point of view, and not merely as an academic matter.

After the War.

THAT others are fully alive to the conditions which are likely to prevail in the future is shown by an article in the last issue of "Engineering." An account is given of a meeting held in Germany to promote export trade at the termination of the war, and it is evident that, with characteristic thoroughness, the Germans have prepared an organisation to deal with the subject. According to our contemporary, Prof. HARMS, of the Society for the Promotion of the Institute for Maritime Traffic and World Commerce, gave a lecture on the necessity for a careful cultivation of German foreign trade after the war, and at the same time pointed out that even during the war the necessary steps must be taken. The meeting considered the further development of the Foreign Trade Department of the War Committee of the German Industry for the furtherance of German commerce in the domain of foreign trade, and stated their intention of entering into communication with other commercial associations so as to do justice to the widely ramified interests of the Fatherland. It is well for our readers to know these things, and for them to prepare. Britain needs no Society for the Promotion of World Commerce. Modification of the scope and aims of existing societies and institutions, together with an all-round awakening, will go far in meeting the threatened rivalry; but, as we have said, it is well for us to know what the other man is doing.

Supply of Technically Trained Men.

A SUPPLY of suitable men for undertaking advanced technical work in the offices and shops of engineering firms can be obtained from the following sources: (*a*) Post-graduates from the technical universities and colleges, and (*b*) assistants from works. Inability to appreciate practical demands and lack of perseverance, which practice teaches, are the principal drawbacks of the purely college trained man. From an engineering standpoint, the men from the works are decidedly superior, owing to their riper judgment and clearer appreciation of practical needs; but as a rule such men find it necessary to take or re-take the final year of the degree course before commencing research. Institutions exist in which the training of men for undertaking advanced technical work can be effected. In these institutions, of which the Imperial College of Science and Technology is deservedly one of the best known, courses of study have been specially arranged for this purpose. As an example of a successful arrangement, the advanced courses in electrical engineering at the City and Guilds (En-

gineering) College may be mentioned. In this college the students are encouraged to undertake research work in co-operation with the members of the staff under whom they are working. In this way suitable guidance is given to the student in his work, along with the necessary assistance and encouragement. The result is usually the publication of a Paper of direct engineering interest. In connection with Government encouragement and endowment of research work, an important matter arises concerning the position of those professors and teachers who have hitherto been engaged in research and in the training of others in research. Since most of this work has been of a voluntary nature, there is a danger of losing a valuable asset if such work is ignored. Teachers engaged in prosecuting researches and in training men to carry out original and independent work should be officially recognised and remunerated. Furthermore, care should be taken that the position acquired by these teachers through such work should neither be lost sight of, nor injuriously affected in, or by, any comprehensive scheme which may be formulated.

Alien Enemy Patents.

Elsewhere we give an abstract of the report of the Special Patents Tribunal of the Patent Office which was constituted last year for the purpose of dealing with the applications for licences, &c., under patents owned by alien enemies. The number of applications was 387, but only 294 patents were involved. 245 licences were granted, two patents were voided and 31 applications were refused, either because the applicants were not fit or competent to carry on the manufacture, or because it had not been established that there was a demand for the article covered by the patent. We think no objection can be taken to the procedure adopted by the Tribunal, for the general rule has been to grant licences rather than to annul the patent. Except for grave reasons of State, it would be inequitable to confiscate the private property of individual alien enemies at this stage. We can afford to await events and see what treatment will be meted out at the end of the war to our nationals who own German patents. We question, however, whether the Board of Trade are wise in insisting upon evidence of the applicant's ability to manufacture or that there is a demand for the article covered by a patent. It is not easy to supply evidence of this, for time alone can prove whether there will be a demand for an article. It is satisfactory, however, to note that it is the intention of the Board of Trade to make the licences granted to British traders of a permanent character; otherwise it would not pay a British firm to incur the expense and trouble of making preparations to manufacture under a patent. We are not surprised to learn that in some cases, and particularly in the chemical and machine embroidery industries, more than one application was necessary, for it was found that the position was somewhat complicated owing to the fact that a group of patents related to certain inventions, and there were patents of addition, &c. We doubt whether the Tribunal has been liberal enough in the grant of licences, for in some instances within our knowledge German articles which are now manufactured under licence in this country cost from 120 to 150 per cent. more than they did before the war. The manufacture of articles such as these cannot be profitably continued here after the war, except with the aid of a strong protective tariff, and this may not be available.

Practical Science.

We are now approaching the time of year when every society or section of a society listens to a presidential address. It is perhaps only natural that under present conditions these addresses should bear very largely upon some phase of the gigantic struggle in which we are engaged. We deal with two of these addresses in our present issue. That of Col. J. F. Lister to the Birmingham Section of the Institution of Electrical Engineers deals essentially with war, and outlines the very important duties that are carried out by signal units in the field. It is a subject with which few civilians are familiar, but it is one that has assumed enormous importance with the extension of the modern battle line. On the other hand, the presidential address by Prof. E. W. Marchant to the Liverpool Engineering Society deals particularly with the relation of science to practice in times of peace. Prof. Marchant gives some interesting examples of the progress that has been effected by suitable investigation. Thus, the cost of static transformers 20 years ago was £2. 10s. per kilowatt, whereas large transformers can now be built for 10s. per kilowatt. This great reduction in price would not have been possible but for investigations which resulted in the production of special steel, or in the realisation of the most suitable methods of dissipating the heat that is produced when the transformer is in use.

As an example of what can be done at the present time Prof. Marchant mentions the case of the magneto. When war broke out Germany had obtained practically a monopoly in the manufacture of this type of machine. In order to fill the gap Mr. Watson worked out a design of magneto on scientific lines superior to that which had formerly been imported from Germany. A company was formed which is now making 250 of these machines a week, and will soon be making from 1,000 to 1,500 per week. What we feel about this kind of investigation is that its value is realised theoretically in this country, and the work that is done by companies abroad is recognised. The research laboratory of the General Electric Co. of America is well-known, and the results that have been obtained have been published far and wide. Yet we doubt if any serious effort is being made to vary the haphazard way which we have followed for years. Spasmodic efforts are all very well in their way, but they cannot possibly replace effectively the organised efforts of well-directed industrial research carried out by manufacturing companies.

The Passing of Red Tape.

In ordinary times there are many vexatious statutory and administrative checks upon municipal work, more particularly in regard to capital expenditure for the development of business undertakings, such as electricity supply and tramways. Naturally the war has not made things easier in this respect owing to the insistent call for economy. It is, however, quite refreshing to come across a case where a manager of municipal electricity works has had the courage to break through the hide-bound regulations and to do what is obviously the right thing. The demand for electrical energy for power and industrial purposes is so great in Sheffield that large extensions have had to be carried out recently. These, however, have proved insufficient, and further extensions are urgently required in order to maintain an efficient supply of energy to the many important munition works in the district. Rather than run any risk, the energetic and enterprising manager of the electric supply department (Mr. S. Edgar Fedden) placed orders for plant of the value of about £12,000 on his own responsibility. When the position was explained, the Electric Supply Committee and the Council approved the action of their general manager, though we doubt very much if the L.G. Board officials will be pleased at his unorthodox ways. However, Mr. Fedden need not be greatly perturbed by the criticism of the Board, for it is obvious that he acted

rightly in the present circumstances, when it is so difficult to get contracts for plant placed. National and municipal interests ought to be the first consideration, and his example may have a stimulating effect upon administrative departments. At all events, we hope so; in fact, we should like to see Mr. FEDDEN at the head of the L.G. Board for six or twelve months, for we are sure he would introduce some business methods into that department.

An Electric Gun (?)—Mons. Bachelet, who will be remembered as the proposer of the "flying train" a few years ago, is now said to be bringing forward an electric gun acting on the same principle.

Nobel Prizes.—It is reported that the Swedish Academy of Sciences has decided to apply to the Swedish Government to postpone the awards of the Nobel prizes for physics and chemistry until 1916.

Director of Factory Construction.—Mr. John Hunter, managing director of the firm of Sir William Arroll & Co., has resigned from the board of directors of that company to accept the invitation of the Minister of Munitions to become Director of Factory Construction in connection with the National Projectile Factories now being erected in various places in the country.

Electrical Fog Dispelling.—It is reported from San Francisco that experiments are to be carried out there shortly with an electrical machine for the dispelling of fog. The apparatus, constructed by Government scientists at the Panama-Pacific Exposition, will be a huge transformer that can take 1,000 kw. at 2,300 volts. This is to be stepped up to 1,000,000 volts. It is expected to produce a broad and continuous arc 100 ft. long.

Electric Trucks at Cristobal.—Some particulars of the motor coal trucks used at Cristobal on the Panama Canal are given in "Power." These are of 10 tons capacity, and driven by a three-phase 25-cycle 440-volt motor, which can drive the car at 200 ft. per min. Men are required to load, start, dump and stop the cars, but no attendants need travel with the cars. A headway of 30 seconds is allowed, enabling one loop of track to deal with 1,000 tons per hour. For Balboa coaling station 34 cars of a very similar design will also be built.

Use of the Flame Arc in Paint and Dye Testing.—In a recent Paper read before the American Electrochemical Society, Mr. W. R. Mott stated that a white flame arc of 25 amperes gives at a distance of 2 ft. a light more intense than summer sunlight, and in paint and dye testing would have the advantage over sunlight that it would be available in exactly the same intensity and direction for the whole 24 hours of the day. The high amperage white-flame arc has now no rival as the cheapest and most powerful source of light for photo engraving, and is becoming more and more extensively used for blue-printing, photographic studio work, and the manufacture of chemicals by night.

Mine Rescue Signalling Device.—Writing in "The Coal Age" Mr. O. Cartlidge, manager of Mine Rescue Stations, Illinois, has described a cheap and convenient signalling outfit for men engaged in rescue work in mines. Three No. 6 Columbia dry cells are placed in the centre of a drum on which is wound 1,000 ft. of round insulated No. 16, 3-wire cable. Signalling is effected by pressing buttons operating "buzzers" of the ordinary type. That at the free end of the cable is fastened to the rescuer's belt, and about 5 ft. along the wire from this is attached a stout cord at the other end of which is a hand-grip, so that the man can pull the cable along without straining the connections; similar hand-holds are placed at intervals along the wire for other members of the gang. This apparatus (which does not weigh more than 100 lb.) has an advantage over a telephone in that the signaller does not have to attempt articulation in a suffocating atmosphere.

India Office Appointment.—Mr. George H. Collier has been appointed Director-General of Stores at the India Office in succession to Mr. H. J. W. Fry, C.I.E., retired, and Mr. Richard R. Howlett succeeds Mr. Collier as Deputy Director-General of Stores.

Electrification on the Lancashire & Yorkshire Railway.—According to the "Tramway and Railway World," the conversion of the railway between Manchester (Victoria Station) and Bury, *via* Prestwich, to electric working on the third rail system, is expected to reach completion during this month. Power will be obtained from Manchester Corporation until the power-house at Clifton Junction is completed. Corridor carriages will be provided similar to those on the Liverpool-Southport electric line.

Radiography of Metals.—In the research laboratory of the General Electric Co. Mr. W. P. Davey has been making investigations into the possibility of detecting blow-holes in steel castings, which he has described in the "General Electric Review." Having found that this was possible in castings $\frac{9}{16}$ in. thick when using a Coolidge tube, experiments were carried out with a view to finding the exposure needed for a given thickness and the smallest size of air-hole that could be shown radiographically in a given thickness. The following equations were found to hold good approximately for different thicknesses of metals and voltages, corresponding to different spark gaps between points. If E is the exposure in milliampere minutes, and X the thickness of the steel in centimetres, for a 15 in. spark gap $E=0{\cdot}1\log^{-1}_{10}0{\cdot}71X$, for a 13 in. gap $E=0{\cdot}15\log^{-1}_{10}0{\cdot}71X$, and for an 11 in. gap $E=0{\cdot}6\log^{-1}_{10}0{\cdot}82X$. With a wedge of air between two metal plates it was found that 0·021 in. of air could be detected in $1\frac{1}{4}$ in. of steel, or 0·007 in. of air in $\frac{5}{8}$ in. of steel. Radiographs of autogenous welds in $\frac{1}{2}$ in. steel showed a difference in appearance between good, underheated and burned welds, the last exhibiting a porous structure. Besides blow-holes, radiographs will indicate slag inclusions or porous spots, though no fluoroscopic screen has yet been evolved sensitive enough to make them directly visible.

The World's Sources of Fuel and Motive Power.—The "Thomas Hawksley" lecture for this year was given before the Institution of Mechanical Engineers last Friday by Dr. Dugald Clerk, F.R.S., on the above subject. The president, Dr. W. Cawthorne Unwin, F.R.S., was in the chair. Dr. Clerk first alluded to the attention Hawksley himself had given to this matter, and then traced the development of mechanical power from the beginning of the last century. The old Newcomen engine consumed about 20 lb. of coal per indicated h.p.-hour, and the Watt from 5 to 7; but coal in those times was cheap, because of the small demand, and even in 1836 the total mechanical horse-power of the country only amounted to 30,000 H.P. In 1903 the output of coal from Great Britain was about 230,000,000 tons, of which about 168,000,000 tons were consumed here; but by greater economy this might be reduced by 60,000,000 tons. In discussing other sources of power Dr. Clerk said that all our available energy came from past or present solar radiation, and that the whole world might be looked upon as a huge solar engine producing the circulation of water that gave us hydraulic power. It had been calculated that the rainfall in the British Isles would be sufficient to give 100 H.P. per square mile, but it was naturally only possible to utilise such power in hilly districts, such as in Scotland. About 150,000,000 H.P. of the world's power could be produced hydraulically. Dr. Clerk then discussed the various steps by which heat engines had been made more efficient, mentioning the early hot-air engines and the first internal-combustion engine, made by Cecil in 1815. Some interesting graphs were shown to demonstrate the recent growth of the use of the steam turbine. After the lecture a vote of thanks was proposed by Dr. H. S. Hele-Shaw and seconded by Sir Maurice FitzMaurice. In responding, Dr. Clerk gave a short description of the new hydraulic laboratories equipped by Dr. Charles Hawksley at the Imperial College of Science and Technology.

OBITUARY.

Sir Arthur William Rücker.—We regret to record the death of Sir Arthur William Rücker, F.R.S., D.Sc., late principal of the University of London.

He was demonstrator in the Clarendon Laboratory of the University of Oxford from 1871 to 1874, when he was appointed professor of mathematics and physics in the then newly-founded Yorkshire College, Leeds, where he remained until 1885. He occupied the chair of physics in the Royal College of Science, London, till his appointment in 1901 as principal of the reconstituted University of London, of which he was also a Fellow. He was president of the Physical Society of London from 1893 to 1895, and president of section A of the British Association in 1894. He was treasurer of the British Association from 1891–98, and was president of the Association at the Glasgow meeting in 1901. He was elected a Fellow of the Royal Society in 1884, was awarded a Royal Medal in 1891, and was secretary of the Society for the five years 1896–1901. He was also president of the magnetic section of the Meteorological Conference, which met at Bristol in 1898 and at Paris in 1900. He received the honour of knighthood at the Coronation in 1902. Sir Arthur Rücker was author (or joint author) of several scientific Papers (published in the "Transactions" of the Royal Society, &c.), and in recent years he served as a member of the Commission on Irish Universities in 1906, of that on the University of Belfast in 1908, of the Carnegie Trust for the Universities of Scotland, of the Board of Trade Committee on Sight Tests, of the Royal Commission of the 1851 Exhibition, in 1911, and of the Board of Visitors of the Royal Observatory, Greenwich. He was a doctor of science in the Universities of Oxford, Cambridge, Victoria, Leeds and Belfast; and Glasgow and Edinburgh conferred on him the degree of LL.D.

Killed in Action.—We regret to record the death of Second-Lieut. Christopher Moor, 2nd Hampshire Regiment. He took honours in mechanical science at Pembroke College, Cambridge, and after a tour in Canada in 1913 attended a post-graduate course of engineering at McGill University, Montreal, but was in England when war was declared. He was killed on August 6th in a charge on the slopes of Achi Baba.

The deepest sympathy will be felt with Mr. Alexander Ross, president of the Institution of Civil Engineers, at the loss of his son, Second-Lieut. John Alexander Ross, 17th London Regiment, who was killed in France on Oct. 26, aged 34. He took his commission in February and left for France in September.

The following, formerly in the mains department of the County of London Electric Supply Co., are also reported killed in action: Private G. W. R. Peek, 6th Batt. Duke of Cornwall's Light Infantry, died of wounds in hospital, Oct. 12; Corporal Sydney A. Wood, Machine Gun Section, "B" Co., Norfolk Regt., killed on Oct. 9; Private E. Gordon Morley, Queen's Westminster's, killed on Oct. 12.

PERSONAL.

Mr. John Barrington Pearson, general manager of Cowans, Sheldon & Co., of Carlisle, is, with the consent of his firm, undertaking work as assistant superintendent of the Royal Laboratory at Woolwich Arsenal for the period of the war.

Mr. T. K. Richardson, the station superintendent at Marylebone (London), has been granted three months' sick leave.

APPOINTMENTS VACANT.

A physical and mechanical laboratory assistant, with sound knowledge of physics, mechanics and mathematics, is required for the research department of large steel works engaged in Government work. *See advertisement.*

A station fitter, linesman jointer, wireman, fitter and engine drivers and switchboard attendants are wanted for military camps. Applications (endorsed "Power House Staff") to Chief Engineer, Southern Command, Salisbury.

A switchboard attendant is wanted for Canterbury electricity works. *See an advertisement.*

The Council of the Royal Horticultural Society invite applications for the post of steward and caretaker of the laboratory at Wisley. The duties include working electric light, petrol, gas heating and pumping plants. Applications to the Director, Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey. *See also an advertisement.*

An assistant buyer is wanted for a large electrical and mechanical engineering firm in the Midlands. *See advertisement.*

Appointments will shortly be made in connection with a 1,000-kw. electric power installation at a large military camp in North Yorkshire, including an assistant engineer, junior shift engineers, station fitter, engine driver, stokers, stoker-trimmer, wireman and mate. Applicants must have had good experience of three-phase central station work. Applications to the Commanding Royal Engineers, York District, 12, Wenlock-terrace, York.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—It has been found necessary to make some alterations in the dates of the Institution meetings for the coming session. The opening meeting will be held on Nov. 18, when Mr. C. P. Sparks will deliver his presidential address. Other meetings are as follow: Nov. 25, Prof. A. B. Field on "Some Difficulties of Design of High-speed Generators"; Dec. 16, Mr. J. R. Beard on "The Design of High-pressure Distributing Systems"; Jan. 13, Prof. Miles Walker on "The Predetermination of the Performance of Dynamo-electric Machinery"; and Jan. 20, Mr. N. W. Storer on "The Possibilities in the Design of Continuous-current Traction Motors."

Royal Society.—Among the Papers read yesterday was one by Mr. W. B. Hardy, F.R.S., on "An Application of the Principle of Dynamical Similitude to Molecular Physics," and one by Prof. W. G. Duffield on "The Consumption of Carbon in the Electric Arc." Among the Papers published during the vacation is that read by Dr. S. W. Richardson on "Some Experiments on the Properties of Dielectrics."

Royal Institution.—The 90th illustrated Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. H. H. Turner, F.R.S., his title being "Wireless Messages from the Stars." The subjects are as follow: "How the Messages are Carried," Tuesday, Dec. 28; "How the Messages are Received," Thursday, Dec. 30; "First Message: 'We are very far away,'" Saturday, Jan. 1; "Second Message: 'Some of us are Giants and some are Dwarfs,'" Tuesday, Jan. 4; "Third Message: 'But we all behave much as you do,'" Thursday, Jan. 6; "Fourth Message: 'And in fact we are your Blood Relations,'" Saturday, Jan. 8. The lecture hour is 3 p.m.

Röntgen Society.—At a meeting of the Röntgen Society, held on Tuesday last, Mr. J. H. Gardiner, in his presidential address, said that English manufacturers were now making X-ray apparatus superior to the German productions, which had almost a monopoly before the war. He exhibited some of the latest apparatus now used by Army doctors, among which was a device for the rapid location of bullets.

ARRANGEMENTS FOR THE WEEK.

THURSDAY, Nov. 11th.

Yorkshire Section of the Institution of Electrical Engineers. *7 p.m.* Opening meeting and smoking concert at the Hotel Metropole, Leeds.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing Nov. 8, 1915:—

Drills, 6.15 to 7.15; 7.15 to 8.15 p.m.

Saturday, Nov. 6.—Company parade, 2.30 p.m.

Monday, Nov. 8.—Section 1, technical; section 3, squad or working party.

Tuesday, Nov. 9.—Section 2, technical; section 4, shooting or working party.

Thursday, Nov. 11.—Section 3, technical; section 1, shooting or working party.

Friday, Nov. 12.—Section 4, technical; section 2, squad or working party.

Sections for technical drill will fall in at the headquarters of London Electrical Engineers (T.F.), 46, Regency-street, S.W. Sections for signal signalling, shooting and working parties will fall in at the new headquarters, Chester House, Eccleston place, S.W. Volunteers for guard work on Sunday, Nov. 7, are requested to give early notice to their section commanders.

CONTROL AND PROTECTION OF ELECTRIC SYSTEMS.*

BY C. P. STEINMETZ.

When the first commercial electric circuit issued from a station the problem of control and of protection arose. It was a simple problem at first, an ammeter and voltmeter to measure current and voltage; a knife-blade switch to send the current into the desired path, or withdraw it; the fuse to open the circuit in emergencies; and if the wires became crossed and fuse and switch failed, generator and engines stopped and not much harm was done. With the extension of the circuits into the suburbs some lightning troubles were felt and led to the introduction of lightning arresters—in the early days based mainly on hope and trust in providence rather, as very little was known of lightning phenomena. Since these days, less than a generation ago, enormous changes have taken place, and the electric systems have increased in size, in voltage and in extension. Where 100 H.P. machines were large once, now steam turbine alternators of 40,000 H.P. and more are in commercial operation. The steam engine has made room for the steam turbine, and the steam turbine does not stop when the wires are crossed and a short-circuit occurs, and the momentum of the turbine discs, revolving at velocities of 300 to 400 miles per hour, can supply ample energy for the destruction of any part of the system.

Feeders of 10,000 H.P. or more, generators of 40,000 H.P. have to be controlled by switching; an attempt to open such a circuit by the knife-blade switch of old would lead to the destruction of the switch—and probably its operator. Instead of small machines operating separately on independent circuits, huge generators now feed in parallel into the system of 'bus bars, on which is concentrated all the power of the station or the group of stations which are tied together. Numerous stations and systems of interconnected stations of 100,000 H.P. to 250,000 H.P. and over are in operation, and the 500,000 H.P mark has been reached. Anywhere on the 'bus bars of the station or in the feeders near the station there is available, destructively in case of an accident, as a short circuit, not only the entire power of the station, of perhaps 500,000 H.P., but the far greater power which the station generators can give momentarily. Short-circuit currents of 40 to 50 times normal full-load current may momentarily flow from some turbo-alternators, representing 10 and more times full-load power.

Such a station, or group of closely interconnected stations, of 500,000 H.P. full-load capacity, may momentarily send into a short circuit at the 'bus bars over 5,000,000 H.P. This is the power of Niagara; for Niagara is estimated variously at from 5,000,000 H.P. to 15,000,000 H.P. It is obvious that no switch or circuit breaker can be built safely to open such power, to suddenly stop Niagara, especially when considering that many hundreds of feeders issue from the 'bus bars, that in any one of these feeders a short-circuit in the cable may let loose the power of the entire system, and every feeder thus requires such a circuit breaker. With 500,000 H.P. station capacity, a momentarily overload capacity 10 times as high, assuming that we could build a circuit breaker to open this short-circuit power as quickly as in three to four cycles, or one-eighth second; this would require to dissipate in the circuit-breaker the energy of over 200,000,000 ft.-lb.—the destructive energy of 1,000 tons dropping from a height of 100 ft. This is about the energy of a projectile of 2,000 lb. weight leaving the cannon at the velocity of 2,500 ft. per second. It is the destructive energy of two heavy railway trains, of 400 tons each, going at 60 miles per hour, and meeting in head-on collision. It is the energy of the explosion of 30 lb. of dynamite.

Equally great has been the increase of voltage; where once 2,000 volts were high-voltage distribution, in circuits of a few miles length, now circuits of hundreds of miles length are in operation at voltages of 100,000 to 150,000. Such voltages jump toward any object for over 1 ft. distance, and will maintain arcs of practically unlimited distance; that is, with 100,000 volts and practically unlimited power at the back of it, an arc can extend for hundreds of feet. Thus no simple switch will open such voltages under power.

Transmission systems at high voltages have been interconnected with each other into networks, which spread and extend, and already to-day often represent thousands of miles of interconnected high-voltage lines, covering tens of thousands of square miles, and picking up every lightning, every atmospheric disturbance within this entire area. Thus the lightning protection also has become a far larger problem than in the small circuits of old. But far greater than the energy of any lightning stroke is the energy stored as magnetic field surrounding the conductors, as dielectric field radiating from the conductors of these big transmission systems, and if this internal energy of the system is set surging, its effects are far more destructive than those of lightning, and the effects may not be merely momentary as those of lightning, but continued, as maintained energy continuously replaces the stored internal energy which causes the destructive surge. And, in addition hereto, far greater reliability and continuity of service is to-day demanded from the electric system than was in the early days, and that at a lower cost of electric energy; and it must be remembered that, with the increasing cost of living, electricity is one of the few commodities which has steadily decreased in price. The foremost problem of control of electric systems thus is that of controlling enormous powers; the foremost problem of protection is that against self-destruction by its own power.

Current and voltage have grown beyond the values for which instruments can be built, and *current transformers* and *voltage transformers* are interposed between the circuit and the instruments measuring it. With the general introduction of parallel operation, *power-factor indicators* are required to insure the division of load without excessive waste currents; *frequency indicators* and *synchronising devices* safely to connect machines into the system. With hundreds of feeders radiating from the generating station, the office of the load dispatcher has become essential, and the necessity of keeping exact records of all operations and of all accidents and incidents is of the greatest importance. Automatic recording devices thus have been developed, as the *multi-recorder*, to record within fractional seconds, all important events, as opening and closing of switches, starting and stopping of generators, surges, lightning disturbances, &c. Such automatic devices afford a valuable check on the operating staff, but more important still is their record in emergencies, where a number of things happen almost at once, where the attention of the operators is detracted from instrument observation by the necessity of action, and the record thus must be made only afterwards from memory, which is not very accurate in such a period of excitement. It is just in such abnormal conditions that the most complete and accurate record is of greatest importance, to enable the engineers to determine with certainty what happened and why it happened, so as to take steps to guard against its recurrence.

Oil circuit-breakers have been developed, which can safely and without disturbance close and open the feeder circuits of over 10,000 H.P. and generator circuits of 40,000 H.P. and more, with an ample margin of overload capacity. In these the circuit is opened under oil with such mechanical arrangement of contacts and oil vessel that in the moment of circuit opening the current is extinguished at the end of a half-wave by the rapid expansion and shifting of the oil vapour which is produced by the arc, and which in the first moment is under high compression, due to the momentum of the oil, which has to be set in motion.

The most serious danger, in the growth of electric systems was, however, the possibility of self-destruction by the power let loose under the short circuit, and there were anxious years for the operators and managers of these large electric systems before the industry devised the means of safely controlling unlimited power. More than once, when a serious short-circuit occurred and a disaster was averted only by luck, the system was cut into two or three sections and these operated independently, to limit the power. But when months passed without further accidents, invariably due to the requirements of economy and reliability of operation, the sections came together again and parallel operation of the entire system was restored.

This, the most serious problem of the high-power electric system, was solved by the development of the *power-limiting reactances*. In the generator leads, between generators and 'bus bars, are inserted reactances, capable of standing enormous overloads, of a size sufficiently small not to interfere with the normal flow of power at full load or any overload which the generator may be called upon, but large enough to limit materially the generator current and power at short-circuit. Usually the *generator reactances* limit the momentary short-circuit current to about 10 to 12 times full-load current; that is, the momentary short-circuit power to about 2½ times full-load power. This solved the problem for medium-sized stations. Thus, in a 60,000 H.P station, instead of a possible short-circuit power of over 500,000 H.P., the power is limited to 150,000 H.P.

However, even with generator reactances, with increasing size of station, the power which may be let loose under short circuit becomes large beyond control; with a 400,000 H.P. station, with generator power-limiting reactances, 1,000,000 H.P. may still be concentrated at a short-circuit.

'Bus bar reactances then were introduced; that is, the 'bus bars divided into sections by reactances sufficiently small not to interfere with the interchange of power along the 'bus bars, and thereby retaining the advantage of parallel operation, but large enough to limit the flow of power, which, in case of a short-circuit on one 'bus bar section, can flow into it from the adjoining sections. With such

* Paper presented at a joint meeting of the Electrical Section of the Franklin Institute and the Philadelphia Section of the Am.Inst.E.E

reactances in the 'bus bars and in the tie feeders between the stations, the system is divided into sections of about 60,000 H.P. each. A short-circuit then can seriously involve one 'bus bar section only, and the destructive power of a short-circuit is limited to that of one section, plus the limited power which can flow from the two adjoining sections a total of 150,000 H.P. to 200,000 H.P., and this is within the emergency limit of the modern oil circuit breaker of moderate size. It still represents a terrific energy, nearly 10,000,000 ft.-lb., and is a severe strain on the circuit breaker. These 'bus bar reactances permit an unlimited extension of the system, and the short-circuit on a section of 500,000 H.P. system is no more severe than a short-circuit on a 100,000 H.P. system, and there is now no limitation to the future increase to electric systems of many millions of horse-power capacity, operating in parallel on one set of 'bus bars.

With hundreds of feeders radiating from the 'bus bars, the probability of a short-circuit in feeders is far greater than in the 'bus bars, and a material advantage, therefore, is given by *feeder reactance*; that is, reactance interposed between the feeder or a group of feeders and the 'bus bars, so that a short-circuit in the feeder is still more limited than a short-circuit in the 'bus bars.

By the development of generator reactances, 'bus bar reactances and feeder reactances, the problem of the power control of large systems for protection against self-destruction by short-circuit has been solved, and unlimited extension of systems without any increase of danger has been made possible, and experience has shown that after the introduction of such power-limiting reactances dead short-circuits have occurred at the 'bus bars of very large systems without even interfering with the operation of most of the synchronous apparatus on the system. Not all three classes of reactances are always necessary; in systems of moderate size 'bus bar reactances may not yet be needed. In low-head water-power plants, with slow-speed multipolar alternators of inherently limited short-circuit current, generator reactances may be unnecessary and only 'bus bar reactances required. Such, for instance, is the case at the Keokuk plant on the Mississippi River. Again, with a perfect system of generator and 'bus bar reactances, feeder reactances may be dispensed with—though they are even then an advantage. In high-voltage transmission networks, even of very high power, power-limiting reactances sometimes may not be required or are less essential. With a considerable number of medium-sized water-power plants feeding into a transmission system, the power of each individual generating station may not be sufficient to give destructive values under short-circuit, and the impedance of the lines between the generating stations may be sufficient to limit the power which can feed into the short-circuit at one station. In transmission networks, therefore, power-limiting reactances are necessary only in very large generating stations, such as the Keokuk station, or where several fairly large stations are close together, and also, as generator reactances, in turbo-alternators connected into the system as steam reserve.

To cut off a disabled line or feeder with the voltages and powers of our modern systems is beyond the capacity of the fuse or simple blade switch, and automatic oil circuit breakers are generally used. However, the problem has become more difficult by the increasing demand for reliability and continuity of service. The two main sources of troubles in lines and cables are *grounds* and *short-circuits* between phases. In transmission lines a ground on one phase is the most frequent trouble, and short-circuits are rare except in lines in which the design was faulty, or reliability had been sacrificed to cheapness, and the spacing between conductors chosen too small, so that they swing together during wind storms, &c. A short-circuit is far more serious than a ground, as in the former the current is limited only by the generator capacity, while with a ground the current has no return except if the neutral is grounded, and then over the resistance of the neutral and the current, and with it the shock on the system, is therefore very much less, especially if safeguards against the occurrence of high frequency by *arcing grounds* are installed. In a well designed transmission line a short-circuit usually occurs only as the result of two simultaneous grounds. A ground on one conductor, however, raises the voltage against ground of the other two phases, from the Y voltage to the delta voltage of the system, and thereby increases the strain on the insulation of the other two phases. It thus either introduces the danger of a second ground, causing a short-circuit, or requires a higher grade of insulation.

This has led to two methods of operation of transmission systems. In one the neutral of the transformers is grounded, frequently through a resistance where the resistance of the ground is not high enough to limit the current. Then a ground on one phase is a partial short-circuit to the neutral, and causes a large current to flow, and thereby opens the automatic breakers and cuts off the circuit before the ground has developed to a short-circuit. However, this method, the "*grounded Y system*," means that dirt at every ground, every flash over of an insulator by lightning, &c., [illegible] the other two sound phases, and thereby the strain on the insulation of the system, and thus the liability of a second ground, and of a short-circuit. In the other the neutral of the system is not grounded, the insulation of the circuit being made good enough safely to stand the increased strain put on it by a ground on one phase, and by an *arcing ground suppressor*, &c., care is taken not to continue an arcing ground—leading to high frequency disturbances—but convert it into a metallic ground. In this case, the "*isolated delta*" *system*, service can be maintained on the circuit, even if one phase grounds, until arrangements are made to take care of the load, or the fault found and remedied, and the continuity of service thus is not interfered with. However, the cost of line construction is higher, due to the better insulation required. The relation between grounded Y and isolated delta thus is that of cheapness versus reliability and continuity of operation, and, as a rule we find grounded Y systems where lowest cost of development is considered essential and occasional interruption of service not considered objectionable, while the isolated delta is generally preferred in systems in which reliability and continuity of service are considered as of first importance, such as in the extension across the country of the great Metropolitan Edison systems—systems which are proud of their record that the voltage has not been off their 'bus bars for 10 years or more.

Different are the conditions in underground cable systems. In a cable the three conductors are so close together that a ground on one conductor quickly reaches the other conductors and becomes a short-circuit. A grounded cable, therefore, cannot be kept in service, but has to be cut out as promptly as possible. In these systems it therefore is customary to ground the neutral through a resistance sufficiently low, in case of a ground on one conductor of a cable, to allow sufficient current to flow to open circuit breaker and cut off the cable, but sufficiently high not to give a severe shock on the system. Or, where grounding of the neutral is considered undesirable, an arrangement of relays is made to give the same effect. With underground cables such cutting off of a disabled feeder does not interfere with the continuity of service, as a number of feeder cables are always used in multiple for every important sub-station.

However, the problem of cutting off a disabled feeder by the operation of the circuit breaker due to the large current taken by the grounded feeder, is not so simple. Assuming that three cables feed in multiple into a sub-station, and one of these feeders grounds, a large current then flows from the generating station into this cable to ground, and the circuit breaker at the generator end of this feeder opens. This, however, does not stop the current rush, but a large current still flows through the damaged cables into the ground, coming back from the sub-station, and flows to the sub-station from the generating station through the two parallel feeders, which are undamaged; that is, short-circuit current feeds back through these two cables over the sub-station, and these two cables also open their overload circuit breakers, cutting off and thereby shutting down the sub-station. If the sub-station is connected by tie feeders to adjoining sub-stations, current feeds back into the faulty cable over these tie feeders from adjoining sub-stations, and these tie feeders and the cables feeding the adjoining sub-stations from the generating station, open their circuit breakers by overload, and in this manner a ground in one cable may shut down a number of sub-stations, possibly the entire system. *Time-limit devices* in the circuit breakers are insufficient to protect against such extended shut downs resulting from a single fault in a cable. A permanent time limit is not permissible in large systems, as with a dead short-circuit the circuit breakers must open instantly before extensive damage is done by the large power of the short circuit. Therefore so-called "*inverse time limit*" circuit breakers are generally used; that is, circuit breakers in which the time limit of their operation decreases with increasing overload. Such circuit breakers would first cut off the cable carrying the greatest excess current—that is, the faulty cable—and then those of less excess current; but, as with the cutting off of the faulty cable [illegible] at both ends the excess current stops, other cables should not be interfered with. However, the inverse time-limit circuit breaker necessarily must be practically instantaneous under short-circuit, and, therefore, while the time limit discriminates between 100 or 200 or 300 per cent. overload, it cannot discriminate between short circuits of various severity; that is, not only the faulty cable, but its parallel undamaged cable and the tie cables to other sub-stations, &c., would open, and while the extent of the shutdown would be somewhat limited, it is still far beyond the extent permitted by reliability of service. Thus devices become necessary to select a disabled feeder and cut it out without cutting off its parallel feeders or the tie feeders to the sub-station served by the faulty feeder, regardless of what excess currents these may carry. This is a problem which has not yet been completely solved.

As the result in general in high power systems of high standard of reliability the radial system of sub-station supply is used; that is, each sub-station is fed by a separate set of cables, and the sub-stations are not interconnected into a network by a system of tie

feeders. This radial system, however, is materially less economical in feeder copper than the interconnected network, since the radial system requires for each sub-station a feeder capacity equal to the maximum power demand of the individual sub-station, while in the network, by cross-feeding between the sub-stations, the feeder capacity is reduced to that required by the average maximum demand of the sub-stations.

To avoid a shutdown of the sub-station by a fault in one of its feeders, the different feeders of the same sub-station are not connected in parallel in the sub-station, but feed separate translating devices, as transformers and converters, and are paralleled in the sub-station only on the secondary side of transformer or converter. In case of a faulty feeder, the current feeding back into the fault over the other feeders of the same sub-station, therefore, has to pass through two sets of translating devices, and this limits it sufficiently to allow the time-limit relay of the circuit breaker to operate and cut out the faulty feeder without opening the other feeders; that is, without shutting down the sub-station.

However, the economic disadvantage of the radial system remains, and an effective *selective feeder relay*, which could be relied upon to pick out the faulty feeder and no other, would offer material advantages. Such a selective device is afforded by the use of *pilot cables*. Each cable or feeder is duplicated by a smaller low-voltage, three-phase cable, which joins the secondaries of current transformers connected into the two ends of the main cable. If the main cable is undamaged, the same current comes out of it as flows into it, and the connections to the pilot cable are such that in this case the secondary currents would be in opposition; that is, neutralise each other. If, however, the main cable grounds, current flows into it from both sides, the secondary currents in the pilot cable then add, and the current flowing in the pilot cable operates the relay which opens the circuit breaker. This arrangement is very perfect in operation, capable of cutting out the damaged cable whether feeder cable or tie cable, without interferring with any other cable, but it has the formidable disadvantage of doubling the number of cables required in the system, and while the pilot cables are small and of low voltage, they occupy room in the underground ducts which carry the electric circuits inAmerican cities. Thus this method of control by pilot cable is, due to its high cost of installation, very little used in America.

Another method is that of the "*split conductor*" *cable*. Every cable conductor is made of two parts, of which the one surrounds the other concentrically, with some insulation between them. Normally there is no P.D. between the inner and the outer half of the conductor, as they are connected with each other at the ends of the cable. If, however, a ground occurs on the cable, this ground can at first reach only the outer half of the conductor, and a P.D. and current appears between the inner and outer half of the conductor and operates the circuit breakers, through a relay connected between the two halves of the conductor, at either end of the cable. This method also works very satisfactorily, but has the same economic disadvantage, though to a lesser degree, as the method of pilot cables, in that the split conductor cable is materially larger and more expensive than the standard cable. It is, therefore, used to a limited extent only.

The usual method of taking care of the problem, at least in most cases, is by the so-called "*reverse power relay*," also wrongly called "reverse current relay." When a cable grounds, the current at its end reverses; that is, flows into the cable ("feeding back") instead of coming out of it. However, this reversal of current by itself can do nothing, as it is an alternating current, and as such has no direction of its own, but only a relative direction to other alternating waves, as that of the voltage. Installing then a wattmeter relay at the end of the cable—that is, a relay operated by the action of two coils upon each other, the one coil energised by the current, the other by the voltage; if the current reverses, the voltage remaining the same, the pull of the relay reverses and thereby closes the operating circuit, which opens the circuit breaker which disconnects the cable. Such reverse power relay operates perfectly so long as there is any voltage for the reverse current to act upon. If, however, a short circuit occurs at or close to the sub-station, the voltage vanishes and with it the reverse power relay looses its pull. To guard against this the installation of reactances is recommended between cables and sub-stations to give a sufficient voltage drop to operate the relay. However, this is an additional complication. The reverse power relay is not adapted to guard tie feeders between stations, as in these the current reverses in direction with the change of the distribution of load between the sub-stations. Thus the reverse power relay does not make the operation of interconnected networks of sub-stations possible, but in the radial system of operation, which is generally used, it is the only device which is generally available economically, and is very satisfactory—which must be realised—that it cannot operate where there is no voltage left.

In overhead transmission systems the problems of selectivity are essentially the same as in underground cable systems, except that in interconnected networks of high-tension power the high impedance of the lines often gives an automatic partial selectivity, which cannot exist with the low impedance of cable systems.

Interference by *lightning* with high-potential transmission lines has rather decreased with increasing line voltage, and is in very fortunate when considering the enormous extent of these systems and the resulting certainty of lightning effects. In the present high-potential transmission lines voltages have been reached incomparable with the voltage of lightning disturbances; possibly not with the voltage of the direct lightning stroke—but direct strokes into lines are rare—but few lightning-induced voltages reach beyond the insulation strength of modern high-voltage lines. In 100,000 volt lines the insulators are tested for one minute at 200,000 to 250,000 volts, and stand momentarily, for the very short time of lightning, over 500,000 volts. Thus it is rare that lightning flashes-over the suspension insulators of our very high-voltage transmission systems. A flash-over, with the grounded Y system, shuts down the circuit, often without any damage, while with the isolated delta system it may not even shut down the circuit, but is taken care of by the protective device against flash-overs, the arcing ground suppressor in the station. Most lightning voltages incapable of destroying the line insulation run along the line until their energy is dissipated or they reach a station, and there they often do serious damage. The most important problem of lightning protection thus has become the rapid damping out of line disturbances caused by lightning so as to make them harmless before they reach the station. The most effective method heretofore is the overhead ground wire. By its screening effect it lowers the voltage which lightning can induce in the line, but far more important is its powerful damping effect on the line disturbance, the travelling wave caused by lightning which runs towards the station. As short-circuited secondary to the line wire, the ground wire absorbs and dissipates in its resistance the energy of the travelling wave, and causes it to die out at a rate several times more rapid than is the case in a line which is not protected by ground wire.

Far more destructive than the energy of lightning may be the *internal energy* of the system. While a lightning stroke may amount to millions of horse-power at a duration of a millionth of a second, this means only thousands of foot-pounds. In a transmission network of thousands of miles extent a surge of the system may amount to many thousands of horse-power. But even a surge of 100 H.P. only is liable to be very destructive, as it may be continual, the generator power continually replenishing the surge energy, and 100 H.P. during one hour means 200,000,000 ft.-lb. Thus the foremost problem is again the protection of the system against destruction by its internal energy, and lightning is dangerous mainly by letting loose the internal energy. Against damage by breakdown to ground, by over-voltages, effective and complete protection is given by the *aluminium cell lightning arrester*, so that the problem of over-voltage protection resolves into the economic question, how far the cost of lightning arresters is warranted by the elimination of the danger of breakdown to ground.

Impulses, high-frequency oscillations and stationary waves are the most common other dangers. An *impulse* is an electrical effect in which voltage and current rise rapidly—with a "steep wave front"—and then gradually taper down and die out. Such impulses are produced by switching operation, by flash over the insulators, by induction from lightning flashes, &c. The danger from impulse voltages lies in the local piling up of voltage due to its steep wave front. Thus, for instance, when a switch is closed and 100,000 volts put on to a line at the moment of closing the switch, 100,000 volts suddenly appear in the line at the switch, while perhaps 5 ft. away the line voltage is still zero. Gradually—with the velocity of light, or 188,000 miles per second—the voltage spreads over the line as an impulse. Suppose now such impulse reaches the terminals of a transformer near the source of the impulse, where its wave front is still very steep. When the full impulse voltage reaches the first transformer turn the second transformer turn is still at zero voltage, and the full voltage of 100,000 comes on the insulation between the first two turns. While the transformer winding is insulated to stand 200,000 volts to ground for one minute, and momentarily still much higher voltage, normally the voltage between adjacent turns may be only 10 volts, and with all the extra insulation between the end turns, even if we make this insulation to stand 1,000 times the voltage to which it is normally exposed, it would be far below standing 100,000 volts. Thus the danger from impulses is that they produce voltages across small parts of the circuit, single turns or coils, which are often many thousand times the normal voltage existing in this part of the circuit; thus they may be far below the total circuit

voltage and thus would not discharge over the over-voltage protective devices or "lightning arresters." Fortunately, such steep wave fronts rapidly flatten out in the progress of the wave along the circuit, so that their danger is largely limited to the immediate neighbourhood of the origin of the impulse.

Assuming now that we would, by a condenser in shunt to the circuit, bypass the energy of the impulse for only one-millionth of a second. During one-millionth of a second the impulse travels about 1,000 ft., and such a very small condenser would flatten the wave front to 1,000 ft. length. With such a flattened wave of 1,000 ft. front, before full voltage appears at the transformer terminals, the beginning of the impulse is passed over 10 or more turns and the impulse voltage thus distributes over the insulation of a number of turns, and no difficulty exists in giving the end turns an extra insulation sufficient to stand the voltage.

The foremost cases of high-frequency oscillations are spark discharges from the line, arcing grounds, &c. Their danger also is the piling up of voltage in reactive devices, such as current transformers, end turns of power transformers, &c. While a current transformer may take only a few volts at the normal frequency of 60 cycles, at 10,000 times this frequency it would take 10,000 times the voltage and then break down between turns and between terminals. Inductance to reflect the high-frequency oscillation back into the line—which can stand it—with shunted capacity, and a non-inductive or preferably, a capacity bypath to the inductive device such as the aluminium cell, offers protection against the danger from high-frequency oscillations. The best guard against interference by high-frequency oscillations is, however, to avoid all causes which may produce them, and the foremost cause is the arc. Thus arcs, arcing grounds, spark discharges, open-air switches, &c., should be carefully avoided in transmission systems, as introducing the dangers of high-frequency disturbances. This is to a large extent a designing problem.

In apparatus capable of electric oscillation—that is, apparatus of high inductance, considerable capacity, but very low energy losses, such as high-potential transformer windings—under certain conditions *stationary waves* may occur; that is, high-frequency impulses or oscillations, coming from the outside, built up by resonance to higher and higher voltages. Such stationary high-frequency waves are extremely destructive, as their energy is practically unlimited, is given by the low-frequency power of the system. Their frequencies usually are fairly low, between 10,000 and 100,000 cycles, and therefore it is more difficult to deal with them than with the oscillations of many hundred thousands or millions of cycles.

The best protection against them is not to allow them to build up. This is done by designing the apparatus so as to give the least ability to stationary oscillations, and by dissipating their energy, and thereby limiting their voltage, by shunted resistance. To avoid excessive waste of power in such shunted dissipating resistances a condenser of moderate capacity is connected in series with them. Such condensers practically cut off the flow of power at the low machine frequency, but permit the flow of large currents through them into the dissipating resistance at the much higher frequencies of the standing waves.

In considering the protection of modern electrical systems it must be realised that the various sources and kinds of interference or danger require correspondingly different protective devices; it would be just as unreasonable to expect a standard type of "lightning arrester" to protect an electric system against all possible troubles as it would be to call for a single standard "safety device" which would protect a railway train against all possible dangers, from a broken rail or a washout of the roadbed to a collision or a boiler explosion.

THE APPLICATION OF ELECTRICITY TO THE HEATING OF METALS.*

BY E. L. BISHOP.

Summary.—This Paper covers the recent developments, present status and limitations in the application of electricity to the heating of metals for the purposes of annealing, hardening or other heat treatments. Furnaces employing electricity as a source of heat may be roughly classified into laboratory and commercial divisions. A brief discussion is given of different types of furnaces employed in laboratory work and an outline of the application of these furnaces to commercial service, where such application has been made.

The different types of furnaces, whether for laboratory or for commercial use, may be classified according to the methods employed to transform the electrical energy into heat in the material.

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

These methods are: (*a*) By passing the current through the metal to be treated, so that the metal forms a part of the circuit; (*b*) by passing the current through a resistance material, the heat thus produced being radiated and conducted to the metal; (*c*) by surrounding the metal with an alternating-current circuit, so that eddy currents are produced in the metal, these currents generating the necessary heat.

These three methods are radically different, in that the metal is heated in a different way in each case.

First Method.—In this process the resistance of the material to the passage of the current causes the liberation of the heat uniformly throughout the material, provided the cross section be uniform and the surface has uniform radiation. The process is limited in application by the size of the pieces which can be conveniently heated and to which a current can be conducted by means of proper terminals. An apparatus of this type has been used to some extent for the annealing and hardening of small iron and steel wire. The wire which is to be treated is shown at A (Fig. 1) clamped to one terminal of a source of electricity; the other end is clamped below the mercury in the glass tube C (Fig. 1). The current is applied until the wire has attained the desired temperature, when the mercury cup D is suddenly raised, causing the mercury to rise in the tube C, thus cooling the wire, and at the same time shunting the current through the mercury. The current is then cut off and the wire removed. The resistance of the wire should be small in comparison to that of the rest of the circuit, so that the current will not increase appreciably as the mercury rises; otherwise, unequal heating will result. The consistent results obtained in this way are due to the fact that the

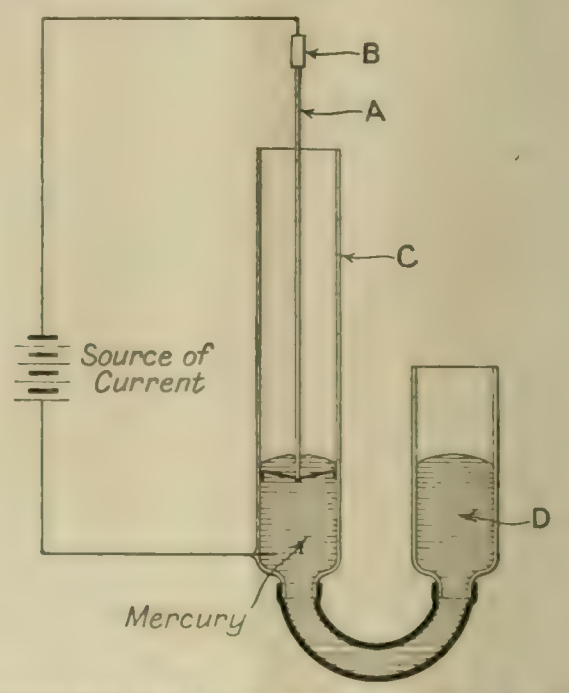


Fig. 1.—Apparatus for Annealing and Hardening Small Iron and Steel Wire.

metal is heated uniformly to any desired temperature, and also to the fact that the whole of the material is at the same temperature when cooled. This method of heating metals has had very few commercial applications, although for certain classes of work it should prove useful.

Second Method.—One of the earliest and most useful types of electric furnaces is that due to the firm of Heræus. It consists of a tube wound in its middle portion with an electric resistor. The ends of the tube are cooled by air or else by a copper coil through which water flows. The tube may be of porcelain, in which case a ribbon of resistance metal may be wound on it. These tubes are porous and cannot be used for a vacuum furnace. Glazed German porcelain may be used up to 1,180° C. and a vacuum maintained. For higher temperatures, a nickel tube may be employed. These furnaces are advantageous where a constant temperature is desired. They are easily constructed and consequently have been extensively applied.

One of the more recent developments is the Arsem vacuum furnace (Fig. 2). The general design of the Arsem furnace comprises a heater of such shape that it almost entirely encloses the object to be heated. The heaters in the various types of furnaces differ somewhat, according to the size of the furnace and the use to which it is to be put. In one case, the heater is a graphite helix, in an upright position; and in another, it is composed of four grids, made by sawing graphite slabs. The vacuum chamber is of steel. All joints are made tight by lead gaskets. The electrode joints have to be made so that they are air-tight, electrically insulated and not liable to deterioration by heat. The radiation screen is a device for diminishing the amount of heat lost by direct radiation from the heater, and thus increases the efficiency of the furnace. This is shown by the fact that the

temperature-energy curve is approximately a semi-cubical parabola, whereas, without the radiation screen, the curve would follow the Stefan-Boltzmann fourth-power law, like an incandescent lamp. In the small vertical type of furnace, the radiation screen is a rectangular graphite box filled with graphite powder, which is a poor conductor of heat.

The temperature can be quickly brought to any desired point, as determined by the calibration curve, and maintained constant for long periods, while the behaviour of the article being heated may be observed through the mica window at the top. The range of temperature extends to 3,100°C., using a maximum of 15 kw., but most experiments do not require a higher temperature than 2,500°C., which can be obtained with 10 kw. This type of furnace is especially useful for small scale experiments that can be performed in

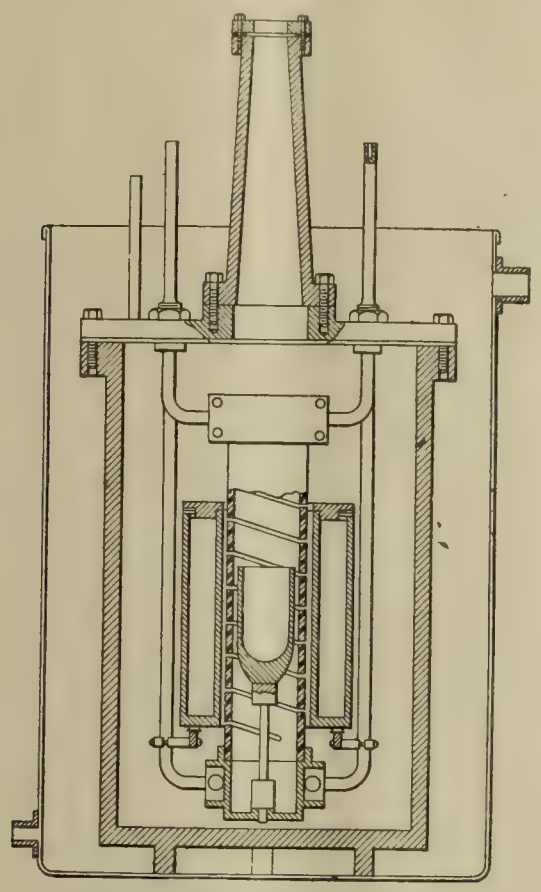


FIG. 2.—ARSEM FURNACE.

crucibles 1½ in. in diameter and 4 in. high. Of the various uses which naturally suggest themselves the following may be mentioned: Preparation of metals, alloys, carbides, silicides and other compounds; determination of the melting points of metals, alloys, glazes, slags and refractory materials by an optical pyrometer, or by reference to the furnace calibration curve; calibration of optical pyrometers; distillation of refractory substances for separation or purification; study of the equilibrium in reactions depending upon the pressure of gaseous phase; many reactions can be studied quantitatively with accurately weighed quantities.

For chemical analysis, annealing, enamelling, ceramic experiments and ignitions of all kinds, where a temperature of 1,000°C. is desired, the muffle furnace (a modification of the Heræus type) is the best type. In most of these furnaces the heating resistance is completely

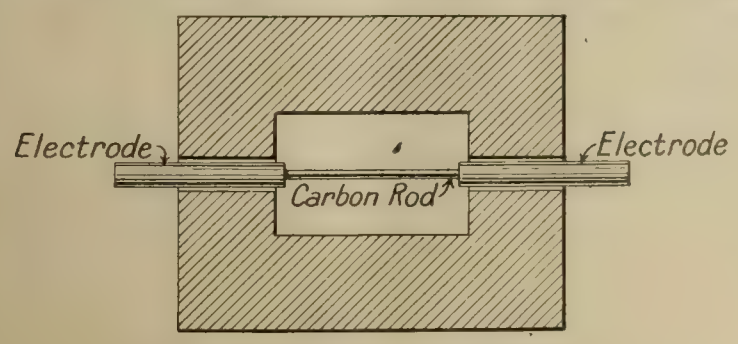


FIG. 3.—SECTION OF BORCHER'S FURNACE.

embedded in the walls of the muffle, which is thereby fairly uniformly heated. The maximum temperature for which they can be used is 1,000°C., and regulation of the temperature between 800° and 1,000°C. is effected by means of a rheostat. In one type of the muffle furnace a useful feature in the form of a device which serves both as cut-out and current-indicator is introduced. This consists of a gold wire loop, which forms part of the heating circuit and is visible through a mica window in one side of the muffle covering. When starting the furnace, the resistance should be adjusted until the gold wire just begins to glow. After a little while, the loop will indicate a drop in the current, and more resistance may be switched out until the wire begins to glow again. As the temperature rises, the loop will become heated by the furnace, and the current necessary to keep it at red heat will gradually decrease. The appearance of the wire loop, accordingly, serves for regulating the current to the heat of the furnace. All that is necessary is to adjust the current from time to time to maintain the loop at red heat, so operation should be left to even an unskilled workman, after one or two lessons. For many purposes, this device renders the use of a pyrometer unnecessary.

The type of furnace due to Borcher (Fig. 3) consists of a carbon rod placed between large electrodes. Current flowing through the carbon rod heats it, and the substance to be heated surrounds the rod. The application of this type of furnace is limited by the temperature to which the graphite and carbon can be raised without oxidation.

A furnace by Watts consists of a rectangular brick box, into which the crucibles are set, crushed carbon shovelled in and packed around them and the current turned on until the desired temperature is reached. Outside dimensions: Length, 54 in.; width, 28 in.; depth, 26 in. Inside dimensions: Length, 40 in.; width, 12½ in.; depth, 9 in. This furnace holds 27 crucibles 3 in. in diameter and 7 in. high and is used to melt iron and other metals.

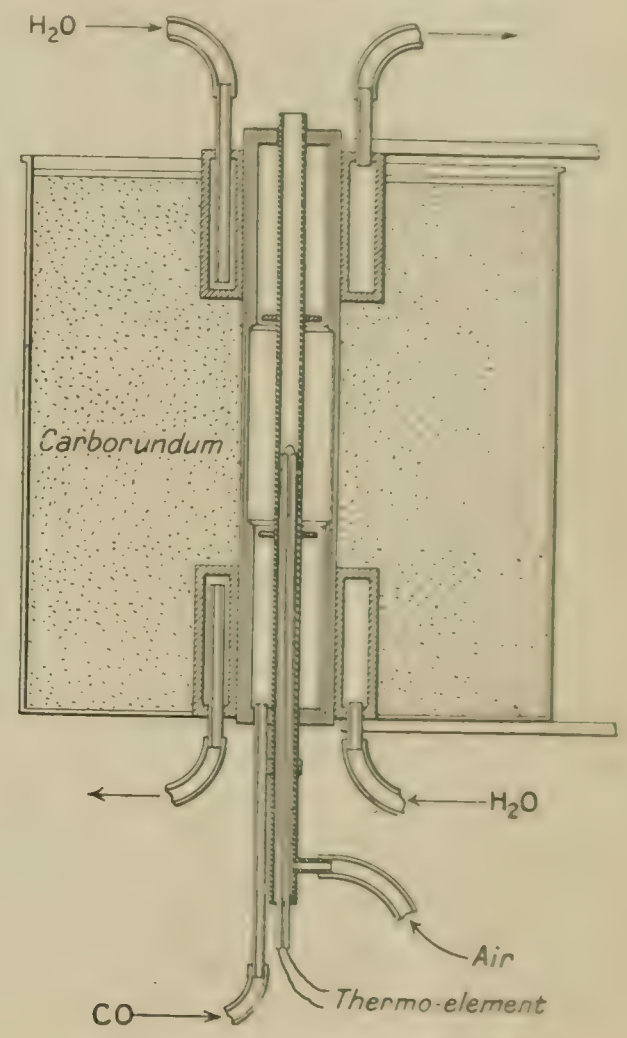


FIG. 4.—SOSMAN'S CARBON FURNACE.

The Sosman carbon furnace (Fig. 4) is a modification of this type, in which powdered carbon or carborundum surrounds a chamber containing the substance to be heated. High and uniform temperatures have been claimed for this furnace, but its application in this form is limited to small laboratory practice; however, a modification used by Bailey has proved of commercial importance.

(*To be concluded.*)

THE ELECTRIC FURNACE FOR RE-HEATING, HEAT TREATING AND ANNEALING.*

BY T. F. BAILY.

Summary.—The author gives figures of cost and efficiency of electric furnaces for re-heating and annealing, and calls attention to the great opening there is for electric heating in this direction, particularly in soaking-pits.

RE-HEATING FURNACES WITH GRANULAR RESISTORS.

The type of furnace that seems best adapted for re-heating operations is the resistance type, in which the material to be heated is entirely separate from, and independent of, the resistance elements in which the heat is generated by the electric current. This arrange-

* Abstract of a Paper read before the Engineers' Society of Western Pennsylvania.

ment makes for the maximum simplicity and convenience in operation. A general description of this type of furnace is as follows :—

Through the side walls of a furnace shell made of suitable refractories are inserted two carbon graphite electrodes. The inner ends of these electrodes extend into a trough of highly refractory material. This trough is filled with the resistance material itself, usually some form of broken carbon, and makes contact at each end with the electrodes. The outside ends of the electrodes are connected by means of suitable copper terminals and cables to the regulating transformer and switch, by means of which the voltage impressed across the furnace is regulated, the voltage thrown on the furnace having a definite relation to the current flow and heat input. The material to be heated is placed conveniently adjacent, at the side or above or underneath the resistance material and its containers, as the case may be.

In some heating operations the actual cost of heating per ton is less with electric furnaces than with combustion furnaces, while in some heat-treating and annealing operations the precision with which the operations are carried on must be the justification for the higher cost of heating in the electric furnace. In a general way it may be stated that the higher the temperature at which the heating operation is conducted the higher the relative economy in the use of electric furnaces. At the lower temperature there is less difference in the thermal efficiency of electric and combustion furnaces, but here the electric furnace shows great superiority in the way of temperature control.

The chief advantages of electric furnaces are the non-oxidising atmosphere, ease of control, evenness of temperature and cleanliness. Also the space required is smaller, and the resistors are run at a temperature only slightly above that of the hearth, whereas the furnace gases in a combustion furnace are of necessity several hundred degrees higher than the temperature desired in the furnace.

The actual theoretical heat required expressed in kilowatt-hours per ton of metal is given in Table I. for heating to the temperature given.

Table I.

Material.	Deg. Fahr.	Kw.-hour per ton.	Material.	Deg. Fahr.	Kw.-hour per ton.
Iron.....	2,200	230	Copper	1,400	90
Iron.....	2,000	215	Brass	1,300	85
Iron.....	1,800	200	Aluminium .	950	140
Iron.....	1,650	170	Aluminium .	750	110
Iron.....	1,500	150	Silver.....	1,300	50
Iron.....	1,250	115	German silver	1,300	75
Iron.....	900	75			

The thermal efficiencies of electric furnaces vary greatly with the size and capacity in tons per hour. The wall loss on a forging furnace of 60 kw. capacity heating 250 lb. of steel per hour to 2,200 F., will be approximately 30 kw., showing a thermal efficiency of 50 per cent. A furnace of 1 ton per hour capacity for 2,200 deg. will show an efficiency of 75 per cent.

In annealing work a furnace of 100 kw. per hour capacity will heat 600 lb. of metal to 1,650 deg. with an efficiency of 50 per cent., while a furnace of 600 kw. capacity heating 3 tons of steel per hour will show an efficiency as high as 90 per cent. All the above figures are typical for the usual classes of work handled in the capacity named.

The Electric Furnace for Re-heating.

The first type of these granular resistor furnaces forge-heating was designed for heating small bars and billets such as are used for small forgings, and for temperatures up to 2,300 deg. The general construction of these furnaces was as follows : The furnace proper was constructed of firebrick much after the method of prevailing oil-fired furnaces. Through the sides of the furnace were inserted large electrodes, the inner ends protruding into the furnace chamber. Foundry coke crushed to pea size was placed in the space between the electrodes and formed the resistor of the furnace. The opening to the furnace was in front, and the bars of metal to be heated were placed directly over the resistance body but not in contact with it. The necessary variable voltage supply to this furnace was regulated by the field rheostat of a small single-phase alternator. This furnace was run commercially for several weeks in place of the oil-fired furnace usually used for the hammer and on various sizes of material. Some of the difficulties encountered in this furnace besides its rather low thermal efficiency were burning off of the electrodes at the point where they emerged from the furnace ; the burning out of the refractory materials supporting the resistance material itself ; trouble with electrical connections between furnace cables and electrodes, and great variation in the electrical resistance of the resistance material itself.

In the six years that have elapsed since the construction of this early furnace, these difficulties have been well overcome. By the use of a steel shell for the outside wall of the furnace instead of brick, and with this space filled with suitable insulating material, the thermal efficiency of the small furnaces has been very materially increased, as is shown by the accompanying results on a 30 kw. furnace :—

Duration of test, 5 hours 5 minutes. Current mostly at 25 volts.
Energy used = 167 kw.-hours.
Total weight of steel heated to 2,200°F. = 765 lb.
Energy per ton of metal heated = 436·6.
Temperature difference, 2,150 deg. Specific heat of steel, 0·199 approx.
Efficiency = 57·5 per cent.

The burning off of the electrodes at the place where they leave the furnace walls has been entirely eliminated, one set of electrodes lasting for months at a time in continuous service.

The troubles encountered in connecting the electric cables to the electrodes have been eliminated, so that no trouble is experienced now from this source. For furnace temperatures not exceeding 2,500°F. this type of furnace will answer every reasonable requirement, and in operating cost will compare very favourably with oil furnaces, figuring electrical energy at 1 cent. per kilowatt-hour and oil at 4 cents per gallon, so that as actual fuel cost alone is concerned, while there is an additional saving due to the non-oxidising of the metal amounting to a saving of from 2 to 5 per cent. of the metal heated. This type of furnace is suitable for tonnages up to 1 ton per hour capacity, and billets not exceeding 4 ft. in length.

Continuous Furnaces.

For furnaces of capacities of 1 ton per hour and above, the continuous type of billet heating furnace offers some advantage in economy as well as in mechanical operation, as in the continuous type only the discharge end of the furnace reaches the full ruling temperature, the lower temperature of the feeding end reducing wall loss of the furnace very materially. The following calculation of a heat balance-sheet may be taken as typical for this type of continuous billet heating furnace heating material to 2,000 deg. :—

Capacity, 10 tons per hour ; temperature, 2,000 deg. ; wall loss in kilowatt-hour, 250 ; theoretical heat required per hour by metal in kilowatts, 2,150 ; kilowatt-hours per ton of metal heated, 240 ; cost of heating per ton with current at 0·125d. per kilowatt, 5s.

This figure of cost per ton of metal heated becomes prohibitive unless account is taken of the metal loss due to the oxidising influence of the flame in gas-fired billet heating furnaces. Even making allowances of 2 per cent. on £4 steel, this type of furnace seems to have no prospect of competition for large tonnages unless the cost of electric current is under the rate named in the above tabulation. In heating higher grades of steel, especially steel of crucible quality, the saving in scale over any combustion furnace practice will far outweigh the higher cost of heating by the electric furnace.

In large tonnages of heavy billets a combustion furnace using producer gas firing to, say, 1,500°F., or above, and heating from this temperature to the desired rolling temperature by electricity, offers advantages of low fuel cost per ton of metal heated, and at the same time a minimum amount of oxidation of the metal, as the low ruling temperature of the gas end will permit a high thermal efficiency even with a non-oxidising flame, while the final heating is done in the electric end of the unit which is readily maintained under a reducing atmosphere.

Such a furnace as this can be expected to show a thermal efficiency in the gas end of 50 per cent. and in the electric end 75 per cent. With coal at 8s. per ton and electricity at 0·125d. per kilowatt, the total cost of heating should not exceed for coal alone 5d., and electricity 1s 4¼d., making a total cost of 1s 9¼d. per ton.

This cost compared with a direct-fired heating furnace having a coal consumption of 200 lb. per ton of metal heated, would show an excess cost for the combination gas and electric furnace of 11¼d. per ton. But with a saving of 2 per cent. in metal worth £4 per ton, the combination gas and electric furnace would show an actual saving of 8¾d. per ton of metal heated, besides giving to the metal all the advantages of the precision in uniform temperature throughout the billets, as well as a uniform rolling temperature.

Soaking Pits.

The type of electric furnace which seems, however, to be destined to have the largest commercial application in rolling mill operations is the soaking pit, and it is doubtful whether any gas-fired pits of large size can compete in cost of operation with electric pits where current is supplied at the usual rates of electric current available for this service, provided the ingots are charged hot into the furnace. A heat balance sheet for a four-hole soaking pit holding 16 3½-ton ingots and having passed through it 648 tons per 24 hours would be as follows, assuming a wall loss of 500 kw. per hour :—

With ingots stripped hot, interiors molten, no heat required for the metal itself, the current consumption would then be 500 kw-hour per 27 tons of ingots, or less than 20 kw.-hour per ton of ingots.

soaked. With ingots averaging 1,650 deg., the current consumption for 27 tons per hour would amount to 1,620 kw. per hour, or a current consumption of 60 kw.-hour per ton absorbed by the metal. To this should be added 40 kw.-hour per ton as wall loss. This higher figure for wall loss per ton of metal heated is due to the reduced capacity of the pit in tons per hour when handling the cold ingots on account of the longer time required for heating and soaking. Thus the current consumption for ingots charged at 1,650 deg. would be 100 kw.-hour per ton.

With cold ingots the heat absorbed by the metal will be 230 kw.-hour per ton, and with a wall loss under this condition of 185 kw.-hour per ton 315 kw. hour per ton would be the current required for cold ingots. But as cold ingots are a rather small percentage of the total ingots handled in a modern steel mill, these high figures are of no serious consequence in considering electric furnaces for soaking pit operations.

It is apparent from these calculations that electric soaking pits can compete with gas-fired pits, even where moderately hot stripping and charging is practised. Besides this, the electric pit, as in the heating furnaces mentioned before, has the advantage of a non-oxidising atmosphere, which will mean a saving of from 1 to 2 per cent. of the weight of ingots put through the pit. Another advantage worthy of note is that an electric pit will take only one-third the space of a gas-fired pit of the same capacity. A feature of even greater importance than almost any other is the elimination of surface defects in the ingots, due to scale or oxidation, a matter now receiving considerable attention by steel makers.

Electric Furnaces for Heat Treating and Annealing.

The rapid growth of the practice of heat treating and a realisation of the precision with which this treatment must be carried on in order to secure uniform results, has opened a particularly desirable field for the electric furnace, especially as the electric furnace can be more accurately controlled and a greater uniformity of heat throughout the furnace maintained in commercial operation than with combustion furnaces. A comparatively slight variation in either blast pressure or fuel supply in a combustion furnace very quickly affects the ruling temperature, while in the electric furnace, owing to the comparatively great mass of heated refractory material of walls and roof acting as a heat storage or accumulator, the variation in temperature is reduced to a minimum. In practice the current may be off for periods of an hour at a time without affecting the temperature more than a few degrees.

This type of furnace may be described as follows: In the usual steel sheet is constructed an arched roof of firebrick, so arranged as to reflect the heat radiated from the resistor troughs on to the hearth located between the two resistor units running lengthwise of the furnace. The material to be heated is handled through the doors of the furnace located in the end walls. The hearth, if not subject to mechanical abraison, is made of suitable firebrick. Where the abraison is likely to be severe, cast-iron plates replace the firebrick.

A heat balance-sheet of a furnace of this type of 100 kw. capacity and with hearth area 5 ft. by 6 ft. and heating 600 lb. per hour to 1,650°F., will show the following efficiencies :—

Heat absorbed by the metal, 50 kw.
Heat lost through the walls, 35 kw.
Heat lost through the doors and door openings, due to the frequent charging and withdrawing, 15 kw.

Continuous Furnaces.

For furnaces of more than ½ ton per hour capacity, and for higher thermal efficiencies, the continuous type of furnace is desirable. A typical furnace of the continuous type for annealing German silver or brass stampings in steel pans has a hearth 15 ft. long by 2 ft. wide, and a rated electrical capacity of 200 kw. A mechanical charger operated by a motor-driven winch with hand-operated clutch pushes the pans in through the charging door one after another, seven pans being in the furnace at one time. The pans passing through the furnace are supported by a hearth made of cast-iron grids each 2 ft. square. The pan when discharged is dumped automatically into a water-sealed discharge hood. The metal under treatment falls into a tank of either clear water or pickling solution, depending upon the cleanliness of the material before it is charged. The pan is caught by two rails and held suspended above the trough. It may be taken out from under the water-sealed hood through the counter-balanced swing door.

In operating the furnace, a pan filled with material to be treated is placed on the runway in front of the pusher. The small hand lever near the top of the furnace front operates the clutch on the motor-driven winch on top of the furnace. The first movement of the cylinder raises both doors enough to admit the pans, which are 3 in high; a stop on the cable holds the doors at this height while the pan of fresh material is pushed into the furnace. As the fresh pan enters the pan at the discharge end is pushed on to a dumping carriage, its own weight automatically tips the pan, dumping the contents into a hopper, the lower end of which is submerged in the quenching tank; the annealed material falls into a perforated container basket, which at intervals is lifted out of the quenching tank. As the pan starts to tilt, the pusher carriage is pulled out of the charging end and the doors are dropped. Thus in this furnace the material is not exposed to the atmosphere at any time after entering until taken out from the quenching tank. This entirely eliminates the possibility of oxidation as the furnace itself has a reducing atmosphere. A heat balance-sheet of this furnace annealing German silver at 1,400°F. shows the following :—

Heat absorbed by 2,000 lb. of metal, 80 kw.
Heat absorbed by 400 lb. of steel pans, 28 kw.
Heat lost through walls and doors, 24 kw.

A heat balance-sheet of this furnace heating 1,500 lb. of steel per hour to 1,650 deg. will show the following :—

Heat absorbed by 400 lb. of pans, 34 kw.
Heat absorbed by 1,500 lb. of metal, 127½ kw.
Heat lost through walls and doors, 30 kw.

The advantage of this type of furnace over the non-continuous furnace is a lower labour cost and the fact that the material when brought to the desired temperature may be more quickly removed, eliminating largely the danger of over-heating, and at the same time allowing the material under treatment to be brought to temperature more gradually.

The type of furnace best adapted to heat treating which requires precision is the automatic continuous type, wherein the material under treatment, when brought to the predetermined temperature, is automatically discharged either into the air or into some quenching medium. This method of operation reduces the human element and the chance of error to a minimum. The only part of the operation dependent on the operator is the placing of the material to be heated on the charging platform. When the material at the discharge end of the furnace reaches the maximum temperature, a special pyrometer closes an electrical circuit, which in turn closes, through a suitable relay, the solenoid operated radial dial switch; the various electrical circuits in turn operate the doors, pusher and quenching apparatus.

A typical two-furnace equipment of this type having three operations, heating above the critical point, quenching and re-heating for drawing, consists of the following parts: Two furnaces, a quenching tank, a quenching machine, a control pulpit and two contact-making pyrometers. As all the motions of the equipment are controlled from one radial dial switch, the equipment, when once adjusted, is so interlocked that no material can get through the furnace unless it is first heated to the exact temperature (a maximum of 5°F is allowed). Immediately upon reaching this temperature it is pushed and allowed to remain in the quenching bath a stipulated time; at the end of this time it is withdrawn from the bath and placed on the charging platform of the drawing furnace. When the material at the discharge end of the drawing furnace reaches the desired temperature, the pyrometer of this furnace sets in operation the operating mechanism, pushing into the furnace the material just brought out of the quenching bath and at the same time discharging the material that has come to temperature.

It is only by this automatic method that the highest class of work in heat-treating can be done, as the only part of the operation depending on the human factor is, as mentioned above, the placing of the material to be heated on the charging platform of the first furnace.

The greatest feature and one that cannot be emphasised too much is that when the material is delivered at the discharge end of the equipment it has received the treatment as per the setting of the

Table II.

Carbon per cent.	Treated or untreated.	Ultimate strength.	Elastic limit.	Elongation.	Reduction in area.	Per ton cost of elec. heat treatment, current at ½d per kw.-hour	Increase in ultimate strength.	Increase in elastic limit.	Increase in cost for heat treating steel costing £10 per ton.
0·25	Untreated	73,000	29,000	24	50	...	...	...	...
0·25	Treated ...	112,000	70,000	10	50	$1.50	53	140	5
0·45	Untreated	92,000	36,000	18	42	...	...	...	...
0·45	Treated ...	155,000	92,000	10	55	1.50	68	153	5
0·65	Untreated	121,000	40,000	10	24	...	...	...	...
0·65	Treated ...	169,000	115,000	7	34	1.50	40	188	5

Treatment consisting of heating to 850°C., quenching in water, reheating to 550°C.
Data taken from Harbord and Hall.

control equipment, and nothing else. The greatest objection to heat treatment as generally practised to-day with combustion furnaces is due to the inability to obtain duplicate results. The automatic equipment just described eliminates the uncertainties of non-automatic equipments and enables heat treating to be done with as great a precision as it is possible to measure. While with hand operation it is possible to obtain excellent results in actual practice at times, a considerable portion of the material treated will fall below the standard as determined by physical tests. The automatic equipment gives every piece exactly the same treatment.

A tabulation of the results that may be obtained with costs of such a treatment as has just been described is given in Table II. It will thus be seen that for a comparatively small cost, steel of much better physical qualities is obtained.

Conclusion.

In conclusion it may be stated that the small electric re-heating furnaces are commercially feasible from a fuel standpoint alone, where the current consumption per ton is 400 kw.-hour and the rate is 0·5d. per kilowatt-hour, compared with oil where the consumption per ton is 100 gallons at a cost of 2d. per gallon, or natural gas where the consumption per ton is 12,000 cubic ft. at 1s. 4½d. per 1,000 cubic ft. On this basis of metal saving and with a consumption of 100 gallons of fuel oil per ton, in order to compete with electricity at 0·5d. oil would have to cost not more than 0·75d. per gallon, or with oil at 1·5d. the fuel consumption would have to be under 50 gallons per ton.

Electric furnaces of the continuous type of 5 tons per hour capacity will show commercial economy over coal-fired furnaces of the same capacity which require 200 lb. of coal per ton of steel, with coal at 8s. per ton, while the electric furnace requires an electric current consumption of 250 kw.-hour per ton, current at 0·25d. per kilowatt hour, with a metal saving of 3 per cent. over coal-firing, heating a steel worth £7 per ton.

The user of steel to-day is willing to pay the additional cost for the additional physical qualities to be obtained by proper heat treatment, but he has never been willing and never will be willing to pay for the so-called heat treatment that has in too many cases consisted of simply putting the material through a furnace. Physical qualities of the highest character have been obtained from time to time by treatment in combustion furnaces, but it is almost impossible to obtain duplicate results from day to day, owing to the many variables including the greatest of all, the human element. The automatic electric furnace requires the minimum of attention in its regulation, and the human element is eliminated completely in the cycle of operation, excepting in placing the material on the charging platform of the furnace.

When the engineer realises that for an additional cost of from 8s. to 12s. per ton he can with certainty get the full value of results possible with heat treatment, the demand for heat-treated material will be a great many times larger than it is to-day.

Electric furnaces have come to stay, and while in the past a great deal of bad steel has been made in all classes of electric furnaces, it must be realised that the same sort of operators would probably have made a great deal worse steel in any other kind of furnace. The application of electric furnaces in melting and refining, and in heating and heat treating, has only begun, and while the total current now used in this country in electric steel furnaces is only a few thousand kilowatts at this time, within the next 10 years it should be several hundred thousand kilowatts. With the growth of electric furnace loads, with their high load factor and power factor, the cost of current per kilowatt-hour will be materially reduced, so that even electric smelting, when the high quality of pig iron thus produced is taken into consideration, may become, even in this district, commercially feasible for the better grades of iron to be used in the manufacture of high-grade steels, while electric furnaces for heat treating, re-heating and the soaking of ingots will have come to hold the same relation and importance in industrial heating operations as the electric motor now holds in the field of industrial power.

In replying to the discussion that followed the reading of the Paper the author stated that a typical furnace taking 200 kw. had required only 16s. 8d. spent in supplying two electrodes and had required repairs to the brickwork taking 12 silica bricks. It had run about 6,000 hours. The cost of the electric furnaces themselves was roughly four to five times the cost of a combustion furnace of the same capacity. The highest temperature at which they had so far run furnaces was 2,700 F. and such furnaces ran as long as three weeks without any repairs; they then required new linings which cost about 10s. and took half a day to renew, counting the time of cooling the furnace down. Metal resistors might be feasible for temperatures up to 1,500 F. They had recently guaranteed the upkeep of some furnaces to be within 3d. per ton of metal heated.

ON AN ADJUSTABLE PRISM-SHAPED MULTIPLE SPARK-GAP.*

BY B. THIEME.

The usual quenched spark and explosive gaps for wireless telegraphy are far from being all that is desired owing to their rapid deterioration; in fact, the attainment of a pure quenching and impact excitation is practically impossible with the irregular burning away of the sparking surfaces such as generally occurs. Boas has tried to remedy this, and has described the construction of spark-gaps in which, by employing tungsten for the sparking surfaces, very little burning away took place. Such gaps have not, however, been very generally adopted owing to the difficulties attending the working of the metal.

Another way of overcoming this difficulty has been suggested by Martens in a Paper read before the German Physical Society. Martens showed that by the combination of two oscillatory circuits it is possible so to connect the sender that, for the same energy, the oscillation takes place almost entirely in these circuits without overloading the spark-gap. Such a method has recently formed the subject of a patent application by Seibt. None the less, it is impossible to avoid burning away the sparking surfaces in the course of time, and for technical reasons also the above-mentioned connection scheme is not likely to be generally adopted. The question thus arises how it is possible to provide for such wireless stations as have, with no reserve of spare parts, to remain at sea for long periods, or, like meteorological stations, have to get along without skilled assistance. For it often occurs, especially in the case of meteorological stations, that sending has to be effected at one time with ordinary spark, and at other times with quenched spark, the same spark-gap being used in both cases.

Cylindrical spark-gaps, consisting of silvered copper cylinders provided with means for rotating the discs are known; such rotation being for the purpose of surmounting the difficulty of the eating away of the electrode material. Such gaps, of which several are used in series, often give good service, but even in their case the spark fairly easily eats into the metal, and then remains fixed at the spot thus affected, so that the quenching effect after a short period of use is mostly very small. The cause of this is to be sought in two directions—namely, first, the curvature of the cylinders, due to which the sparks are compelled to pass only at the immediately contiguous edges of the cylinders, and, therefore, in a very small area; and, secondly, the fact that the separation of the cylinders is never absolutely the same, so that at various places on the sparking line a field of different strength is set up, which behaviour also does not contribute to an enhancement of the quenching effect.

Another disturbing factor is that owing to small inaccuracies in the position of the two axes, the distance between the cylinders changes, in the course of their rotation for the purpose of bringing new sparking surfaces into action; the adjustment of the station is thus changed, and strong ionisation and local heating occur. Since the field can only extend along the line of contact of the cylinders, and not radially as in the case of plate-shaped gaps, the damping is disproportionately high.

As a result of the author's attempts to produce a spark-gap possessing all the advantages he commenced by employing for his cylinder gap cylinders provided with tungsten coatings, and eventually the cylinders were made entirely of tungsten. These spark-gaps, which have been more fully described in the "Zeitschrift für technische Physik" (Vol. II., p. 5, 1914), are, however, designed mainly for what may be called technical stations, while the author is concerned, in the present case, more particularly in providing a spark-gap, suitable for all purposes, which should not only be as simple as possible to produce, but which could be used for various loadings and different sending methods.

The electrodes were for this purpose no longer cylinders, but were made in the form of prisms; a regular octagonal prism proved the most practical. Several such prisms are connected in series. By keying the prisms on a plane surface, parallelism of the sparking surfaces is secured. When, after long-continued use the sparking surfaces get eaten away, the whole lot of the active prism surfaces can at once be renewed by the simple expedient of lifting them out of their setting and turning them one-eighth of a revolution (the amount of one face).

For the different purposes for which they are to be used the separate prism surfaces can be coated with different materials; the arrangement thus allows of a wide range of adaptability.

In cases where the load may be at times very different from that at other times, and it is even proposed to adjust for such loads by means

* Paper read before the German Physical Society.

of short-circuiting one or more of the gaps, the prisms can be made with unequal sides, so that surfaces of greater or smaller area are opposite to one another (for the purpose of securing low spark-decrement).

For adjusting the sparking distance, each pair of prisms is made into a unit, the axes being fastened together though insulated from one another; each such pair can be interchanged and can be shifted with respect to the other prism units, perpendicularly to the axial direction and axial plane. In this way a fine adjustment of the electrode separating distance is obtained by mechanical means in a very simple manner, so that, in order to attain the lowest possible decrement, the length of the separate spark gaps can be altered, even whilst sending is being carried on, to near the limit of the quenching action. The advantage of such an arrangement is obvious. The mechanical micrometric adjustment has the advantage that irregularities in the electrode separations are almost entirely obviated. As a result of this adjustability the station is in any event capable of handling a larger primary output.

ELECTRIFICATION ON THE LONDON & SOUTH-WESTERN RAILWAY.

(*Concluded from p.* 128.)

The Sub-stations.

Fig. 39 shows diagrammatically the transmission from the power house to the sub-stations and the distribution from these to the third rail. From this it will be seen that there are nine sub-stations which are supplied from the power house through 8 high-tension feeders, either directly or by means of looping, at a pressure of 11,000 volts.

The equipment is practically identical in all the sub-stations, except at Clapham Junction, where restrictions were imposed by the limited space in which the sub-station is built. Otherwise, the equipment varies from one sub-station to another merely in the number and power of the rotary converters. Fig. 40 shows the general arrangement of a sub-station.

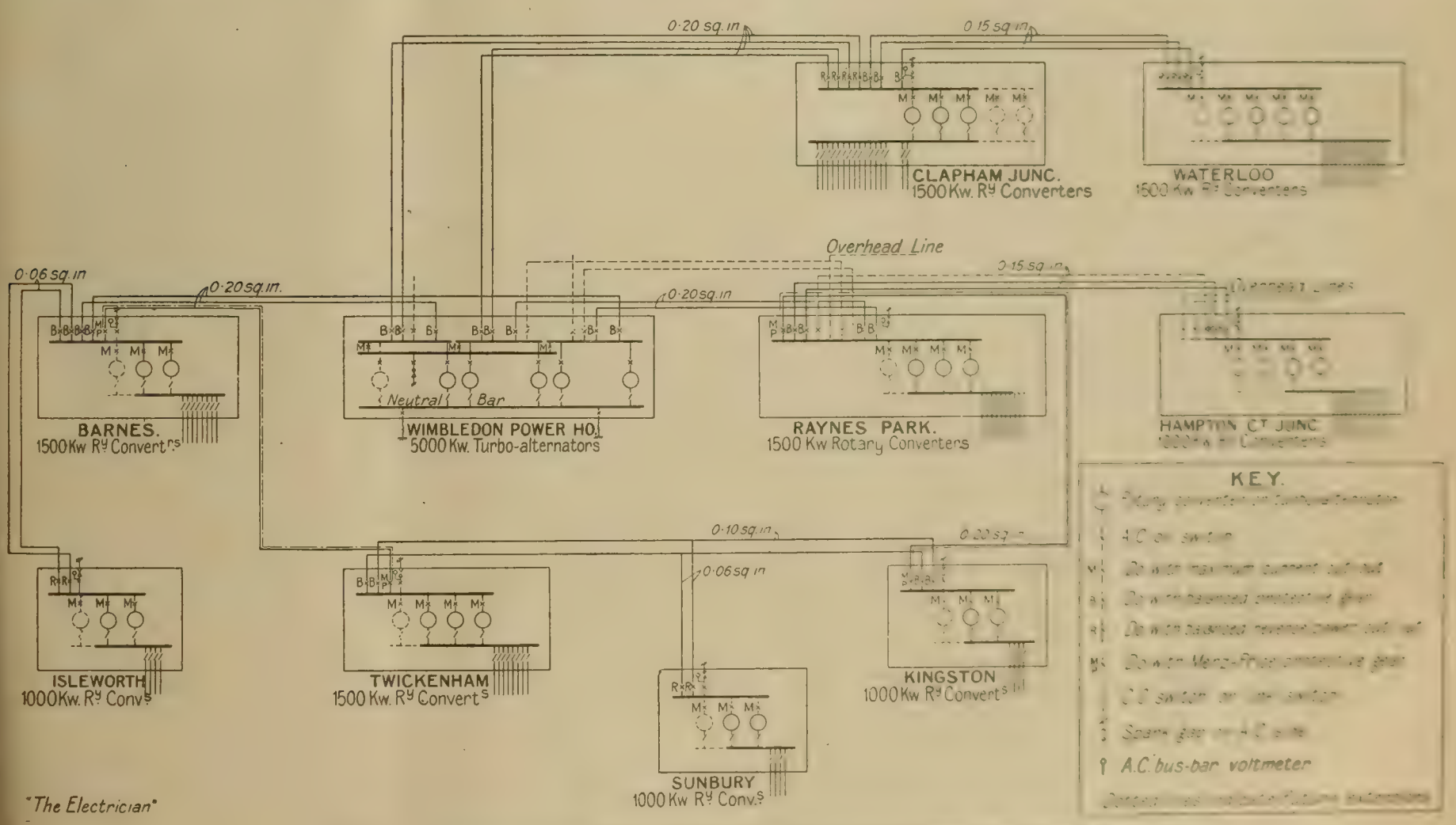


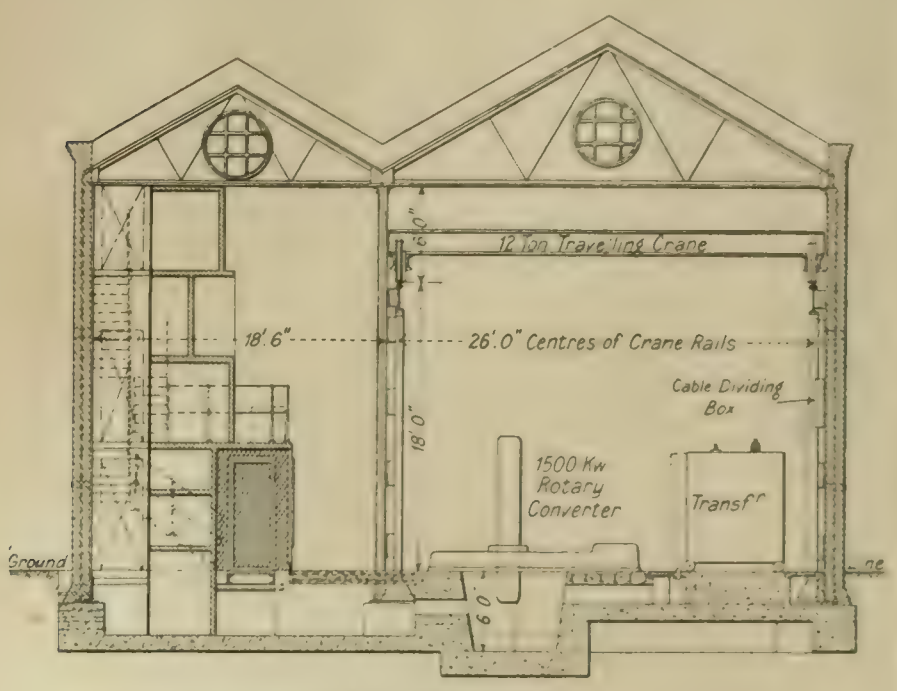
Fig. 39.—Diagram of the Power House, Transmission System and Sub-stations.

The rotary converters, which are by the British Thomson-Houston Co., are of the reactance controlled six-phase type, arranged with an induction motor mounted on the shaft for self synchronising. There are 15 1,500 kw. machines, running at 300 revs. per min., and eight 1,000 kw. machines running at 375 revs. per min., installed at present, with provision for six more 1,500 kw. and five 1,000 kw. machines in the future. These capacities include a heavy overload rating; in fact, the machines can be run continuously at an overload of 25 per cent. Great attention has been given to the question of clearances and creepage surface, and the rotary converters have been designed to prevent the accumulation of dirt on any of the surfaces of the machines. A view of these machines is shown in Fig. 42.

The connections of the starting motor are shown in Fig. 41. With this arrangement starting up becomes a very simple matter. The starting motor, which is made with one pair of poles less than the rotary, is connected in series with the latter. The field of the rotary is at first left unexcited, but connected to the commutator. As the motor runs up, the field excites from the residual magnetism, and the rotary pulls itself into synchronism. Just before this takes place the voltmeter on the starting motor shows large fluctuations, but becomes steady at the moment of synchronism. The starting motor is then short-circuited by closing the main switch, and is finally cut out. An indication is also given by synchronising lamps.

Each converter is supplied through three single-phase transformers, supplied by the British Electric Transformer Co. These transformers are of the standard oil-cooled "Berry" type of 550 k.v.a. for the 1,500 kw. rotaries and 370 k.v.a. for the 1,000 kw. rotaries, wound for a ratio of 10,750/445 volts at 25 cycles, with primary tappings at 2½ per cent. and 5 per cent. above and below the normal. They are enclosed in heavily riveted sheet steel cases, which are fitted with external radiating and circulating tubes welded into the tank, thus

constituting an absolutely oil-tight case. The cases themselves are mounted on rollers for convenience in handling, and are provided with lifting lugs, so that each transformer



SECTION AT A.B.

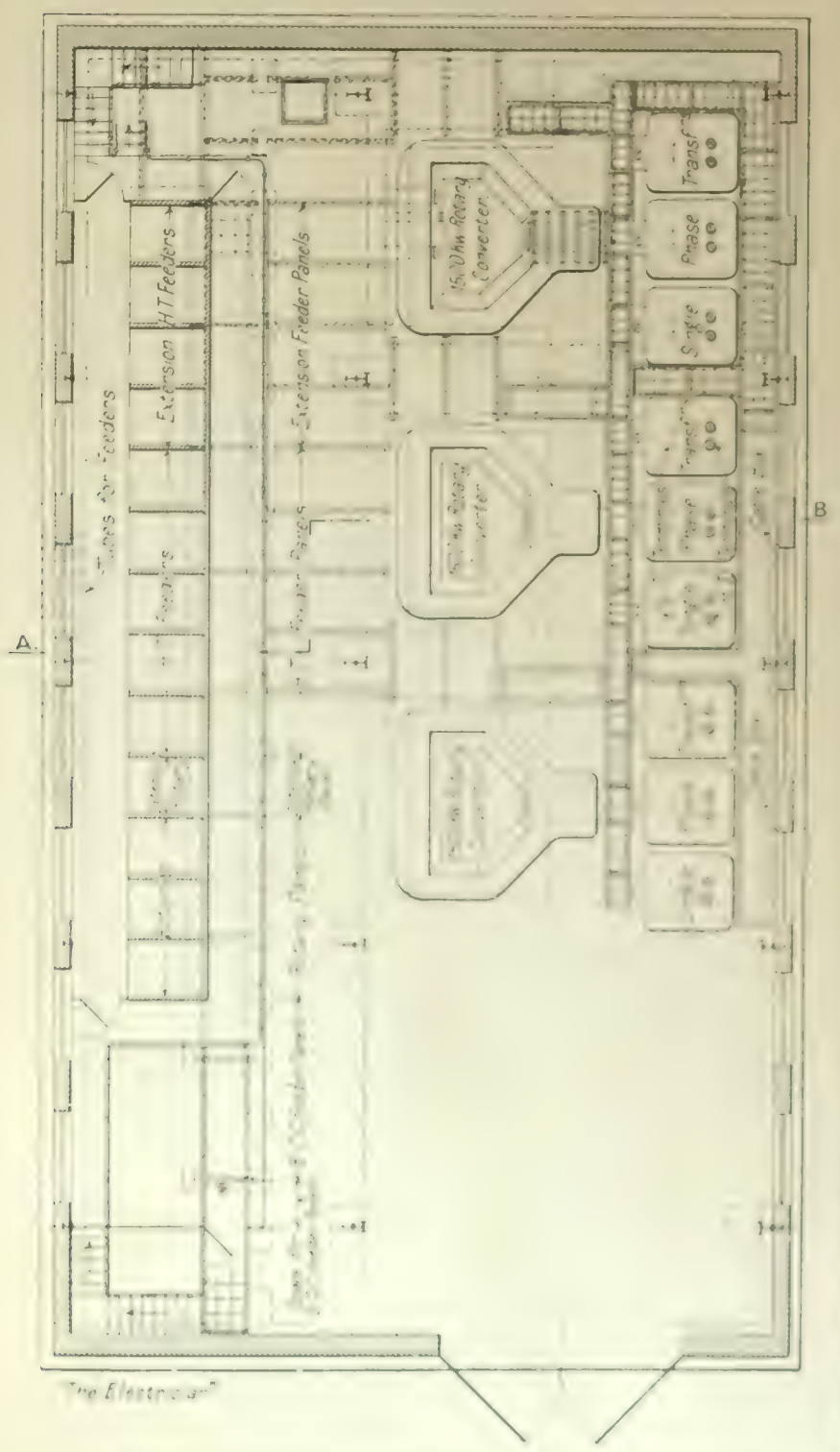


FIG. 40.—PLAN AND CROSS-SECTION OF A SUB-STATION.

may be handled complete with oil if required. Bare type terminals are brought up through the covers of the tanks for both primary and secondary leads. The specified temperature rise limits were as follows: 90°F. for continuous full load, 99°F. for 25% overload for one hour. A bank of these transformers is seen in Fig. 43.

In the sub-stations at Waterloo, Clapham Junction, Raynes Park and Twickenham motor generators are provided by Bruce Peebles & Co., which generate single-phase current at 3,300 volts and a frequency of 75, this current being transmitted and stepped down by transformers along the line for signalling purposes. The generator in each case is an open-type single-phase alternator with direct-coupled exciter. The four machines just mentioned are driven by three-phase motors, fitted with short-circuiting and brush-lifting gear. In addition, three similar sets driven by shunt-wound continuous-current motors have been supplied, two of these being for the power station and the third machine being at the Waterloo sub-station. The continuous-current sets run at 900 revs. per min., whilst the induction sets run at 732 revs. per min.

The sub-stations are equipped with overhead travellers by Herbert Morris, Ltd.

The switchgear for the sub-stations was supplied by the British Thomson-Houston Co., and consists of plant for extra high tension, for the continuous-current feeders and for the

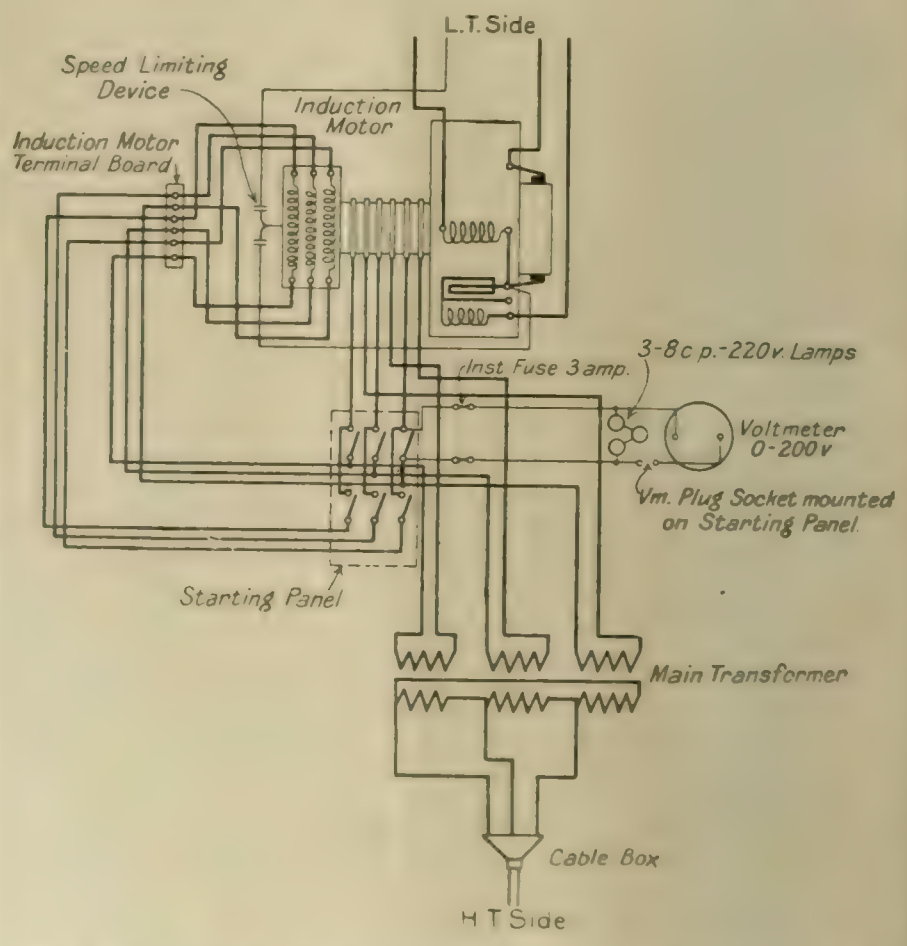


FIG. 41.—DIAGRAM OF CONNECTIONS OF ROTARY CONVERTER AND STARTING MOTOR.

control of the sub-station plant, including the signalling generators and transformers. The extra-high-tension apparatus is all contained in moulded stone cubicles, the phases being kept in separate cells by means of barriers, access to these cubicles being by means of steel doors. The locks on these doors are arranged in the same manner as on the main station switchgear.

The switchgear is arranged on three levels, as seen in Fig. 44. The basement contains the cable boxes; the ground floor, the instrument transformers; the middle floor, the oil switches and bus bars; and the top floor the bus bar potential transformers and spark gaps. A gallery gives access to the various apparatus. The passages round the extra-high-tension switchgear are fitted with glass treads. All the connections are made by means of bare copper.

The oil-tubes containing the high-tension switchgear and conductors are separated by a passage way from the control board, which is placed in front of it.

We may now refer to the switchgear in detail. Each high-tension feeder is brought into the basement to a trifurcating

box, and thence to the isolating switches contained in the lowest cell, as seen in Fig. 44. The cell above contains a potential transformer; also the current transformers on each phase for the Ferranti-Waters protection. The current transformers are all porcelain insulated. A third cell contains current transformers for an ammeter. On the floor above, the conductors are taken to three-phase oil switches mechanically operated, and in the cell above this each phase is taken to its appropriate 'bus bar through isolating switches. As in the case of the power house switchgear, the 'bus bars are carried along in horizontal cells the whole length of the switchgear compartment. The necessary connections are made through a vertical partition to the feeders and other conductors.

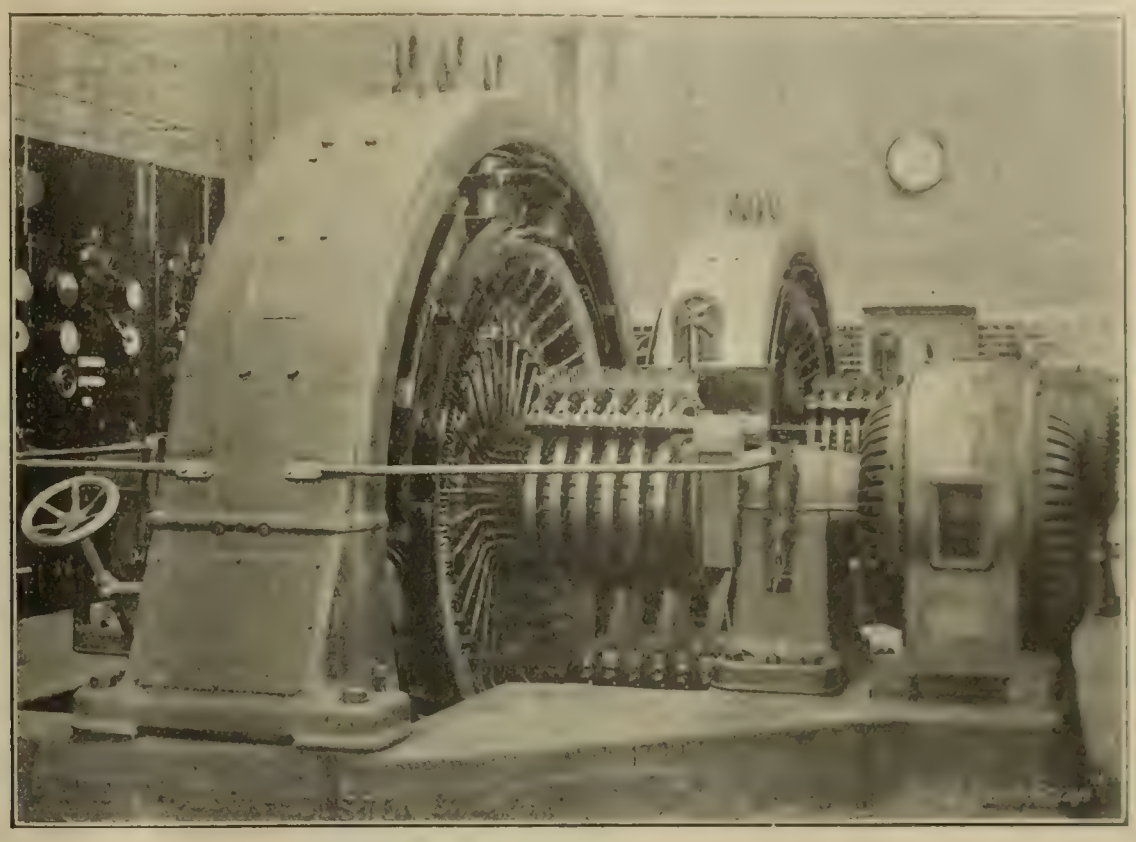


FIG. 42.—VIEW OF ROTARY CONVERTERS.

Two special cells are provided for a potential transformer giving the voltage on the 'bus bars and for spark-gaps of the horn type for protecting the feeders respectively.

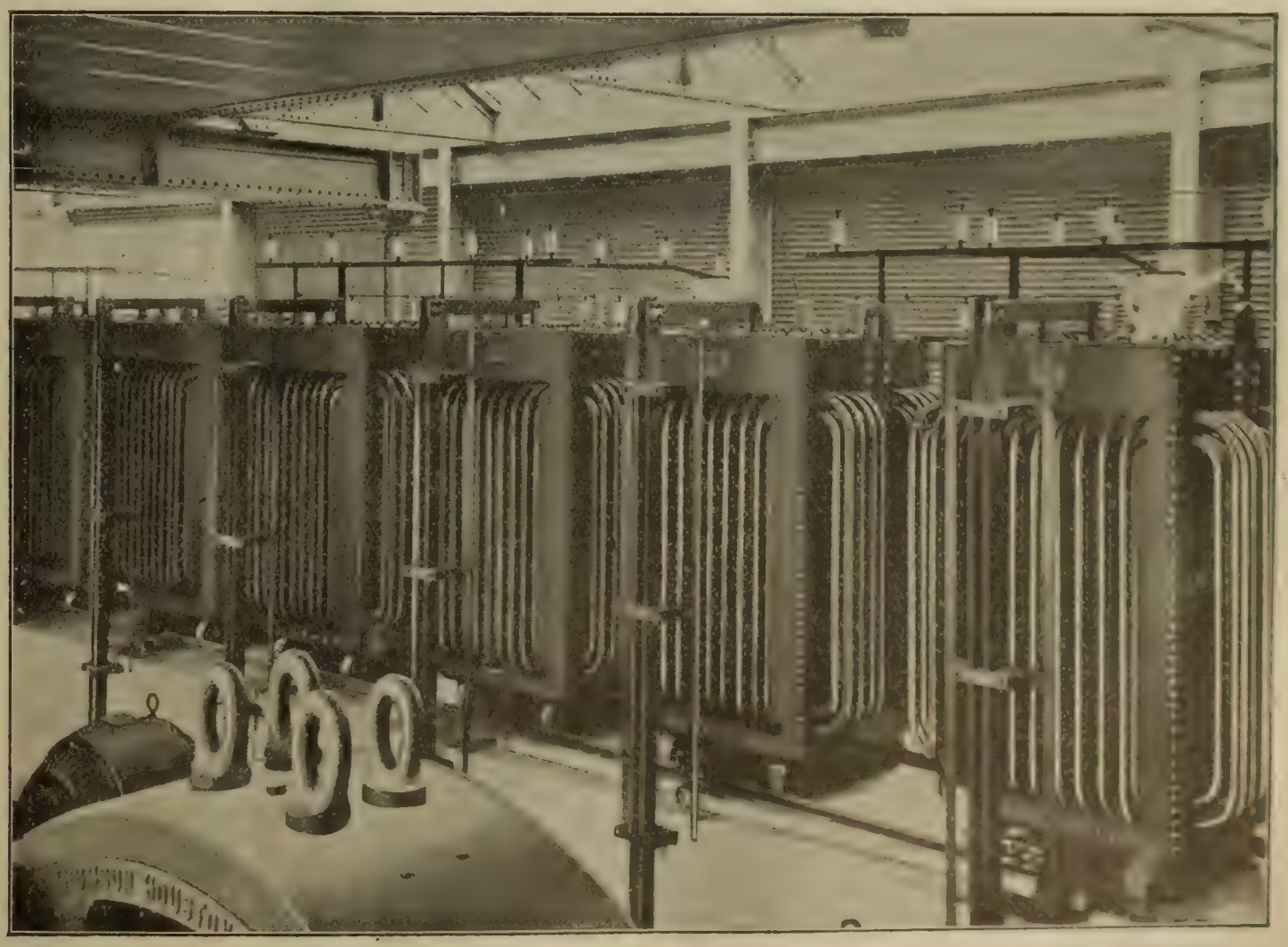


FIG. 43.—VIEW OF BANK OF TRANSFORMERS.

The connections from the 'bus bars to the transformers for the rotary converters are run in practically the same way as the feeder connections just described.

Passing to the control board, which is shown in elevation in Fig. 45, the high-tension feeder panels are provided with a voltmeter and ammeter, an operating handle for the oil switch and indicating lamps, and alongside is a panel carrying the Ferranti-Waters relays for protecting the three phases. There is a panel carrying a voltmeter indicating the high-tension 'bus-bar pressure, and one indicating the low-tension 'bus-bar voltage; also the handle for operating the oil switch controlling the potential transformer on the 'bus bars and spark-gaps.

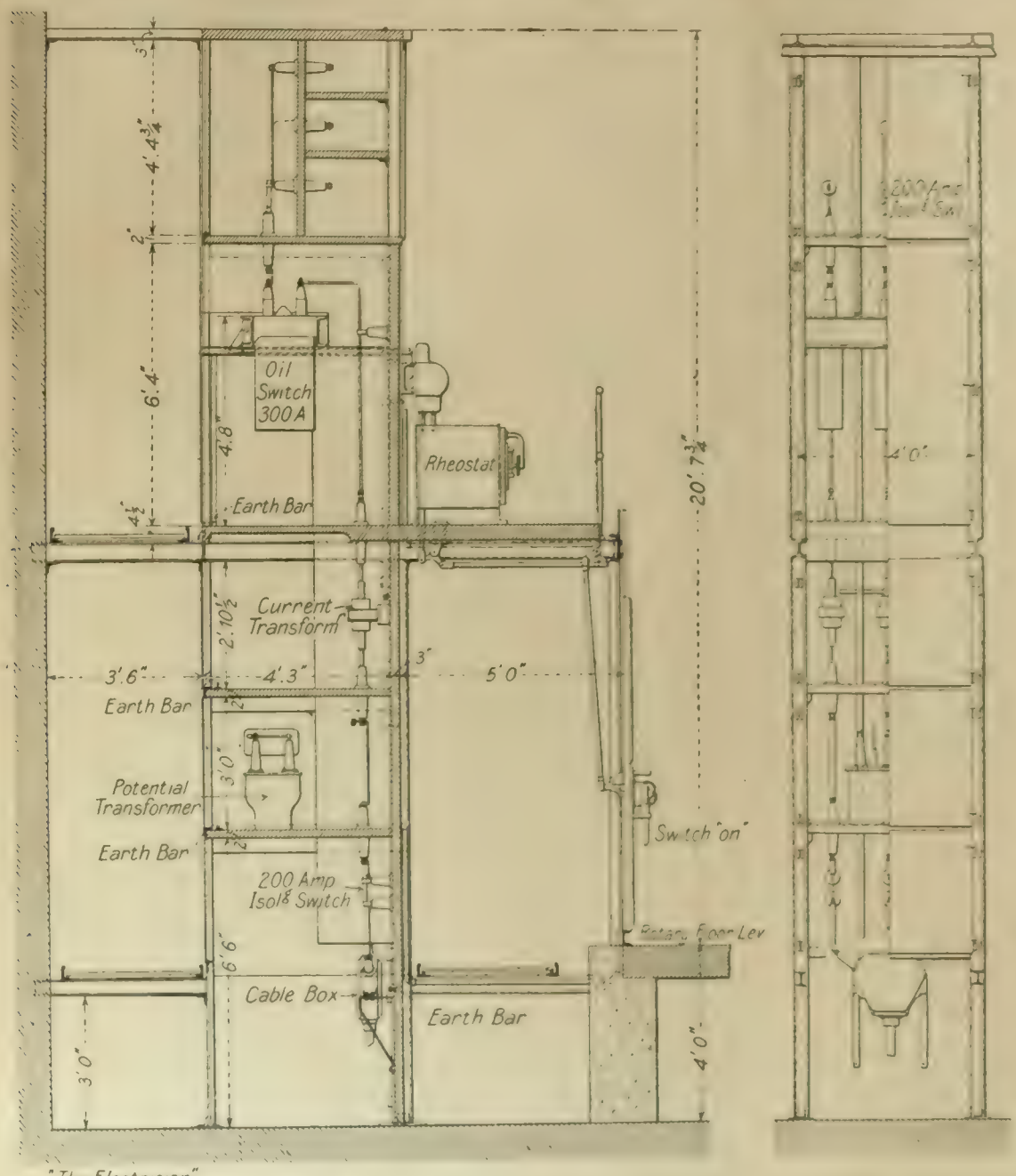


FIG. 44.—ARRANGEMENT OF SWITCHGEAR.

The panels for the rotary converters carry an oil switch control handle, low-tension main switch, an automatic cut-out, extra-high-tension and low-tension ammeters, a field regulator and an ammeter showing the field current. The extra-high-tension instruments are arranged on one side of the panel and the continuous-current instruments on the other.

The oil switches, which are of the B.T.-H. heavy tank type, are operated mechanically from the control panels by means of rods. Each phase is contained in a separate tank, and the mechanism is arranged so as to give a maximum clearance at the terminals of the oil switches.

The low-tension conductors from the rotaries are taken from the rotary panels to the 'bus bars behind the board. These 'bus bars extend behind the low-tension control board, consisting of feeder panels in line with the other panels. Each feeder is taken from the 'bus bars through a main switch, ammeter and circuit-breaker, and thence overhead to a second board situated behind the control board, where each feeder is taken through a choking coil and an isolating switch. The choking coils are provided with spark-gaps to give protection against lightning discharges, and the spark gaps are fitted with isolating switches.

The continuous-current boards (Fig. 46) take the usual form of traction control panels—that is, slate panels having the instruments, circuit-breakers and switches mounted on the front with the 'bus bars and connections on the back. The sectional area of the 'bus bars in the various sub-stations ranges from 2 sq. in. to 10 sq. in. All the joints are faced, tinned and clamped together by means of heavy malleable iron clamps, thus avoiding the drilling of any holes in the 'bus bars, and all the bars and connections are painted with blue and red anti-sulphuric enamel. All the panels are enamelled on both sides, and all small wiring is carried out with bare

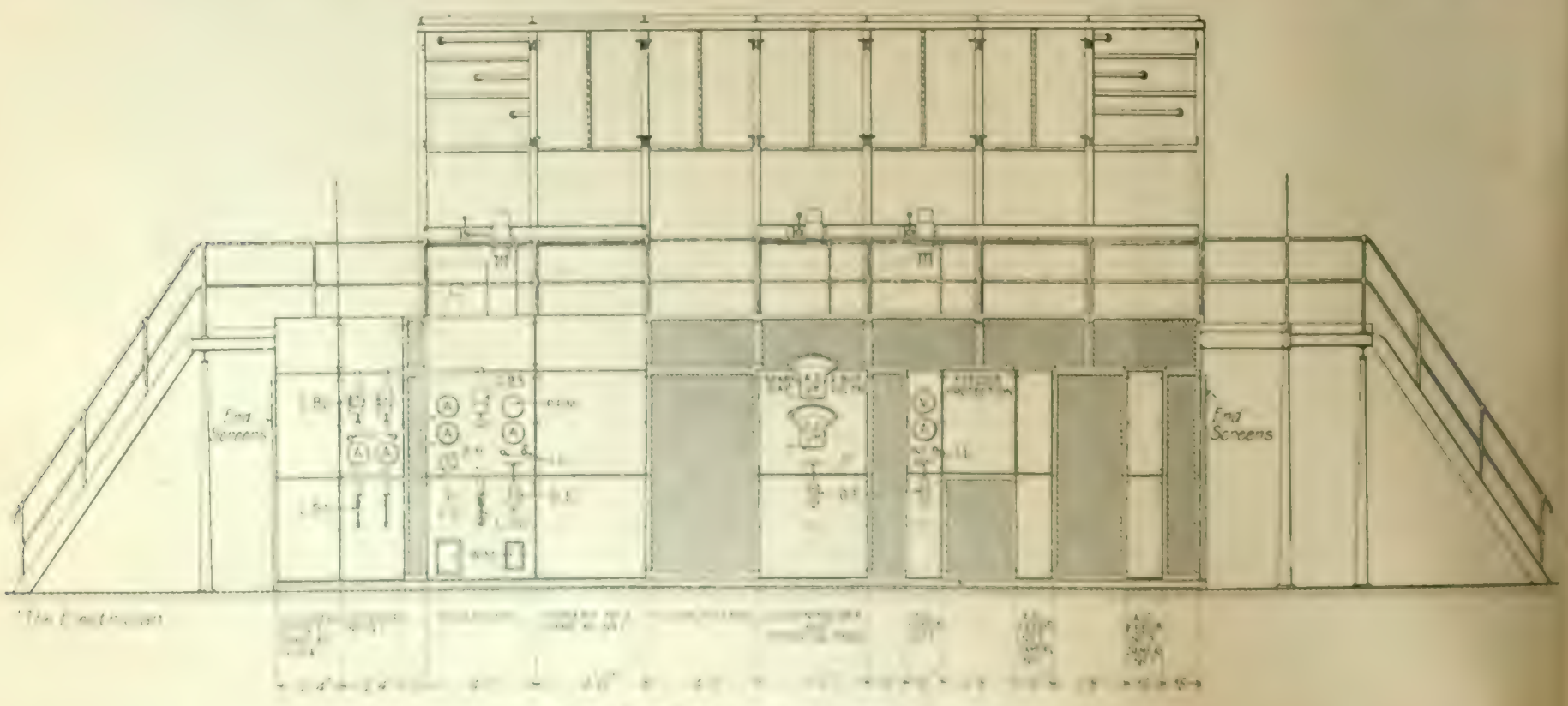


FIG. 46.—ELEVATION OF CONTROL BOARD.

A.A. = Ammeter. P.F.M. = Power Factor Meter. C.B. = Circuit Breakers. C B3. = 3,000 Amp. Circuit Breaker with Reverse Attachment. O.E. = Overhead Earthing Switch. F.S. = Field Switch. W.M. = Wattmeter. L.S. = 1,200 Amp. Lever Switch. L.S. = 2,000 Amp. Lever Switch.

copper wire secured to the panels by means of porcelain cleats.

The negative conductors of the rotary converters are taken

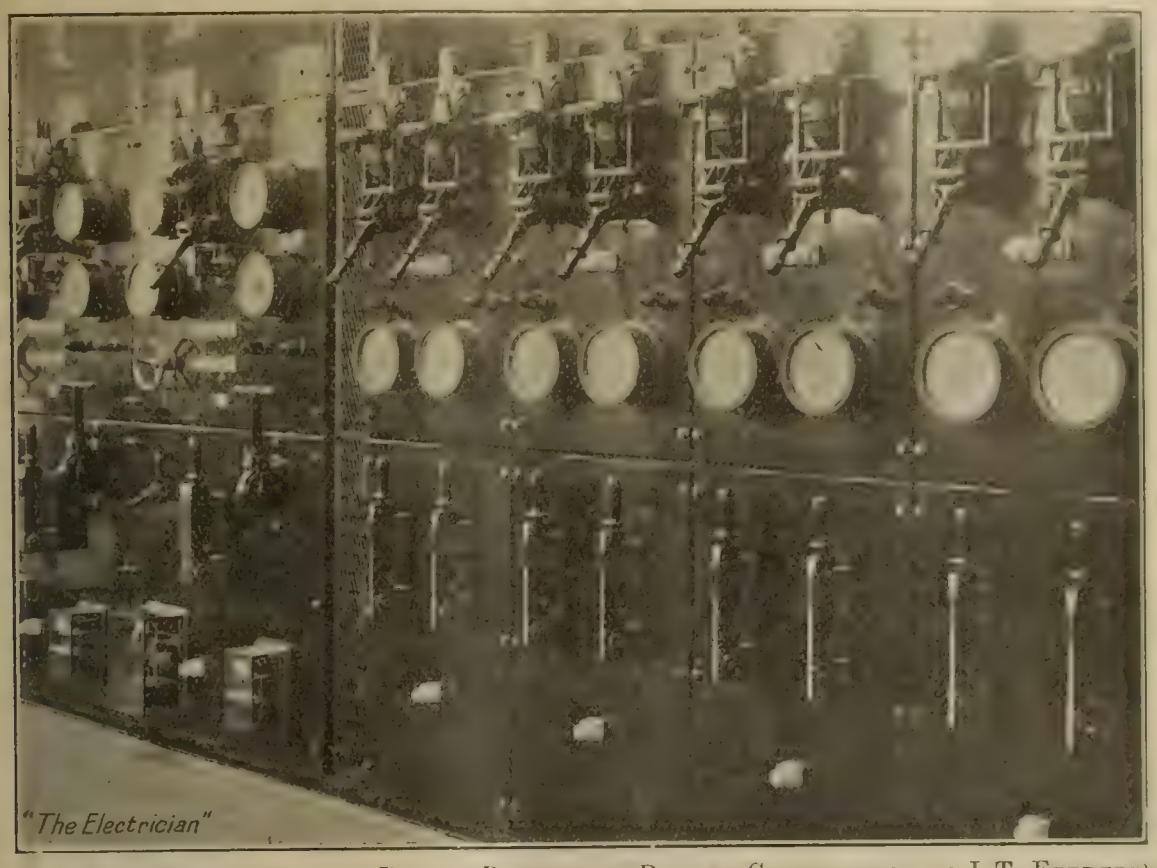


FIG. 46.—VIEW OF CONTROL BOARD (PANELS FOR ROTARY CONVERTERS AND L.T FEEDERS).

direct to the main 'bus bar, and the negative feeders are taken straight from the negative 'bus bar to the rails.

The lighting and signalling control boards are of the draw-out ironclad type, and are seen in Fig. 47. They control one

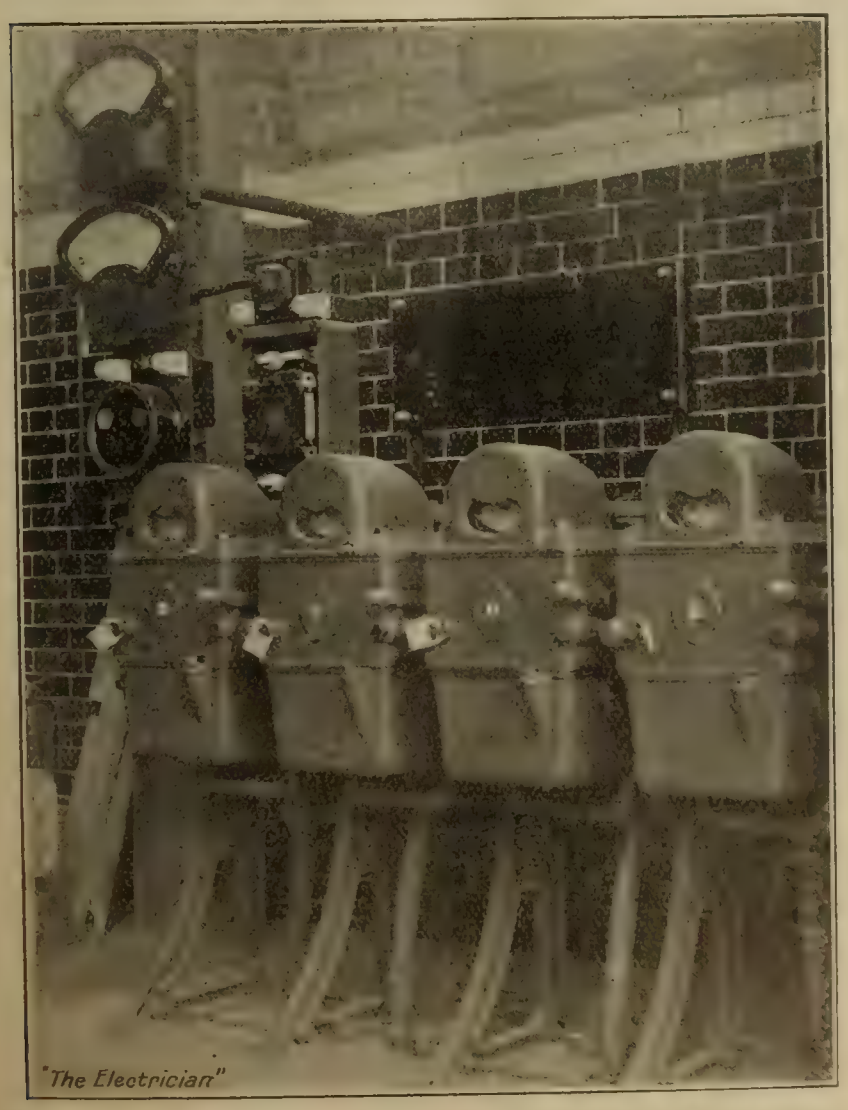


FIG. 47.—VIEW OF CONTROL BOARD FOR LIGHTING AND SIGNALLING.

or more motor-generators (giving a single-phase supply at 75 cycles for lighting, &c.) and 15 k.v.a. transformers.

At the Waterloo sub-station there are special panels for con-

trolling the Waterloo and City Railway which will no longer be run by its own power house, and a battery of 200 Tudor cells having a capacity of 800 ampere hours at the 1-hour rate. In the event of a breakdown the battery is capable of handling these trains for a short period.

We desire to express our thanks to Mr. Herbert Jones, chief electrical engineer of the Railway Company, and to Messrs. Kennedy & Donkin, consulting engineers for the power house and sub-stations, for placing every information at our disposal enabling us to prepare the description here given.

ARTIFICIAL ILLUMINANTS FOR USE IN PRACTICAL PHOTOGRAPHY.*

BY C. E. KENNETH MEES, D.Sc.

Artificial illuminants can be used in negative making for portraiture, cinematograph work and photo-engraving. For portraiture diffused sources are necessary, and either a large source, such as that given by a bank of Cooper-Hewitt lamps, must be used or the light must be reflected from a large area.

In cinematograph work about ½ kw. per square foot of stage is used, the usual arrangement including the use of Cooper-Hewitt lamps overhead and at one side of the stage, and arcs in front. For photo-engraving an arc lamp is hung on each side of the copyboard, most engravers using flame carbon arcs. For printing papers the enclosed arc is used for silver papers, while for platinum the Cooper-Hewitt lamp is satisfactory. In printing fish-glue on metal it is important that a small source of light should be used in order to get sharp definition of the dots, and the printing should be as far away as possible. The following illuminants are recommended for portraiture: Flame arcs, Cooper-Hewitt lamps, and nitrogen tungsen lamps; for cinematograph work, the Cooper-Hewitt, quartz arc and flame are; for photo-engraving, the enclosed arc and flame arc; for silver printing, the enclosed or flame arcs; for platinum printing, the Cooper-Hewitt lamp.

The photographic efficiency of artificial illuminants depends upon their quality and upon their visual efficiency, but must be considered from the point of view of the materials used, which materials are of three chief kinds: (*a*) Panchromatic materials sensitive to the whole spectrum and used with filters to give a rendering similar to that seen by the eye, or for colour photography; (*b*) ordinary materials having their maximum sensitiveness in the blue-violet; ( ) materials sensitive only to the ultra-violet.

For panchromatic materials the efficiency of the illuminant will depend almost entirely upon its visual efficiency, while for ordinary materials the chief point of importance is the efficiency in the blue-violet, but, since the latitude and freedom from halation increase with shorter wave-lengths, it is better to use light sources having their maximum near 400$\mu\mu$ rather than near 470$\mu\mu$. It is pointed out that nearly all artificial illuminants have application in some branch of photography or other.

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ELECTRICITY APPLIED TO THE HEATING OF METALS.

In our present issue we give two Papers dealing with electric furnaces for the heating of metals. In the first of these, by Mr. F. L. BISHOP, some account is given of various types of furnace suitable for the heating of metals in the laboratory. Furnaces of this kind form an extremely useful adjunct to the ordinary laboratory equipment, and enable results to be obtained that would otherwise be difficult. For example, the remarkable magnetic results recently published by Mr. YENSEN were obtained by the melting of iron *in vacuo* in an electric furnace. The employment of such devices in the laboratory is always interesting as an indication that similar methods will in all probability be extended to engineering problems in the near future. From this point of view the other Paper to which we have referred, namely, one by Mr. T. F. BAILY, is of more than usual importance, because it gives results of experience in ordinary practical everyday working on a considerable scale.

We doubt if it is realised in this country what a future there may be for the application of electric heating to the heat treatment of metals in steel works. The figures given by Mr. BAILY show an increase in the ultimate strength of heat treated steel over untreated steel varying from 40 per cent. to 68 per cent. and in the elastic limit from 140 per cent. to 188 per cent. On the other hand, the increase in cost merely amounts to 5 per cent. The advantage of heat treatment is probably quite realised by those who are concerned with the production of steel, but the difficulty is that the ordinary combustion type of furnace is not easy to control, and therefore there is a good deal of uncertainty in producing the same result in every case. On the other hand, with electric control the whole process may be made

so automatic that uniform results can be obtained without difficulty.

In taking up a subject of this kind we are apt to think that the cost of heating electrically must be too high for commercial results to be obtained. Mr. BAILY, however, demonstrates that this is by no means the case. For example, he states that where the consumption per ton is 400 kw.-hours, at the price of ½d. per unit, the result compares satisfactorily with oil at 2d. per gallon, taking 100 gallons of oil per ton and having regard to the fact that there is a substantial saving in the metal through the use of a non-oxidising atmosphere. Similarly, electric furnaces of the continuous type with a capacity of 5 tons per hour show a commercial economy over coal-fired furnaces of the same capacity which require 200 lb. of coal per ton of steel, with coal at 8s. per ton, provided the electric furnace consumes 250 kw. hours per ton with current at ¼d. per kilowatt-hour, and assuming a metal saving of 3 per cent. The efficiency of the electric furnace for such purposes varies from, say, 50 per cent. to 75 per cent., depending upon the size and the temperature at which it is run, the efficiency being greater for the higher temperatures. It is also pointed out that there should be a good opening for electric heating in connection with soaking pits, for here the advantages are very marked. The cost in this case would only be 5d. per ton, the consumption being at the rate of 20 kw.-hours per ton.

We think the author is correct in his view that the application of electric furnaces to melting and refining and to heat treatment is only just beginning, and that within the next 10 years the consumption of electric power for this purpose will rise to several hundred thousands of kilowatts. Obviously, to the station engineer, loads so provided will be exceedingly attractive. From every point of view, therefore, it behoves the steel maker, the furnace maker and the station engineer to look into this subject and to grasp its possibilities.

SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION.

BY PROF. G. W. O. HOWE, D.SC.

Every student of electrical engineering who makes a serious attempt to get clear physical conceptions of the fundamental principles of electromagnetic induction is faced sooner or later with a problem which presents itself in various forms, but which is, perhaps, most often expressed in the question: If a cylindrical bar magnet or a solenoid be rotated about its axis will its magnetic field rotate with it? The writer is often asked this question by those who are no longer students except in the wider sense of the word, and the present article is an attempt to throw some light on this and on a few other problems arising out of it. The difficulty is brought out clearly by the following experimental question: C (Fig. 1) is a stationary coil carrying a steady current, as shown by the arrow, and D is a disc rotating about an axis which is also the axis of the coil. If there be sliding contacts at the axis and edge of the disc, will an induced current be sent through the galvanometer G? If, now, the disc be kept at rest and the coil rotated about its axis, sliding contacts being used to carry the current into and out of the rotating coil, will there be any difference in the induced current through the galvanometer G from that obtained in the previous case?

When the solenoid is at rest and the disc rotated the arrangement is similar to that of the Lorenz apparatus, and it is well known that an E.M.F. is induced in the disc. When the disc is at rest and the solenoid rotated one is tempted to argue that, because the relative motion is unchanged, the induced E.M.F, should be the same as before. Experiment shows, however, that no reading is now obtained on the galvanometer. Does this prove, then, that the magnetic field produced by the solenoid does not rotate with the solenoid? There can be no definite answer to this question, because it has no definite meaning. The peculiar condition of the ether which we call the magnetic field is absolutely constant in direction and magnitude at every point, whether the solenoid is at rest or rotating about its axis, and it seems impossible to attach any definite meaning to the question as to whether this peculiar condition of the ether is rotating or not. When the disc is rotated, whether the solenoid be at rest or not, the conducting material of which the disc is made cuts through the ether, and this ether, being in the peculiar condition known as a magnetic field, causes electric forces to be induced in the material moving through it. By the rotation of the disc a regular drift is given to its electrons, and every positive electron is equivalent to a current in the direction of rotation, while every negative electron is equivalent to a current in the opposite direction; we should, therefore, expect these electrons to experience a force tending to move them radially inwards or outwards, depending on their sign—that is, we should expect an E.M.F. to be induced in the rotating disc.

Let the piece of disc shown in cross-section in Fig. 2 be moving away from the reader, then the electric force E induced in the disc will be in the direction indicated. The E.M.F. around any closed path lying either entirely in the conductor or entirely outside it is zero; but if an infinitely narrow rectangle 1 cm. long is considered, with one side radially in the disc, and the other side just outside the disc, as shown in Fig. 2B, the E.M.F. around the circuit is $E=Hv$, where v is

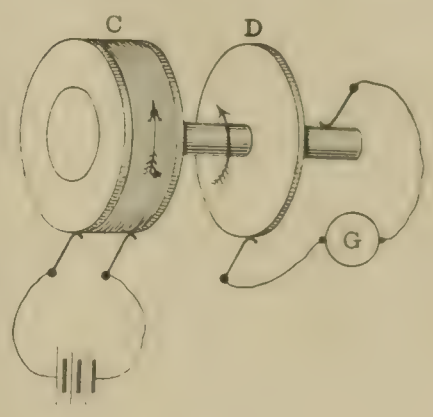


FIG. 1.

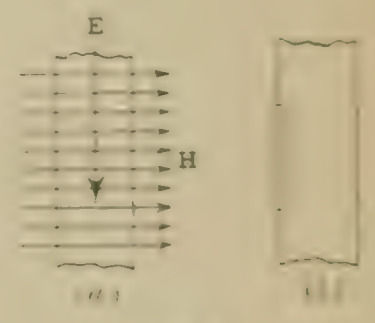


FIG. 2.

the velocity. This is obtained either by considering the side in the disc to be cutting the magnetic field, or from the point of view of the rate of change of flux through the rectangle. One side of it, being outside the disc, is assumed to be stationary, while the other side is a part of the disc and rotates with it. The infinitely narrow rectangle is, therefore, only infinitely narrow for a moment, and then opens out into an annular sector of uniformly increasing area through which the magnetic flux passes. Whichever point of view is adopted, the E.M.F. vanishes as soon as the disc comes to rest, quite irrespective of the rotation of the solenoid.

A very interesting, and at first sight very puzzling, problem is the nature of the mechanical reaction which must oppose the driving torque when current is taken from the rotating disc. When an ordinary dynamo is loaded the turning moment exerted by the engine must necessarily be opposed by an equal and opposite moment. This mechanical reaction is produced by the tangential component of the magnetic field in the air-gap, by means of which the driving torque is transmitted to the field magnet system, and thus to the holding-down bolts. By analogy, one might be led to expect that the solenoid or field coil of Fig. 1, or of the ordinary Lorenz apparatus, would tend to rotate with the disc as soon as current was taken from the latter. This is not the case, however, and one cannot very well imagine a distribution of the magnetic field capable of exerting a torque on the solenoid. If power is taken from the disc it must be supplied mechanically to the spindle by means of a torque acting against an equal and opposite torque; hence, if the field coil does not supply the mechanical reaction, something

else must, and a little consideration of the distribution of the magnetic field will show that the external circuit of the dynamo has to withstand the driving torque. To see this clearly it is only necessary to imagine the external circuit to consist simply of a fixed disc, FD (Fig. 3), near the rotating one RD. If the fixed disc carry a number of brushes, B_1, at its rim, which rub on the periphery of the rotating disc, and also a number of brushes, B_2, rubbing on the spindle, the current will flow radially outwards in the rotating disc and return radially inwards in the fixed disc, which now constitutes the external circuit. These currents in the two discs produce no external magnetic effects, but a circular magnetic field in the space between the two, which is superimposed on the field due to the field coil, causing the resultant field to take a skew path between the discs, as shown in Fig. 4. Since there is a tension along the lines of force it is evident that the driving torque exerted on the spindle is transmitted to the fixed disc—that is, to the external circuit—which must, therefore, be suitably fixed to prevent its movement. With the ordinary arrangement of a single brush and a wire to collect and take away the current from the periphery of the rotating disc, the skewing of the magnetic field will not be symmetrical, but the field will be distorted in such a way that a couple will act on the wires constituting the leads from the machine.

It is interesting to notice that if one starts from any point in Fig. 3 and follows a line of force the line is skewed in passing from disc to disc, and one does not come back to the point from which one started, so that the lines considered individually do not form closed curves.

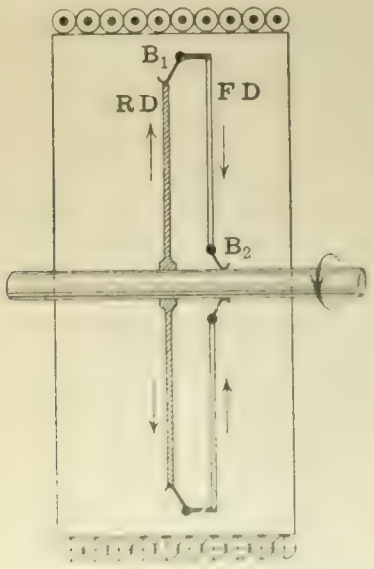


Fig. 3.

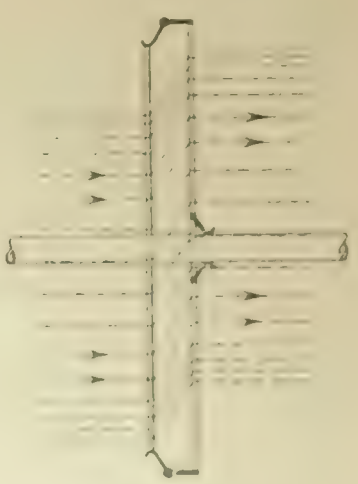


Fig. 4.

A favourite experiment to consider in connection with the question, Does the field of a bar magnet rotate when the magnet is rotated about its axis? is represented in Fig. 5. When the magnet is rotated a current flows round the circuit AFDCBA, and gives a reading on the galvanometer G, so that an E.M.F. must have been induced somewhere in the circuit, and it is sometimes assumed that it is in the wire, due to the rotation of the field. It is difficult to conceive that this can be so, since the wire AFDCB is at rest in a magnetic field which is certainly undergoing no change either in magnitude or direction. It may be objected that, although there is no change in the strength and direction of the field, the lines of force may still be rotating around the axis of the magnet. This appears to imply that the lines of force have an individuality and are capable of being earmarked like vortex smoke rings in air. In the case of the two parallel discs just considered, the vortex rings would have to be broken when the machine was loaded and joined up to others. When the conductor is moved in the field the induction of electric force can be understood, for we are forcibly moving the electrons of which the conductor is composed. Within the rotating magnet we have a conductor—viz., the steel magnet itself—moving through the magnetised ether, and this, as we have seen, produces an electric force within the steel. The E.M.F. (i.e., the line integral of the electric force E around any closed path lying entirely within the magnet, or entirely outside the magnet, is zero, because in either case the flux linking the closed path is invariable. If, however, the closed path is a narrow rectangle 1 cm. long, with one side just within the magnet and lying along a generating line of the cylinder, and the other side just outside the magnet and therefore at rest, as in Fig. 2B, then, as the magnet rotates the rectangle increases in area, and the flux through it increases proportionately, so that an E.M.F. is induced in the closed path. Hence, from a consideration of the E.M.F. induced in any closed path, one would conclude that the seat of the phenomenon was the surface of the magnet. From the point of view of the conductor cutting through the magnetic field, the induced electric force E at any point in the magnet is equal to Bv, where B is the flux density and v the velocity; its direction is normal to the plane containing B and v.

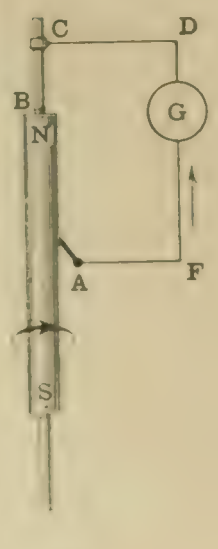


Fig. 5.



Fig. 6.

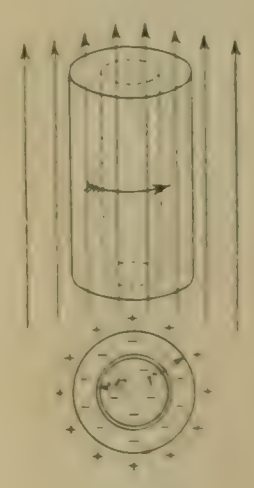


Fig. 7.

If the magnet be rotated about its axis with the electric circuit broken or removed, the electric forces will still be induced in it as before. Minute currents will flow in the material as the magnet is brought up to speed, and these currents will cause a distribution of electric charges somewhat as shown in Fig. 6. These charges are not confined to the surface, but are distributed throughout the material in such a way that the electric field due to them exactly neutralises the field due to electromagnetic induction at every point within the magnet. When this condition of equilibrium is reached there will be no further currents within the material. External to the magnet there will be an electric field due to the charges on the magnet.

The statement just made that the charges are not entirely on the surface of the magnet may appear to some to be contrary to one of the fundamental principles of electrostatics. This is not so, however, since we have induced E.M.F.s, and one would be equally justified in expecting the two terminals of a dynamo to be at the same potential because they are connected by a conductor—viz., the armature winding.

If a long metal cylinder be rotated about its axis in a uniform magnetic field parallel to the axis as shown in Fig. 7, an outward radial electric force will be induced as in the Lorenz apparatus. If the cylinder be hollow a positive charge will collect on the outside and a negative charge on the inside, until the field within the material due to these charges exactly neutralises the induced electric force due to the rotation. This would not be possible were the surface charges the only ones, because the electrostatic field strength would then vary inversely as the radius, whereas the electric field due to rotation is directly proportional to the radius. If the cylinder is solid there is no inside surface, and the negative charge is distributed throughout the material, the total being equal to the positive charge on the outside (Fig. 7). The distribution of the negative charge can be calculated as follows:—

Let x=distance from the axis, q=charge within cylinder of radius x per centimetre of length: then the field strength E. at x due to the charges is

$$E_x = \frac{4\pi q}{2\pi x} = \frac{2q}{x}.$$

and this must equal the induced electric force at this point due to rotation with an angular velocity, ω, in a field of density B. Therefore

$$\frac{2q}{x} = \frac{B\omega x}{3\times10^{10}}$$

$$q = \frac{B\omega x^2}{6\times10^{10}}$$

$$\frac{dq}{dx} = \frac{B\omega x}{3\times10^{10}}$$

and the density

$$\rho = \frac{1}{2\pi x}\cdot\frac{dq}{dx} = \frac{B\omega}{6\pi\times10^{10}}$$

Hence the negative charge is distributed uniformly throughout the cylinder with a density, ρ, given by the above formula, while a positive charge of the same total amount—viz., $\pi r^2\rho$ per centimetre of length—is distributed over the surface of the cylinder. There is in this case no external electric field, since we are considering a long cylinder and neglecting the ends.

An interesting case, in which the rotating body is not a conductor but an insulator, has been considered by Poincaré in an article* which should be read by all interested in the problem of unipolar induction.

An ebonite annular ring of thickness t is rotated about its axis between two annular rings of copper (Fig. 8). The latter are fixed at a distance apart of D, so that the air-gap on each side of the ebonite ring is $(D-t)/2$. This constitutes a condenser with fixed electrodes and rotating dielectric. At the centre a vertical bar magnet is placed as shown. Whether this magnet is rotating or not is immaterial, except for secondary phenomena due to the magnet becoming charged by its own rotation. When the ebonite ring is run up to speed a transient current flows through the wire joining the copper rings, and the condenser becomes charged, due to the electric force induced in the ebonite ring by its rotation in the radial magnetic field. In the figure the ring is approaching the reader on the left and receding from him on the right; the induced electric force E is downwards, and causes a current to flow momentarily through the external circuit from the lower to the upper coating. Tubes of electric displacement pass from the positive charge on the upper coating, through the air and ebonite, to the negative charge on the lower coating. This displacement is not due to any difference of potential between the coatings, as these are joined by a wire in which, except for the first moment, no current is flowing and no E.M.F. is being induced, but is due to the induced electric force in the ebonite. Across the air-gap from A to B there is no induced force, and the potential must fall by an amount $4\pi\delta\times AB$ or $2\pi\delta(D-t)$. The potential must fall by the same amount between C and F. To maintain the displacement δ across the ebonite from B to C requires an E.M.F. of $4\pi\delta\times BC/k$ or $4\pi\delta t/k$, where k is the specific inductive capacity of ebonite. Hence the total drop round the whole circuit is

$$4\pi\delta(D-t+t/k),$$

and this must necessarily be equal to the total induced E.M.F., which is Et, where $E=Bv/3\times10^{10}$ (the magnetic field is assumed to be radial in the plane of rotation). Hence

$$Et=4\pi\delta(D-t+t/k).$$

It appears to the writer that Poincaré makes a mistake when he says that the potential undergoes a sudden jump of $Et/2$ at

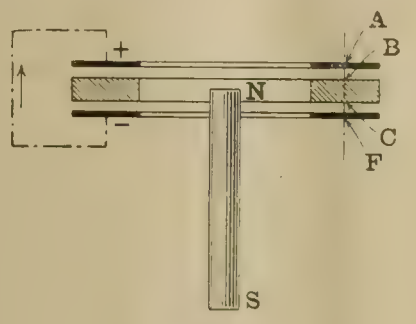


Fig. 8.

* "L'Éclairage Électrique," Vol. XXIII., p. 41 (1900).

the surface of the ebonite. The sudden jump is in the electric force induced by the rotation as in Fig. 9 (b). The potential varies as shown in Fig. 9 (d), and not as I consider it should, according to Fig. 9 (c). If the dielectric at each face that is made be not perfect, but allow a gradual leakage, a charge will gradually accumulate on its surface until the resultant electric force within it is reduced to zero. When this condition is reached we have

$$Bv = 4\pi\delta(D-t+t/k) = 3\times10^{10}\delta(D-t+t/k).$$

and the air-gaps have to withstand the whole E.M.F. induced in the rotating disc. Even with a ring of perfect dielectric, if its specific inductive capacity be high, the electric field strength in the air may be much greater than that in the ebonite, as shown in Fig. 9 (c), which shows the resultant value of E, whereas Fig. 9 (b) shows only the component due to electromagnetic induction.

With regard to the much debated question as to whether the induction of electromotive force should be considered as due to the cutting of lines or to the change of flux through a circuit, it appears to the writer that the conception of the conductor cutting a magnetic field can always be correctly applied when the magnetic field is undergoing no change. Its application to any point of the conductor gives the electric force induced at that point by the movement of the conductor in the field. The actual resultant value of the electric field at the point will, in general, be different, and in many cases in the opposite direction, due to the potential gradient produced by electric forces induced (or introduced galvanically or thermally) in other parts of the circuit. A simple example is the brake disc of a meter. Immediately between the poles of the magnet, the resultant electric force, and therefore the current, are in the direction of the induced electric force,

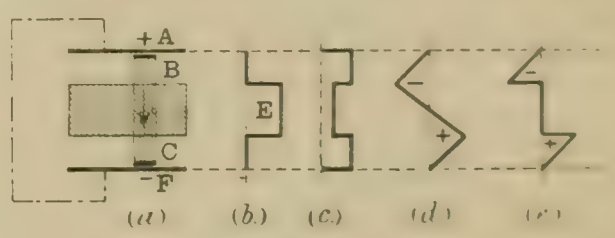


Fig. 9.

whereas further away in the fringe of the magnetic field the resultant electric field and the current are in the opposite direction to the induced electric force.

If the field is changing, however, whether the conductor be moving or not, the conception of the electric force induced at any point must be given up If we say, as before, that the resultant electric force at any point is made up of two components, one due to induction and the other to the potential gradient, we are in this difficulty: the P.D. between two points, or the potential gradient at a point, is a conception of electrostatics, and is indefinable when the magnetic field is changing, since the work done in carrying a unit pole from one point to another depends entirely on the path followed. Hence the other component due to electromagnetic induction must be equally indefinable.

When the magnetic field in the neighbourhood of a conductor is changing it seems physically incorrect to say that the peculiar condition of the ether which we call a magnetic field is cutting the conductor, whereas it seems perfectly natural to consider the change in that condition at a given point, which can then be extended to finding the average change in the condition over any given surface, whether it be 1 sq. cm. in space or the surface bounded by any electric circuit.

When the magnetic field is stationary and the conductor is moved the two conceptions agree, since the change of flux through the circuit must be the resultant of the cutting of lines at the different parts of the circuit. In this case it certainly seems that the fundamental cause of the induction of electric force is the cutting of the material, whether conducting or insulating, through the magnetic field. It gives a clearer conception of the action of the Lorenz apparatus than does the

consideration of the change of flux through an imaginary rectangle partly in the disc and partly in the air. When, however, the magnetic field is changing we can no longer consider the *electric force* induced at *a point*, but are compelled by the nature of things to consider the *electromotive force* around a closed curve, and this can only be done, except in special cases, by considering the rate of change of the magnetic flux through the area enclosed by the curve.

THE RELATION OF SCIENCE TO PRACTICE IN ENGINEERING.*

It is with electrical engineering science and practice that I intend to deal mainly this evening, as it is the branch of engineering in which the relation between the two factors is most close and is of the greatest practical value. As Dr. Unwin pointed out in his Presidential address to the Institution of Mechanical Engineers, it is due to the application of scientific method, and the development of technical instruction that Germany holds the position she has attained in engineering constructional work during the past 20 years. One may go further and say that the chief reason for the remarkable effort she has been able to put forth in the great war which we are now waging, has been the development of the engineering appliances connected with warfare, and the industrial organisation she has created for the equipment of her armies.

It is not necessary that we should try and copy exactly what Germany has done in imparting the technical instruction she has given to her students and engineers; the methods used must be adapted to the English mind, and to the instinct of the English engineer. There is much to avoid, but there are some directions in which we can learn a great deal and can improve our methods of manufacture. To illustrate the effect of scientific study in one direction only, it is sufficient to compare the cost of electrical plant with what it was 20 years ago. A normal figure for static transformers was £2. 10s. per kilowatt; now a large transformer can be built for 10s. per kilowatt. This reduction in price is due to two things, to the discovery of alloyed steel, which has a much higher electrical resistance than ordinary transformer iron, and magnetic qualities very little inferior, which has enabled a smaller iron section to be used; and, secondly, to the scientific study of the most effective method of getting rid of the waste heat, which has enabled an enormous increase in the size of unit to be effected.

The laboratory attached to a college or university has usually limited facilities for large scale engineering research; it does not find its use in such investigations, it must deal in principles and theories which are really fundamental. Researches of this kind naturally divide into three groups: (1) Investigation of the properties of materials used in engineering; (2) investigation of apparatus and machines, their origination and design; (3) investigation of a more physical kind on new phenomena with a view to their development for practical use. All these fields of research are vast in extent and their exploration is only begun.

In regard to the first group, copper, as *the* material for electrical engineers, has received a great deal of attention, and this has lead to marked improvement. Thus the great effect of arsenic and of phosphorus was discovered. Aluminium is now receiving similar attention. Stalloy and similar alloys have resulted from this class of work, and attention is now being given in this country to magnet steel. Another direction of fruitful investigation has been the study of oils for insulation.

One of the most interesting studies of materials that is now being undertaken is that of their properties under the influence of high-frequency currents. The possibility that iron can be magnetised and demagnetised several million times a second has now been clearly demonstrated. The behaviour of these materials under magnetising force of this frequency requires still further investigation.

It has already been shown by Alexanderson and others, among whom Mr. N. W. McLachlan may be mentioned, that iron heats very rapidly when strongly magnetised, on account of the eddy currents developed in the mass of material, even of the thinnest sheets, a result which shows one of the difficulties involved in the development of a high-frequency current by dynamo. The qualities of dielectrics under high-frequency electrification requires much further study. As an example of the importance of finding a dielectric with small hysteresis loss it may be mentioned that it was found impossible in the station for transatlantic signalling erected by the Marconi Company, at Clifden, to use oil in the condensers, on account of the loss of energy involved in its electrification; the condenser house, with air as dielectric, occupied a large building, 10 times as big as that which would have been necessary with an oil condenser. The use of high-frequency current has opened up a wide range of investigation on the properties of material, which will require a large amount of time and patient study before the materials can be used to the best advantage.

Passing to the design of apparatus, an example of what scientific design and experiment may accomplish has recently come to my notice through the activity of one of my students. I refer to the practical monopoly that Germany had obtained in the manufacture of magnetos. When the war broke out a company was formed, and Mr. Watson worked out the design of a good magneto. The manufacture was not a mere copy of that which had previously come from Germany. It was worked out on scientific lines, and the result was a machine superior to that which had formerly been imported from Germany. The firm is now making 250 machines a week, is extending its works rapidly, and will soon be turning out from 1,000 to 1,500 machines per week, mostly for British and Allied Governments. This is an excellent example of what may be done by scientific organisation, and the use of scientific knowledge, but it is only one example. A great deal remains to be done in this direction.

One of the most remarkable developments which has taken place during the past few years has been the equipment, by such firms as the General Electric Co. of America, of testing and research laboratories, which are really laboratories of applied physics, and which do not attempt to make themselves of direct use in the testing and examination of electrical or other machinery. The results have been remarkable, including the half-watt lamp and the work of Langmuir.

If, as seems probable, laboratories for investigations of this kind spring up and develop in connection with many large manufacturing firms, scientifically trained men will be required to man them. It is one of the functions of the universities and technical schools to supply these men. It is in this direction that there should be the closest co-operation between the engineering schools of the country and the manufacturing firms. The students of universities and colleges are well adapted by their training to occupy positions in such laboratories; but if they are to be obtained, they must receive some financial encouragement. I do not wish to lay stress on thi point here, as I have dealt with it already elsewhere.

We must be prepared, after the war is over, for a fierce and unscrupulous war of commerce, not only with Germany, but with other countries less highly developed. We have had examples almost without number of the abuse of our generous and open treatment of Germans in the past. We shall not, I hope, make the mistake of failing to recognise the kind of people with which we have to deal. One cannot deny them, however, the qualities of cleverness and industry; and we shall, I am convinced, make a great mistake if we attempt to rest on our oars after the victory, to which we all look forward, has been achieved. It will take us all our time, with all the political advantages we hope to gain, to maintain our place in the world's markets. We shall have a powerful commercial competitor in America, a competitor who will not have suffered the devastating capital losses we are suffering through this war. We shall have to use to the full our scientific knowledge, so as to save every penny that we can, of unnecessary expenditure in material, or in labour. The manufacturers, as I have already explained, are realising this fact. The Government has already established a Research Council, and, it is to be hoped, may also assist by supporting the institutions which supply the raw material of scientific development.

* Abstract of a Presidential address by Prof. E. W. Marchant to the Liverpool Engineering Society.

CORRESPONDENCE.

SINE WAVE ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—The importance of a good sine wave for alternating current testing operations is very great, and Mr. Seemann has done good service in calling attention to it, especially as so many of the alternators at present in use for testing work have very irregular wave forms. It can hardly be considered, however, that Mr. Seemann's solution of the problem is a satisfactory one, involving as it does the profiling of the poles and the maintenance of a standard load.

There is a perfectly simple method of securing a sine wave P.D. under all ordinary conditions of load—viz., to use a cylindrical stator and rotor, and to graduate the distribution of copper in both windings according to a sine law, so that both the field and armature reactions are sinusoidal. This is the

method I have employed for several years with perfect success for phase-shifting transformers (a set of curves from one of these transformers was shown in an article on "The Alternate-current Potentiometer as a Standard Instrument" in THE ELECTRICIAN, May 7, 1915); and I have recently designed an alternator on the same lines, which I propose to call a distortionless sine-wave alternator. With such an arrangement it should be impossible to get anything but a perfect sine wave P.D. with any conditions either of load or phase, unless the current wave is greatly distorted externally, as in the case of a choking coil with highly saturated core. I hope to send you further particulars of both these transformers and alternators shortly.—I am, &c.,

Westminster, Oct. 29. CHARLES V. DRYSDALE.

DISTRIBUTED CAPACITY OF SOLENOIDS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your current number is published an abstract of a Paper on "The Distributed Capacity of Single-layer Solenoids," read before the American Physical Society by Mr. J. C. Hubbard, and printed in abstract in the "Physical Review," Vol. VI., p. 58. So far as one can judge from the abstracts, the Paper covers practically the same ground as my Paper on "The Calibration of Wave-meters," read before the London Physical Society in 1912 (*see* "Proceedings," p. 251), differing only in the method of measuring the frequency. Mr. Hubbard's experiments led him to the same conclusion as that stated in my Paper—viz., that the distributed capacity of a coil can be taken as a constant for all values of the frequency up to the natural frequency of the coil. This results in a linear relation between the added capacity and the square of the wave-lengths. To judge from the concluding remark, that "the distributed capacity of a single-layer solenoid is found to be a number of the same order of magnitude as the radius of the coil, but shows relatively slight variation with the axial length, number of turns and diameter of wire," I suspect that the author is unaware of Drude's classical Paper on this subject ("Annalen der Physik, 1902, IX., p. 322). In my Paper I gave a table showing the distributed capacity of four coils, each of 2 millihenries, but varying in diameter from 5 cm. to 20 cm.; the capacity varied only from 0·52 to 0·66 times the radius of the coil over this extreme range.—I am, &c.,

South Kensington, Oct. 30. G. W. O. HOWE.

IMPREGNATED STOCKINGETTE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am requiring a supply of small tubing made up of *impregnated stockingette*. I believe there is a firm manufacturing in the country, but cannot at the moment find their name. No doubt among your records you have this noted, and I shall feel very much obliged, if so, if you would advise me.—I am, &c.,

Oct. 20. INSULATOR.

[Will one of our readers kindly supply us with the name of the manufacturer of this material?—ED.]

[We regret that we are compelled to hold over some correspondence.—ED.]

COL. J. F. LISTER'S ADDRESS TO THE BIRMINGHAM LOCAL SECTION OF THE I.E.E.*

If we look on an armed force in the field, such as the British Expeditionary Force in France, as bearing some sort of analogy to a living organism, then we may say that the signal service takes the place of the nervous system, and the General Officer Commanding in Chief that of the brain. Just as the nerves of the organism report to the brain the information about the outside world obtained by the senses, and flash back the decision of the brain which sets the whole organism in motion, so reports of the enemy's activities on every side are forwarded to general headquarters by the signal service and the orders to move transmitted outwards again to the units of the army.

* Abstract of an address delivered by Col. Lister, as Chairman, on Oct. 27.

Before going into the details of the organisation of signal units, it is necessary to consider shortly the available means of communication. These may be given as under: (*a*) Despatch riding, (*b*) visual signalling, (*c*) vibrator with light equipment, (*d*) vibrator with heavy equipment, or cable section, (*e*) airline, and (*f*) light permanent line equipment.

(*a*) Despatch riding is the time-honoured method of circulating orders to an army, and has been the subject of many stories and pictures. It may be done on foot, horseback, motor bicycle, car, train, or by any other available means. In practice, in a civilised country, the motor bicycle may be said to have superseded all other means of carrying messages.

(*b*) Visual signalling may be done in many ways, but can be practically neglected under the circumstances of the present campaign, as any movement is bound to draw artillery fire.

(*c*) The vibrator with light equipment is used for communications from the divisional to the brigade and battalion headquarters.

(*d*) The vibrator with heavy equipment (cable section) is used for communication between the corps and the divisions, and any other places where required. The cable is carried on 2-mile drums—four drums on a wagon—and is paid out and picked up from the wagon. It can be laid at the rate of 3 miles an hour in ordinary country. When required to be used with ordinary D.C. telegraph sets, it is necessary to pole the cable, or tie it up to trees to protect its insulation.

(*e*) Airline is a light equipment which consists of bare wire, carried on insulators, supported by a portable pole. It can be erected at the rate of a mile an hour in ordinary country, and by employing a suitable number of detachments, a long line can be erected in a very short time. It is eminently suitable for ordinary telegraph work, but cannot, of course, be employed in any area liable to be shelled by the enemy.

(*f*) Light permanent line equipment is provided for line of communication companies, by which means they can produce a good permanent line at the rate of about 5 miles per diem, but in a civilised country it is usually possible to utilise or repair the permanent lines of the country, and it is not necessary to consider this work in any detail, as it begins to approximate to the usual routine of commercial telegraph working.

The following are the various signal units which are provided to operate from the various centres:—

A divisional signal company, which is responsible for keeping up connections from the divisional headquarters to the brigade and battalion headquarters. It is provided with a section carrying light vibrator equipment for each brigade, a cable section for keeping in touch with the corps as the division advances, and an office staff.

A corps signal company consists of a headquarters, three cable sections for keeping in touch with the divisions, and one airline section for keeping in touch with the army as the corps advances.

An army signal company consists of headquarters, one cable section, and three airline sections, to enable it to keep in touch with its corps and general headquarters as the army advances.

The whole art of a successful signal service is in ensuring that communications are preserved intact while the force is either advancing or retreating. The signal service exists for the use of the staff, and is practically a portion of the staff. The officer in charge of signals, therefore, lives with the staff, and should be absolutely conversant with all that is going on. This knowledge should enable him to forecast probable moves, and in some cases to make his arrangements in advance.

The staff of an army is divided into three main branches:—

General staff, which deals with operations.

Adjutant-general's branch, which deals with personnel.

Quartermaster's branch, which deals with supplies and stores.

To enable the staff to do its work properly, it is necessary for it to work in comfort, and free from fear of interruption by the enemy, so that the normal position of the staff and the signal office is some distance behind the troops which they serve. When, however, the force is engaged with the enemy, it is essential that the General should move up to the troops he is directing, and he is accompanied by his general staff officers; the other branches of the staff, however, remaining behind. This entails the signal office throwing out an advance signal office (usually called a report centre), to which all messages dealing with the operations can be delivered, and where the General can always be found.

Omitting the divisional companies, where communication is very much subject to interruption by the enemy, the methods adopted depend on the circumstances under which the corps or army finds itself, and it is customary to run the first rapid connection by cable, using vibrator, subsequently to pole these cables, and finally to replace them by airline if there appears to be any likelihood of them being required for more than a day or two. Permanent lines in a civilised country

are used whenever available, but except in a country which has not been occupied by the enemy, the necessary repairs will probably be found to be too extensive to be undertaken by signal units attached to the fighting units, and will have to be left to communication companies in the rear. Where permanent lines are used very great care indeed is required to ensure that all circuits leading into the enemy's lines are disconnected from the communications of the army. In the case of a vibrator it is not sufficient merely to cut the permanent lines, but a whole bay must be let down. Instances have occurred in this campaign of an instrument in a British signal office tapping out a German message, and as an illustration of what may happen, the Germans themselves lit a whole town in the British lines during several weeks last winter, which was supplied by high-tension system from a neighbouring town in possession of the Germans.

For those who are not conversant with telegraph instruments it might be advantageous to say a few words about the instruments employed in the field. The Morse alphabet, which is used by all countries employing the Roman alphabet, is formed by various combinations of two distinct signals, on the principle that the most commonly used letters are formed by the shortest signals. In the instruments used for military purposes the difference between the two signals is the difference of duration, one signal, known as a dash, being three times the length of the other, known as a dot. The interval between the component dots and dashes forming a letter is equal in duration to one dot, that between each complete letter forming a word to two dots, and that between words to three dots. The dots and dashes are sent by pressing a key, and thereby completing a circuit for the requisite duration of time. Using ordinary direct current, the signals are produced at the other end by the attraction of the armature of an electromagnet, signals being read by the duration of time between the two clicks made by the armature on being attracted to the poles of the magnet, and on being released on the cessation of the current. A set made up in this way is known as a single current set, but it is obvious that to work a set of this description over any distance would entail prohibitive battery power, and therefore a relay is introduced at the receiving station. When a relay is employed, the coils of the sounder magnets are replaced by the coils of a relay magnet, which, when the circuit is completed, causes the armature of the relay to travel from one stop to another. It is possible by a method based on the principle of divided circuits to operate and receive at the same time at both ends of a single line; this is called duplex working, the method working at one end at a time being known as simplex. It is possible to duplicate duplex working, known as quadruplex, thereby causing four messages to be sent simultaneously—two in each direction—but in practice, it is found that the method is usually impracticable in the field owing to the high standard of insulation required in the lines. Furthermore, military traffic differs from ordinary commercial working, in that periods of greatest pressure are usually in one direction only. To enable heavy traffic to be dealt with on the lines of communication, Wheatstone's is the most suitable system that can be employed, and full advantage is taken of these instruments. The principle of Wheatstone is, instead of the impulses being sent by an operator, perforated tapes are punched out, which, on being led through the apparatus cause the necessary impulses to be sent out, and to be printed in dots and dashes on a tape at the receiving end. Any number of clerks can be employed in punching the perforated slip, and a great deal of work, such as casualty lists, indents, returns, &c., can be punched during quieter times of the day.

The vibrator is an instrument which was specially invented for military work. In the vibrator system the signals, instead of being intervals of silence between sharp and distinct sounds, are given by long or short buzzes in a telephone receiver separated by periods of silence. To produce these signals in the receiver a rapidly vibrating current is required—the period of vibration being about 150 to 500 a second, or those of sound waves. If the period is kept constant a more or less musical note is produced in the receiver.

The advantages of this system are: (1) The telephone receiver is extremely sensitive, and consequently a very small current is required. (2) Vibratory currents will pass through condensers, and consequently a circuit can be divided into two parts, so that ordinary direct currents will pass through one path only, and the vibrating currents through the other. This enables one line to be used for two independent telegraph circuits at the same time. (3) It is easy to produce a very high momentary E.M.F. by means of induction coils, and this, combined with small current required, enables the system to be used on lines of a very high resistance and poor insulation without very much battery power, which would otherwise be required. (4) The telephone receiver requires no adjustment, and is always ready to receive either strong or weak signals. (5) The instruments required are light, and the battery power small, consequently the apparatus is very portable.

The following are the principal disadvantages of the vibrator systems: (1) A vibratory current induces similar currents in all neighbouring wires, so that two vibratory circuits cannot be run side by side for a short distance or even connected to the same earth, although it is wonderful how a trained operator can pick out the signals meant for him even when the induction on the line is very bad. Further, vibrating currents induce similar currents on all telephone circuits in the neighbourhood, seriously interfering with the latter, and also enabling messages to be read by persons for whom they are not intended. (2) Every line has a certain capacity between itself and earth, and the capacity increases with the length of the line. Vibrating currents will pass through such a capacity and leak to earth on a long line, even if it is well insulated. The vibrating system is, therefore, not suited for working on long lines, and about 40 miles is found to be the limit for field cable. (3) The buzzer is found to be more tiring to the operator than an ordinary sounder, and the speed of working is not so great.

For short vibrator lines it has been found necessary to provide single-current sets, which are used whenever cable line is down for some time; the cable itself being poled or raised from the ground by tying to trees. This is principally to avoid induction in the office, and being short distances, excessive battery power is not required.

Besides vibrator sets, a portable telephone and vibrator is used for brigade signalling, and for linesman's work on the lines. The additional condenser which is carried in the body of the instrument enables the lineman to work an ordinary circuit without interfering with signals which are being sent. A vibrator line can also be tapped at any point, and the signals read. When a vibrator is superimposed in an ordinary direct-current set, it is necessary that there should be a certain capacity and self-induction in the line between the direct current and the vibrator sets; this is usually inserted specially by means of an apparatus known by the name of a separator.

The instruments used in a signal office are generally carried made-up, so that connections, upon opening an office, are reduced to a minimum. The incoming lines are usually laid either on to a commutator or terminal board, so that sets may be changed from one line to another without the necessity of re-connecting the whole office up again. Lightning protectors are either carried on the terminal board or baseboard of instrument sets.

Besides the main work of the signal service which has been slightly sketched above, it is usual when a staff is stationary for some period to provide a small telephone system between the various offices, which system very often grows to a considerable size. Telephones are not suitable for sending messages nor can they be used where firing is going on.

Wireless forms a special branch of signal work, and it is not advisable at the present time to make any mention of the methods employed.

A very important matter remains to be dealt with, namely, the organisation of traffic through the various signal offices. The details of the system adopted vary according to the amount of traffic involved: whether the office consists of a vibrator set and an operator deposited by the roadside, or an army office where many lines come in and a large bulk of traffic has to be dealt with, the general principles are the same in all cases. As all offices work night and day three distinct reliefs are provided; two are capable of coping with the work when the office is stationary, but a third is necessary to enable moves to be carried out without interfering with communications. The instruments are duplicated, two reliefs being fully equipped, whilst the third is not. This enables the new office to be set up while the old one is still working, and when the change is made at the new office the old one is dismantled and brought on. The technical side of the work is kept quite distinct in the offices from the traffic side. At large offices a superintendent is appointed to look after the circuits and instruments, whilst a supervisor is required for traffic only.

Messages are received by a counter clerk as in an ordinary post office, but the signal service being used for the staff, the counter clerk may very often be advantageously placed in the staff office itself, when he sits next to the staff clerk, who registers all messages sent and received by the staff. The counter clerk dates, codes and numbers, counts the number of words, and then passes same on to the supervisor. The supervisor enters the number, adds the prefix, which denotes where the message is to be sent, and passes same to the operator. This arrangement is required, as in a military telegraph office the circuits may be continually altered, and a supervisor always is to keep in touch with this, and he is often the only man who knows what route a message to a given unit can be sent. When the message has been sent by the operator it is passed to a clerk, who completes the record of that message and files it. The

record clerk also records received messages, files one copy, and sends out a copy to the addressee.

Despatch riders are either worked practically as a separate office or are considered as an alternative circuit, and noted accordingly.

At the conclusion of the address Colonel Lister described, with the aid of a highly interesting diagram, the telegraphic arrangements of a recent battle, giving a realistic idea of the complicated and elaborate nature of the telegraphic service employed in the field.

THE INSTALLATION AND WORKING OF STORAGE BATTERIES.

In a Paper read before the Association of Supervising Electricians last Tuesday Mr. R. Rankin gave some sound rules, which we wish were always observed in the working of storage batteries. We give the substance of these below :—

1. *Do Not Discharge below the Limits Specified by the Makers.*—It must not be assumed that an engineer can put his battery on load at any time and at any current it will carry unless it is at the time in a fit condition. What a battery can do at any time depends on what it has already done at that time. In this respect it differs from a generator. If it is intended to use a battery at unexpected or irregular times steps must be taken to have it as far as possible always ready in a charged condition. If this is arranged even a small battery will deal with emergencies which would very much overtax a generator of the same normal rating, the overload capacity of a battery in current being enormously high.

2. *Do Not have the Battery in a Discharged Condition Longer than is Unavoidable.*

3. *Make Sure that Every Charge is a Full One.*—Approximate relative capacities and the corresponding currents and final voltages of a cell at different ratings are given in the following table. If discharge is invariably continued to some definite voltage irrespective of the rate over-discharge may result :—

Duration of discharge in hours.	Capacity in terms of maximum.	Rate of discharge in terms of 10-hour rate.	Minimum final P.D. volts.
10	1·00	1·00	1·83
9	0·98	1·09	1·83
8	0·95	1·19	1·83
7	0·92	1·31	1·83
6	0·88	1·46	1·83
5	0·83	1·67	1·83
4	0·78	1·95	1·80
3	0·72	2·39	1·80
2	0·63	3·17	1·78
1	0·50	5·00	1·75
0·75	0·45	5·84	1·70
0·5	0·37	7·45	1·70
0·25	0·22	8·95	1·70
Peak	...	12·50	1·60

4. *Unless for Special Reasons Charge Only at the Specified Rate.*—If the discharge is always continued until a definite total voltage is reached, and if the switchboard voltmeter is reading high the battery may be over-discharged on every discharge, and the effect will be disastrous. Cells slightly lower in capacity than those in the body of the battery will get into bad condition, and will never get a chance to pull round again.

5. *Do Not Pre-determine the Charge as a Definite Percentage of the Discharge.*

6. *Attend to Defective Cells at Once.*—If low or sick cells are not attended to at once each discharge will bring them into worse condition, and if the trouble is not attended to and removed the cells may be ruined. It may be observed that the amount by which they are out of line with or lower than the others need only be small to give trouble of this sort a beginning. Where cells are properly charged, however, the usual excess charge is sufficient to level up small inequalities in the condition of the cells, but if a few of the cells are allowed to get very low in condition, and the battery as a whole, therefore, seems low in capacity, nothing but harm can result from overcharging the whole battery on their account.

7. *Check Periodically the Accuracy of the Instruments.*

8. *Keep the Level of the Electrolyte above the Tops of the Plates by the Addition of Pure Water Only.*

In dealing with the indispensable instructions the following further remarks may be made :—

Transgression of (1) means over-discharge and excessive sulphation. It is just the danger of excessive sulphation consequent on heavy discharge which limits the output which a battery maker will specify or permit. The point to be observed is that the trouble is cumulative. It has also to be remembered that these may be odd cells in somewhat worse condition than the average and if too the charge is continually pushed over or even just to the permissible limits those cells simply get worse until they go out of hand altogether.

In regard to (3), if the charge is not full some of the active material furthest from the surface remains in a sulphated condition, and this sulphate may develop into the stubborn variety. The action of the charging current is to increase the density of the acid in the pores and interstices of the active material, and this may assist the tendency of the unreduced sulphate towards irreducibility. Further, if the subsequent discharge is a heavy one it is most likely to run the cells down too far.

Referring to (4), the normal rate is that which the makers have found by experience to be the most efficient and the most suitable for their plates. It is a fact little realised that a cell cannot be properly charged at very low rates. The negative plates will be charged, but if the charging current is below a certain value it simply sulphates the positives instead of charging them. The value at which this action commences is not very well defined, but it is just as well for an attendant to find out the minimum charging current which the makers will permit. Such low rate charging sulphates, corrodes and buckles the positives, especially Planté positives. This action explains why it has been emphasised that a milking booster should be capable of giving the full normal charging current.

With regard to (5), charging a battery in such a way that the ampere-hours put in on charge always exceed those taken out on discharge by a definite percentage is one of the most fruitful sources of battery trouble.

It is a very common notion that if the charge in ampere-hours is 10 per cent. greater than the discharge everything is O.K. It is easy to show that not only is this figure wrong, but that the idea underlying it is wrong. Further, all rates of charging are not equally effective, and whereas 11·1 per cent. of overcharge may suffice at the maker's specified normal charging rate, 15 per cent. may be required at a rate 50 per cent. in excess of the normal. Again, low rate charging may practically not be charging the positives at all, as has been pointed out. The difficulty is that if a cell is allowed to get badly sulphated it will gas furiously long before it is fully charged.

Charging until the battery reaches a definite voltage as well as discharging in the same way may lead to undercharge and over-discharge if the voltmeters are not strictly accurate.

EDUCATIONAL NOTES.

Leeds University.—We learn that there is nothing to report in regard to new features or developments in the current session. The staff of the University is so depleted by men having gone on active service, and those who remain are so much occupied with national work of one kind or another, that there is not much opportunity for developing even the regular work.

In addition the number of students is greatly diminished, and developments which were in contemplation have had to be postponed. Thirteen students entered upon two or three-year courses in the engineering department at the beginning of 1914-15, and not one of these has returned for the second year, nine being now in H.M. Forces and four engaged on munition work. Although from the point of view of educational interests such an occurrence is, to say the least of it, disturbing, yet the University authorities rejoice at the spirit of loyalty in their young men, of which the above is only a typical instance. At present there are no second-year students in the engineering departments, and only one third year student. There are still a few first-year students, but their number has been steadily diminishing ever since the beginning of the session through one after another going into the Army or into munitions work.

University of Birmingham.—As the new university buildings, including the laboratories of the engineering, metallurgy, mining, chemistry and physics departments, erected a few years ago at Edgbaston, have been handed over to the War Office for a military hospital, it will be readily understood that it has been found impossible to introduce new features.

A considerable number of students in the mechanical engineering department are engaged in scientific work on explosives for the War Office. The number of students is about half of those in attendance in ordinary years.

PARLIAMENTARY INTELLIGENCE.

EXCESS PROFITS TAX.

On the 28th ult. M . G ant asked the Chancello of the Excheque if comme cial companies, which exist unde statuto y limitations in egard to tenure or statutory charges and prices, would be permitted, under the Finance Bill, to submit their cases to the Commissioners for consideration in regard to excess profits.

In reply, Mr. McKenna said : In the case of statutory companies, any question of the adequancy of the 6 per cent. rate of return, in view of statutory limitations as to period or conditions of tenure, would be matters for consideration of the Board of Referees under Clause 38.

We understand that the Chancellor of the Exchequer recently received a deputation representing an important and influential group of London and provincial electric supply undertakings on the above question.]

Ericht Water & Electric Power (Extension of Time) Order.—The promoters of this Provisional Order have notified that it has been withdrawn.

Royal Assent.—The Royal Assent to the Post Office and Telegraphs Act and the London County Council (Tramways and Improvements) Act was given on Thursday last.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

15,783 B.T.-H. Co. (G.E. Co.) Electrical vacuum discharge devices.
An electric vacuum discharge apparatus comprising a sealed envelope containing a cathode adapted to be heated, and a co-operating anode and a conductor arranged in operative relation to the electrodes, the envelope being evacuated to such an extent that there are no visible or other indications of gas ionisation when a discharge passes between the electrodes.

18,239 SIEMENS & HALSKE AKT.-GES. Telephone installations. (4/8/13.)

18,242 MUSSO. Transmission of electrical impulses over telegraph circuits of high electrostatic capacity. (Patent of addition not granted).

18,243 MUSSO. Apparatus for the transmission of electrical impulses in telegraph systems. (Patent of addition not granted).

19,386 HARLAT. Automatic device for recording orders given on ship board from the bridge to the engine room. (3/9/13.)

19,446 B.T.-H. Co. (G.E. Co.) Protecting hot cathode vacuum tubes or other devices having similar characteristics from overload.
A system of electric distribution comprising a source of alternating current, a discharge device having unilateral conductivity and passing a substantially constant current with a variable impressed voltage, a load being connected in series with said device, and means responsive to an abnormal increase of energy in said device for de-energising it.

20,429 JENNINGS & PLAYFAIR. Thermostatic apparatus for the control of valves for heating apparatus and the like.

20,453 RELAY AUTOMATIC TELEPHONE Co., formerly known as Betulander Automatic Telephone Co., & AITKEN. Manual and semi-automatic telephone systems. (Cognate application 22,716/14.)

20,557 B.T.-H. Co. (G.E. Co.) Catenary supports for electric conductors.

20,650 JAMES, WILKIE, KENYON & TORRANCE. Apparatus for generating high-tension electricity.

22,906 MCGAURAN. Telephone call recorders.

22,936 IMRAY. (Siemens-Schuckert Werke Ges.) Regulating devices for electric polyphase shunt commutator machines.
A control process for polyphase shunt commutator machines of the type described in which, under certain conditions, the current carried by the commutator brushes is reduced to diverting part of the electrical energy generated in the stator winding to an energy-consuming device.

23,105 CHAMBERS. Mine-signalling apparatus.

23,778 WILKINSON. Thermal switches.

1915 SPECIFICATIONS.

2,148 MARTIN (TURNER). Telephone apparatus.

2,[illegible] [illegible] & Co. [illegible]

4,820 SHARP. Dielectric composition.

5,174 TIGERSTEDT. Microphone. (9/4/14.)

8,[illegible] [illegible] & Wynne. [illegible]
engine cabin of a train.

APPLICATIONS FOR PATENTS

NOTE.—*The [illegible] open to inspection 12 months after the date [illegible]*

October 11, 1915.

14,368 HOOKHAM. Consolidation treatment of tungsten or like refractory metal.

14,377 NEULAND. Dynamo-electric machines.*

14,382 CODD. Contact-breakers of induction coils.*

[illegible]

14,396 NEALE. Laying telephone or telegraph wire.

14,405 [illegible]

14,415 [illegible]

14,423 [illegible]

14,430 [illegible]
wires, metal cords, and the like.*

14,438 [illegible]

[illegible]

14,454 [illegible]

14,462 [illegible]

14,472 THOMPSON. Actuating signals on and communicating with trains. (Addition to 18,443/14.)

14,473, 14,474 DAVIDSON. Submarine signal sound-receiving apparatus.*

14,482 B.T.-H. Co. (G.E. Co., U.S.) Protective devices for electric distribution systems.

14,484 KENNEDY-MCGREGOR. Sparking plugs.

14,496 W. T. HENLEY'S TELEGRAPH WORKS Co. & HARRIS. Filling with insulating compound of electric [illegible] junction boxes.

14,498 AKT.-GES. BROWN, BOVERI ET CIE. Maximum time relays. (30/11/14, Germany.*

14,499 YATES, [illegible] CAMPLING & PARKER. Guards for the cords or wires of telephone [illegible] *

14,500 PETHENUD & CHAPELEAU. Radiotelegraphy. (15/10/14, France.)*

14,503 HARRY W. COX & Co. & BRUGGENKATE. Mercury breaks or interrupters on inductive circuits.

October 14, 1915.

14,508 ZEISS. Telemeters. (Addition to 20,263/14. 4/11/14, Germany.)*

14,516 LA COUR. Dynamo-electric machine for transforming alternating current into continuous current or vice versa. (14/10/14, Germany.)*

14,533 PRENTICE. Mounting of electrical apparatus in frames or cases.

14,539 HARRISON. [illegible]

14,548 FEIX & [illegible] DAIMLER-MOTOREN-AKT.-GES. Electro-mechanical driving arrangements for vehicles and other purposes. (2/9/13, Austria.)*

14,553 SULLIVAN. Galvanometers.

October 15, 1915.

14,557 FRANKLIN. Locking and sealing device adapted to emergency tumbler switches or the like.

14,585 [illegible] & SON & BEAUND. Attachable mirror for magnetic compasses and other instruments of precision.

14,594 SIGNAL GES.M.B.H. Membranous or diaphragm transmitters for submarine sound signals. (15/10/14, Germany.)*

October 16, 1915.

14,630 MITCHELL, MITCHELL, WYNDHAM & WYNDHAM. Holding and adjusting in any required position the carbons of arc lamps.

14,633, 14,643 HEYS. (Neuland Patents, Ltd., U.S.) Dynamo-electric machines.*

14,650 SHAW, SHAW & SHARP. Alternating-current electric motors.

October 18, 1915.

14,692 GUYMER. Creeper or cable layer.

14,696 SIEMENS & HALSKE AKT.-GES. Spark-gap arrangements for oscillatory circuits. (23/11/14, Germany.)*

October 19, 1915.

14,729 LONG. Transmission and reception of ether waves, *e.g.*, those used in wireless telegraphy.

14,734 JOHNSON. Sparking-plugs.

14,746 AUTOMATIC TELEPHONE MFG. Co. & ARCHER. Electric heating apparatus.*

14,769 B.T.-H. Co. (G.E. Co., U.S.) Wireless signalling systems.

14,783 CRARY. Electric stoves.*

14,790 LOWE. Device for facilitating the engagement of trolly wheels with overhead trolly lines.*

October 20, 1915.

14,803 WOOLLEY & TIMMINS. Electric cable bracket and bolt.

14,819 FERGUSON. Internal-combustion engines having electrical accessories.

14,844 THOMPSON. Actuating signals on and communicating with trains. (Addition to 18,443/14.)

14,851 B.T.-H. Co. & RALPH. Magneto-electric machines.

14,864 GELL. High-frequency generators.

October 21, 1915.

14,881 COLIN. Sparking plugs.

14,885 HEENAN & FROUDE, HEENAN & WALKER. Dynamo-meters.

14,895 PEDERSEN. Magnets for/of magnetos. (Divided application on 9,054/21/6/15.)

14,896 PEDERSEN. Make-and-break mechanism for/of magnetos. (Divided application on 9,054/21/6/15.)

14,897, 14,898 PEDERSEN. Armatures or cores for/of magnetos. (Divided application on 22,741/19/11/14, and 9,054/21/6/15.)

14,915. B.T.-H. Co. (G.E. Co., U.S.) Leading-in conductors.

14,918 SIEMENS & HALSKE AKT.-GES. Production of Vacua, and means therfor. (14/11/14, Germany.)*

October 22, 1915.

14,941 PEARCE. Electric and gas lamps.

14,949 MILLER. Automatically and sumultaneously controlling anti-aircraft guns and searchlights.

14,955 BACHELET. Electro-magnetic pumps.

14,965 BROWN. Telephone headpieces.

October 23, 1915.

14,993 CONNER. Magneto-electric machines for ignition in internal-combustion engines.

14,994 WALTER MCGEE & SON & WALLS. Spooling machines.

14,995 CONNER. Contact making and breaking devices of magneto-electric machines for ignition in internal-combustion engines.

15,008 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric ship propulsion.

15,010 ROSENBERG. Telephone receivers.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Offices on payment of the prices indicated in parentheses. It is only necessary to specify the number when sending remittance.]

600. "Elementary Practical Metallurgy for Technical Students." By J. H. Stansbie. 3s. 6d. net (3s. 10d.)

601. "Introduction to the Mechanics of Fluids." By E. H. Barton. 6s. net (6s. 4d.)

602. "Test Methods for Steam Power Plants." By E. H. Tenny. 10s. 6d. net.

603. "The Molecular Volumes of Liquid Chemical Compounds." By C. Le Bas. 7s. 6d. net (7s. 9d.)

604. "Course on the Solution of Spherical Triangle for the Mathematical Laboratory." By H. Bell. 2s. 6d. net (2s. 9d.)

605. "Course in Fourier's Analysis and Periodogram Analysis for the Mathematical Laboratory." By Carse and Shearer. 3s. 6d. net (3s. 10d.)

606. "Model Engineering." By H. Greenly. 5s. net (5s. 4d.)

607. "Annals of the Solar Physics Observatory, Cambridge." By J. B. Hobrecht. Vol. III., part I. 9s. net (9s. 4d.)

608. "The Limitations of Science." By L. T. More. 6s. 6d. net (6s. 10d.)

609. "Commercial Practice." By A. Schofield. 2s. 6d. net (2s. 9d.)

610. "A Treatise on Light." By R. A. Houstoun. 7s. 6d. net (7s. 9d.)

611. "Introductory Course of Practical Physics." By J. Moffat. 1s. net (1s. 0d.)

612. "Elementary Lessons in Electricity and Magnetism." By S. P. Thompson. New edition. 4s. 6d. (4s. 9d.)

613. "[illegible] Theory and Practice." By W. Abbott. 3s. 6d. (3s. 9d.)

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	177	Half-Watt Lamp Fittings. Illustrated	35
Imports and Exports of Electrical Manufactures	178	Mazda "Poster" Stamps	36
Bankruptcies, &c.	178	Carron Fires. Illustrated	36
Electricity Supply	178	New Osram Poster. Illustrated	38
Lighting and Power Notes	179		
Traction Notes	179		
Empire Notes	180	Miscellaneous Notes	181
Foreign Notes	180	Tenders Invited	182
		Tenders Received & Accepted	182
The Round Table	31	Companies' Meetings and Reports	182
The "Point Fives"	31	City Notes	183
"Jackson" Fires. Illustrated	32	Electrical Companies' Share List	183
Automatic Machine Tool Control. Illustrated	33		

COMMERCIAL TOPICS.

The Abuse of the Telephone. We ought perhaps to have written "Abuse on the Telephone." According to the new Statutory Telephone Regulations, the use of offensive language has (apparently) become so common that new rules have had to be introduced to protect women operators. Powers have now been taken by the Department to cut off communication at once in cases where abusive language is employed by the subscriber or other user of the 'phone. We feel strongly that the Department has not taken any too early steps in this matter, for there is no doubt that, of late especially, the telephone service has, from a variety of reasons, many no doubt of which are unavoidable, caused much irritation, and a class of user has arisen who has come to feel that his only satisfaction lies in abusing the staff, instruments and everything connected with the telephone. We feel sure, however, the new statutory regulations will not be employed too rigorously. There is a time when one who is using the telephone may be said to reach what is known as "the limit" of endurance. We hope prominent notice will be given to all subscribers that they must bear the telephone burden along with the other burdens of life, and realise that the man or woman at the other end is doing his or her best in the circumstances. The war has taught us many lessons, and if the war, aided by the new statutory regulations, teaches us patience on and with the telephone, and especially courtesy to the female staff, there will be something to be thankful for. At the same time it will be unwise for the Department to assume, or to regulate, that the subscriber has no rights, and perhaps something can be done to "regulate" these also. Some time ago, we remember, there was issued a Post Office document setting out a form of answers which telephone operators were to make to subscribers under specified conditions. Perhaps the Department will issue, in similar form, a list of admitted expressions which a telephone subscriber should use under given irritating circumstances.

* * * *

The Australasian Market. The abstract of the report of H.M. Trade Commissioner for New Zealand (Mr. W. G. Wickham) which is given in another column, deserves careful consideration from British manufacturers. Although the report contains much that is obvious, it makes some useful suggestions for popularising British goods in New Zealand. The present is a most opportune time for pushing our trade in the Colonies, and especially in Australia and New Zealand, for, in addition to an intensely anti-German feeling, there is a strong desire to help the Mother Country and to purchase goods of British manufacture wherever possible. Our manufacturers would do well to take advantage of this state of affairs, for undoubtedly there is a great future for electrical engineering in the Commonwealth, and if suitable steps are now taken much of the German trade in electrical supplies will be captured. With some cheap German articles it is impossible to compete, and we agree with Mr. Wickham when he says that unless we unbend and hustle, the whole trade will go to the United States or some other country. If, therefore, we wish to expand our trade and to make our commercial relations with New Zealand and Australia still closer, we must bestir ourselves and see that no neutral country reaps the reward to which we are legitimately entitled. Like other Trade Commissioners who have reported upon the state of the overseas markets, Mr. Wickham makes a strong point of the danger of United States competition in the future, and refers to the [illegible] endeavours now being made by U.S. manufacturers to capture the markets which the Germans will most likely never again have the opportunity of occupying, or at least of monopolising. While we are conducting the war with the utmost strenuousness and with the fixed determination to win, we must not overlook the fact that peace has its victories no less than war, and that those markets which are susceptible to our influence must be attacked at once, or we shall find when we go to present our goods that the door is closed to us. Meanwhile the British Trade Commissioners are doing the Empire good service in putting the case for increased observation before British manufacturers. The report which appears on another page from the Canadian Special Trade Commissioner, Mr. C. F. Just, regarding the development of trade in Siberia, is also commercially instructive at this time, and makes a fitting sequel to the report of Mr. Wickham.

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Electric Supply Charges. Owing to the higher charges now made by electricity supply undertakers much discussion has taken place as to the legal position of the undertakers and their consumers. In the first place it must be borne in mind that the relations between the undertaker and the consumer are of a purely contractual character, except that the undertaker must not make any charge in excess of the maximum allowed by the Provisional Electric Lighting Order under which supply is given. Subject to this, and to the condition that the undertaker must not give any undue preference, the parties may make whatever agreement they like. In the early days of electricity supply the Board of Trade fixed the maximum price of current at 13s. 4d. per quarter for any quantity up to 20 units and 8d. per unit beyond, but with the cheapening of generating plant these figures were reduced. Before the war the general rule was to make the price 11s. 8d. for 20 units and 7d. per unit after, although there were some cases where the maximum was 6d., and in a few small rural areas 8d. per unit was allowed. One effect of the war has been to increase the price of coal and other materials very much, and some provincial undertakers have been obliged to ask the Board of Trade to allow an increase in the maximum price from 6d. (or 7d.) to 8d. per unit, and the Board have granted some of these applications for the period of the war. Naturally this has led to some grumbling, but it must be borne in mind that gas, the rival illuminant, is equally affected and the burden of the higher charges should be borne equitably by all concerned. In the next place, we think that consumers should get reasonable notice of an increase in prices, and intending consumers would do well to insist upon the insertion of a suitable clause in their agreements providing for due notice of any change of price or method of charging. Though in the great majority of cases due notice has been given, we have come across a few instances of attempts to make the increases retrospective. This is obviously inequitable, and courts of law would give no encouragement to this sort of thing. Another point which has arisen relates to power users with a coal clause in their contracts. It has been found that, owing to the increase in the cost of materials (other than coal) and the advance in wages, &c., the present form of the coal clause is not a sufficient protection to undertakers. In a few cases consumers have seen the reasonableness of the demand for an increased charge, but failing mutual agreement the undertaker must abide by the terms of his contract. While on this question of increased charges we would like to impress upon municipal undertakers the unwisdom of appropriating surplus profits to the relief of rates. For many years we have been protesting against the use of electric supply profits for this purpose until adequate reserve and contingency funds had been formed. It is doubtful whether these profits should, under any circumstances, be voted in aid of the general rate, but it is unfair to consumers and to general public to do so until the undertaking is in a sound financial condition. If supply authorities had had proper reserve funds they would not now be compelled to raise their charges so soon. However, we hope that the situation will be reviewed in a calm and impartial spirit after the war, and that there will be more business and less politics than we have hitherto had in municipal affairs.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Oct. 24, 1915, *to* Oct. 30, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. carbons, 9 pkgs.; unenumerated, 46 pkgs.
GRIMSBY.—*Denmark:* Carbon electrodes, 21 pkgs.
HULL.—*U.S.A.:* Unenumerated, 13 pkgs.
LIVERPOOL.—*U.S.A.:* Unenumerated, 167 pkgs. *Spain:* Unenumerated, 152 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £202; carbon candles, £50; elec. lamps, 9 pkgs.; lamp parts, £592; unenumerated, £1,258—91 pkgs. *Holland:* Elec. lamps, £1,360—102 pkgs.; wire and cable, £865; unenumerated, £192. *France:* Elec. lamps, £300, carbon candles, £733; wire and cable, £31; unenumerated, £412 *Denmark:* Elec. machinery, £21. *Italy:* Wire and cable, £1,994. *Sweden:* Elec. machinery, £16; elec. lamps, £275; lamp parts, £41. *Spain:* Unenumerated, £12.
CANADA.—Unenumerated, 16 pkgs.
NORWAY.—Elec. machinery, £81
SWITZERLAND.—Carbon candles, £109; elec. machinery, £78; unenumerated, £1,109.
BELGIUM.—Telephone materials, £10.
GIBRALTAR.—Old wire and cable, £150.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. machinery, £299; wire and cable, £262; unenumerated, £262. *Melbourne:* Wire and cable, £305; elec. machinery, £41; elec. glow lamps, £496; unenumerated, £1,173. *Sydney:* Elec. machinery, £157; wire and cable, £722; unenumerated, £2,667. *Wellington:* Elec. machinery, £21; wire and cable, £5,404; unenumerated, £2,651. *Brisbane:* Elec. machinery, £186; unenumerated, £353. *Christchurch:* Unenumerated, £127. *Dunedin:* Wire and cable, £245; unenumerated, £29. *Hobart:* Elec. machinery, £36; unenumerated, £38. *Lyttelton:* Unenumerated, £233. *Adelaide:* Wire and cable, £120; unenumerated, £183. *Fremantle:* Wire and cable, £105; unenumerated, £24. *Launceston:* Unenumerated, £23. *Invercargill:* Elec. machinery, £32. *Mackay:* Unenumerated, £8. *Newcastle:* Elec. machinery, £157. *Perth:* Unenumerated, £22. *Wanganui:* Wire and cable, £891. *Townsville:* Unenumerated, £29.
AFRICA.—*Durban:* Elec. machinery, £16; unenumerated, £722. *Port Elizabeth:* Unenumerated, £71. *Cape Town:* Elec. machinery, £13; unenumerated, £722. *Delagoa Bay:* Unenumerated, £10. *East London:* Unenumerated, £55. *Mombasa:* Elec. machinery, £90. *Napier:* Elec. machinery, £93; unenumerated, £46. *Zanzibar:* Unenumerated, £63.
EGYPT.—*Port Said:* Unenumerated, £13.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £543; elec. machinery, £2,225; telegraph material, £115; unenumerated, £2,389. *Valparaiso:* Wire and cable, £253. *Rio de Janeiro:* Unenumerated, £18. *Pernambuco:* Elec. machinery, £424; unenumerated, £160. *Monte Video:* Wire and cable, £86. *Rosario:* Unenumerated, £228.
U.S.A.—*New York:* Elec. machinery, £107; unenumerated, £32. *Philadelphia:* Unenumerated, £96.
CANADA.—*Montreal:* Unenumerated, £18. *Vancouver, B.C.:* Unenumerated, £59.
HOLLAND.—*Amsterdam:* Wire and cable, £489; elec. machinery, £194; unenumerated, £132. *Rotterdam:* Wire and cable, £652; elec. machinery, £145; unenumerated, £769. *Bergen:* Unenumerated, £143.
SPAIN.—*Barcelona:* Elec. machinery, £34; unenumerated, £56. *Cadiz:* Elec. fans, £378. *Carthagena:* Unenumerated, £2,400.
ITALY.—*Naples:* Unenumerated, £97. *Genoa:* Unenumerated, £181.
PORTUGAL.—*Lisbon:* Wire and cable, £1,679.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £188; unenumerated, £668. *Calcutta:* Elec. machinery, £1,113; elec. glow lamps, 13,650 (No.); wire and cable, £298; unenumerated, £936. *Madras:* Elec. machinery £37; unenumerated, £1,044. *Ceylon:* Wire and cable, £142; elec. machinery, £1,520, unenumerated, £267. *Singapore:* Elec. machinery, £237. *Karachi:* Unenumerated, £23. *Bankok:* Wire and cable, £110; unenumerated, £89. *Penang:* Unenumerated, £35. *Port Swettenham:* Unenumerated, £189. *Rangoon:* Unenumerated, £267.
CHINA.—*Shanghai:* Unenumerated, £641. *Tientsin:* Unenumerated, £18.
JAPAN.—*Yokohama:* Unenumerated, £31. *Nagasaki:* Elec. machinery, £459.
WEST INDIES.—*Batavia:* Wire and cable, £141.
MALTA.—Unenumerated, £24.
GIBRALTAR.—Unenumerated, £42.
NEW GUINEA. *Port Moresby:* Unenumerated, £2.
FRANCE.—*Boulogne:* Unenumerated, £31. *Dieppe:* Unenumerated, £30. *Havre* Elec. machinery, £72. *Dunkirk:* Unenumerated, £34.

FOREIGN GOODS (duty paid and free).

Hong Kong: Unenumerated, £16. *London:* Unenumerated, £38. *Liverpool:* Unenumerated, £63. *Manchester:* Unenumerated, £2. *Calcutta:* Unenumerated, £2. *Glasgow:* Unenumerated, £6. *London:* Unenumerated, £54. *Manchester:* Unenumerated, £2. *Liverpool:* Unenumerated, £7.

IN TRANSIT.

Melbourne: Elec. lamps, £264.

FOREIGN FREE GOODS (entered in transit or through Bills of Lading).

Adelaide: Unenumerated, £34. *Melbourne:* Unenumerated, £230.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BANKRUPTCIES, &c.

Claims agains James Wm. and Tom Whitaker Tattersall, electrical engineers, Kimberley-road, Willesden lane, London, N.W., are to be sent by Nov. 13 to Mr. E. S. Grey, Bankruptcy-buildings, London, W.C.

Claims against Chas. Hellyer Pearson (trading as Pearson & Co. and as the B.O.A. Engineering Co.), electrical engineers, &c., 51a, Mosley-street and Stockton-street, Manchester, and 4, Manchester-road, Hyde, are to be sent by Nov. 19 to Mr. A. Yearsley, 27, Brazennose-street, Manchester.

ELECTRICITY SUPPLY.

EXTENSIONS.

Belfast.—Messrs. Workman, Clark & Co. have been authorised to erect a small power house near the Thompson graving dock.

Birmingham.—At the meeting of the Electric Supply Committee last week it was reported that the temporary station at Nechells would be completed in about three weeks.

With this temporary station in operation the committee hope that the difficulties in regard to the supply of electric current will cease, but they appeal to consumers to adopt a policy of economy during the next three weeks, especially between 5 and 7 o'clock. By doing so they will help the department materially to maintain a steady supply, and there will be no fear of an interruption such as occurred recently.

Bradford.—On Friday last a 5,000 kw. turbo-generator and two 1,500 kw. rotary converters at the Valley-road electricity works were started up in the presence of members of the Electricity Committee, officials, contractors and guests. The latter included Mr. Blackman of Sunderland, a former borough electrical engineer of Bradford, and Mr. W. B. Woodhouse, of the Yorkshire Electric Power Co.

Mr. J. Haley, chairman of the Electricity Committee, who conducted the party over the works, formally started the new turbo-generator, which has been named "Kathleen Haley." One of the rotary converters was started by Mr. John Hoyle (deputy-chairman of the Committee), and the other by Ald. A. Peel.

Luncheon was afterwards served in the Banqueting Chamber of the Town Hall, Mr. Haley presiding. After the loyal toasts the Lord Mayor (Ald. G. H. Robinson) proposed "The Electricity Department and its New Plant." While he knew little about electricity, he claimed to know something about the commercial part of the undertaking. In Bradford, where they had the first municipal electricity undertaking in the country, they felt pride in having been pioneers in the work. Having given a sketch of the history of electricity supply in the city he said he did not think that the present installation was going to meet the constantly growing demand, and during the next 12 months the Committee would have to consider the question of making further extensions. As showing the great economies in steam consumption which had been effected, he stated that on changing from high speed to slow speed there was a saving of 20 per cent. in coal, when turbos were put in there was a further saving of 15 per cent., and he was told that the set started that day would effect a saving of 12 per cent. The total works cost per unit was in 1885 2·24d., in 1910 0·582d. and last year 0·526d. The average price obtained per unit for current sold was 4·807d. in 1895, and last year (when the works made their biggest profit) 1·14d.

In reply, the Chairman paid a tribute to the great services of the Lord Mayor during the 11 years that he had been chairman of the Committee. About two years ago there was a keen controversy about the proposed purchase of a turbine in Berlin. After a visit to Berlin, a deputation returned with the information that much more favourable steam consumption could be obtained at 10 per cent less cost than the best English tender. The Committee thought, therefore, that they were only doing their duty to the ratepayers in accepting the tender for the German machine. Whether the Germans would have kept their contract faithfully could not be known now, but safeguards had been demanded and it had been determined to keep them rigidly to their contract. Mr. Roles was in London actually on his way to Berlin when the war broke out. In consequence of the war they had, of course, to begin again, and the British Westinghouse Co. secured the contract, and had carried it out very satisfactorily. The whole of the scheme was to cost about £80,000. During the past year the department had been taxed very seriously. Only that week an arrangement had been come to for the giving of a supply having a maximum demand of at least 1,000 kw. for the operation of electric furnaces which it was anticipated would be used for 24 hours per day the year round. Dumb Mills, in which over 26,000 spindles were to be installed, were also to be run by electric power, and the use of electric power in the textile trade generally was constantly growing. Domestic consumers were also increasing. The only case where development was not taking place, as might have been expected, was in connection with electric vehicles for heavy haulage, where high speed was not a necessity. That was the fault of Bradford and not of the machine. As an engineer he could testify to the satisfactory way in which the extension had been carried on and the good work the contractors had put into the plant. He had confidence in the future rapid growth of the department, and the faster it grew the better it would be for the health and well being of the city.

Mr. W. B. Woodhouse, who responded for the guests, appealed for a spirit of co-operation between the Corporation and his company. He thought it was now realised that to give a satisfactory supply of electricity it must be done on a large scale. His company had been customers of the Corporation, and he hoped they might yet be bigger customers. The more electricity was used for power purposes and the less smoke there would be in the atmosphere.

Ald. A. Peel gave the toast of "The Contractors," and Mr. A. G. Lavessy, of the British Westinghouse Co., and Mr. Bertram Thomas replied.

Ald. J. Haythurst proposed "The Engineer and Staff," and paid a warm tribute to the good work of Mr. Roles. Important services had

been rendered by engineers in general and by those who had served at their electricity works in particular. 20 per cent. of the men had entered the fighting services; they were a great credit to the department, and it was to be hoped that all would return safe and sound.

Mr. T. Roles, city electrical engineer, acknowledged the toast. He was happy to have on his staff a band of enthusiasts who considered duty their first consideration.

Ipswich.—An inquiry was held here last week into the Council's application for sanction to borrow £3,100 for the installation of coal bunkers and coal-handling plant at the electricity supply works.

Mr. A. MOFFAT (assistant town clerk) outlined the circumstances which had led to the application for the loan, and the inspector (Mr. R. H. Bicknell), having received formal information from the officials, visited the station.

Shoreditch (London).—The L.C.C. has agreed to sanction the Borough Council's application to borrow £1,500 for new services, subject to the expenditure thereunder being limited from March last until the termination of the war.

Stoke-on-Trent.—Last week the Council decided to apply to the L.G. Board for sanction to borrow the further sum of £1,000 to cover expenditure for the six summer months, and for £1,000 to cover prospective expenditure on distributing mains to the end of the financial year, against the balance of sanctions already approved by the Board.

Wolverhampton.—The L.G. Board notify that they are not perpared to sanction a loan of £5,000 to defray expenditure on ordinary extensions of electricity mains, but they will raise no objection to the proposed expenditure of £1,365 for affording a supply of electricity to certain firms engaged on war work.

GENERAL.

Barking.—The Council have concluded negotiations for a loan of £13,654 for electricity works extensions at 4½ per cent., with a procuration fee of 1½ per cent. (including stamps), the mortgage to be for 10 years certain.

Bermondsey (London).—The Electricity Committee reports having given instructions for an application to be made for the release of Sergt. W. Allis, London Electrical Engineers, who is willing to return to his work of meter tester. &c.

Bolton.—Last week the borough electrical engineer (Mr. W. J. H. Wood) gave an interesting address on the new power station to the members of the local Property Owners' and Ratepayers' Association.

Having dealt with the economic and hygienic effects of centralising power supply, he said it would be interesting to know what would be the result if for some reason the electricity department suddenly ceased to exist. He said that the large engineering works in the town and several of the cotton mills and bleachers would be completely stopped, putting thousands of hands out of work. There would even be a shortage of bread, as a number of bakers worked their machinery by electricity; butchers and users of refrigerating machinery would be seriously inconvenienced; the picture palaces and places of amusement would be shut down, not to mention the majority of the shops, and at least 3,000 houses would be in darkness; and last, but not least, the whole of the tramway system would come to a standstill. The new power station was well situated, equipped with modern and most efficient plant, and was naturally able to generate electricity at a very much lower rate than was possible at Spa-road. Two turbines, each of 5,500 H.P., built by Messrs. Musgrave & Sons, had been installed. The capital expended was £130,000, and of that sum £95,000 represented contracts let to local firms. The alteration necessary to the system of distribution and the sub-station scheme involved a £23,000 further. The capital cost of the Back o'th' Bank power station only amounted to £15. 2s. per kilowatt of plant, but that of Spa-road station was £28. 3s. per kilowatt. There were over 4,000 different consumers (including many engaged on munition work) to whom the department was responsible for supplying energy.

Brighton.—The chief engineer and manager of the electric supply department (Mr. John Christie) reported to the Lighting Committee last week that 74 of the staff of 190 had temporarily left to join H.M. Forces.

Mr. CHRISTIE pointed out that the loss of so many of the best men had made it most difficult for the supply to be carried on with reasonable efficiency and reliability. The last two men who joined did so without giving notice, and as one of them was due for night duty it involved his mate (who should have been relieved at midnight) working 16 hours on end. He therefore suggested that a resolution should be passed that, in future, no further employés from the department should be allowed to enlist without giving reasonable notice, and that failure to do so would entail forfeiture of their claim to an allowance.

The Committee resolved that Mr. Christie be authorised to inform the employés of the undertaking that in future no allowance will be made by the Corporation to dependants of men joining H.M. Forces unless such men first obtain the consent of the engineer.

Chester.—The electrical engineer (Mr. S. E. Britton) reported to the Electricity Committee that he had interviewed several bulk supply consumers, who acknowledged the necessity of the price of electricity being increased, but objected to the proposed [illegible] only by the bulk consumers. It was, therefore, resolved that after the 25th prox. the charges for electricity supplied to all consumers be increased 15 per cent., and that the notices of the alterations be given.

Middlesbrough.—The Council have authorised alterations at the electricity works to enable the whole of the supply to be taken from the Cleveland & Durham Electric Power Co.

The alterations to the cables, &c., will cost £270, and will obviate the proposed installation of a large booster at a cost of £1,000. It will enable the department to dispense with the services of an engine driver, a stoker, a switchboard attendant and three labourers, thus effecting a saving of £508 a year.

LIGHTING & POWER NOTES.

Edinburgh.—On the recommendation of the Cleaning and Lighting Committee the Council have decided to employ the street arc lamps between 6 and 8 a.m. during the winter months.

Electricity in Colliery Work.—Last week Harrington Council granted the application of the Workington Iron & Steel Co. to carry under the roadway near the level crossing at Lowca their electric cables for supplying electricity at the sidings on the L. & N.W. Railway, and to supply power to the bottom of Lowca brow for their beck pump.

Gloucester.—Last week the Council adopted a recommendation to apply for sanction to borrow £25,000 for extensions of the generating plant in order to give a supply of electric current for power and lighting to the Gloucester Paper Mills (Ltd.).

Perth.—The Corporation have sanctioned the extension of the electric supply cables to the works of Messrs. John Moncrieff (Ltd.).

TRACTION NOTES.

Edgware & Hampstead Railway.—The Board of Trade have extended for one year, from Aug. 7, 1915, the time limited by the Edgware and Hampstead Railway Act, 1912, for the exercise of the powers for the compulsory purchase of lands and easements authorised by the said Act.

Hackney (London).—The question of the relative economy in buying horses or purchasing a motor vehicle for the Highways department was recently discussed by the Council, and the recommendation to purchase additional horses was referred back.

Liverpool.—About 1,300 employés of the tramways department (or 50 per cent. of the total) have joined H.M. Forces, and 300 others are working on munitions.

Manchester.—The formal opening of the Hyde-road tramcar shed extension and new stores took place on the 27th ult.

The extension provides additional accommodation for 90 cars, and there is also a three-storey building for the storage of materials and equipment. The area of the sheds and buildings covered by roofs is now 10¼ acres, and the total cost of the land and buildings is £277,000.

The LORD MAYOR said the acquisition of the Hyde-road site might be regarded as providential, because it had proved so serviceable, despite the fact that the Committee were held up to ridicule at the time of the purchase. The development of their tramway undertaking was one of the most wonderful of municipal enterprises in the kingdom, and it was a triumph of organisation.

Subsequenty the party had luncheon at the tramway offices, Ald. Bowes presiding. Presentations were made to Ald. Bowes and Ald. Wilson (who has been a member of the Tramways Committee from the start).

In reply to a vote of thanks, Ald. Bowes said that, under their united guidance, aided by their inestimable general manager (Mr. J. M. McElroy), the work of the department had doubled in every respect during the eight years of his chairmanship. £15,000 had been collected for war charities on their tramway cars.

Women Conductors and Drivers.—Leeds Corporation have engaged 150 women conductors, and 50 started work on the tramcars on Friday last.

Burnley, Liverpool, West Hartlepool and Rochdale Corporations have resolved to appoint women tramcar conductors, and applications are being invited. On the London United Tramways women are also to be utilised as conductors.

At Glasgow a number of women who expressed their willingness to become tramcar drivers began training on Monday. No decision to employ women as drivers has been come to, but it is regarded as probable that after a course of training many of the applicants will be accepted as capable of undertaking the work.

EMPIRE NOTES.

Australasia.—*British Manufacturers and the New Zealand Market.* H.M. Trade Commissioner for New Zealand (Mr. W. G. Wickham) says in his report for 1914 :—

Samples of German hardware have been sent to the United Kingdom in the past and circulated in manufacturing centres, but he (Mr. Wickham) has not heard of any effective attempt having been made to compete with the goods. Many of the German goods are little more than cheap imitations of British makes, and it is doubtful whether it is desirable for the United Kingdom to lower its standard. There are, however, articles of utility supplied from Germany that are good, well finished and cheap, and which United Kingdom manufacturers do not make. When the manufacturer, further, refuses to parcel and pack his goods as his customers require he is simply putting himself out of the market. If the British manufacturer does not unbend and hustle the whole trade will go to the United States or any other country which will meet the requirements of buyers. British goods are almost invariably more expensive and in most cases of better quality than others, and if the makers are unwilling to reduce the quality they must either reduce the cost or convince the public that it is advantageous to buy the more expensive goods. As much time, brains and energy should be employed in producing economies in packing and shipping as in reducing cost of manufacture. Several cases could be instanced, notably in pottery goods, such as insulators, &c., where British manufacturers, beaten on price, have attributed it to higher labour cost, whereas it was obvious that smaller scale of production was the important factor. Also manufacturers must arrange to be able to deliver from stock, or else lose orders. The retailers' policy is usually to get something cheaper than competitors, and to push goods solely on price. Manufacturers should, therefore, consider what can be done to promote the sale of their goods in spite of their being more costly than others. Mr. Wickham suggests that the British manufacturer should (1) give the retailer special inducements to push his goods by allowing a good discount ; (2) make the goods popular with the shop assistant by studying his convenience in parcelling and labelling ; (3) save the retailer most of the work of "talking" the goods up by supplying him liberally with leaflets giving the selling points and merits ; (4) stimulate the demand by spending money on advertising ; (5) put goods, at his own expense, on show in shops and wholesale showrooms, of a better quality than there is any obvious demand for ; and (6) see that his agents thoroughly understand the selling points of his goods and are keen to push them in spite of price.

Manufacturers must realise, says Mr. Wickham, that merchants and retailers do not care what goods or whose goods they sell, and that they will handle those which they can dispose of with the minimum of trouble.

The vice-president of the N.S.W. Legislative Council (Mr. Fitzgerald), in moving the second reading of the (Sydney) City and Suburban Electric Railways Bill, pointed out that in the metropolitan area the population was about 800,000. The problem of communication between the north and south shores of the harbour was held in contemplation throughout the present scheme. The corollary of the scheme would be the building of the North Shore bridge. That would be a matter for the Greater Sydney Council, if created, acting in co-operation with the Government and the Railways Commissioners. He thought the bridge would be erected in five years.

The Victorian railways department has entered into a contract with the Electric Supply Co. of Victoria to supply electrical energy for driving the department's workshops at Ballarat and Bendigo.

Hobart Gas Co. have confirmed the preliminary agreement for the sale to the hydro-electric department of the State of all the company's electrical plant, machinery and contracts, for £108,000.

Canada.—The Imperial Trade Correspondent at Toronto (Mr. F. W. Field) says that among the articles which are now being made in Canada as a result of the disturbance of the import trade by the war, are high carbon and manganese steel, molybdenum, zinc, steel drums, pyrometers, drawn tungsten wire, accumulators, sand blast apparatus, light metal wares, glass, &c.

Canadian manufacturers have also increased their production of goods which have been manufactured in Canada for some years. This applies to tungsten lamps, carbon electrodes, carbides, hardware, &c.

FOREIGN NOTES.

Argentina.—A decree has been issued authorising Senores Pedro A. Barros and Jose Isac to establish a public telephone service in Comodoro Rivadavia and the neighbouring districts. The concession is for 30 years.

The Supreme Court of the Nation has given judgment in the action brought by the Cia Alemana Transatlantica de Electricidad against Moron Municipality. The municipality, in accordance with a decree of the Government of the Province of Buenos Ayres, declared void a contract made with the company in 1906 for public lighting for 20 years. The company brought an action before the Supreme Court of the Province which decided in their favour, declaring the concession valid, and this judgment has now been upheld.

The Provincial Government of Buenos Ayres propose to establish an electrical power house at La Plata, chiefly to supply light to Government offices. The plans have been prepared by Engineer Kreutzer, on the basis of the good results obtained from internal combustion petroleum motors at the new waterworks in the Saavedra Park. With coal fuel the total cost of raising 1 cubic metre of drinking water (exclusive of cost of staff) was 2·863 centavos. With petroleum motors the cost was reduced to 0·52 centavos, representing an annual saving of $129,330 m/n. The engineer considers that, utilising petroleum motors, $300,000 m/n. will be required to transform partially the existing machinery, which will result, with the new installation, in an annual economy of $130,000 in the cost of the water supply. By operating the electric power house, in conjunction with the water supply scheme, the electric current should thus cost 3 cents per unit, which will mean a reduction of the annual expenditure on this account in Government buildings from $96,000 to $11,796. Current could be profitably supplied to private consumers at a rebate of 50 per cent. on the existing tariff.

The Buenos Ayres Municipal Intendancy has reported favourably to the Municipal Commission concerning an application recently made for the organisation and exploitation of a new telephone service within the city radius. It is suggested that the period of concession should be 10 years instead of the 30 asked for, renewable for a second 10 years at the option of the municipality, that the concessionaire be required to pay a royalty of 6 per cent. of gross receipts during the first 10 years and 12 per cent. during the second 10 years, and that the cables be overhead with the exception of those from one square to another.

China.—A consular report states that extra cost of war insurance seriously affected business at Canton, but the subsequent reduction of war insurance enabled business with the United Kingdom to be resumed.

In many cases German firms were unable to fulfil contracts and these were in some instances placed elsewhere, notably some for electric plant in Canton.

Imports into Canton in 1914 included electrical material valued at £18,602 (compared with £15,138 in 1913 and £11,114 in 1912), scientific instruments £3,258 (against £5,188 and £3,740), and railway plant and materials £11,625 (£5,877 and £2,362).

Italy.—The latest bulletin of the British Chamber of Commerce in Italy contains an article calling attention to the present opportunity for an extension of British trade in Italy.

It is stated that there is an opening for all branches of British enterprise, and it is desirable that the ground should be strenuously prepared by British firms ; otherwise, when peace has been declared, the Germans and Austrians will pick up their old connections too easily and regain the lost ground. Their successes were due to their tenacity, to their adaptability and devotion to their business, qualities which the war will not have uprooted. British firms should study the bigger interests, such as banking, shipping, industrial and engineering enterprises, if efforts are to be successful. German commerce has been aided, not only by the "money-capital" invested, but especially by the "man-capital" they have been able to place in concerns apparently belonging to the countries in which they are located. The manufacturer should take account of the tastes of his customers, and, if necessary, modifications should be made in the style, quality and packing of goods. In quoting, freight, carriage, duty, &c., should (if requested) be taken into account, and care should be exercised in the choice of an agent. Personal acquaintance with foreign customers is a great advantage, and a principal or department manager should visit them with the agent about once a year.

Russia.—*Western Siberia.*—The "Weekly Bulletin" of the Canadian Department of Trade and Commerce contains a report by the Canadian Special Trade Commissioner (Mr. C. F. Just) on the development of trade in Siberia, in which he says :—

In Western Siberia, stretching from the Urals, to a line drawn through Irkutsk, trade conditions and the influences which control them are similar to those existing in European Russia. Fully 50 per cent. of the trade of Western Siberia is controlled by Moscow merchants. These firms have branches in the principal centres, but purchases for their stores are made in Moscow. The development of the country and the establishment of strong local independent firms, however, are bringing about a change, and direct buying must ultimately become a general practice. Most foreign firms pay little attention to the Siberian market ; they are content to place their representation in the hands of a single firm in European Russia, who appoint a sub-agent for Siberia, as both parties look for a substantial profit, and this increases the cost of goods and restricts sales. German firms abandoned this practice several years ago. By trade grouping and by sending out competent travellers speaking the language, and carrying a full range of samples to the chief centres, they have been able to build up a direct trade on a satisfactory basis.

In regard to general hardware, tools, &c., visits to the large general stores at Omsk showed that goods of German origin are stocked to a surprising extent. Stocks everywhere are being rapidly depleted, and the question of replacing them is causing anxiety. In one store, with a business of 3,000,000 roubles a year, the articles urgently needed include cutlery, pumps (hand pumps especially), stocks and dies, bolts and nuts, pulleys, valves and fittings for radiators, electric light fittings, lamps, bell pushes, and fans, meters, dynamos, drills, files, saws, drilling machines,

and tools of every class. Financial strength to carry on trade is a greater necessity in Western Siberia than in European Russia, and trade grouping by firms wishing to enter the market is important. While profits are great, expenses are high, and in testing the possibilities of a new market it is a wise policy to share expenses. Local agents urge that representatives of grouped industries should visit the country and get into touch with local conditions. The granting of extended credit has been an important factor in securing business in Western Siberia. Although the market is extensive, it is safe if care in the granting of credit is exercised. In the opinion of local agents credit is required of from six to nine months from the date of the delivery of goods. The most advantageously placed centres for business are Omsk, Tomsk, Tobolsk, Novo-Nikloaievsk, Krasnoyarsk and Irkutsk. The first, and the last three, are at points where the Trans-Siberian Railway crosses the principal rivers which, during the greater part of the year, provide cheap transport facilities over vast areas.

MISCELLANEOUS NOTES.

Alien Enemy Patents.—A report has been issued by the Patents Tribunal of the Patent Office which was constituted for dealing with alien enemy patents, &c.

The general procedure has been to give licences under the patent rather than to annul the patent and make the protected article or preparation the subject of open competition. Since the end of Aug., 1914, when the tribunal was constituted, 387 applications have been made for licences under enemy-owned patents. In some cases more than one applicant applied in respect of the same patent, and the number of patents concerned has been 294. In 245 cases licences have been granted. Two patents have been definitely voided, and for the time being they are dead. Both the voided patents were concerned with the "Thermit" process of welding, the utility of which in the present war for military and naval purposes it can well be imagined is almost unlimited. Three patents have been suspended generally without the grant of a licence. In these cases the Board of Trade was apparently influenced by the contention that the patents stood in the way of the development of other patents, in respect of which licences had already been granted. The Board refused 31 applications for licences on the grounds either that the applicants were not fit or competent to carry on manufacture, or that no case had been made out that there was a demand for the article covered by the patent. Through the agency of the Patent Tribunal the manufacture of a number of important and essential commodities has been started in this country. Many of them doubtless will prove to be established industries. Some of the most important cases at the outset dealt with German chemical processes, and competition for the rights of these patents was keen between British and French firms. The strong hold which the Germans had obtained on certain branches of the chemical industry was demonstrated over and over again in proceedings before the tribunal. Some very valuable mechanical and engineering patents have also been before the tribunal. Evidence by some of the prominent Nottingham traders with reference to the machine embroidery industry left it clear that Germans held almost exclusive command of the market. The thoroughness of German methods was illustrated by the difficulties with which some of the British applicants found themselves confronted when endeavouring to obtain the rights of certain inventions. In numbers of cases applicants who had succeeded in obtaining licences under one patent found that the privilege was useless unless other patents were included, and valuable time had to be wasted in securing the extension of the original licence. It is the intention of the Board of Trade to make the licences granted to British traders of a permanent character, provided satisfactory terms are offered at the close of the war to the German owners of the patents, and this should ensure the continuous use of the patents by British industry in the interests of the British consumers. In the meantime the Public Trustee is collecting the royalties which in peace time would be payable under the licences to the owners of the patents. The ultimate destination of the accumulated royalties is not decided. On the point as to whether they should be paid over to Germany, the readiness of the German owners to concede favourable terms to the English licensees will doubtless have a considerable bearing. The sum so far collected by the Public Trustee is approximately £1,000.

British Empire Industrial Exhibition.—To further the scheme for the holding of a British Empire Industrial Exhibition at the conclusion of the war, which is being organised by the Institute of Industry, Aldwych Site, Strand, W.C., an Advisory Committee has been formed.

The committee is a representative one, and includes the Agents-General for the Colonies, &c. There will be two exhibitions in reality. The first, an exhibition of all British industries, will run for one month only; and the second, showing the natural resources of the Empire and its industries as a whole, for three months. The exhibition of purely British industries will include sections for the iron and steel trades, engineering, electrical trades, china and pottery, metal industries, shipbuilding, harbour and dock equipment, &c. The sectionising of the exhibition of the natural resources and industries of the Empire would follow on somewhat similar lines. With a view of enabling the British public to appreciate in full the enormous resources of the Empire in natural materials, and with a view of capturing those industries engaged in the development of these and now largely controlled by Germany, it is proposed to make the exhibition of British industries and of the natural resources of our Empire in 1917 as comprehensive as possible. At the conclusion of the war we may expect strenuous competition from Germany in all phases of industrial activity, and now is the time to organise and take steps to adopt such measures as will neutralise the advantages she now hold. Care will be exercised by the committee to show at the exhibition the uses which Germany has made of our natural resources in the development of her industries, notably. The exhibition proposals have received the full approval of most of the representatives of the Dominions and Colonies, who greatly appreciate the potential value of such an exhibition in the development of the resources of the Dominions and Colonies. Promises of support have already been received to the movement, and to such an extent that it would be necessary to devote an exhibition wholly to the natural resources of the Empire and other Imperial industries.

Contracts with Alien Enemies.—At the last meeting of Manchester Corporation Ald. Walker moved that the following clause be added to standing order 76, viz. :—

No contract shall be entered into with any person of German or Austrian nationality; no contract shall be entered into with any firm or company whose subscribed capital (whether by way of shares or otherwise) is held or controlled to the extent of one-third or upwards by persons of German or Austrian nationality.

The resolution was seconded and passed unanimously.

Customs Duties.—The following are revised tariff valuations for metals imported into Egypt, with effect from Oct. 1 to Nov. 30, 1915, or until denunciation. In cases where the old and new valuations differ the old valuations are given in parentheses. The English equivalents of the new valuations are also shown.

Copper and brass sheets, 98 (110) millièmes per kilog (=10·96d. per lb.). Copper sheets, plain, and copper in rolls and bars, 95 (107) mill. per kilog (=10·6d. per lb.). Copper ingots, 92 (104) mill. per kilog (=10·5d. per lb.). Tin ingots and bars, 150 (165) mill. per kilog (=16·77d. per lb.). Lead sheets, pipe and pig, 26 mill. per kilog (=2·91d. per lb.). Zinc sheets and ingots and phosphor bronze, 100 (130) mill. per kilog (=11·18d. per lb.). Antimony, 130 mill. per kilog (=14·54d. per lb.). Quicksilver, 580 mill. per kilog (=64·85d. per lb.). Copper wire, brass wire and brass sheets (24 in. by 28 in., 8 lb. to 5 lb.), ad val (as before).

Inquests.—An inquest was held at Neath last week into the death of Matteo Simeone (19), an assistant at a local restaurant.

Evidence was given that deceased tried to play a trick on another assistant by bringing him into contact with a brass rod which was connected to an electric conductor. The other assistant moved away and deceased then jumped on the counter, sitting on the brass rod, afterwards putting his feet on the metal plate on the floor. He then exclaimed: "John, turn the electric off" and fell back. The current was turned on by deceased and he got the shock when his feet touched the metal plate.

Nicholas Ullo, confectioner, said that about 18 months ago he had the brass rail connected to his electric wires to keep the boys away and to prevent stealing. He knew nothing about electricity.

Mr. Wesley Evans, electrical engineer, said one of his men laid on the supply of electricity without his knowledge. He had made a test, and a current of 30 volts was passing between the rail and the footplate. The voltage in the supply mains was 220, but 30 was the maximum obtainable at the spot where deceased dropped. It was not uncommon for a workman to get a shock of 220 volts.

Dr. Ll. Lewis said that when he saw Matteo very soon after the accident he was dead. The voltage being so small, the shock could not have caused death if deceased were organically sound.

The jury returned a verdict from electric shock accelerated by heart disease, and added the rider that the Corporation be asked to find out whether any similar contrivances existed in the town, and, if so, that steps be taken to have them done away with.

Further evidence was given at the resumed inquest last week on Edgar M. Jackman, an arc lamp trimmer, who was employed by Islington (London) Borough Council.

Deceased ascended an arc lamp column for the purpose of trimming the lamp. On reaching the top he was seen to fall backwards to the pavement, and death was due to coma arising from laceration of the brain, following fracture of the skull and other injuries. It was stated that at the time Jackman ascended the column, the switch was turned on and it would be possible for him to receive an electric shock, thus causing blisters which were discovered on his hands. Deceased had not carried out instructions as he ought to have switched off the current before ascending the column.

The jury returned a verdict of "Accidental death."

"The Syren and Shipping Illustrated."—The 1,000th issue of this journal appeared on Wednesday, and consists of over 400 pages. Amongst its numerous articles are contributions on Electric Arc Welding, The Development of Liquid Fuel, and Wireless Telegraphy and Electricity on Shipboard.

Other articles which may interest our readers are "Mexican Oil," "The Work of the Institution of Naval Architects," "Corrosion of Metals," "The Early Development of Marine Engineering," "The Geared Turbine in Cargo Steamers," "Improvements in Steam Raising Plant," &c. The contributors include many leading naval architects and engineers. The number weighs 2¾ lb., and it is excellently printed on good paper and liberally illustrated. The price is only 1s.

TENDERS INVITED.

Tramway and Electrical Stores.

BRADFORD Corporation require tenders by Nov. 13 for 12 months' supply of General Stores for the tramways department, including Bolts, Nuts, &c., Lamp Fittings, Insulating Material and Tapes, Fuse Wire, Controller fingers, Oils, &c. Schedule, &c., from the General Manager, 7, Hall Ings, Bradford.

DUBLIN UNITED TRAMWAYS CO. (1896) require tenders by Nov. 15 for 12 months' supply of General Stores, including Car Fittings, Iron, Steel, Electric Supplies, &c. Forms of tender from the Secretary, 9, Upper Sackville-street, Dublin.

MANCHESTER Tramways Committee require tenders by 10 a.m. Nov. 16 for Steel Girder Tram Rails, Special Track Work and Tongues and Crossings. Specifications, &c., from the General Manager, 55, Piccadilly, Manchester.

CHATHAM Corporation require tenders by 10 a.m. Nov. 24 for one year's supply of Stores and Materials, including incandescent Electric Lamps, &c. Specifications from Borough Surveyor.

Lampholders.

The COMMISSIONERS OF H.M. WORKS AND PUBLIC BUILDINGS require tenders by 11 a.m. Nov. 8 for supply of Cord Grip Electric Lampholders. Forms of tender from the Controller of Supplies, 18, Queen Anne's Gate, Westminster, S.W.

Wiring.

BARROW Corporation want tenders by noon Nov. 8 for Electric Lighting of Victoria Schools, Oxford-street, Barrow. Specifications, &c., from the Borough Electrical Engineer.

Telegraph and Telephone Material.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Nov. 17 for Switchboard Parts and Accessories (schedule 343), Telegraph Instruments (schedule 345), Protectors and Parts, &c. (schedule 346), and Ironwork (schedule 358) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Specifications, &c., for the above contracts can be obtained from the respective Deputy Postmasters-General.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Railway Stores.

The SLIGO, LEITRIM & NORTHERN COUNTIES RAILWAY CO. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Stores, including Telegraph Materials, Rubber Goods, Lead, Oils, &c. Forms of tender from the Secretary, Enniskillen.

Boilers, &c.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c, of two Water-tube Boilers and Accessories at Newcastle Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Electric Cables, Transformers and Switchgear.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED.

GLASGOW.—The following tenders have been accepted for the tramways department:—

Edgar Allen & Co., special trackwork: Mayor & Coulson switchboard for head office: Crompton & Co. and A. Watson & Co., electric heaters for Govan depot.

PLYMOUTH.—The Corporation have accepted the tender of the Brush Electrical Engineering Co. for the supply of six new tramcar bodies and that of the British Westinghouse Co. for electrical equipments for same.

LUTON—The Corporation have placed orders with the British Thomson-Houston Co. for a 500 kw. converter and transformer (at £1,177) and for switchgear (at £949).

MANCHESTER.—The Corporation have accepted the tender of Seddon & Sons for wiring the extension of the Harpurhey High School for Girls.

SALFORD.—The Corporation have accepted the tender of W. Geipel & Co. for the supply and delivery of 20,000 pairs of flame arc lamp carbons at £130. 15s.

NEWPORT (MON.)—The Corporation have accepted the tender of the British Thomson-Houston Co. for 264 kw. of converting plant at £1,173.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS

CAPE ELECTRIC TRAMWAYS (LTD.)—For the year ended June 30 the profit was £80,615. 7s. 2d., and after providing for debenture interest, redemption of debentures, and taking into account the balance brought forward, the credit balance is £14,286. 0s. 11d. From this the reserve fund has been credited with £12,000, leaving £2,286. 0s. 11d. The directors recommend payment of a dividend in respect of the past year of 5 per cent. on the ordinary share capital, absorbing £24,937. 2s., and leaving £7,724. 18s. 11d. to be carried forward. During the past year the tramways carried 21,680,070 passengers, earning £206,122. 19s. 6d., against 20,886,146 passengers and £200,409. 3s. 5d. in 1913-14. Though the traffic shows some expansion, the state of war in South Africa during the year added considerably to the working costs by reason of the additional cost of labour and the allowances granted to employés on active service, over and above which there is also an increase in the cost of all supplies. Mr. F. Haines, the acting secretary, has been appointed secretary in succession to the late Mr. S. W. Jameson.

CORDOBA CENTRAL RAILWAY CO. (LTD.)—Lord Farrer, who presided at the meeting last week, said that their investments included holdings in the Tucuman Tramways Light & Power Co., which amounted at June 30 to £164,937. This included £155,000 5 per cent. debenture stock. As the result of the reorganisation, alterations and improvements introduced on being carried out, the earnings of the Tucuman electrical concerns were showing improvement, and when the balance of the first part of the programme of works had been completed, which should be during next year, further considerable additions to the net revenue were expected.

DRAKE & GORHAM (LTD.)—The directors' report for the year ended June 30 states that, after payment of all charges, including bonuses due to staff, allowances to those who have joined the National Forces, and making provision for contingencies, the net profit is £3,816. 19s. 9d., which, with £1,911. 2s. 9d. brought forward, makes a total of £5,728. 2s. 6d. It is proposed to pay a dividend at the rate of 2½ per cent. per annum (£3,125), to write down goodwill by £1,000 and to carry forward £1,623. 2s. 6d. Country house lighting has been curtailed by the war, but the organisation of the company has been utilised in providing light and power for powder factories, chemical works, camps and hospitals.

which has kept the staff fully employed. As, however, this work was undertaken at low rates the profit on the installation department as a whole shows a reduction. The wholesale department has maintained its position and profits in spite of prevailing conditions. The agency for commercial electric vehicles with Edison batteries has resulted in a number of sales, and development of this department during the current year has already taken place. Two directors and 60 members of the staff (two of whom have been killed and one wounded) volunteered for National Service, and up to June 30 £810. 16s. 5d. had been paid in allowances.

FRASER & CHALMERS (LTD.)—At the meeting last week the chairman Mr. A. W. Tait) said the past year's profit was £12,058, compared with £8,377 for the previous year and £4,604 in 1913. The progress shown last year had been maintained, and, although the results were not good, there was some satisfaction in the fact that progress had been recorded during a particularly difficult time. The trading had been affected by the war, and difficulties had been experienced in obtaining supplies of raw materials and in maintaining a sufficient labour force. Owing to the close proximity to other works and to Woolwich Arsenal there was at present an unprecedented demand for skilled and unskilled labour, and the housing problem in that district added to the difficulties of the situation. The progress recorded in the manufacture and sale of steam turbines and turbo-blowers last year has been fully maintained, and the results from that department showed an improvement, and there was every promise that it would continue to grow in importance. The orders taken in the coal conveying and coal handling department had been very satisfactory, and they were carrying out certain substantial orders for the French Government, and also in South Africa and China. A certain amount of business had been secured in Bettington boilers, and further inquiries were under consideration. During the year business in South Africa had shown some improvement. Owing to the pressure of the demand, they had had to place come of their orders in the United States. The trading in Australia and in Canada showed a falling off compared with the previous year. Certain new business had been secured in Australia, and the satisfactory crops in Canada should improve conditions there in the near future. Their representative had established himself in Petrograd, and had opened offices there. Although there was not much prospect of immediate business, largely due to the exchange problem, the ground was being prepared for future work They had erected a new and larger power station at the Erith works to meet special conditions which had arisen. The company had entered into a contract for a limited period for the supply of electric power to Vickers' works. In the event of it not being continued after the expiration of the existing agreement the power station would supply all the needs of their own works at a considerably lower cost for power than in the past. There had also been a certain amount of expenditure during the year on plant, machinery and tools to increase the efficiency of manufacture. The concentration at Erith of the sales departments and general accountancy with the manufacturing end of the business had proved a great advantage, and had largely contributed to more efficient and economic administration. Owing to the requirements of the Government, all orders and instructions from them must receive precedence over any other work, and, in consequence, there was considerable difficulty in maintaining certain branches of the business, which, no doubt, would make it somewhat difficult to restore the balance when normal conditions were resumed.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors' report for the six months ended June 30 states that the amount to credit of revenue is £36,454. 3s. 9d., against £41,482. 9s. 8d. for the corresponding half-year of 1914, and the expenses have been £27,225. 0s. 8d. against £26,900. 4s. 10d. The profit is £9,229. 3s. 1d. (compared with £14,582. 4s. 10d. last year), to which is added £1,741. 8s. 5d. interest on investments, and £6,348. 16s. 4d. brought forward, making an available total of £17,319. 7s. 10d. The directors propose that this amount be dealt with as follows: On the first and second preference shares dividends of 6s. per share for six months to June 30, and on the ordinary shares a dividend of 9d. per share for the same period (tax free), leaving £2,237. 15s. 1d. to be carried forward. The war conditions referred to in the last report have during the half-year involved an abnormal expenditure of over £7,000. The cost of repairs to cables is £3,263 less, partly owing to receipts for the hire of the "Henry Holmes" and to a smaller quantity of cable having been used in repairs. The traffic receipts during the current half-year, to which are added the special subsidies granted in respect of a reduction of rates, so far show a considerable falling off in comparison with those of the corresponding half-year of 1914. In August last a hurricane passed over the West Indies, affecting an unusually large area and resulting in damage to several of the land lines and cables, causing a great dislocation of traffic for about 12 days. The cost of repairs to cables during the current half-year will, in consequence, probably exceed the average. Subject to the sanction of the shareholders, the directors propose to subscribe 50 guineas to the fund which is being raised under the auspices of the Colonial Office for the troops who form the West Indian Contingent.

WESTERN TELEGRAPH CO. (LTD.)—The revenue for the year ended June 30 amounted to £983,262. 15s. 4d. and the working expenses to £338,893. 9s. 10d. After providing £32,747 for debenture stock interest, and £33,348. 14s. 9d. for income tax, there remains £578,273. 10s. 9d.; to this is added £33,157. 9s. 8d. brought forward, making a total of £611,431. 0s. 5d. Three interim dividends, amounting to £93,568. 10s., have been paid, £150,000 has been applied towards reduction of amount of capital expenditure in excess of share capital and debenture stock issued, £150,000 transferred to general reserve, £30,000 to land and buildings depreciation fund and £50,000 to provision on account of investment fluctuations. The directors now recommend the payment of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, also the payment of a bonus of 2s. per share, both tax free, which together will amount to £85,880, leaving £85,880. 0s. 5d. to be carried forward. The dividend and bonus are payable on Nov. 11 inst. and the register of transfers will be closed from the 2nd to the 10th inst., inclusive.

CITY NOTES.

MEMORANDA (Nov. 3).—Bank rate 5 per cent. (since Aug. 9, 1914). Consols 65. Consols Pay Day Nov. 5 Stocks and Shares Pay Days Nov. 11 and 25. Pay Days Nov. 12 and 26. Price of silver, 24¼

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—The directors have declared a dividend of 1s. 3d. per share, being at rate of 5 per cent. per annum (less tax) for the quarter ended Sept. 30 last.

CLAUD HAMILTON (LTD.)—The directors have declared a dividend of 5 per cent. on the ordinary shares.

CONSOLIDATED SIGNAL CO. (LTD.)—A final preference dividend of 3 per cent. has been declared, making for the year 6 per cent., less tax.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. LIMITED & REDUCED).—A petition to confirm a resolution reducing the capital of this company from £500,000 to £300,000 will be heard by Mr. Justice Sarganton Nov. 16.

DELABOLE ELECTRIC LIGHTING & SUPPLY CO. (LTD.)—At the recent annual meeting the directors' recommendation that 5 per cent. dividend be paid was agreed to, and the Old Delabole Slate Co. was thanked for its generosity in supplying the power.

MONTREAL LIGHT, HEAT & POWER CO. (LTD.)—A dividend of 2½ per cent. has been declared for the quarter to Oct. 31.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Wednesday, Nov. 3. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	NAME.	Price, Wed. Nov. 3.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 2 8	Mar. Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb. Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅞	6 0 9	Feb. Aug
5	10%	Brompton & Kensington Ord.	5⅝	6 0 2	Mar. Sept
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	85	4 15 4	Jan. July
5	2/3	Do. 4½% Pref.	3⅛	6 5 0	..
5	5%	Do. Ord.	4	6 5 0	Apr. Oct
10	9%	City of London Elec. Lt. Ord.	11⅞	7 11 7	Feb. Aug
10	6/0	Do 6% Pref.	12¼	4 17 0	May, Nov
St.	5%	Do. 5% Deb. St.	99½	5 0 3	Jun. Dec
10	7%	County of London Ord.	10⅜	7 0 0	Mar. Sept
10	6%	Do. 6% Pret.	9⅛	6 0 7	Feb. Aug
St.	4½%	Do. 2nd Deb.	91	4 12 7	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	79½	5 17 8	Jan. July
5	9%	Kensington and Knightsbridge Ord.	9⅝	7 5 5	Feb. Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan. July
5	3/0	London Elec. Supp. 6% Pref.	4⅜	6 1 6	..
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan. July
5	3½%	Metropolitan E. Supp. Ord.	2⅛	7 15 6	Mar. Aug.
St.	4½%	Do. 1st Mort. Deb.	95¼	4 14 0	Jan. July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan. July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99¼	6 0 7	Mar. Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	May, Nov
1	6%	North Metropolitan E. P. Supp. 6% Pref	1	6 0 0	Apr. Oct
4	5%	South London E.S. Ord	3	6 13 4	May, Nov
St.	4½%	Urban Elec. Supp. 4½% Db. St.	84	5 7 10	Apr. Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅛	7 2 3	May, Nov
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar. Sept
5	4½%	Do. 4½% Cum. Pref.	1⅛	5	Jan. July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	74½	6 .. 5	Jan. July
St.	6%	Do 6% Cum. Pref	8½	8 15 2	Mar. Sept
St.	4%	Central London Gen. Assented Ord	6⅜	6 5 3	..
St.	4%	Do. do Assented Def. Ord	5⅛	6 5 6	..
St.	4½%	Do. 4½% Pref.	101	4 8 0	Jan. July
St.	4%	Do 4% Deb. St.	90½	4 5 4	May, Nov
St.	4%	City & S. London Deb.	84	4 15 3	May, Nov
St.	5%	Do. Pret. 1890	80	6 5 0	Feb. Aug
10	5½%	Lanarkshire Tramways	7⅛	5 17 11	Feb. Aug
10	1%	London Electric Ry. Ord.	1⅝	5 17 9	Jan. July
St.	4%	Do. 4% Pret.	58½	6 16 9	Mar. Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan. July
St.	1%	Metropolitan Ry. Con. Ord.	23	4 6 11	Feb. Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb. Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 9	Feb. Aug
St.	3½%	Do. 3½% A Debs	86½	4 4 0	Jan. July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan. July
St.	..	Metropolitan. Dist. Ry. Ord.	1⅜	.. ..	Feb. Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	89	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	115	5 4 4	Jan, July

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Wed., Nov. 3	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways	—*cont.*		
St	4%	Metropolitan Dist. Ry. 4% Debs.	66½	5 14 0	Jan, July
St.	4%	Do. 4% Debs. (1903-5).....	68½	5 16 9	Jan, July
St.	4%	Do. 4% Guar. Stock.....	75½	5 6 0	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1¼	..	..
1/0	..	Do. A Ord.....	[illegible]	..	..
St.	6%	Do. 6% Inc. Debs.	104⅝	5 15 5	Mar, Sept
..	6%	Do. 6% Inc. Bds., with coup. 16....	70½	8 9 7	Mar, Sept
..	4½%	Do. 4½% Bds.	98½	4 11 7	Jan, July
5	..	Yorkshire W. Riding Ord.....	[illegible]	..	March
5	6%	Do. Pref.....	4[illegible]	6 15 3	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2[illegible]	6 9 10	Apl, Oct
1	6%	Do. 6% Pref.....	1[illegible]	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.....	1[illegible]	4 11 9	Mar
100	5%	Do. Prior Lien Debs.	92½	5 7 10	Jan, July
1	6%	Do. 6% Pref.....	[illegible]	6 13 4	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10[illegible]	7 8 11	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5[illegible]	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	[illegible]	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	2[illegible]	7 7 8	April
100	6%	Do. 6% Prior Lien Debs.....	101½	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70½	5 13 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.....	10[illegible]	7 6 4	Jan, July
5	2/6	Do. 5% Pref.	4[illegible]	6 3 1	Feb, Aug
1	15%	Castner Kellner	[illegible]	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	[illegible]	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.....	[illegible]	..	Feb, Aug
1	6%	Elec. Construction Ord.	[illegible]	9 2 10	May
1	7%	Do. 7% Cum. Pref.	[illegible]	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10[illegible]	9 12 3	July
10	6%	Do. 6% Pref.	9[illegible]	6 4 11	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord..	12[illegible]	7 15 4	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	[illegible]	4 14 9	..
St.	4½%	Do. 4½% Db.	92½	4 17 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7[illegible]	6 6 7	Feb, Aug
10	5%	Do. Pref.	8[illegible]	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	97½	4 2 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	33[illegible]	7 4 4	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.....	1[illegible]	4 10 7	May, Aug
1	6d.	Do. 5% Pref.....	[illegible]	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	82[illegible]	4 17 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.....	100[illegible]	4 9 9	Jan, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.....	100†	5 19 6	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.....	22[illegible]	6 15 [illegible]	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	6[illegible]	6 1 3	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	7[illegible]	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15[illegible]	6 11 [illegible]	..
5	5/0	Direct Spanish 10% Pref.....	7½	6 13 4	..
10	4%	Direct United States.....	[illegible]	6 12 [illegible]	Ja.Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	122†	5 14 9	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.....	65[illegible]	5 6 1	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80[illegible]	4 19 [illegible]	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs...	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11[illegible]	6 1 0	Ja, Ap,Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8....	33½	5 19 5	Ja, My, Jly
25	13%	Indo-European	46[illegible]†	7 0 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.....	1[illegible]	5 6 7	April
1	7%	Do. 7% Pref.....	1[illegible]	3 19 0	July
10	1%	West India & Panama Ord.....	1[illegible]	8 2 6	May, Nov
10	6%	Do. 1st Pref.	[illegible]	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12[illegible]	5 12 0	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	7[illegible]†	5 0 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.....	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	129½	6 3 7	Ja.Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.....	75	6 13 4	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	[illegible]	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.....	100½†	4 9 10	May, Nov
1	10%	*Oriental Telephone Ord.	1[illegible]†	5 3 3	Apl, Oct
St.	4%	Do. Db. St.	81	4 12 9	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 [illegible]	Jan, July
5	8%	United River Plate Ord.....	5[illegible]†	7 0 [illegible]	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4[illegible]	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 [illegible]	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust.....	10½	5 17 1	Sp.Dc,Mr,Jn
10	6%	Do. 6% Pf.	10	6 0 9	Sp.Dc.Mr.Jn
100	5%	Mackay Companies' Common	80	6 5 [illegible]	Ja, Apl, Jly.O
..	4%	Do $100 Pref	68½	5 16 9	Ja.Ap, Jly.O
100	6%	Submarine Cable Trust Certs.....	121	5 16 9	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	77	6 10 3	Jun, Dec
St.	4½%	Do. 4½% Debs	74	6 1 7	Jan, July
St.	4%	Do. 4% Debs.....	74½	5 7 5	Jan, July
5	2/9	Do. 5½% 1st Pref.....	3½	7 17 2	Jan, July
5	2/9	Do. 5½% 2nd Pref.....	3[illegible]	7 10 6	Jan, July
100	2%	Brazilian Traction Ord.	57[illegible]†	6 11 [illegible]	Fb,M,Aug,N
100	$1½	Do. 6% Pref.....	9[illegible]	6 12 7	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.....	6[illegible]	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4[illegible]	5 5 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	61[illegible]	7 5 5	..
5	9½%	Calcutta Elec. Trams. Ord.	7[illegible]	7 16 9	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.....	8[illegible]	5 13 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref. ..	5	6 0 0	..
100	5%	Manaos Trams 5% Debs.....	6[illegible]	7 4 11	Jan, July
..	..	Mexico Trams Common St.	38[illegible]	..	Fb,M,Aug,N.
..	5%	Do. 5% Bds	7[illegible]	10 6 2	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)..	[illegible]	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 50 yr. Bds	7[illegible]	6 12 [illegible]	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.....	4[illegible]	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.....	47	5 3 1	Jun, Dec
10	6/-	Bombay E. S. & T. 6% Pref.....	10[illegible]	5 18 [illegible]	..
5	9%	Calcutta E. S. Corp. Ord	6†	7 10 [illegible]	May, Nov
5	5%	Do. 5% Pref	4[illegible]	5 4 4	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	12[illegible]	5 9 2	Ja,Ap,Jn,O
St.	5%	Melbourn eElec. Supply5% 1stMt. Debs.	9[illegible]	5 2 0	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	9[illegible]	5 3 4	Apl, Oct
..	5%	Shawinigan Water & Power 5% Bds....	103[illegible]	4 16 10	Jan, July
..	6%	Do. Com. Stock	14[illegible]	4 3 7	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	9[illegible]	4 13 4	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	86	5 1 2	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	1[illegible]	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.....	91½	6 0 9	Jan, July

* And 1½% Bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 3, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes.....	13½d.
Solid Drawn Copper Tubes	13½d.
Brazed Copper Tubes	15½d.
Brazed Brass Tubes	13½d.
Brass Wire	12½d
Copper Wire	12½d.
Rolled Brass	12½d.
Brass Sheets	13½d.

	per ton.
Copper Sheets	£107 0 0
Spelter	£81 0 0
English Lead.....	£25 15 0
Antimony	Nominal.

Old Metals:	per ton.
Clean Scrap Copper	£71 10 0
Brazier y Copper Scrap.....	£63 0 0
Clean Scrap Brass.....	£54 0 0
Old Lead	£22 5 0
Old Zinc.....	£45 0 0
Hollow Pewter	£110 0 0
Black Pewter.....	£75 0 0
Gun Metal	£61 0 0

Mr. A. Joseph, Earl-street. London-road, Southwark. London, S.E., quotes under date Nov. 2, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£95 0 0
Clean Mixed Brass	£55 0 0
Clean Copper.....	£71 0 0
Brazier y Copper.....	£63 0 0
Gun Metal	£63 0 0
Old Lead.....	£22 0 0
Tea Lead.....	£20 0 0
Old Zinc.....	£48 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £70; Commercial Tinman's Solder, £95; Blowpipe Solder, £106.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation ...	Oct. 27	1,619	+ 145	21	39,116	+ 1,870
Anglo-Argentine	,, 28	48,033	— 1,010	21	2,186,099	— 136.897
Ashton-under-Lyne.....	,, 30	464	+ 78	31	15,207	+ 1,061
Ayr Corporation.....	,, 30	245	+ 19	24	10,882	+ 575
Birkenhead Corporation..	,, 31	1,314	+ 153	31	42,545	+ 3,324
Birmingham Corporation. Trams	,, 23	15,180	+ 3,408	30	414,191	+ 51,715
Birmingham Corporation. Buses	,, 23	785	+ 68	30	25,617	+ 17,182
Blackburn Corporation ..	,, 27	1,087	+ 58	31	41,135	— 471
Blackpool Corporation ..	,, 28	703	+ 85	31	62,957	+ 1,328
Blackpool and Fleetwood	,, 30	357	— 16	43	36,295	— 260
Bolton Corporation.....	,, 31	2,581	+ 115	31§	83,617	— 2,296
Bournemouth.... Trams	,, 27	1,716	+ 108	30	67,156	+ 3,570
Bournemouth.... Buses	,, 27	7	..	30	857	— 102
Bradford Corporation	,, 30	5,914	— 103	30	203.218	+ 8,330
Brighton Corporation	,, 31	940	+ 22	31§	36.870	+ 52
Bristol Trams Trams ..	,, 29	4,432	+ 185	43	202,220	+ 1,331
Bristol Trams Buses,&c.	,, 29	4,478	+ 585	43	210,353	+ 37,234
Burmah E. Trams & Ltg.	..	..	..	..	..	..
Burnley Corporation	,, 30	1,560	+ 335	4	6,293	+ 1,048
Burton Corporation.....	..	..	..	..	..	..
Bury Corporation	,, 31	1,291	— 115	31§	42,928	— 750
Calcutta Tramways Co. ..	,, 30	R56,550	+ R375	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	,, 16	2,653	+ 162	28	78,928	— 2,996
Cork Electric Trams Co...	,, 28	485	+ 21	43	21,839	+ 28
Coventry Corporation ..	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	..	..	..	..	..	..
Dover Corporation.....	,, 30	269	+ 22	30	9,996	+ 1,801
Dublin & Lucan Railway .	,, 29	134	+ 15	17	2 831	+ 97
Dublin United	,, 29	5,833	+ 426	43	264,876	+ 10,458
Dundee Corporation	,, 27	1,320	+ 99	24§	32,742	+ 1 697
East Ham Council	,, 30	1,238	+ 44	30¶	40,584	+ 5,651
Exeter Corporation.....	,, 29	339	+ 24	30	12,028	+ 705
Glasgow Corporation.....	,, 30	21,856	+ 1,860	22‡	476,634	+ 36,064
Glossop Trams	,, 30	127	+ 26	44	5,534	+ 124
Gloucester Corpn.	,, 27	296	+ 10	30	10,388	+ 113
Halifax Corpn. .. Trams	,, 26	2,037	+ 29	30	69.690	+ 897
Halifax Corpn. .. Buses	,, 26	44	+ 3	30	1,555	+ 14
Hastings Elec. Trams Co..	,, 28	739	— 98	43	43.034	— 59
Huddersfield Corpn.....	,, 30	2.450	+ 163	30	83.764	+ 12.562
Hull Corporation	,, 30	2,982	+ 47	30	96,771	— 3,613
Ilford District Council....	,, 30	582	+ 20	30	20,246	+ 2,877
Ilkeston Corporation.....	,, 27	156	+ 6	30	4,114	+ 106
Ipswich Corporation	..	..	..	..	..	..
Isle of Thanet Co.	..	..	..	..	..	..
Kilmarnock Corporation..	,, 30	164	+ 11	24	4,175	+ 128
Lanarkshire Trams Co. ..	,, 28	2.001	+ 174	43	85.324	+ 3,863
Lancashire United	,, 27	1,617	+ 144	43	75,561	+ 4.682
Leeds Corporation	,, 30	8,314	+ 476	31	277,502	+ 21,631
Leicester Corporation	..	..	..	..	..	..
Leith Corporation	,, 30	749	+ 60	24	19,002	+ 1.156
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation ..	,, 23	13,248	+ 436	42¶	566,418	+ 7.103
Llandudno & Colwyn Bay R	,, 29	214	+ 54	48	16,533	+ 1,637
London County Council ..	..	..	..	..	..	..
Lowestoft Corporation ...	..	..	..	..	..	..
Maidstone Corporation...	,, 28	182	+ 3	30	6,979	+ 157
Manchester Corporation ..	,, 30	17,631	+ 1,214	30	553,310	+ 18.206
Nelson Corporation	..	..	..	..	..	..
Newcastle-upon-Tyne Corpn	,, 30	6,388	+ 705	31¶	195,354	+ 27.473
Newport (Mon.) Corpn....	,, 30	784	+ 28	31	26,047	— 162
Northampton Corporation	,, 29	651	+ 48	30¶	22,842	+ 4,463
Nottingham Corporation	,, 28	3,561	+ 328	30	114,428	+ 7,734
Oldham Corporation	..	..	..	..	..	..
Portsmouth Corporation..	,, 23	2,220	+ 125	30	78,757	..
Preston Corporation	,, 27	909	+ 72	30••	29,335	+ 645
Ramsgate	..	..	..	..	..	..
Rotherham Corporation ..	,, 27	1.176	+ 224	30	35,067	+ 3,549
Salford Corporation.....	..	..	..	..	..	..
†Sheffield Corporation.....	,, 27	9,099	+ 1.625	30¶	271,965	+ 35.552
Southampton Corpn.	,, 27	1,426	+ 280	30	46,354	+ 4.610
Southend Corporation....	,, 27	614	— 110	30	27,368	— 7.457
South Shields	,, 23	765	+ 106	29¶	24,163	+ 849
St'lyb'dge,Hyde,&c.,Jt. B.	..	..	..	..	..	..
Sunderland Corporation ..	,, 31	1,427	+ 82	31	46.599	— 134
Sunderland District	,, 27	574	+ 7	52	30,120	— 464
Swindon Corporation	..	..	..	..	..	..
Tynemouth Trams Co.	,, 20	574	— 80	16	10,412	— 412
Wallasey Corporation	,, 30	1,093	+ 56	30¶	40,892	+ 301
Walsall Corporation	..	..	..	..	..	..
Walthamstow	..	..	..	..	..	..
Warrington Corporation..	..	..	..	..	..	..
West Ham Corporation...	,, 28	2.891	+ 147	30	95.563	+ 9 271
Wigan Corporation	,, 28	1,687	+ 226	30	46 744	+ 1,943
Wolverhampton Corpn...	,, 27	1,074	+ 89	4	4,280	+ 223
Yorkshire W.R. Trams ...	..	..	..	..	..	..

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 185
Arrangements for the Week .. 188
The Application of Electricity to the Heating of Metals. By F. L. Bishop. Illustrated. *Concluded* 189
5,000-Volt Continuous Current Traction. By N. W. Storer. Illustrated 190
Electric Power in Canadian Industry. By Charles H. Mitchell. Illustrated 192
Production of Undamped Electric Oscillations by Quenched Spark Dischargers. By Hidetsugu Yagi. Illus. 195
The Construction of Insulators out of "Hard Paper" or "Pertinax." By K. Fischer. Illustrated 197
Effects of Electrolysis on Engineering Structures. By Albert F. Ganz, M.E. 199
POWER SUPPLY 202
REVIEWS 203
A Treatise on Hand Lettering for Engineers, Architects, Surveyors and Students of Mechanical Drawing [Lineham].
REVIEWS—*Continued.*
Die Wirtschaftlich Günstigste Spannung für Fernübertragun, gen Mittelst Freileitungen [Helmuth Eimer].
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Bedermann, B.Sc., A.M.I.E.E. Illustrated. *Continued* 204
Science in the War and After the War 207
CORRESPONDENCE 207
Battery Vehicles (P. A. Mossay).
"Some Problems of Electromagnetic Induction" (E. A. Biedermann, W. Tolmé Maccall and G. W. O. Howe).
The Direction Finder (Alessandro Artom).
Nomenclature of Electrical Illumination 210
The "Electrician" Commercial and Industrial Section .. 211–222

NOTES.

Recruiting and Common Sense.

IF we remember rightly, in the early days of the war large numbers of recruits for the new armies were drawn from the engineering trades, and from among other trades, the pursuit of which is a matter of life and death in time of war. Months afterwards the inevitable shortages made the position clear. Many of these men were sent back as hurriedly as they had been recruited in order to continue the making of munitions. Many months of labour were thus lost, to say nothing of the cost of training the men for military duties. Not profiting by so recent a lesson, the Dundee and other town councils have dealt in light-hearted fashion with the subject of recruiting in their electricity departments. According to the "Dundee Advertiser" it is a fair characterisation of the attitude of several of the councillors, particularly the treasurer, to sum it up in the words, "Let the men recruit if they want to, and if afterwards we find we cannot get on without them we can try to get them back through the Appeal Committee." It should be noted that the electricity works at Dundee, and at many other towns, are now at the irreducible minimum as regards staff. These works supply power and light to innumerable factories in which munitions are being made, and there is a limit beyond which one cannot go if one has to be sure of continuity of supply. We feel that this is a matter with which the Incorporated Municipal Electrical Association will be dealing, and it is not unlikely that the Association is taking decisive action in the proper quarters. The matter has been brought before the notice of the Minister of Munitions, and we are glad to note that the common sense view is taken that electrical supply companies are engaged upon work of vital importance, and that employers should refrain from attracting labour from these essential undertakings. We take the strongest exception to the attitude of those who, through lack of knowledge, think these matters may be ignored. Every electrical engineer knows that the policy of "wait and see" cannot be applied to the management of an electricity works, and business men know that it cannot be applied to any successful enterprise.

Built-up Insulation.

NEW insulating materials are constantly being invented. Porcelain, mica, and all the well-known insulating substances, which have long stood the test of time, have their valuable properties; but the peculiarities of their structure present limits to their adaptability; there is an entire absence of plasticity about them, and they by no means fit so readily into the design as a draughtsman would wish. It is, therefore, interesting to note the qualities of an insulating material which is known in Germany under the name of "hard paper," a special brand of which is called by the trade name of "Pertinax," and described in our present issue by Mr. K. FISCHER. It appears substantially to be a form of hardened paper, the stiffening being produced by the addition of resins. Natural resins have the disadvantage that they soften at temperatures well below that of boiling water, and consequently synthetic resins are used in building up Pertinax, with the result that temperatures up to 200°C. produce no harmful results. The product appears to have many useful properties, owing to its adaptability and stable properties. In this connection it may be well to draw attention to the fact that much greater temperature-rises are permissible than formerly. Thus from America there recently came the report of certain tests which have been carried out at Niagara on some 3,750 k.v.a. generators, the windings of which are insulated by mica, secured in position by cambric; and it was found that although these windings had been submitted for years to temperatures ranging up to 285°C., no damage was found to have been done to the mica insulation when the generators were overhauled. This shows that, at least for this type of insulation, our allowances for temperature rise have erred on the conservative side.

Electrolysis by Earthed Returns.

IT is strange to see that so much confusion still reigns in the United States in regard to electrolysis by stray currents from earthed returns, and an enormous amount of damage has been done in that part of the world by such currents through the lack of regulations. The subject is emphasised by a Paper, which we reproduce in abstract on another page, by Mr. A. F. GANZ. The only new feature in recent years has been the development of reinforced concrete buildings, and some doubt has been felt whether buildings of this class would be affected

by electrolysis. Undoubtedly, under certain conditions, they may be adversely affected, but experience so far has shown that the necessary conditions would be very abnormal, and we do not suppose there is the slighest possibility of damage through such causes in this country. In the United States, on the other hand, it is difficult to say just where the danger may stop, or where it may be negligible. At the present time there seems to be a demand for what is not very happily called "electrical drainage," and details are given by Mr. GANZ of the various precautions that are taken, such as insulated joints in pipes.

EVIDENTLY in some cases the P.D.s involved are very considerable, and instances are reported where, in interrupting or rejointing pipe mains, electric arcing is produced; and, consequently, in some cities it is the custom to bridge a joint with heavy copper wire before breaking, in order to prevent danger from arcing. The whole trouble comes, of course, from the desire to economise in copper, with the result that drastic remedies have to be taken in due course. For example, from Pittsburg it is reported that the "drainage cables" connecting the underground pipes to the main railway station aggregate 86 sq. cm. cross-section, and that the current drained from these pipes is nearly one-half the total station current. It appears that the Board of Trade of this country, notwithstanding the many defects which are attributed to it, has led the way in this particular subject. But other countries are slow to follow. In Germany some rules have been suggested, according to which it seems that the voltage drop in the return circuit under certain conditions would be even less than the drop permitted in this country. So far, however, no definite action has been taken, and the question in the remaining countries seems to be left to posterity.

5,000-Volt Continuous Current Traction.

FROM an article given in a recent issue of the "Electric Railway Journal"—published in abstract elsewhere—it appears that the Michigan United Traction Co. have co-operated with the Westinghouse Electric & Mfg. Co. in the construction and testing of a 5,000-volt continuous-current locomotive. Apart from the several difficult problems connected with the design and construction of the motors and control gear, which appear to have been overcome, the most interesting feature of the equipment is the use of mercury vapour rectifiers in the sub-station for furnishing high-voltage current. Such rectifiers have already been largely used for various purposes. It will be remembered that some time ago the Westinghouse Company constructed an experimental mercury vapour rectifier locomotive, but this is the first time that such rectifiers have been used instead of rotary converters in traction sub-stations. In the article a description of the equipment is given. The tests were commenced as recently as June 1st of this year, and it is stated that up to the present the locomotive has performed its work without a single interruption. Information as to cost, dimensions and efficiency has not yet been published. These are matters which appeal to the railway engineer. From the point of view of the locomotive alone, it is not unlikely that the continuous current equipment will compare favourably with the corresponding alternating current equipment. We hope that further particulars will be given in due course, and in the meantime we think credit is due to the manufacturers for making such an experiment, and to the railway company for giving the necessary facilities for the making of the tests.

Scientific and Industrial Research. The committee of the Privy Council for Scientific and Industrial Research has invited the Council of the Physical Society to furnish a statement indicating specific problems requiring scientific investigation in the industries with which the Society is most intimately concerned. Doubtless similar steps are being taken in regard to other societies.

London & South-Western Electrification.—In the description of this work in our last issue we omitted to mention that the low-tension switchboard instruments seen in Fig. 46 are the well-known Circscale instruments made by the Record Electrical Co.

Nobel Prizes.—The Swedish Government has decided that the Nobel Prizes are to be awarded this year instead of being postponed till 1916. Those for physics are given to Mr. T. A. Edison and Mr. N. Tesla, and that for chemistry to Prof. Theodor Svedberg.

The A.E.G.—As an offset to the reduction of its foreign business the Allgemeine Elektricitäts Gesellschaft has been forced to seek further outlets for its activities in Germany, and in this connection power production for industrial purposes takes the first place. According to "Engineering," on account of the purchase by the City of Berlin of the power stations of that city, formerly owned by the Berlin Electricity Works, a concern closely related to the A.E.G., the capital of the latter company now stands at £9,550,000. This huge sum, if used as wisely in the future as A.E.G. enterprise is known to have been in the past, will make itself felt in the electrical industry.

British Standardisation Rules for Electrical Machinery.—We have received from the Engineering Standards Committee a copy of the British Standardisation Rules for Electrical Machinery (Report No. 72), which entirely supersedes Report No. 36, published in 1907.

These rules, which do not apply to traction motors, are divided into 20 sections dealing with types of machines, classes of rating, maximum cooling air temperature, measurement of temperature, embedded temperature detectors, limits of both temperature and temperature rise, mechanical and stalling requirements, dielectric tests, transformer terminal marking, &c. The subjects are dealt with very completely, the report containing no less than 123 clauses.

The Committee has had the benefit of the co-operation of the American Standards Committee and the Canadian National Committee of the I.E.C. in their work, with the result that on all essential points the American and British rules for the rating of electrical machinery are in practical agreement.

The Sub-Committee which has been entrusted with the drafting of these rules, and of which Dr. R. T. Glazebrook, C.B., is Chairman, includes: Messrs. C. H. Wordingham and L. J. Steele (representing the Admiralty), Captain G. L. Hall, R.E., and G. H. Roberts (representing the War Office), H. C. Gunton (representing the General Post Office), Llewellyn Preece (representing the Crown Agents for the Colonies), A. R. Everest and C. Rodgers (nominated by the B.E.A.M.A.), John Christie (nominated by the I.M.E.A.), W. Duddell, Dr. Gisbert Kapp, H. W. Miller, W. M. Mordey, C. H. Merz, W. H. Patchell, Captain H. R. Sankey, R.E. (ret.), Alexander Siemens and Roger T. Smith.

Proposed Chemical Intelligence Branch of the Board of Trade.—At a meeting of the Society of Chemical Industry on Monday, 1st inst., a meeting was held to consider the suggestion of Dr. M. A. Forster that a chemical intelligence department should be instituted by the Government as a branch of the Board of Trade. Dr. Forster said that chemistry had been shamefully neglected by the Government and the British public, especially in its industrial applications. During the past 12 months, however, more readiness had been shown to make use of the services of skilled chemists, and the High Explosives Committee of the Munitions Department had not rejected a single suggestion from a chemist without full consideration. The work of the department he proposed would be divided into three sections—technical, techno-commercial and techno-educational—the first to deal with information of a scientific character, the second to collect statistics with regard to the distribution of chemicals throughout the world, together with prices and cost of transport, and the third to consider methods for training chemists and technical foremen, and to collect data concerning opportunities for research. The estimated cost of the scheme is £5,000 per annum. The scheme did not meet with unanimous support, some members suggesting as a better alternative a combined action of the various societies connected with the chemical industry.

Characteristics of Iron Alloys.—Entitled "The Magnetic Properties of some Iron Alloys Melted in Vacuo," Mr. Trygve

D. Yensen read a Paper before the American Institute of Electrical Engineers. The author described further experiments on various alloys of the electrolytic iron melted in vacuo with other elements. He then dealt briefly with the iron-boron and iron-carbon alloys, and presented results obtained with the iron-cobalt alloy Fe_2Co, but gave in greater detail the data in regard to iron-silicon alloys, from which the most remarkable results were obtained. The two best alloys were obtained with about 0·15 per cent. and 3·40 per cent. silicon, after annealing at 1,100°C. The values of maximum permeability for both of these alloys are above 50,000, and the values of hysteresis loss for B_{max}=10,000 and 15,000 are about 300 and 1,000 ergs per cubic centimetre per cycle respectively. The hysteresis loss is one-eighth and one-third of the corresponding loss for commercial silicon steel. While both alloys have similar magnetic properties, the 3·40 per cent. silicon alloy has a specific electrical resistance nearly five times that of the 0·15 per cent. alloy, making it particularly desirable for use in electromagnetic machinery in places where a low eddy-current loss is a requirement, in addition to high permeability and low hysteresis loss. We hope to give an abstract of this interesting Paper in an early issue.

Enlistment of Clerical and Commercial Employees.—At the request of the Clerical and Commercial Employment Committee of the Home Office, the Council of the Institution of Electrical Engineers desire to call the attention of employers to the urgent necessity of giving immediate and detailed consideration to the question of replacing the men now in their employ who in the near future will be called up in increasing numbers to serve in the military forces of the country.

As regards substitutes, it is understood that the supply of men who are over military age or who have been rejected by the authorities as unfit for military service is wholly inadequate to satisfy present and contingent demands. Of men who have been invalided out of the Army, and who will generally be regarded as having a first claim to employment, comparatively few have yet been returned to civil life. Lads under military age are being largely employed in the place of enlisted men, but here again the supply is short, and this expedient is subject to the serious disadvantage that if the employés are not far short of military age they may leave the employer just at the time when they are becoming useful.

In the case of technical assistants and skilled tradesmen it is not possible to make any general suggestion, and the question of their replacement is one which will have to be solved by each employer according to circumstances, but as regards clerical and commercial employees it is to the ranks of women that employers must chiefly turn for substitutes. In some of the larger and more highly organised concerns, such as banks, insurance offices, &c., employers have so far experienced little difficulty in replenishing with women their depleted staffs. The women in these cases are very often the friends or relatives of members of the existing staff. The Council believe that a considerable part of the problem will be solved if large employers will adopt this means of replacing enlisted men. The women clerks so engaged are employed at first, at all events, in the more elementary branches of clerical work, and in a surprisingly large number of cases no previous business training seems to be required.

It is certain, however, that in the near future, as men are called up for the forces under Lord Derby's scheme, there will be a great and increasing demand in all commerical centres for clerical labour which the sources of supply alluded to will be altogether unable to meet, and the abovementioned committee of the Home Office have accordingly decided to approach immediately the local authorities in all important towns and to invite them to start at once schemes for organising a supply of clerical workers, and for fitting them, so far as can be done in the time available, by emergency classes to supply the places of the men who will have gone.

The Council desire also to bring to the notice of the electrical industry that at a conference recently held at the Home Office, Lord Derby laid special stress on the desirability of giving preference wherever possible to the women relatives of enlisted men.

In the interests of recruiting, it is highly important that the places of enlisted men should be kept open for them. This is an honourable rule, and, so far as the Council are aware, a practically universal one in the branches of employment here referred to. No less desirable is it that the employment of substitutes for enlisted men should be known to be and declared to be temporary and for the period of the war only.

Under the circumstances, the Council wish to impress upon employers the importance of considering at once how their arrangements can best be remodelled as their present men are called up, and what number and class of women or other substitutes they will require.

Lastly, as regards the question of the exemption from military service, of men regarded by the employer as indispensable for carrying on his business, the Council are informed that the arrangements on this point are under consideration.

Long-Distance Radiotelephony.—We have received some particulars from Dr. Lee de Forest in regard to the installation of high-power "oscillating audions" or "oscillons," for the purpose of radiotelephone transmission at the large U.S. naval station at Arlington, near Washington, D.C., commenced in the spring of this year, under the auspices of the "Western Electric" Co., of New York.

This company last year purchased licences for wireless telephone purposes under all the audion, transmitting and receiving patents of Dr. Lee de Forest, and also under all of the John Stone Stone patents. This was in addition to the exclusive licence for uni-telephone purposes under the de Forest audion patents, for long-distance telephone purposes service, notably on the trans-continental lines of the American Telegraph & Telephone Co. At Arlington station, in May of this year, a large number of oscillion bulbs, each 7 in. in diameter, were connected in multiple with common filament-lighting circuits, and with their "plate-filament" circuits supplied from an ordinary continuous-current generator at 250 to 500 volts. Thanks to the positive resistance characteristic of the "Oscillion" type of oscillator it is possible to operate a practically unlimited number of such lamps in multiple, each adding its quota to the sum total of oscillating energy in a common oscillation circuit. When the voice was finally heard from Arlington to San Francisco, Honolulu, and at the Eiffel Tower, 300 of these lamps were used in parallel. By impressing on the "grid" circuit of an oscillating audion the slightest change of potential the oscillating energy output in the ring or plate circuit is controlled to a remarkable extent; a principle discovered by de Forest as early as 1909. Here, then, resides the chief advantage of the oscillion type of radiotelephone generator over the arc and high-frequency generator types—the ability to control, by small voice-controlled currents, the energy of each of a large number of oscillating units, operating in multiple upon a common output circuit. Thus, at Arlington a "master microphone" controls the oscillating energy output of 300 lamps, each adding some 200 watts to the common antenna system. Any attempt to control 60 kw. *en bloc* by any form of microphonic device would have been utterly impossible. Notwithstanding all that may be said in praise of this novel type of high-power radiotelephone transmitter, the fact must not be overlooked that the extraordinary distances here covered were quite impossible without the audion detector and amplifier at the receiver. True, even with this ultra-sensitive detector and thousand-fold magnification of voice currents, the words finally heard at Eiffel Tower were quite faint; but that words transmitted across the Atlantic were heard at all is sufficient earnest of what the near future will produce. The long delay in actually transmitting from Arlington to Paris was very largely due to the difficulties attending the use of the Eiffel Tower antenna for these tests, because of its almost continual use for war purposes. The times when Arlington was transmitting and Eiffel Tower was available for listening were few and far between. Moreover, there was a great deal of interference from German and other powerful radiotelegraph stations. However, the actual reception of even four spoken words across the Atlantic marks indeed an epoch in the history of communication; the wonder of which increases when one considers that this feat is made possible by the use of *incandescent lamp* apparatus, both for transmitting and receiving.

Telegraph Cable Lodge (No. 2,470).—This well-known Masonic Lodge, which was started in 1893 for the benefit of men of the cable service throughout the world, met on Wednesday, 10th inst., at the Hotel Cecil, Strand, London, when Bro. J. G. Youngson installed Bro. Col. J. H. Harrison Hogge, P.M. No. 130, as his successor in the chair. The new W.M., who at one time was in the cable service, was well supported by a distinguished gathering of members of the craft, among whom were many prominent representatives of submarine telegraphy.

OBITUARY.

Andrew H. Munro.—We learn from the "Australian Mining Standard" that Mr. Andrew H. Munro, who was, until recently, lecturer on electrical engineering at the Working Men's College, Melbourne, was found dead on Aug. 29 on the railway line near Flinders-street station, Melbourne.

Capt. D. Reginald Salomons.—On Oct. 28, whilst in command of troops, Capt. D. R. Salomons (of the 13rd Kent Field Company R.E., only son of Sir David and Lady Salomons, of Broomhill, Tunbridge Wells) was drowned.

Henry Frederick Porter.—We regret to announce the death of Mr. H. F. Porter, chief clerk in the general manager's office of the Eastern Extension Australasia & China Telegraph Co., Electra House, London. Mr. Porter joined the Eastern Company's service (traffic dept.) in 1876, and was transferred into the secretary's department of the Eastern Extension Company in 1882. He was in apparently good health until a few months ago, but succumbed to an attack of Bright's disease on Monday last. He retired from the service in April, 1915.

KILLED IN ACTION.—Capt. Baron Trevenen James, Royal Engineers, attached Royal Flying Corps, previously reported missing, is now stated to have been killed. He was 26 years of age. Formerly with the Royal Engineers, he joined the Royal Flying Corps three years ago, and did much experimental work in wireless telegraphy for aeroplanes, being regarded as the pioneer in wireless ranging with artillery. He received the Military Cross in June.

We regret to have to record the death of Lieut. Nigel George Crompton, R.E., younger son of Col. R. E. Crompton, C.B. Lieut. Crompton, who was 27 years of age, was killed in action on the 5th inst.

PERSONAL.

Prof. George Hartley Bryan, F.R.S., has been elected to an Honorary Fellowship at Peterhouse. Prof. Bryan holds the Chair of Pure and Applied Mathematics in the University College of North Wales (Bangor), and has made extensive researches in thermodynamics and aeronautics.

Mr. T. O. Callender, the popular managing-director of Callender's Cable & Construction Co., has been added to the Commission of the Peace for the County of Kent.

Mr. Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Mfg. Co., Pittsburg, has been appointed a member of the Naval Advisory Board, U.S.A.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

Tyne Electrical Engineers.—Second Lieuts. W. A. Souter, J. F. S. Hunter, A. B. Williamson, J. R. Abbott, H. O. Rogerson, H. Sherlock, C. F. Scott, E. H. Gibbon, D. Myles and F. B. C. Sutthery to be Temporary Lieutenants. A. Reed to be Quartermaster and Hon. Lieutenant, A. J. Sergeant to be Quartermaster and Hon. Lieutenant. Temp. Lieut. R. L. Wood is seconded.

APPOINTMENTS VACANT AND FILLED.

There is a vacancy on the professional staff of the Bennett College, Regent-street, Sheffield, for an assistant tutor in the electrical department. *See advertisement.*

A switchboard attendant is wanted for a large station in the West of England ; must be used to three-wire d.c. system with batteries and boosters. *See advertisement.*

The manager of the South Eastern Hotel, Deal, advertises for an electrician, with knowledge of telephones, heating and steam apparatus.

The Council of the Royal Horticultural Society invite applications for the post of steward and caretaker of the laboratory at Wisley. The duties include working electric light, petrol, gas heating and pumping plants. Applications to the Director, Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey.

Wolverhampton Guardians require an assistant in the engineering department, which deals with steam engines, electrical generating plant, &c. Salary £50, with residence, rations, &c. Applications (on forms supplied) to the Clerk by first post Nov. 23.

Mr. H. J. Smith, of Worcester, has been appointed manager of the Tynemouth & District Electric Traction Co.

INSTITUTIONS AND SOCIETIES.

Scottish Local Section of the I.E.E.—The opening meeting of the current session was held at Glasgow on Nov. 9, when Mr. D. A. Starr, chief engineer and manager of the Clyde Valley Electric Power Co., delivered his inaugural address as chairman. At the outset Mr. Starr referred in appropriate terms to the loss which the section and the Institution had sustained through the death of Mr. H. A. Mavor and Capt. E. George Tidd. Mr. Mavor had left behind him the record of a distinguished career in both theoretical and practical electrical work. Capt. Tidd had ended a useful and active life in the Dardanelles, where he had been killed in action. The speaker then proceeded to describe at length the relation of the electrical industry to the conduct of the war, especially with regard to the output of munitions. He showed that output had been promptly and effectively increased largely as the result of the power supplies available in the generating stations of the electrical undertakings all over the country. Referring to the problem of the cost of production, the speaker said that during the past year or two the price of coal had increased 40 per cent. Comparing the prices for 1911 and 1912 with present prices the increase was nearly 100 per cent. This increase had to some extent been checked by the Price of Coal (Limitation) Act and by legislation affecting the export of coal. The remedy for the power producer was to insert a coal clause in contracts with consumers on the basis of a fixed price per ton delivered to the power house, and adjust the price per unit according to increase or decrease of fuel costs per ton. In some cases a fixed price for a standard coal at the pit mouth had been taken, so as to guard against an abnormal rise in the price of coal. The labour problem since the outbreak of war had also seriously entered into the cost of production, and the speaker strongly deprecated the line of action known as "collective bargaining." He contrasted such action with the cheerful bravery of the soldier in the trenches. Briefly discussing the question of apprenticeship, Mr. Starr favoured a sandwich system, whereby the theoretical and practical sides of the profession could be acquired. To meet war conditions and to relieve the maximum number of men the speaker advocated the employment of female labour. In conclusion, Mr. Starr reviewed the possibilities of the electrical industry after the war, and was inclined to be optimistic as regards the industry in Britain. While they would require to "wait and see," he urged that their waiting be watchful. With Britain fully "waked up" the recapture of their former world trade by the Germans should be a "negative possibility." Mr. Starr was suitably thanked for his address.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 12th (to-day).

PHYSICAL SOCIETY.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute, South Kensington, S.W. Agenda : Paper on "The Effect of Electric Oscillations on the Magnetic Properties of Iron, Investigated by the Campograph," by Prof. J. A. Fleming, F.R.S., and Mr. P. R. Coursey ; and demonstrations of a Hydraulic Analogy of a Wheatstone Bridge, a Lecture Table Method of Obtaining Recalescence Curves, and the Leeds and Northrup Recorder, by Mr. R. S. Whipple.

MONDAY, Nov. 15th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Concert (Ladies' night) at Holborn Restaurant, London, W.C.

TUESDAY, Nov. 16th.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at Engineers' Club, Albert-square, Manchester. Chairman's address by Mr. B. Welbourn.

WEDNESDAY, Nov. 17th.

NOTTINGHAM SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at Welbeck Hotel, Nottingham. Paper on "The Lay-out and Equipment of Engineering Works," by Mr. F. A. Garratt.

THURSDAY, Nov. 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment, W.C. Presidential address by Mr. C. P. Sparks, and presentation to the Institution of a collection of Papers of Michael Faraday, by Mr. D. J. Blakley.

FRIDAY, Nov. 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Papers on "The Chemical and Mechanical Relations of Iron, Molybdenum and Carbon," by Profs. J. O. Arnold, F.R.S., and A. A. Read ; and on "The Cause and Effect of 'Ghost Lines' in Large Steel Forgings," by Prof. J. O. Arnold, F.R.S.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

The following orders have been issued for the week commencing November 15, 1915 :

Drills : 6:25 to 7:25 ; 7:25 to 8:25.

Monday, Nov. 15.—Sections 1 and 2, technical ; Sections 3 and 4, squad or working party ; Recruits and Signalling Section.
Tuesday, Nov. 16.—School of Arms with Architects' Corps, 6 to 8 p.m.
Thursday, Nov. 18.—Sections 3 and 4, signalling section, shooting.
Friday, Nov. 19.—Sections 3 and 4, technical ; Sections 1 and 2, squad or working party ; Signalling Section and Recruits.
Saturday, Nov. 20.—Uniform Parade, 3 p.m.

Sections for technical parade at headquarters, London Electrical Engineers, 46, Regency-street. Sections for shooting parade at the miniature ranges. Unless otherwise ordered, all parades at Chester House. In future, and until further orders, Sections 1 and 2 will always parade on Mondays for technical and on Fridays for squad drills, and Sections 3 and 4 will always parade on Mondays for squad drill and Fridays for technical, but Sections 1 and 2, and 3 and 4 will alternate weekly for shooting on Thursdays. Signalling Section will shoot on the same days as Sections 1 and 2. Volunteers for trench work on Sundays are requested to give early notice to their Section commanders.

THE APPLICATION OF ELECTRICITY TO THE HEATING OF METALS.*

BY F. L. BISHOP.

(*Concluded from p.* 159.)

Summary.—This Paper covers the recent developments, present status and limitations in the application of electricity to the heating of metals for the purposes of annealing, hardening or other heat treatments. Furnaces employing electricity as a source of heat may be roughly classified into laboratory and commercial divisions. A brief discussion is given of different types of furnaces employed in laboratory work and an outline of the application of these furnaces to commercial service, where such application has been made.

The Bailey† furnace (Fig. 5) is of the resistance type and consists essentially of two carbon electrodes separated by an intermediate resistance body of a carbonaceous composition, in which the heat is generated. The metal to be heated is placed in the space immediately above the resistance material and directly under the roof of the furnace, ledges at the rear and at the opening supporting the bars or billets, as the case may be. The electrodes enter through the rear wall and are placed slightly convergent, so that the path of the electric current will be shorter from electrode to electrode at the front of the furnace than at the back. This arrangement compensates for the greater cooling in the front, on account of the opening and the charging of cold material. The electrodes entering the furnace from the rear present comparatively large contact surfaces to the resistance material, without the use of special electrode sections. The electrodes are also placed above the resistance materials. This prevents the current from taking a lower course when the furnace is charged with cold metal. The resistance material is crushed coke which will pass over a 0·250 in. iron ring and through a 0·37 in. (9 mm.) ring. This requires a voltage of 200 for a 40 kw. input. The furnace is controlled by means of a regulating transformer and controller.

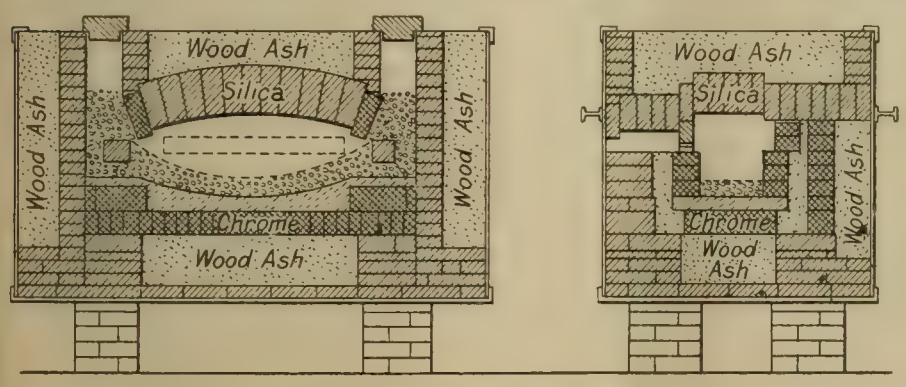


FIG. 5.—BAILEY FURNACE.

The thermal efficiency varies from 33 to 65 per cent., with heating capacities of from 120 lb. to 1,000 lb. per hour. Temperatures of about 3,200°F. (1,765°C.) are obtained. This furnace is used for treating forgings.

The principal advantages of the electric furnace are its high thermal efficiency, non-oxidising atmosphere and freedom from soot, smoke and contamination of gases due to combustion.

Used Grecian Magnitite lining, temperature	3,200°F.
Temperature of iron cut at charging	2,615°F.
Temperature of iron cut at withdrawing	2,600°F.
Amperage	1,150 amperes.
Voltage on furnace	60 volts.
Power factor	0·99
Indicated kilowatts	69 kw.
Metal—8 bars, 1½ in. square by 18 in. long	92 lb.
Time in furnace	20 minutes.
Temperature of metal at charge	60°F.
Temperature of metal at withdrawing	2,360°F.
Kilowatts consumed in heating	23 kw.
Pounds of metal per kilowatt	4 lb.
Kilowatts per ton	500 kw.
Capacity of furnace per hour	276 lb.‡

A resistance type of furnace especially designed for hardening consists of a bath of molten metallic salts or mixtures, which are heated by passing the current through them. The current is led into the bath by means of electrodes, and as soon as the salts become molten, they penetrate all parts of the bath. The metal is immersed in the bath and allowed to remain until it attains the temperature of the bath. This temperature will, of course, depend upon the kind of salts used. One model of this furnace* which has attained considerable commercial use is constructed as follows: The crucible, or container for the bath, is made up of firebricks, which are surrounded by heat-insulating material and supported in a sheet-iron case, as shown in Fig. 6. Two iron electrodes, located on opposite sides of the crucible, direct the current through the bath. A suitable regulator, usually of the switch type, is used. By means of this regulator the available voltage is stepped down to that required by the furnace, and means are also provided for regulating the power and, consequently, the temperature of the bath.

The kind of salt used in these furnaces depends upon the temperature desired. For hardening high-speed steel, barium chloride should be used; while for carbon steel, a mixture of barium chloride and potassium chloride is recommended. For still lower temperatures common salt or saltpetre may be employed; this latter salt being suitable for as low a temperature as 350°C. These salts are non-conductors of current when cold and become conductors of the second class when molten. Means are therefore provided for obtaining a channel of molten conducting salt between the two elec-

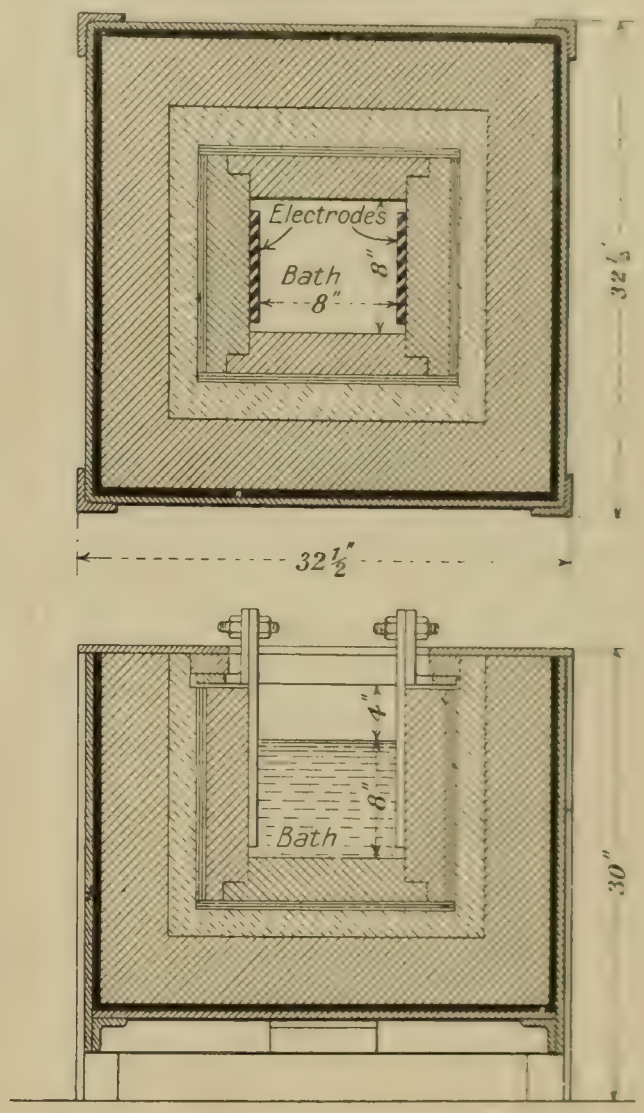


FIG. 6.—ELECTRIC HARDENING FURNACE.

trodes, as illustrated in Fig. 7. With a carbon rod pressed between one of the main electrodes and the auxiliary electrode, power is applied and current flows through the carbon, generating heat therein and causing the surrounding salt to melt. The auxiliary electrode may then be moved slowly toward the main electrode, to which it is connected, leaving a channel of liquid salt between the two main electrodes. With the power left on, the bath will soon become liquid throughout, and any desired temperature, including the very highest used for hardening, can be obtained with precision by adjusting the power through the regulator. The time required for melting all the salt varies from one to two hours, depending upon the size of the bath and the power applied. The temperature of the bath can be accurately measured with a pyrometer, the "fire end" of which is immersed in the bath. The temperature of the bath is absolutely uniform throughout, due to the pronounced circulation. The circulation is caused, mainly, by the electromagnetic forces set up by the heavy current, and, in this respect, these furnaces have a great advantage over all other "wet heat" furnaces.

When a tool is placed in the bath, it will be noted that the surrounding salt solidifies, say, to a thickness of $\frac{1}{32}$ in., and this blanket

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

† "An Electric Furnace for Heating of Bars and Billets," Thaddeus F. B. Bailey, "Trans." of the Amer. Electrochem. Soc.

‡ "Further Development of the Electric Furnace for Heating Bars and Billets," Thaddeus Bailey, "Trans." Am. Electrochem. Soc., Vol. XXI. "Proceedings," Engr. Soc. of Western Penn., Vol. XXXI.

* "Electric Hardening Furnace," M. Unger, "General Electric Review" (U.S.A.), Vol. XVI., No. 3, p. 158.

of salt will melt slowly. This is of great advantage in reducing the shock from sudden heating, the solid salt being a poor conductor of heat. When the tool has finally attained the temperature of the bath and is removed, it will be noted that it is covered with a thin film of salt, which protects against oxidation; but as soon as the steel strikes the cooling medium, the salt chips off, leaving a clean surface. The salt has absolutely no chemical effect upon carbon steel; and if certain precautions are taken, there is no difficulty with high-speed steel. Blistering or pitting of the surface of the tools has never been observed.

This furnace, it is claimed, answers the following conditions, which are evidently necessary in any hardening furnace: (*a*) It must

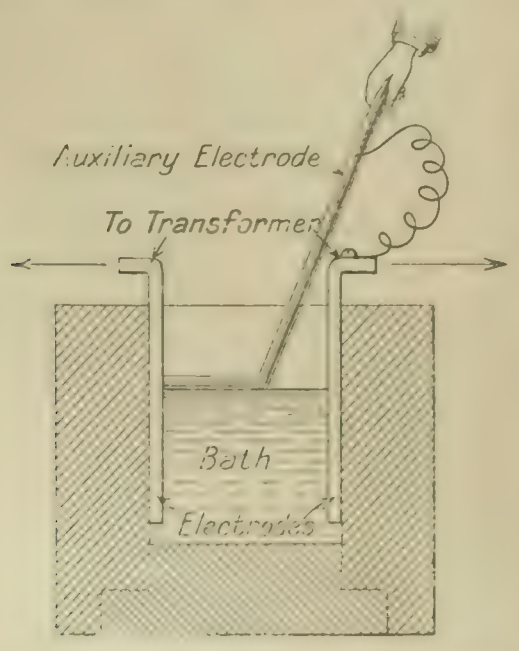


Fig. 7.—Method of Starting Furnace.

be possible to produce and maintain constant any temperature that may be required for any particular steel; (*b*) it must be possible to ascertain practically the exact temperature of the steel; (*c*) the heating must be uniform throughout, and overheating and burning of edges and sharp points of the tools should be made impossible; (*d*) the heating must not be too sudden, so as to avoid internal stresses which may cause warping and cracking of the steel; (*e*) during heating the steel must be protected from oxidation as much as possible; (*f*) the furnace must be efficient and easy to operate.

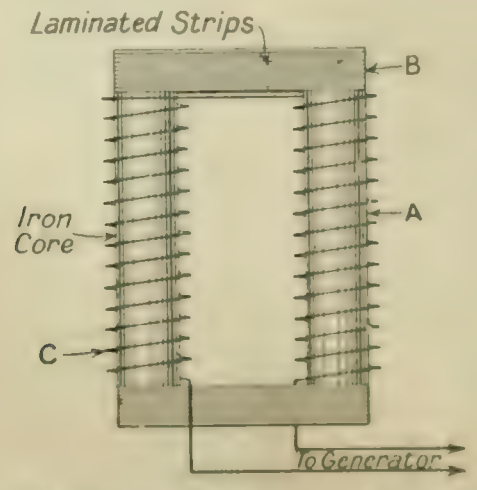


Fig. 8.—Diagram of Bishop's Furnace.

The following tables show the results of experiments made to determine the comparative costs of hardening milling cutters in gas and electric furnaces:*

Gas.				Electric.			
12,300 cubic ft. of gas	£2	3	3	Electric furnace, 200 kw.-hrs.	£1	0	0
Air blast	0	5	0	Coke for preheating	0	1	0
Labour, 50 hours	1	15	5	Salt	0	0	6
				Labour	0	7	0
	£4	3	8		£1	8	6

	Gas.		Electric.
Cost per cutter	10d.	...	3.4d.
Time	40 hours.	...	10 hours.
Cost per hour	1. 8d.	...	2s. 10d.

Third Method.—The third method of applying electricity is accomplished in a modified type of resistance furnace, in which an alternating current is used. This type of furnace (Fig. 8), developed by the author, is especially applicable to the treatment of steel and iron. It consists of a conductor carrying the current and surrounding the metal, which, in this case, acts as the carrier of the magnetic lines of force and, at the same time, as the secondary of a transformer. The eddy currents and magnetic hysteresis heat the metal.

A simple form of the apparatus is constructed as follows: The metal to be heated, A, is contained in the coil, C, which carries an alternating current of about 60 cycles. The metal is joined magnetically by the laminated yokes, B. The whole is surrounded by a heat insulating material. The action of the apparatus is as follows: When the alternating current is applied, a magnetic field is produced, which, in turn, induces eddy currents in the metal, thus transforming the energy of the electric current directly into heat energy in the material.

The following advantages are claimed for this method: (*a*) The metal is heated uniformly, because of the fact that a difference in temperature would immediately cause a corresponding change of the eddy currents in the metal and thus equalise the temperature; (*b*) the application of a magnetic field to the metal causes it to expand and contract, thus producing a kneading effect especially desirable at the recalescent point; (*c*) the heating is carried on uniformly until the recalescence point is reached, when there is a marked change in both the current and E.M.F. of the alternating circuit. This effect can be used to automatically control the temperature; (*d*) heating or cooling the metal through the recalescent point while under the action of a magnetic field greatly improves its quality; (*e*) the method is efficient, because the heat is applied directly to the metal, and thus it is heated uniformly.

It is particularly applicable to large pieces, and has been used extensively for the treatment of automobile engine pistons to remove the stresses due to casting. This was accomplished without subjecting the metal to high temperatures.

* "A New Electric Hardening Furnace," E. Salcetsky and E. Adler. "Trans." Faraday Soc., Vol. V., 1909, p. 15.

5,000-VOLT CONTINUOUS CURRENT TRACTION.*

BY N. W. STORER.

Summary.—The author describes the recent experiments of the Michigan United Traction Co. with a car taking continuous current at 5,000 volts supplied by means of mercury-arc rectifiers. There are four motors, each containing two armatures in one case connected in series, and the high tension has necessitated several new features in the switching and control gear, which are described. A unique method of connecting a storage battery for the auxiliaries and lighting in series with the main motors has also been adopted.

Ten years ago a proposal to equip an interurban car with motors and control apparatus to operate from a 5,000-volt direct-current trolley would have fallen on deaf ears. No one would for one moment have considered such a proposition seriously. But to-day such a car is in daily service, and as the equipment has experienced several months of actual service, it is permissible to give a description of the principal features. The equipment was designed and built by the Westinghouse Electric & Mfg. Co. primarily for the purpose of determining, if possible, the practicable limit to which voltages for direct-current railways could be carried. Five thousand volts was selected as the initial limit, as this is high enough to make easily possible the collection of current for the largest locomotive from an overhead wire. It is also high enough to lessen the amount of line copper and the number of sub-stations, and to secure a good load-factor and efficiency with reasonable cost.

The initial experiments involved the design and construction of two 2,400-volt motors and the necessary control equipment, which were mounted on a car and tested on the interworks railway at East Pittsburgh in the spring of 1914. The equipment was first arranged for series-parallel control with voltages of from 2,400 to 3,000 on the trolly. Then the two motors were connected permanently in series, and the equipment operated at a trolly voltage of 4,000, which was gradually increased until the equipment was finally tested with 7,000 volts on the trolly.

The results were such that the company decided to place a complete four-motor equipment in service. Through the influence of the late Mr. W. A. Foote and of Mr. Frank Silliman, pioneers in the use of high voltages both for transmission and for traction purposes, Mr. J. F. Collins, of the Michigan United Traction Co., agreed to co-operate with the Westinghouse Company in the test, and he offered the use of a branch line 12 miles in length for the purpose of giving the equipment a test in service. The car must operate over the 600-volt line within the city limits. The trolly line was reinsu-

* From the "Electric Railway Journal," slightly abbreviated.

lated and space was allotted in the sub-station for a mercury-arc rectifier equipment which was installed to furnish high-voltage current. A complete car equipment, consisting of four 100 H.P. motors with control and auxiliaries, was installed under the direction of Mr. R. C. Taylor, superintendent of equipment, on one of the Michigan United cars, the completed car weighing approximately 40 tons.

On June 1 of this year preliminary tests were begun after the regular service had been completed for the day. The tests were continued until it was certain the equipment was in proper condition, and the car was then used daily for the last two or three round trips which could be handled by a single car. Since that time the operation has been fairly regular for these trips, and up to date it has continued without a single interruption to the service due to the car equipment. It has not been necessary to change any detail in the equipment since service began, and the car has always been ready for operation when line and power were available. Considering the radical increase in

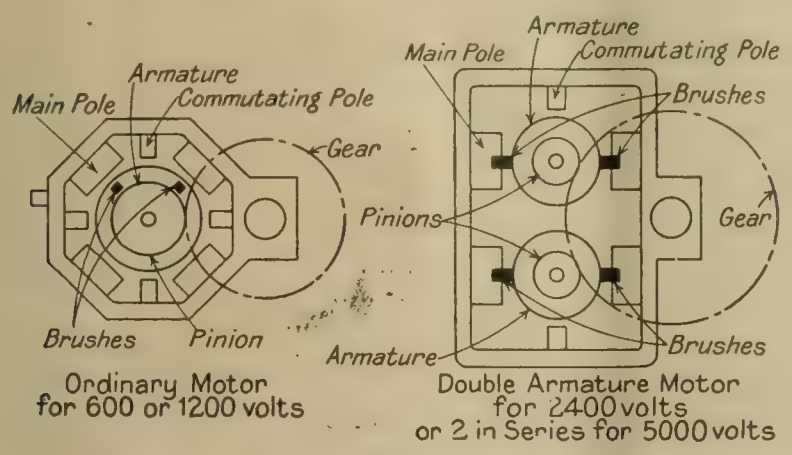


FIG. 1.—COMPARISON OF STANDARD MOTOR AND 5,000-VOLT MOTOR.

voltage over anything previously undertaken and the small size of the motors, this result is remarkable.

Motors.—Of course, the most difficult part of the equipment would appear to be the motors. It is well understood that, in order to secure the maximum benefits from electrification, a railway must be able to operate not only locomotives but multiple-unit car service. Consequently, any system of electrification that hopes for recognition for heavy traction purposes must be suitable for operation on passenger cars. It is not so difficult to secure space for the necessary number of commutator bars and the creepage surface for insulating large locomotive motors for high voltages, but it has been a serious problem to secure these requisites for a motor of the size required for ordinary interurban cars without exceeding commercial limits for weight, cost and dimensions. For that reason the design of the motor was undertaken first, as being the most difficult. One of the first of these motors was exhibited at the Panama–Pacific Exposition. The arrangement of parts is shown schematically in Fig. 1.

The motor is known as the twin-armature bi-polar type, and it has many advantageous features for high voltage work. A bi-polar

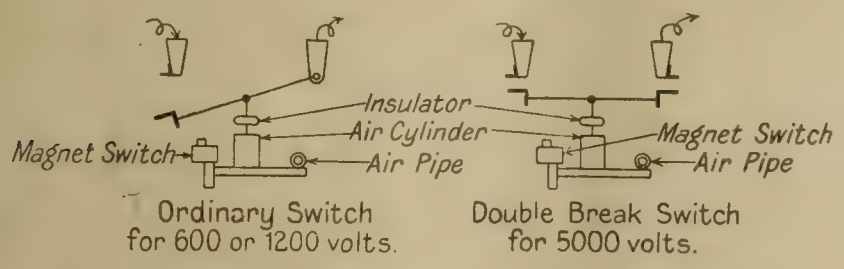


FIG. 2.—SCHEMATIC DIAGRAM OF DOUBLE-BREAK SWITCH.

design permits the use of double the voltage on a given commutator that is possible with a four-pole motor. The twin armatures make the weight but little more than that of a corresponding four-pole motor. Fewer field coils are required than are used with the four-pole motor, and the two armatures, being geared to the same axle, act as one unit and halve the pressure on the gear teeth. The two armatures are connected in series, and consequently, the voltage on each is reduced to lower limits. The form of motor lends itself readily to a very effective type of insulation, and the mechanical construction is simple and rugged.

The performance of the motors has thus far been all that one could ask. There has yet to appear the first defect in any motor that has been built. The commutation is sparkless, and the stability of the motor, as shown by its absolute freedom from flashing, is perfect. Large creepage surfaces are supplied, both on armatures and brush-holders, in order to give immunity from grounds. One characteristic that will assist in the maintenance of the insulation is the fact that the current is small, being only 30 amperes for each traction motor, and that only a few small brushes are required. Thus, with the excellent commutation, there is very little wear either on the brushes or commutators, and consequently the amount of carbon and copper dust originating in the motor is small. It is fully recognised that upon the permanence of the insulation depends the success or failure of the experiment, and this is something that time alone can determine.

Control.—Next to the motors, the control is the most important feature of the equipment, since the switches must close and open the high-voltage circuits properly and must be insulated to stand continuously the maximum voltage to ground in all kinds of service. In order to secure a relatively large number of breaks in series without increasing the number of switches unduly, each switch is made with two breaks in series. (Fig. 2.)

High-Voltage Switches.—The switches are very similar to the standard Westinghouse electro-pneumatic switches, but have some special features, due to the small current and high voltage. The main ideas governing the design of the switch group were safety and reliability in opening the high-voltage circuits and most effective distribution of insulation. The design adopted has both of these desirable features, and, in addition, is extremely simple and rugged. The frames of the switch group are grounded and the interlock wiring is thoroughly protected, in order to isolate the high-voltage current from the control wiring and master-controller. One of the novel features in the switch is the use of an "arc splitter," consisting of a piece of soapstone placed in front of the switch jaws in the path of the arc. The effect of the magnetic field is to blow the arc against this along its entire length until the arc is broken. This greatly increases the length and at the same time chills the arc, and the result is highly

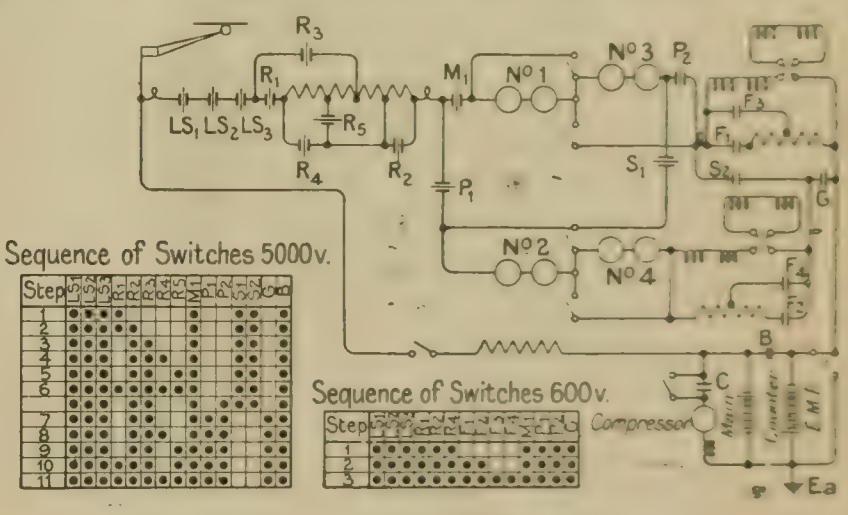


FIG. 3.—SCHEMATIC CONTROL DIAGRAMS.

satisfactory. The operation of the switch groups has been fully as reliable as that of the motors. The circuits are opened with ease, and the appearance of the switches shows scarcely a trace of their having been in service.

Starting Resistance.—Practically the only other part of the control equipment that is subject to the line voltage is the starting rheostat. This is composed of cast alloy grids in a number of frames. These frames are insulated from ground by triple insulation and from each other by double or quadruple insulation. This insulation has thus far proved entirely adequate.

Change-over Apparatus. Inasmuch as the equipment is required to operate through the city of Jackson on 600 volts, a change-over switch is provided which connects the four sets of armatures in parallel. This apparatus consists of two triple pole double throw disconnecting switches with the contacts mounted on porcelain insulators immersed in oil. They are connected together so that they are operated by a single lever, which also operates a small drum that changes a few of the contactor magnet connections.

Low Voltage Switch Group.—One group of switches is provided to effect the necessary changes on the ground side of the equipment and the auxiliaries. This is a standard group which is used ordinarily for small 600-volt car equipments, and it needs no description.

Reverser.—A standard type of electro pneumatically-operated two-motor reverser is used to reverse the connections of the motor fields, the fields being always connected on the ground side of the armatures, so that no extra insulation is required.

Auxiliary Equipment.—Not of least importance is the apparatus needed for furnishing current for control, lights and air-compressor motor. It is well known that the small high-voltage machine known as the dynamotor, which is used for this purpose on 1,200-volt and 1,500-volt equipments, is the least reliable part of the equipment.

This is necessarily the case, since the usual compound winding on the field makes it far more susceptible to flashing troubles, and its small size makes the insulation problem and the armature winding much more difficult. While these 1,200-volt and 1,500-volt equipments are giving excellent results, it was felt that it would be not only very desirable, but necessary, to eliminate the dynamotor from higher voltage equipments, especially for cars, since it would be quite reasonable to expect the difficulties to be multiplied with the voltage. For this reason the entire auxiliary equipment of the 5,000-volt car is operated at 150 volts. The scheme adopted is as follows :—

A 150-volt storage battery, to which all of the auxiliaries are connected, is placed in the main motor circuit between the motors and ground. All the main motor current, therefore, either goes through the battery and charges it, or through the auxiliary circuits which may be connected to the battery at the time the motors are working. By the application of a simple device, the air compressor does practically all its work when the main motors are operating, and thus simply diverts a part of all of the main motor current as required, so that the battery is relieved from furnishing the current to the compressor motor and at the same time does not receive the high charging currents that would otherwise be imposed on it during acceleration. The battery has thus a very light duty to perform, and can be made up of small cells. A set of counter-E.M.F. cells parallels the battery during charging periods to prevent overcharging and excessive charging rates.

The voltage of the battery for such an equipment is determined by the amount of power required for the auxiliaries. The average current required by the auxiliaries should, in order to leave a satisfactory margin, be not more than 80 per cent. of the average current taken by the main motors. The use of 150 volts for the battery in this case indicates that the auxiliaries are expected to use less than 3 per cent. of the total power taken by the car.

The main schematic wiring diagram is shown in Fig. 3. In this diagram the double-break switches are indicated by three parallel lines across the circuit and the single-break switches by two lines. It will be seen that 12 of the former and 10 of the latter are required for this equipment. Considering the fact that these switches control not only the main motor circuits for both 5,000-volt and 600-volt operation, but all of the auxiliaries as well, the equipment is very simple. Very satisfactory operation on 600 volts is secured by shunting the fields of the motors.

As before stated, power for operating this car is obtained from three mercury-arc rectifiers, which receive power from a 60-cycle three-phase system and are operated in series. Connecting the three phases of the system in series gives not only a smooth current wave, but balances the load on the three phases of the transmission system. This is believed to be the first time mercury arc rectifiers have been used in this way to furnish so much power for high-voltage work.

Conclusion. It is fully recognised that the tests have not continued long enough to draw any definite conclusions as to the future use of 5,000-volt direct current for railways. All that can be stated at this time is that the preliminary tests are extremely satisfactory, and the fact that no difficulties in the car equipment have appeared to date indicates that there is ground for the hope that the 5,000-volt direct current railway is a possibility. In any case the amazing fact remains that a commercial car equipment of 100 H.P. motors has been designed, built and tested in commercial service and has a perfect record for the operation to date.

ELECTRIC POWER IN CANADIAN INDUSTRY.*

BY CHARLES H. MITCHELL.

In the study, from the Canadian standpoint, of the use of electric power and its generation and supply, it is necessary to analyse the make up of the typical power load, such as may be found to comprise the greater portion of the aggregate loads throughout the Dominion. In Canada, it is notable that, without exception, all cities are now supplied by or are within the economic distribution zone of hydro-electric sources, and, further, commercial conditions are such that power from these sources is available to the customer at very attractive rates and it is apparent that the future of power-consuming industries has its foundation in the developed and undeveloped water power resources of the country. The Dominion of Canada has an area of 3,745,574 sq. miles, stretching from the Atlantic to the Pacific and from the northern boundary of the United States to the Arctic Ocean. The North west Territories, the vast northern portion of Quebec and the greater part of the Yukon cannot be considered within our generation, to be factors in the industrial field. The possibilities in these districts, from the standpoint of natural resources, are not as yet, with the incomplete investigations made up to the present, capable of appreciation; water-power is plentiful, but so remote from any present market that the capacities of the thousands of known water powers are not included in statistics; within a limited area, the Yukon is an exception. In the provinces set out in Table I., power is available in great abundance.

Within the provinces of the Dominion of Canada, and excluding the North-west Territories, practically all of the Yukon, and the northern and eastern portions of Quebec, it is estimated that 17,764,000 H.P. are available, this amount being inclusive, in the case of Niagara Falls, Fort Francis and the St. Mary's River at Sault Ste. Marie, of only the development permitted by international treaties, and, futher, does not contemplate the full possibilities of storage for the improvement of capacities. The developed powers, which are inclusive of all water powers, aggregate 1,712,193 H.P., as developed by turbines, and this amount is distributed as shown in the following Table :—

Table I.—*Hydraulic Development in Canada.*

Province.	H.P. Developed.
Nova Scotia	21,412
New Brunswick	13,390
Prince Edward Island	500
Quebec	520,000
Ontario	789,466
Manitoba	56,730
Saskatchewan	45
Alberta	33,305
British Columbia	265,345
Yukon	12,000
Total	1,712,193

The relation between population and water power developed makes a very interesting study. It cannot be said that a definite relation exists or should exist, although it is possible that in the future, as the rapidly changing commercial conditions assume a permanent stability from established markets and universal demand, a constant may be deduced for the equation, the variables being environment, government policy, inherent commercial instinct, natural resources of materials, accessibility of market and, above all, available sources of low cost electric power. Horse-power per capita of the various manufacturing countries may be compared on the present standing, and while the contemporary industrial conditions may not readily admit of the projection of these values to the next few years to come, in the commercial future of the world it must be recognised that cheap power will be the keynote of industrial advancement. As statements from official sources, or as computed from all accessible sources of information, the amounts of water power available and developed and the horse-power per capita have been compiled and are here presented for the various industrial countries of Europe and America (Table II.).

Twenty years ago, the position of the various manufacturing countries, in the scale of industrial production, undoubtedly bore a direct relation to the consumption of coal, and power was a major factor in industry. In the present day, where so many factors are in a transitional stage, it cannot be said that either coal consumption, alone, or water power developed, alone, is indicative of commercial standing, although the aggregate power equivalent may be so. All such studies of power economies, however, will disclose that low-cost power is the underlying element of the industrial world.

Fortunate as is Canada in water-power distribution; the added advantage of a great share in the world's mineral resources, with, moreover, the proximity of power to the mines, will by their interdependence provide a great stimulus to the development of both. Coal, iron, copper, nickel, gold, silver, cobalt, lead, asbestos, mica and gypsum are the principal minerals, and the output value of these, aggregating £37,360,480, in 1910, is one of the chief elements in the resources of the Dominion.

While abundance of water powers exist in Canada, to-day only the most exacting governmental administration policies can provide for the anticipated requirements of the future. The majority of water powers within market range will undoubtedly be developed, and the future is of vital importance. It has been fortunate that, in Canada, the water power rights have mostly remained under the control of the Dominion or Provincial Governments. The Dominion Government controls navigable streams, and their water powers, throughout the Dominion and the water powers of the provinces of Manitoba, Saskatchewan and Alberta, the Yukon and the north west Territories, Quebec and New Brunswick have granted powers, heretofore, on broad lines, while Nova Scotia has many of its water powers privately owned outright from 18th century Government land grants: these provinces are now planning much more efficient control. In

* Abstract of a Paper presented at the International Engineering Congress, San Francisco.

Table II.—*Water Power Available and Developed, and the Horse-power per Capita in Various Countries.*

Country.	Area square miles.	Population (latest available figures).	Horse-power available (1915 estimate).	Horse-power developed (1915 estimate).	Per cent. utilised.	Horse-power per square mile of area		Horse-power per capita	
						Available.	Developed.	Available.	Developed.
United States	3,026,600*	92,019,900	28,100,000	7,000,000	24·9	9·3	2·31	0·3	0·076
Canada A	2,000,000	8,033,500†	17,820,000	1,710,843	9·6	8·91	0·86	2·22	0·21
Populated B	927,800	8,000,000	8,094,000	1,700,000	21·0	8·74	1·83	1·01	0·21
Austria-Hungary	241,330	49,418,600	6,460,000	566,000	8·8	26·8	2·34	0·13	0·011
France	207,100	39,601,500	5,587,000	650,000	11·6	27·0	3·14	0·14	0·016
Norway	124,130	2,302,700	5,500,000	1,120,000	20·4	44·3	9·02	2·39	0·487
Spain	194,700	18,618,100	5,000,000	440,000	8·8	25·7	2·27	0·27	0·024
Sweden	172,900	5,521,900	4,500,000	704,500	15·6	26·0	4·08	0·81	0·127
Italy	91,280	28,601,600	4,000,000	976,300	24·4	43·8	10·7	0·14	0·034
Switzerland	15,976	3,742,000	2,000,000	511,000	25·5	125·2	32·0	0·53	0·137
Germany	208,800	64,903,400	1,425,000	618,100	43·4	6·8	2·96	0·02	0·010
Great Britain	88,120	38,802,500	963,000	80,000	8·3	10·9	0·91	0·02	0·002

Canada "A," 2,000,000 sq. miles taken as the area treated in the Conservation Commission's estimate of available water power, and the area which we may expect to see fairly thickly settled during the next few decades; 3,729,700 sq. miles=area of whole Dominion.

† 1911 Census+12 per cent. * Excluding Alaska (area about half million square miles).

the province of Ontario, the administration has become of such exceptional nature that it is worthy of a very complete study, as being, possibly, the greatest of municipal power undertakings.

The Dominion Government's administrative policy affords every reasonable protection to the public, as to rentals, periodic revisions, control of rates, limited grants, &c., and, at the same time, fosters legitimate private enterprise to return reasonable profits. Regulations are in force affording all possible assistance to the development of water powers which have every reasonable assurance of economic utilisation, and, further, before the authorisation to proceed with development is given, complete investigations are undertaken to prove the economic features of design, capacities and costs, and, eventually, supervision is carried out during construction. Proper government supervision and control of the construction and maintenance of all developments is the only safe method of intelligently initiating construction and maintaining an adequate system of river improvement for power purposes. The Hydro-electric Commission of Ontario has created a world-wide interest as an experiment in publicly-owned power. The history and results of the undertaking deserve fullest consideration in dealing with electric power in Canadian industry.

For some years previous to 1906, several of the energetic and leading citizens of central south-western Ontario had endeavoured to secure a working basis for a comprehensive scheme of supplying power to the various municipalities, the City of Toronto comprising the largest interests in the matter. In 1906, the Provincial Government created a Commission empowered to investigate power conditions everywhere in the province, and a further Commission was established after the rendering of the preliminary reports on the situation, which resulted in by-laws on the question of power supply being voted upon by the interested municipalities; and an agreement was entered into by certain cities and towns with the Hydro-electric Power Commission of Ontario for a supply of electric power to be transmitted from Niagara Falls. The Commission is empowered, by Act of Parliament, to make expenditures for the carrying out of the necessary work, and these expenditures are repayable to the Commission by the municipal corporations which have entered into contracts. The price per horse-power per year that each municipality has to pay for the respective block of power is the cost to the Commission and, in addition (*a*) interest at the rate of 4 per cent. upon the moneys expended by the Commission on capital account in the construction or purchase of works; (*b*) an annual sum sufficient to form in 30 years a sinking fund for the retirement of the securities issued by the province, under the Act, for the payment of the cost of the works; and (*c*) line loss and the cost of operating, maintaining, repairing, renewing and insuring the works. The amounts payable are annually adjusted and apportioned.

Tenders were called for the supply of electrical power from the producing companies at Niagara Falls, Ontario, and in March, 1908, the Commission entered into a contract with the Ontario Power Co. for amounts up to 100,000 H.P. Power was obtained from this source at the price of $9.40 (£1·88) per horse-power per annum for amounts up to 25,000 H.P., and when the power demand exceeded 25,000 H.P., the price became $9.00 (£1·8) per horse-power per annum. This price is for 12,000 volt, three-phase, 25 cycle power delivered in the Commission's transformer station at Niagara Falls.

In addition to the district served in the Niagara system, the Commission buys power from the Kaministiquia Power Co., of Fort William, Ontario, and sells to the City of Port Arthur; from the Ottawa and Hull Light and Power Co., selling to the City of Ottawa; from the Auburn Power Co., selling to the City of Peterborough; and from the York and Ontario Power Co. for selling to the group of towns in the St. Lawrence system. Further, the Commission purchased the generating and distributing system of the Simcoe Railway and Power Co., at Big Chute, on the Severn River, and made considerable extensions to the distribution system, this plant being arranged to tie in with a generating plant being built by the Commission at Eugenia Falls, where a 542 ft. head is to be obtained, and which is to supply power on June 1, 1915. A generating station and distribution system has just been completed at Wasdell's Falls, on the Severn River, at the outlet of Lake Couchiching, to supply power to the Wasdell's Falls system. The Commission is at present engaged on the preliminaries to construction of radial electric railroads in the vicinity of Toronto and has undertaken the engineering and construction of the electrification works of the London and Port Stanley Railway.

The following figures show the extent of the distribution area served by the Commission, excluding the Port Arthur, Ottawa and St. Lawrence systems. The transmission lines to-day aggregate 395·7 miles of double-circuit 110,000 volt line; 37 miles of single-circuit 110,000 volt line; 722 miles of single and double-circuit pole lines

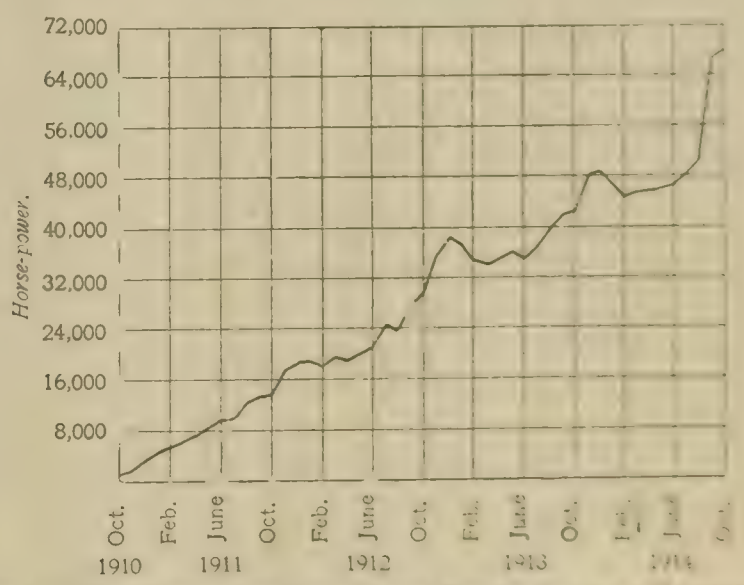


FIG. 1.—CURVE SHOWING INCREASE OF POWER LOAD OF MUNICIPALITIES. NIAGARA SYSTEM. OCT., 1910, TO OCT., 1914.

of voltage from 13,200 up to 46,000; and 77 miles of low voltage circuits. All the 110,000 volt lines and the greater portion of the others, are included in the Niagara system. On Dec. 31, 1914, the number of customers served by the system was 96,744. On Feb. 28, 1915, the power purchased by the Commission was over 160,000 H.P.

Three features are outstanding: First, the power is intended to be available for every class of consumer, rural or urban; second, the equipment and general design are selected for most permanent and effective service; third, the power is supplied to the municipalities at cost. Being assisted by complete, effective legislation from both provincial and municipal standpoints, these operations of the Hydro-electric Power Commission are the broadest examples of municipal ownership. The field entered by the Commission, wherever established municipal plants did not previously exist, was quite fully covered by private companies. The adverse criticism which a publicly-owned, electrical power system must expect when entering an established commercial market was based, at the inception of the Commission's plans, on the monopolistic tendency; on the possible effects of the introduction of provincial party politics; and on the

experimental nature of the scheme. The entire success as a commercial system, as an engineering work, and as a popular undertaking has entirely vindicated the situation.

The sale of power at cost eliminates much competition. This cannot be said to be creating a monopoly, as several of the established companies were able to reduce their rates to a corresponding amount, and with the decidedly less remunerative rates, have been able, by a much increased activity in the handling of business, to maintain a sound financial existence. The popular idea of the effect of a monopoly is that the public pays more and gets less in return, a condition certainly not comparable with the Commission's enterprise.

The experimental features of the engineering and commercial problems, involved, particularly, long distances, it being 233 miles from Niagara Falls to Windsor; the fact that 110,000 volt transmission at the time designs were commenced was in its earliest stages; that power was to be available to the municipalities at 25 cycles, for use in established markets using 60 cycles and 133 cycles; the necessary duplication in many cases of distribution systems; published power prices were based on estimates, only, of cost of construction and distribution; large blocks of power, with corresponding prices, were apportioned to the respective municipalities considerably in excess of their needs at the time, and in reality, in most cases, in excess of the power consumption from all sources of steam, water, gas and oil; an appreciably leavening factor was to be introduced into the industrial rivalry of the various communities; the consideration of an aggregate load of 100,000 H.P., as was anticipated and which was to be an element in the ultimate success, was beyond the comprehension of the great majority; and, possibly, lastly, no apparent provision was made for the development period in acquiring the load contracted for.

The analysis of the foregoing is quite beyond the capabilities of this Paper. In 1908, the municipalities entering into the agreement subscribed for 29,335 H.P.; distribution of power was commenced in 1910; in 1915, the power will be in excess of 100,000 H.P. in the Niagara system alone. These figures may broadly suffice in place of a complete analysis, as each of the problems enumerated was eventually met by a successful solution. The rate of this growth in the Niagara system is shown in Fig. 3, from 1910 to 1915.

The municipalities originally included in the power agreements numbered 15; on Feb. 28, 1915, this number had increased to 82, and the growth in the number of consumers is well shown in the following Table:—

Approximate Number of Consumers (to Dec. 31, 1914).

	1912		1913		1914
Light	33,568	...	63,157	...	93,179
Power	1,399	...	2,532	...	3,565
Total	34,967	...	65,689	...	96,744

The rates at which the Commission sells to the municipality consider the distance from the Niagara or other generating source, cost of 100,000 volt and 13,000 volt local systems of supply, and the amount and load factor of power consumed. The Commission recommends the rates to be applied by the municipality for the consumers, and the municipalities, in general, adopt them. The rates for sale are now on a uniform basis and involve a service charge which, in case of power, consists of a flat rate of 4s., a special rate of approximately 12 times the standard rate for the first 50 hours of service each month, and of approximately eight times the standard rate for the second 50 hours of service each month, the balance being at a standard rate per kilowatt-hour. Domestic lighting rates bear a service charge of 1.5d. or 2d. per 100 sq. ft. of floor area per month, and a standard rate of from 1.2d. to 3.5d. per kilowatt hour. Commercial lighting rates, in general, have a service charge involving the first 30 hours per month, and a standard rate for all additional time. Discounts for prompt payment apply throughout. The average rate paid for domestic service is calculated to be 1.85d. per kilowatt hour. Street lighting rates are, in general, flat rates applied to the particular type of street lighting made used by each respective municipality.

Power is brought from the Ontario Power Co. on a 20-minute peak basis and is taken by the municipalities on a similar manner. The oversale of power, by the Commission, resulting from the time distribution of the respective superimposing peak loads is quite an appreciable amount, and is in excess of the line and transformer losses, &c., which has justified the Commission in excluding loss costs from power rates: the flattening of the load curve, however, over the 24 hour period is gradually reducing the oversale.

As examples of the nature of loads and curves typical summer and winter loads are shown by Fig. 2. The individual loads are typical commercial, domestic and municipal loads and do not include any electrochemical or electrometallurgical loads. The municipal nature of practically all the loads concerned has shown the possibilities of flattening the 24-hour load curve. Pumping to reservoirs is undertaken on off-peak hours and is responsible, to a great extent, for the magnitude of night loads, as shown; and again, the pumping equipment usually includes synchronous motors, which, when necessarily operating as day loads, have a power-factor corrective value favourably comparative with their energy consumption. The load factor on the Niagara system is said to average about 80 per cent.

The Ontario Power Co., at Niagara Falls, the source of power for the Niagara system, has an installed capacity of 160,000 H.P. in 14 generator units, and, in addition to the Hydro-electric Commission of Ontario, has a very large market established in New York State, through the Niagara, Lockport and Ontario Power Co., and a considerable market in Ontario adjacent to the generating plant.

Previous to the use of the Commission's power, the industrial market for steam-generating central electric stations was limited, as the rate for power from the water power companies bore a recognisable relation to cost of power from isolated steam power plants of corresponding capacities. The municipalities served by the Commission represent the major portion of the industrial centres of the province, and amongst these considerable rivalry has existed as to their industrial growth.

The practice of granting of municipal bunuses—of fixed taxation or water rates, debenture or bond guarantees, free sites, money grants, &c., greatly in vogue several years ago—is gradually disappearing, and aside from these inducements the individuality of the community was chiefly based upon transportation facilities, labour

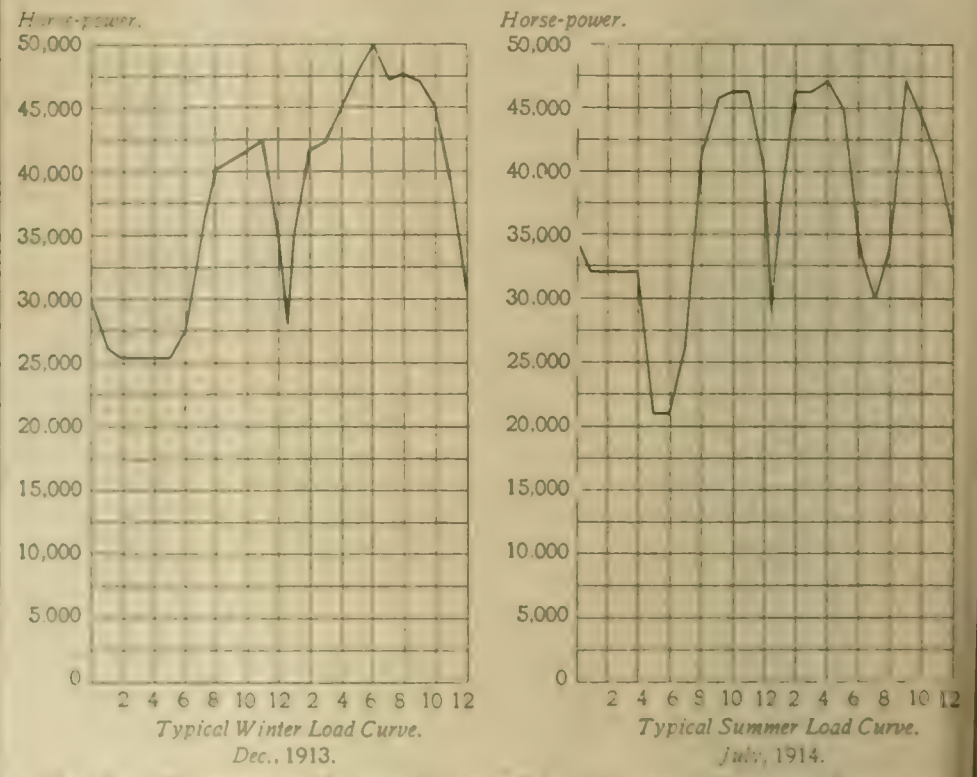


FIG. 2.—WINTER AND SUMMER DAILY LOAD CURVES, NIAGARA SYSTEM.

economics and cost of power. The elimination of cost of power as a selective factor, by the application of comparatively similar rates over a wide area, and the discouragement of bonusing has led to a more fruitful and substantial competition among the municipalities; the active improvement of all public services directly influencing the conditions of transportation and labour.

The powers of the Commission are very wide and extend far beyond the distribution of power. Rates throughout the province may be investigated and controlled on application of any municipality; existing systems and undeveloped sites may be bought or expropriated; systems, in part or complete, may be designed, financed and constructed; rivers may be improved for storage purposes, and so forth. These are particularly mentioned, as they have been included in the actual work of the Commission to date. Further, by its administration, conjointly with the Provincial Department of Lands, Forests and Mines, of all water-power matters under provincial jurisdiction—that is, excluding only such affairs as arise under the Dominion Government's rights on navigable streams—the interests of the municipalities are fully guarded.

The existing competitors, in such portions of the province as are not directly served by the Commission's system, either by influence of the Commission, or by respect for its powers sell at quite comparable rates.

As examples of two conditions of development quite different in aspect to the Hydro-electric Commission, but which, also, are well worth study, reference is made herein to the Shawnigan system, in the province of Quebec, and to the developed and undeveloped sites on the Winnipeg River, in the province of Manitoba. Special attention must be directed to the curves of the Hydro-electric Com-

mission, to the curves of the Shawinigan system, and to the loads in the City of Winnipeg, as denoting the rapid growth in power consumption. It is to be found that throughout the whole of Canada the loads of the power systems have been increased in a like manner. The consideration of such rates of increase as being applicable to the future, creates a most striking condition, and the development to meet such demands can only be supplied by the most careful utilisation of water power sources.

The Shawinigan Water and Power Co., at Shawinigan Falls, Quebec, has an interesting system for study as to industrial use of electric power. This plant is noted for several reasons: First, its magnitude; second, its extent of distribution; third, its creation of an industrial centre from the power standpoint alone; and fourth, its supplying of power for several electrochemical plants. Shawinigan Falls is situated on the St. Maurice River, about 20 miles north of the St. Lawrence River and about 80 miles east of Montreal.

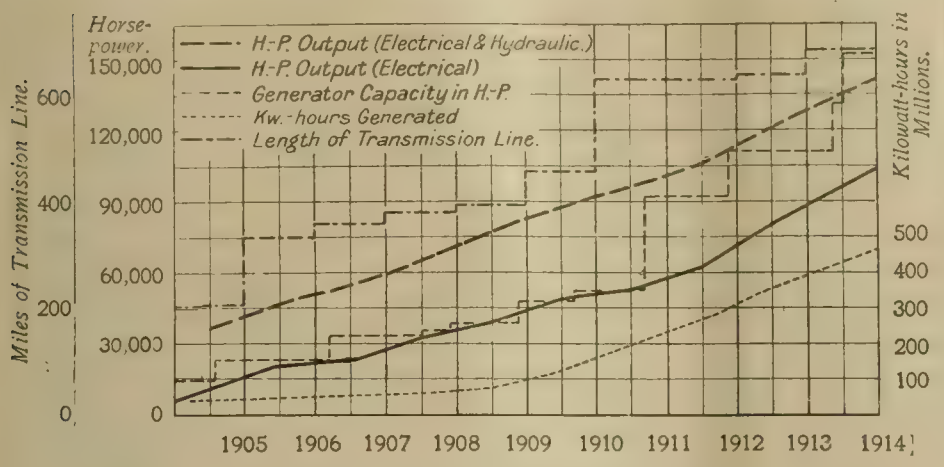


FIG. 3.—GROWTH OF LOAD AND SYSTEM, SHAWINIGAN WATER AND POWER CO., SHAWINIGAN FALLS, QUEBEC.

The St. Maurice River, on completion of the storage works now under construction,* will have a capacity of 204,000 H.P. at the minimum flow period, which practically corresponds to the present capacity of the installed machinery at Shawinigan Falls. The water is used in the two electric generating stations of the company, and, in addition, water is sold to the Northern Aluminium Co. for use in their turbines and to the Belgo-Canadian Pulp and Paper Co. The Northern Aluminium Co. uses water to generate 33,000 H.P. for use in their reduction furnaces; the direct-current generators are installed connected to the hydraulic turbines, the water rates being on the basis of direct-current output. In the Belgo-Canadian Pulp and Paper Co., 14,000 H.P. is delivered by turbines on the pulp grinders. In addition, the Canadian Carbide Co., at Shawinigan Falls, utilises 12,000 H.P., and a cotton factory, 550 H.P.; so that, besides a miscellaneous local load, industries have been created, consuming nearly 60,000 H.P., at a site where but a few years ago no community existed and transportation was entirely absent.

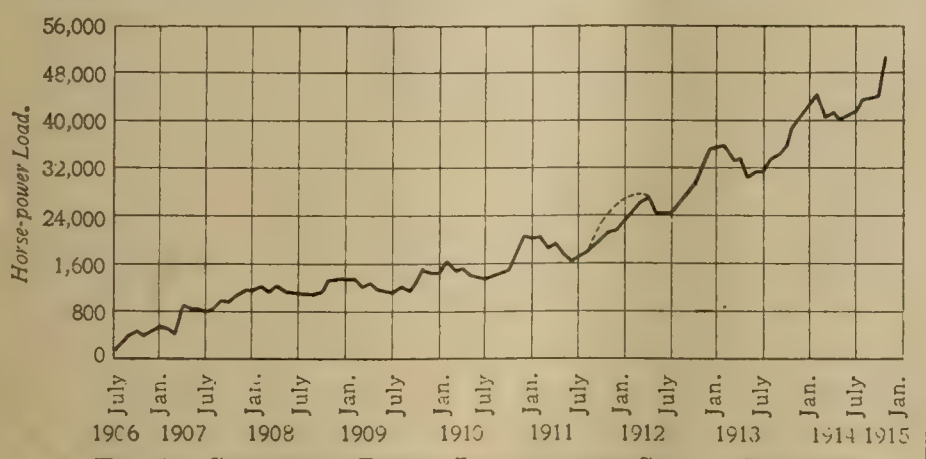


FIG. 4.—GROWTH OF POWER LOADS IN THE CITY OF WINNIPEG.

The Shawinigan Power Plants are two in number, aggregating approximately 150,000 H.P. capacity. No. 2 plant† contains 5 units, each of 20,000 H.P. capacity. The greatest load of the power transmitted is at the City of Montreal, which is served with four direct transmission circuits, direct from Shawinigan Falls; this being but one source of the horse-power consumed in that city. A market for 6,000 H.P. has been built up at the City of Three Rivers, on the St. Lawrence River, a location which affords excellent facilities for transcontinental railway service and lake and ocean transportation. The asbestos district in southern Quebec consumes several thousand horse-power, and the many municipalities in the various districts are also supplied. The growth of power load and equipment of the Shawinigan Co. affords an excellent example of the industrial growth of the country. Fig. 3 shows the comparative values of generating capacity, length of transmission lines, horse-power output and kilowatt-hours generated. Optimism as to the future of the industrial situation is indicated by the excess of generator capacity over the present load.

On the Winnipeg River, in Manitoba, two generating plants have been built to deliver power to the City of Winnipeg. The city itself has constructed a generating plant and transmission system, having a present capacity of 51,500 H.P., at Point du Bois, 77 miles distant from Winnipeg, and the Winnipeg Street Railway Co. has a plant of 28,200 H.P. capacity on the Pinawa Channel, near Lac du Bonnet. These plants have developed a large market in what is at present a non-manufacturing city (for other than local needs) of 210,000 population. The magnitude and character of these loads may be realised from the curves shown in Fig. 4, which shows the curve of growth of the combined loads from year to year.

On the Winnipeg River, within easy reach of three transcontinental railways and at the gateway to the agricultural West, is a series of power sites, which are being the subject of considerable study on the part of the Dominion Government as to the storage facilities and the economic possibilities in the development and market. Storage regulation is feasible to increase the minimum flow from 12,000 second-ft. to 20,000 second-ft., which will result in several sites being well adapted for power purposes, the aggregate capacity of electrical power being 262,000 H.P., in addition to 76,800 H.P. available at Point du Bois and 28,200 H.P. at the Winnipeg Electric Railway Co.'s site.

Western Canada is the granary for a world-wide market and the artificial replenishing of the notably fertile prairie soil is a problem for the future, to be solved only by abundant water supply. The communities, rapidly increasing in number and population, and the manufacturing now commencing for the local market will demand enormous quantities of power. The water powers must be developed for this purpose.

PRODUCTION OF UNDAMPED ELECTRIC OSCILLATIONS BY QUENCHED SPARK DISCHARGERS.

BY HIDETSUGU YAGI.

E. L. Chaffee* seems to have been the first experimentalist to show that a practically undamped electric oscillation can be obtained by means of high frequency quenched sparks between an aluminium cathode and copper anode immersed in a moist hydrogen atmosphere.

The writer has made some observations on the behaviour of an Al-Brass gap in an atmosphere of coal gas, and found similar results. A Braun-tube oscillograph was used for the analysis of the oscillation. The arrangement is shown diagrammatically in Fig. 1. From a storage battery of 440 volts a current of about 0·3-0·4 ampere was supplied through high resistance and large inductance.

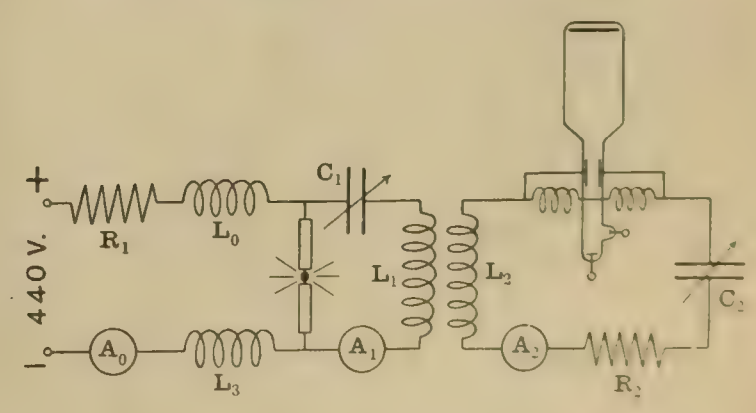


FIG. 1.

Within the range of the variable capacities C_1 and C_2, both being less than 0·003 mfd., the curve on the fluorescent screen of the tube was either a circle or an ellipse, which proves that the oscillation in the secondary circuit is virtually an undamped harmonic oscillation.

When C_1 is larger, the curve when the resistance R_2 is large

* *See* "Canadian Hydraulic Power Development," Mechanical Section, International Engineering Congress, 1915.

† *See* "Electrical World," Vol. LIX., p. 953.

* E. L. Chaffee, "Proc." Amer. Acad. Arts and Sci., XLVII., p. 265. 1911.

has a certain thickness. This shows that the oscillation is not absolutely undamped, but is slightly damped and returns to the original amplitude after every few cycles. When C_1 is increased to 0·015-0·03 mfd., the discharge becomes less frequent, and the image on the screen changes into a spiral when R_2 is increased (Fig. 2).

In these spirals, the amplitude of the oscillation reaches a maximum value after about 1 cycle or $1\frac{1}{2}$ from the initial moment of each oscillation, which corresponds to the number of cycles contained in each spark.

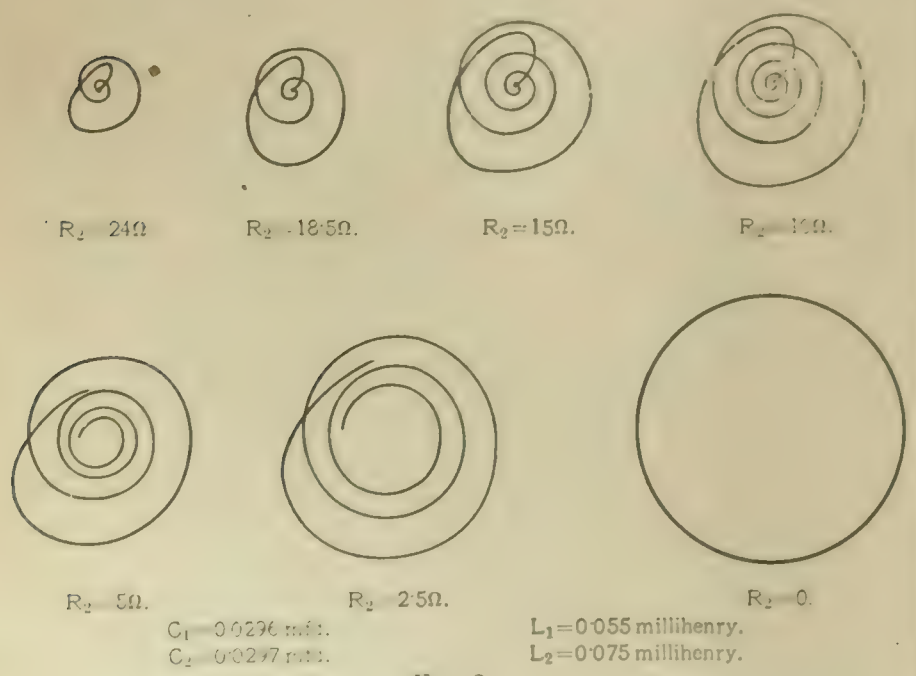


Fig. 2.

As the secondary undamped oscillation is a result of superposition of a number of slightly damped oscillations induced by a series of quenched sparks at high frequencies (10,000 to 100,000 per second) its intensity will be the greatest when each fresh impulse is given in harmony with the previous oscillation, that is to say, the successive trains of oscillations must succeed each other, falling into step with each other, so as to avoid breaks in the vibration. The reaction of the secondary oscillation upon the primary will lead the discharge to take place in such a manner, consequently, so far as the energy supply is limited, that the period of sparking in some cases alternates between two values. It was confirmed by the following experiment, that many such critical conditions make their appearance when the constant of the circuit is gradually varied.

Fig. 3 illustrates the change of the image on the screen, when the frequency is varied by altering C_2. In *a* and *a'* the smaller ellipses of dotted lines indicate the new appearance

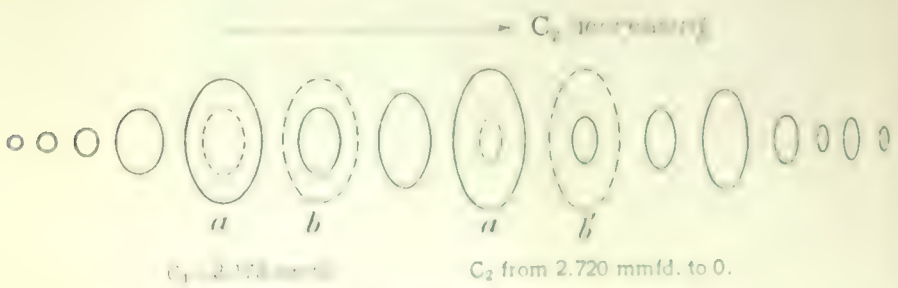


Fig. 3.

of smaller rings. They change to *b* and *b'*, in which the new rings become apparent and the outer ones disappear. This change takes place very sharply at certain points when C_2 is gradually varied. The reading of the ammeter A_2 (Fig. 1) also shows a corresponding fluctuation. The adjustment of C_1 causes similar changes to occur more frequently, because the period of sparking varies proportionally to C_1, while the period of oscillation varies proportionally to $\sqrt{C_1}$.

There are many other factors affecting these two kinds of periods. The gap length and the supply current have the same effect as C_1, and L_2 the same as C_2.

H. Riegger * discovered that the variation of coupling or of C_1 causes a remarkable fluctuation of the secondary current, the explanation for which has not yet been given. In our case the variation of M had but an insignificant effect and no general statement can be made about the effect of coupling, for M and L_2 have entirely different influences. The effect of L_1 is also not significant so far as L_0 is extremely large.

Fig. 4 shows the fluctuation of the effective value of the secondary current measured by means of a hot-wire ammeter. The parts of the curve indicated by dotted lines correspond to

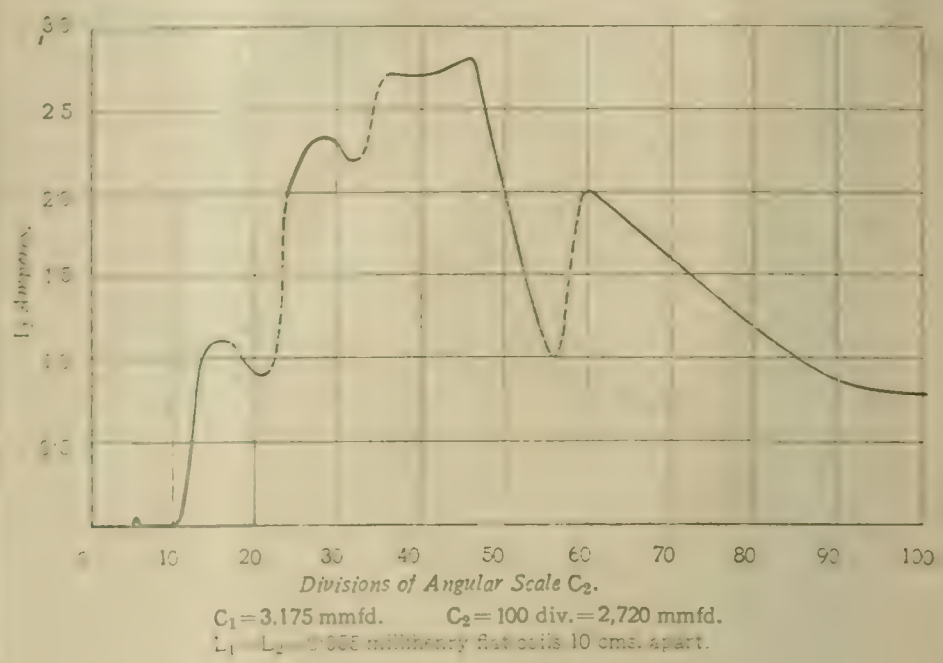


Fig. 4.

the stage of transition. There may have been further similar stages, but they were not distinctly noticeable when the sizes of the two concentric rings were nearly equal. Fig. 5 gives another result when C_1 was varied. Many questions raised by Riegger might be explained if the production of an undamped or a slightly damped continuous oscillation could be assumed. He used an inductor as the source of oscillation, which increases the difficulty in dealing with the problem. If the number of sparks had been sufficiently large and an undamped oscillation created in the secondary in his experiments, then the fluctuation would have been caused in the manner stated above, and not due to the alteration of the quenching action of the gap.

It was also recorded by him that the frequency of the secondary oscillation varies slightly when the gap length is

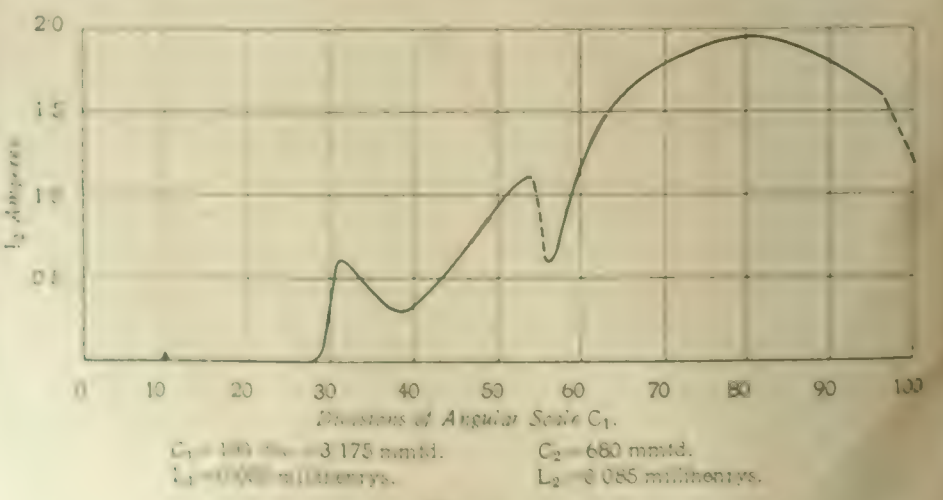


Fig. 5.

altered, and that the combined damping of the primary and the secondary increases with decreased gap length. When the gap is wide and consequently the spark number comparatively low, the free oscillation would be much longer than the forced oscillation. Hence the indication of the wave-meter would be nearly the natural frequency of the secondary circuit and the resonance curve fairly sharp. For a shorter gap length the proportion of the forced oscillation to the free oscillation would become larger and, therefore, the indication of the wave-meter might differ and the resonance curve become less sharp.

* H. Riegger, "Jahrbuch d. drahtl. Telegr.," V., p. 35, 1911.

A wave-meter consisting of a capacity and an inductance is not always an ideal instrument for measuring frequency and taking resonance curves, if an undamped oscillation could possibly be created in the meter circuit. Suppose an arc oscillation of the second kind (Fig. 6). The fundamental frequency may be fairly well detected by means of a wave-meter, but the harmonic corresponding to t_1 may not produce a sufficient effect in the meter circuit when $t_2=2t_1$, because the following

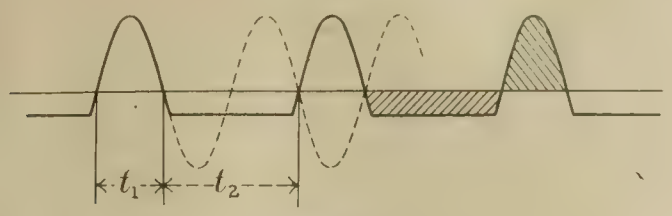


Fig. 6.

impulse would give an impulse in the opposite direction to the preceding one. When $t_2=3t_1$ this harmonic will again be strengthened.

Summary.

1. Practically undamped oscillations may be obtained by means of impact excitation provided that the impulses are sufficiently frequent.

2. According to the ratio of the frequency of the impulses to that of the oscillation there is a significant fluctuation in the intensity of the oscillation.

3. The indication of a wave-meter becomes unreliable as soon as an undamped oscillation is created in the meter circuit, or when the frequency of the impulses is sufficiently high.

I wish to express my obligations to Prof. J. A. Fleming for placing the resources of his laboratory at my disposal in this work.

University College, London.

THE CONSTRUCTION OF INSULATORS OUT OF "HARD PAPER" OR "PERTINAX."*

BY K. FISCHER.

Porcelain has been almost exclusively used for insulating high-tension lines, because this substance has been supposed to be the only one that has the requisite mechanical and electrical properties. For outdoor work, this is certainly true, because nothing is known like porcelain for resisting the effects of atmospheric influences. For indoor work, "hard paper" competes with porcelain, and it seems quite likely to displace porcelain for such work within a reasonable time for pressures above 20,000 volts. But shapes that can easily be made in porcelain may not be suitable for "hard paper," and the present article is intended as a study of the most suitable shapes for this material.

Hard paper was originally used only as insulation in machines and other pieces of apparatus; its electrical properties were therefore the most important thing. It may be as well to describe the method of its preparation. Hard paper, or Pertinax, is made by rolling layers of paper on one another, the paper being impregnated with some kind of resin; at the same time, it is heated and pressure is applied. The method used by the Meirowsky works is to apply the pressure by means of a brake, which is pressed against it by some sort of mechanical tension. The different layers adhere to such an extent that the resulting substance appears uniform in structure. The electrical properties are largely those of paper, but the other properties depend on the resin. Originally natural resins were used, but hard paper has only seriously challenged porcelain since the introduction of synthetic resins, as in Pertinax A. The natural resins were such that the material began to soften at 80°C.; with synthetic resins, no harm is done by a temperature of 180°C. or 200°C. Moreover, with synthetic resins, Pertinax A is almost as free from chemical action as porcelain. It is practically waterproof. It must be admitted that a good many of the better properties of Pertinax have only been brought about by changes and improvements in the method of manufacture. Its mechanical strength is surprising. From many tests the mean modulus of elasticity was found to be 120,000 kg. per square centi-

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft, 35, 1915.

metre, and the breaking stress 1,000 kg. per square centimetre. There are no internal stresses in the substance.

The usual forms in which Pertinax can [illegible] the flat plate and the cylinder. It can be turned in the lathe; but naturally this takes time, costs money, and the pieces that are cut off are useless for any further purpose. Therefore, the particular forms cannot be imitated without considerable loss of material, which in this case costs much more than porcelain. If the electric field passes through from layer to layer, the substance seems to have the peculiar property of distributing it so that the stresses are reduced. If a cylinder is wound on a metal rod, the greatest stress would be at the surface of the rod, and yet the actual breakdown voltage is greater than the calculated; at least if we base our figures on those got from plates, which have a breakdown voltage of 25,000 volts per millimetre. With cylinders, wound on rods, they have withstood voltages (calculated) of 40,000 per millimetre without breaking down. The working stresses of hard paper, at right angles to the layers, can be put at 2,500 volts per millimetre, and the testing voltage at 8,000 or 9,000 volts per millimetre, continued for three minutes. The factor of safety ought to be at least 8. It is much to be desired that tables should be drawn up showing the working stresses of the different materials, and not their breakdown voltages. Much mischief has resulted from an insufficient factor of safety. And particularly has this been the case in calculations which ought to take account of bends and edges of the material. Another very important factor is the dielectric constant, which may be taken at 4·5 as a mean value. This is the case with oil transformers, when two metal surfaces are to be separated by an insulator of hard paper. A disc-like insulator is bad; owing to the sharp edges, the oil might break down at this spot; the insulator itself would not break down under the electric stresses. If the disc had a curved edge, like a very small capstan, this might be better; but with hard paper, the most economical form would have an egg-shaped section. This can easily be pressed out of the tube of the material. A very important point is the corona-phenomena in air. Porcelain has a high dielectric constant, and it is known that at comparatively low pressures, glow discharges takes place on the supporting metal. This is a necessary evil, and porcelain is itself relatively insensitive to this kind of discharge. With porcelain it is usual so to design an insulator that its surface can withstand a stress which is sufficient to break down the adjoining layer of air. With Pertinax one must go further and so design it that no breakdown takes place either in the adjoining layer of air or in the substance itself. This may appear too high an aim, but it is not impossible to meet such conditions. For indoor work, the factor of safety on an insulator ought to be greater than for a transmission line in the open. In order to pervent the breakdown of the air on the surface of an insulator, it is necessary to suppress the glow discharges on the edges of the metal electrodes; because these lead to flash-overs, quite apart from the fact that they gradually attack the material. Thus suppose we have to put an insulator between two metal surfaces, one of which projects beyond the other. The author gives a drawing showing the lack of uniformity in the electric field. Calculations may be useful for the more or less uniform part of the field between the two surfaces, but where the lines escape beyond the edge of the smaller one, only some sort of graphic method seems possible. It will be necessary in such a case to see that the length measured in the direction of the lines of force bears a known ratio to the breadth, measured in the direction of the equipotential lines. Thus on these principles the electric field can be plotted out just like a magnetic field. It must be remembered that the dielectric constant of hard paper is four or five times that of the air. There are, of course, a number of things to consider, even in such a simple case as we have taken. Not only must we bear in mind the distance between the two metal surfaces, but also the ratio of the extents of these surface matters. The minimum distance between two equipotential surfaces determines the first glow discharge If we exceed the value of 2,100 volts per millimetre, then the air will be partially broken down. The shape of the edge of the outer metal surface is also important as determining the shape of the field at this point. We add some figures showing the results of tests on a tube, covering a metal rod, and covered itself with aluminium foil. These are shown by Fig. 1 and Table I. The following formula gives us the voltage e at which the first glow discharge takes place,

$$e=2800 \cdot d^{0.4} \cdot (a-b)^{0.5},$$

where a, b and d are as shown in the drawing.

There are various methods by which the voltage can be raised at which the first glow discharge sets in. This is not only a question of glow discharge, but also of the stresses in the hard paper, where it borders on the edges of the metal. This spot is endangered owing to the gradual heating effect. It is a common idea that matters are improved by thickening the dielectric at the edges. But if the field

Table I.—*Showing the Commencement of the Glow Discharge under the Conditions shown in Fig.* 1. (*Measurements in centimetres.*)

d	*a*—*b*	Voltage of glow discharge.	*d*	*a*—*b*	Voltage of glow discharge.
0·2	10·0	2,600	1·5	20·0	6,700
0·2	20·0	3,100	1·5	30·0	7,000
0·45	20·0	4,375	1·5	35·0	7,275
0·8	20·0	5,830	1·8	20·0	7,580
0·8	30·0	6,725	1·8	30·0	8,160
0·8	40·0	6,420	1·8	40·0	8,750
1·0	20·0	6,100	3·6	20·0	12,500
1·0	30·0	6,420	3·6	30·0	12,800
1·0	40·0	7,000	3·6	40·0	13,400

is drawn out by some graphic method, it will be seen that a very considerable thickening is necessary. This process is also impossible, practically speaking, with hard paper, because the edge can only be thickened by cutting away a corresponding amount of material in the middle. A better plan (as shown in a drawing) is to increase the size of the smaller metal surface in such a way that it no longer remains

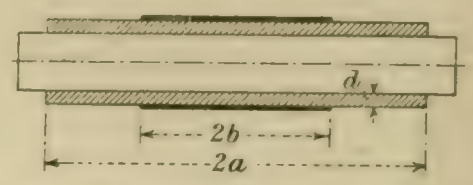


Fig. 1.—Drawing of Insulator to which Table I. refers.

flat, and thus in contact with the insulator over its whole surface, but gradually falls away from the flat surface of the insulator; its surface is thus convex, and separated at its outer edge from the insulator by some distance. The field thus becomes more uniform and the glow discharge does not set in so early. It is correspondingly possible to leave the smaller surface alone, and to separate the upper metal surface from the insulator at its outer edge by a layer of air. This leaves both metal surfaces flat, and the insulator tapers away,

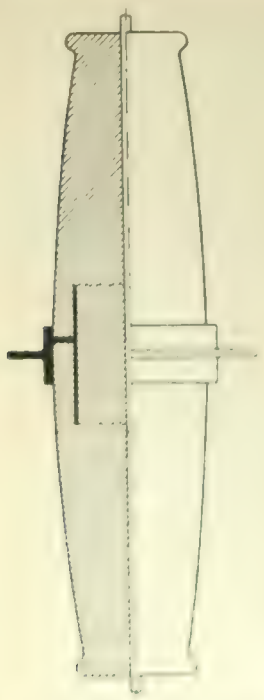


Fig. 2.—An Insulator carrying a Conductor which passes through it.

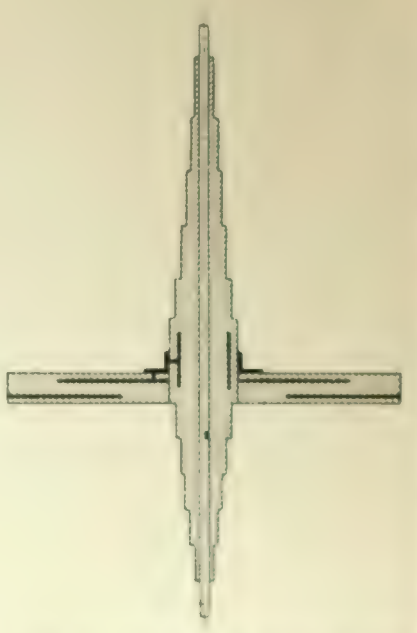


Fig. 3.—Another type of the same Insulator.

being flat on the side in which it is in contact with the smaller metal surface. Thus a tube of Pertinax, 10 mm. thick, was tested with a length of 380 mm. of aluminium foil, and had a rod accurately about 20 mm. in diameter passing through its centre. The tube was 500 mm. long. The first glow discharge set in at 8,800 volts. The ends of the tube were then hollowed out on the lathe, so as to introduce a wedge-shaped layer of air at the ends in contact with the brass rod. This had the effect of raising the voltage of glow-discharge to 7,925. Then the layer of air was removed, and the wedge-shaped space was filled up by pouring in an insulating substance whose dielectric constant was about 5·5. This had the result of lowering the glow-voltage to 7,250.

In order to suppress the glow-discharge on the supporting metal parts of insulators through which the conductor passes, as in overhead structures, the supporting parts should be buried as deeply as possible in the insulator. This can be done by boring short metal in the Pertinax, and connecting it electrically with the support. A figure is given showing how the electric field distributes itself in this case. A table is given (not here reproduced) showing the voltage at which the glow-discharge starts in tubes in which metal surfaces or sheets are embedded, in accordance with a drawing. Naturally this depends on dimensions, *i.e.*, lengths, breadths and thicknesses; but variations of these are included in the table, as in Fig. 1 and Table I. Thus if a metal cylinder is embedded precisely in the middle of a tube of hard paper, 0·2 cm. in thickness, and if the tube projects beyond the metal cylinder by 30 cm. at either end, then the first glow-discharge takes place at 23,000 volts; rather a surprising result when compared with the figures in Table I. This method of suppressing the glow-discharge is very valuable in many cases.

The author then proceeds to give a few instances of actual constructions, as shown in the appended drawings, the shapes being chosen as being specially suitable for the physical, mechanical and electrical properties of hard paper. It is very necessary to get rid of the idea that the shapes which are suitable for porcelain ought to be imitated. The inner parts of a porcelain insulator are often filled

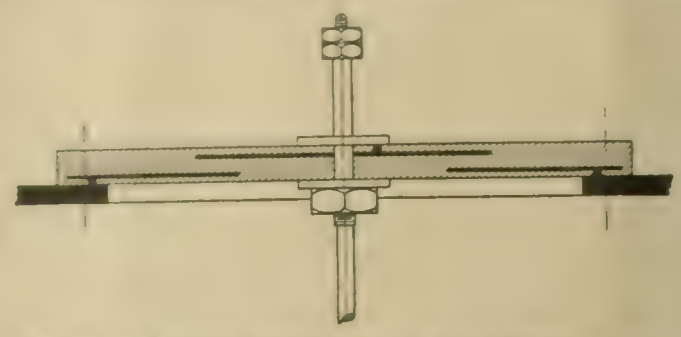


Fig. 4.—Another type of the same Insulator.

with compound; this plan must be avoided with hard paper. Glow-discharge is, moreover, suppressed in two different ways in the two substances; this is again a difference. For the construction of an insulator of hard paper, which is intended to carry a conductor passing through it, we may choose the method shown in Fig. 2, which is not only electrically but also mechanically superior to porcelain. It is not in the least sensitive to shock. It is best made in one piece, which is finally turned up on the lathe so as to make the ends conical. The outer supporting ring is put on warm, and then connected electrically with the buried metal cylinder by a screw, as shown. It is well to notice that one is not confined to the cylinder as the basis of the design. Plates can be used, which have suitable buried metallic portions, as in Fig. 4. It might be used in a condenser; one of the coatings would be connected with the main bolt, and the other is connected to the outer containing oil vessel. It is therefore no longer necessary with transformers and switches to have large projecting insulators, but they can be allowed to lie flat on the surface. This is an advantage in connection with the transport of such apparatus and the packing. For leading cables into a house and protecting them at this point against the rain, these flat insulators are also

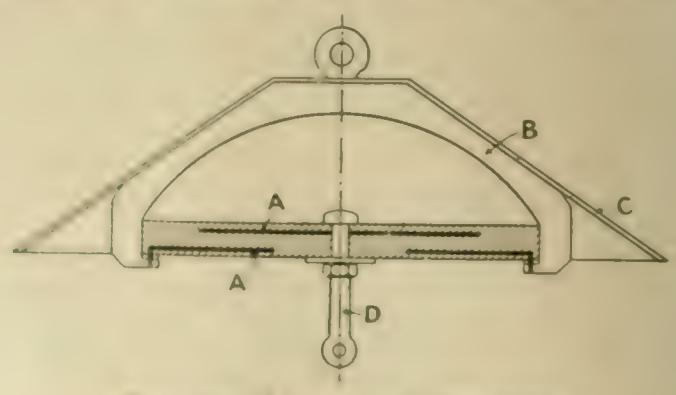


Fig. 5.—A Suspension Insulator.

useful, and they are mechanically just as strong as the cable. A square plate, each side of which measures 1 metre, and which is 30 mm. thick, will withstand a testing pressure of 180,000 volts. Of course the cylindric form can be combined with the plate form. Such a combination is shown in Fig. 3. Each part acts as a condenser and takes a certain proportion of the total voltage, this part being inversely proportional to its capacity. The insets or buried metal portions must also be suitably designed. A special advantage of this arrangement is that the flash-over, if it takes place, passes through the air in the direction of the hypotenuse of the triangle, the right angle of which is formed by the plate and the length of the cylinder. The surface of the material is thus not attacked. A photograph is given of an experimental insulator of this kind: the plate was 380 mm. square, and the height to which the cylinder projected was 400 mm. The first glow discharge set in at 150,000 volts. For insulators that are mere supports, the cylinder type is the best proportion. The first ones were made to imitate porcelain;

but now cylindrical ones are made, smooth on the surface, and not worked on the lathe. They consist essentially of a cylinder, which is gripped, top and bottom by suitable covers; the inner space can be filled with compound, if desired. By embedding metal layers, the glow discharge at the edges can be largely suppressed. The arc is then more likely to pass from the ends, and thus does not attack the substance of the insulator. The plate type of insulator can also be used for an overhead suspension insulator. This is shown in Fig. 5. It is held by iron ribs B, and there are the condenser insets, shown at A. The metal covering C, which extends all round, protects against the rain. In the middle a bolt, D, is shown, which is suitably designed for the circumstances of the case, and may be used as a support for the conductor. The drawing is only intended to show the outlines of an experimental type, which can be further tested and modified, if need be.

EFFECTS OF ELECTROLYSIS ON ENGINEERING STRUCTURES.*

BY ALBERT F. GANZ, M.E.

Summary.—An explanation is given of the way in which electrolysis is caused by stray currents from electric railways with earthed return. Various means are discussed of averting electrolytic corrosion of railway tracks and their supports, sheathed cables, pipes, steel foundations and reinforced concrete structures.

The following are the principal engineering structures which may be affected by electrolysis from stray electric currents:—

1. Electric railway tracks and iron or steel structures supporting these tracks.
2. Underground lead-sheathed cable systems.
3. Underground piping systems.
4. Steel foundations of buildings, bridges, &c., and reinforced concrete structures.

The following notes on electrolysis in these structures are based on American practice.

Effects of Electrolysis on Electric Railway Tracks and on Iron or Steel Structures Supporting these Tracks.

In most practical cases of tracks laid on the ground the current flows from rails to earth over such a widely scattered area that the current density at the points of leaving is quite small, and the corrosion of rails from this cause is correspondingly slow. In such cases the rails usually require replacement from head wear, or for other reasons, before they require replacement because of the corrosion by electrolysis. Certain cases have been found, however, where severe corrosion by electrolysis was produced not only of the rail bases, but also of the spikes fastening the rails to the wooden ties. In these cases the soil or ballast in contact with the rails was relatively wet, the worst cases being found where salt water was present. In such situations every precaution must be taken to increase as much as possible the resistance from the tracks to earth. If this does not accomplish the desired result, the voltage drop in the tracks must be reduced, so that the P.D. between tracks and earth is also reduced.

The principal iron or steel structures supporting electric railway tracks which may be affected by electrolysis are elevated and tunnel structures. Where the construction is such that current can reach these supporting structures from the tracks, such currents may shunt from the supporting structures to earth, and cause damage from electrolysis at the points of leaving.

Elevated railway structures are generally low-resistance metallic conductors, and have in some installations been used as conductors for the return current, in which case they are bonded to the track. In one large installation of this kind it was found that comparatively large currents were shunted by way of the steel columns and footings through the earth and on to underground pipes and cable sheaths, with resulting damage to these pipes and cables, and to the pillar footings, from electrolysis. The trouble was remedied by removing all connections from the steel elevated structure to the running tracks and to the negative 'bus bar. The additional conductance required for the return circuit is supplied by bare negative feeder cables placed on the wooden ties between the tracks, which affords substantial insulation of these feeders. Connections are made between structure and tracks through suitable resistances at neutral points for the purpose of preventing the production of excessive P.D.s between running tracks and structure under abnormal conditions which might arise. These neutral points were located where the running tracks are substantially at the potential of the earth, so as to avoid current flow between tracks and earth under normal conditions.

* Abstract of a Paper read at the International Engineering Congress at San Francisco.

Underground and under-river tunnels often consist of cast-iron shells, made in segments, usually 2 ft. or so in length. Frequently interior grooves at the joints are calked with lead or other packing material. The resistance of such a tunnel structure is largely determined by the resistances at the surfaces of contact between the segments, and therefore varies within wide limits, and may be relatively high. A number of resistance measurements made by the writer of such cast-iron tunnel structures, having a cross-section of approximately 1,250 sq. in., showed resistances varying from 0·002 to 0·01 ohm per 100 ft. of tunnel structure, which is approximately from 5 to 300 times the resistance that would be obtained with a continuous metal of the same cross-section. Where the tracks and structure are metallically in contact the latter acts as an earth-plate of enormous area, and current will, therefore, shunt through earth from this structure, with resultant corrosion of the structure by electrolysis. About two years after beginning electric operation on the New York Central Railroad it was found that corrosion from electrolysis had occurred in the rails and spikes in a wet section. Drains were placed under the tracks in order to keep the ballast dry, and this has entirely eliminated the trouble.

In future constructions of iron or steel elevated and tunnel structures for electric railways, every precaution should be taken to prevent metallic contacts between tracks and structure, and to maintain as high a resistance between tracks and structure as possible. Where desirable, connections between structure and tracks, through suitable resistances, may be made at neutral points; but these connections should not under normal conditions carry substantial currents. Where in existing constructions the resistance between structure and tracks is low, and cannot be adequately increased, and where considerable currents shunt through structure and earth, the most practical way to reduce this shunting current is to reduce the track voltage drop.

Effects of Electrolysis on Underground Lead-sheathed Cable Systems.

Lead-sheathed underground telephone, electric light and power cables are most commonly carried in underground conduits of vitrified clay, concrete, fibre or wood. As the soil in which these conduits are buried is more or less wet, moisture will to a greater or less degree get into the ducts, and thereby produce electrolytic contact between earth and the lead sheaths of the cables. As these lead sheaths are relatively thin, and as the electrochemical equivalent of lead is nearly four times that of iron, these lead-sheathed cables are very sensitive to the electrolytic effects of stray currents reaching them. Wherever, therefore, such lead-sheathed cables are in underground conduits in localities where substantial stray electric currents are present, it is generally found necessary to provide some measures for protecting these cables against corrosion and ultimate destruction by electrolysis. The resistance between earth and the lead cable sheaths in ducts can be increased by constructing the ducts so as to be as waterproof as possible, and also so as to drain towards the man-holes.

The most commonly used method of protecting lead cable sheaths is to "electrically drain" the sheaths to the return circuit of the electric railway, so that the current is taken off by metallic conduction, and is thus prevented from leaving electrolytically and thereby damaging the cable sheaths. Where "electrical drainage" is employed it is important that all of the cable sheaths in the conduit system be connected to the drainage cable. Drainage connections from cable sheaths should ordinarily not be made to tracks, because a high-resistance joint or joints developing in the tracks may destroy the effectiveness of the drainage connection, but should preferably be made as direct as possible to the negative 'bus bar. The object of drainage connections is to render the cable sheaths throughout slightly negative to surrounding earth and to other grounded structures. If such a drainage connection is found to render the cable sheaths more negative than is necessary for protection, so that the sheaths are "over-drained," it is desirable to insert a resistance in series with the drainage connection. If a cable sheath is rendered highly negative to neighbouring structures, such as pipes, this tends to set up current flow from the pipes to the cable sheath, causing corrosion of the pipes by electrolysis.

It is preferable to carry a cable drainage connection directly to the railway sub-station. An ammeter and a knife switch should then be connected in such a drainage connection, and readings of the ammeter noted at least once every day, so that if abnormal conditions develop they can be reported and the cause determined. The drainage circuit must be opened whenever the station is shut down.

Insulating joints in the lead sheaths of cables have been used in some special cases as protection against stray currents, but these joints must only be used with caution, so that P.D.s sufficient to harm the sheaths may not be set up across the joints. However, where an underground cable network has laterals into buildings,

considerable currents frequently flow from pipes to the sheaths of the laterals through accidental metallic contacts in the building, and thence to the cable system. Such current flow to the cable system is most effectively stopped by introducing an insulating joint in the sheath of the cable lateral or in the pipe service inside the building. A number of large telephone companies instal insulating joints in the sheaths of all laterals inside buildings for this purpose.

Where laterals or sections of cables connecting to the main cable system are carried in iron conduits in negative districts it is sometimes found that considerable current flows from earth to the iron conduits and thence to the cable sheaths, which current is delivered to the sheaths of the cable system. Such current flow can generally be stopped by introducing an insulating joint in the sheath of the cable where it leaves the iron conduit and before it is connected to the main cable system. Insulating joints may also be used on either side of a steel bridge crossed by a cable in an iron conduit where the conduit is in metallic contact with the structure of the bridge, and through this with electric railway tracks on the bridge. A simple and cheap construction of insulating joint for lead cable sheaths, which is extensively used, consists in cutting a narrow band of lead out of the sheath and covering the break with a suitable insulating material so as to prevent entrance of moisture.

Effects of Electrolysis on Underground Piping Systems.

Underground piping systems for the transmission and distribution of gas, water, oil and similar materials consist of lengths of iron pipe joined together with screw couplings, lead or other forms of joint. Screw coupling joints generally have a very low electrical resistance comparable to the pipe itself. Cast lead or lead wool joints have an electrical resistance which is equivalent to from a few feet to several hundred feet of continuous pipe, so that the resistance of the lead joints in a pipe line is usually much larger than the resistance of the pipe itself. Cement joints generally have a very high resistance compared with the pipe, so that they may be classed with insulating joints.

Attempts have been made to protect underground pipes from electrolysis by insulating them from earth by paints or dips; but no dip or paint will permanently protect a pipe against electrolysis in wet soil. Where it is attempted to apply a heated material like pitch or asphaltum to a cold pipe it is impossible completely to cover the pipe. Pitch and similar compounds have been applied to pipes with wrappings of jute or of some similar material, a number of layers being applied so as to build up any desired thickness. Such covering, if sufficiently thick, will afford protection against electrolysis, provided that it is mechanically perfect. The great difficulty in practice is to instal such covering without leaving defective spots through which moisture will have access to the metal of the pipe. Pipes, where positive to earth, with coatings or coverings exposing bare spots of metal, are in much greater danger from electrolysis than are bare pipes, for the reason that the stray currents will leave only from these bare spots, and here produce concentrated corrosion. The writer has seen cases where a pipe coated with an imperfect insulating covering was pitted nearly through in one year, whereas a bare pipe in the same locality was very much less affected, because the corrosion was distributed over a larger surface.

One form of insulating covering which appears to afford certain protection is a layer of 1 in. to 2 in. of a material like coal tar pitch, parolite or asphaltum of such a grade that it is not brittle, and so will not crack, but yet is hard enough to remain in place. The cost of carrying out such an installation is prohibitive, however, except in very special cases. Embedding a pipe in cement or concrete, even if this is several inches in thickness, will not protect it from electrolysis, because damp cement or concrete is an electrolytic conductor.

Current flow on metallic pipe lines can be practically prevented by using a sufficient number of insulating joints. It is sometimes possible in the case of individual pipe lines to use comparatively few insulating joints to break up the electrical continuity of the line and substantially protect it from electrolysis, but such joints must be installed only after adequate tests have shown that sufficient current will not leave the pipe on the positive side of a joint to flow to earth, and do serious damage by electrolysis. Insulating joints in pipe lines should not be confined to the positive areas, but should be installed in all places along the pipe line where there is any considerable potential gradient in the earth parallel to the pipe. The number of joints required depends upon the potential gradient and the electrical resistivity of the earth. The effective resistance of a short insulating joint is practically the same as that of a long joint. However, a long insulating joint gives a more even distribution of leakage current than a short joint. The effect of a long joint can be practically secured from a short insulating joint by surrounding the joint and the pipe for some distance on each side of the joint with a heavy layer of insulating material.

Iron pipe lines with electrically conducting joints often cross and parallel electric railway lines of the same or of different systems, in which case stray currents from the electric railways may seriously damage them by electrolysis. Attempts have been made in some of these cases to protect the pipe line by installing insulating joints at a few points in the line, especially at crossings of electric railway tracks. It has generally been found, however, that the pipe on one side of the joint was thereby rendered highly positive in potential to the surrounding earth, resulting in rapid destruction of the pipe on the positive side of the joint, thus causing more acute danger than existed before, when the current left the pipe over a more distributed area. In some cases at points of crossing railways considerable improvement was produced by employing broken stone ballast and keeping the tracks out of contact with the ground for several hundred feet on each side of the crossing. In general, however, satisfactory protection of long-distance pipe lines cannot be obtained by any remedial measures which can be applied to the pipes.

It is occasionally found in long pipe lines that large currents flow to and from localised sections of the line where there are many electric railway tracks and where the pipe is relatively close to these tracks. In some cases the pipe in such localised sections has been protected by insulating joints spaced with sufficient frequency to prevent dangerous voltages across any one of the joints. In other cases the pipe in such a section has been covered with a thick layer of insulating material, and, as an additional precaution, insulating joints have been installed in the pipe at each end of the insulating covering, so that if any defective spots in the covering should develop no current can reach the pipe at these spots and produce electrolysis. In a section of about 6 miles of an 8 in. steel pipe line, where it crosses and runs close to a number of electric railway tracks, large stray railway currents were found flowing to and from the pipe and causing serious corrosion by electrolysis. Twenty-six insulating joints were installed at selected points, and portions aggregating a total length of about 3½ miles of pipe were also covered with 1 in. to 2 in. of parolite surrounded by a wooden box, with the pipe resting on rectangular glass blocks. At both sides of this insulated section it was found that neither insulating joints nor insulating covering could be safely applied to protect the pipe without carrying the insulation practically over the entire length of the pipe, which would have been prohibitive in expense. Protection of the pipe here can be secured only by adequate improvements in the electric railway systems.

Where considerable currents leave a relatively short section of pipe and endanger it by electrolysis, this section can be protected by surrounding it with an auxiliary pipe electrically connected to it, so that the current will leave from the auxiliary pipe. This is called "shielding."

It is sometimes found that underground pipes and other metallic structures of a gas works receive stray currents from the various pipes which connect the works to outside piping systems. Since stray currents are particularly objectionable here, on account of electrolysis and also possible danger from electric sparks, the entrance of such currents has in some gas works been prevented by installing insulating joints in each of the pipes connecting to the works.

In many American cities "electrical drainage" is used for the gas and water piping; but such tests as have been published consist only of current measurements on the pipes and of potential measurements between the drained pipes and trolley tracks. The complete data from which to judge the effectiveness of the system would involve the results of many other tests, particularly of measurements of drop across joints in the pipes, and of measurements of P.D. between the drained pipes and other underground structures.

Electrical drainage was first applied to lead cable sheaths, and the success led to the attempts to apply the drainage method also to pipes. There are marked differences, however, which render the piping system much less suited for electrical drainage. The principal difference is that cable sheaths are continuous electrical conductors, while pipes may be more or less discontinuous, due to the presence of high resistance joints. Also the lead cable sheaths are relatively small and are carried in ducts, which are mostly non-metallic, so that only part of the surface of the cables is in contact with earth, whereas underground pipes are buried directly in earth and generally present enormous contact areas to earth. The result is that, when electrical drainage is applied to pipes, the currents on the pipes are very greatly increased. This results in danger of current shunting around high-resistance joints or leaving the pipe on the positive side of a joint to flow to other structures.

If the pipe which is electrically drained is one which conveys an inflammable liquid or gas, or if it passes through a manhole or other confined space where inflammable gases may collect, the flow of stray current on the pipe may involve the danger of an explosion or fire, particularly at times when the continuity of the pipe is interrupted for repairs or for other causes. Many cases have been reported where in interrupting or re-jointing or re-caulking mains

electric arcing was produced. The writer has found that in a number of cities where pipe drainage is employed it is the general practice, when mains are to be interrupted or a joint is to be re-caulked, first to connect a heavy copper wire across the proposed break, so as to prevent danger from arcing.

Where both gas and water service pipes enter buildings, the result of producing large stray currents on the pipes is generally also to produce a flow of these stray currents through buildings. Such stray currents through buildings constitute a serious fire hazard. In the National Fire Protection Association "Quarterly" a case of this kind is described, where a gas service pipe showing marked pits from electric arcing with a water service pipe was taken from the cellar of a building.

The complete application of electrical drainage to pipes will involve draining all underground piping systems, and, in fact, bonding together all underground metallic structures affected by the stray currents, in such a way that at every point where different structures come into proximity in earth they are brought to practically the same potential.

When electrical drainage is applied to a single system of underground pipes, without making a complete investigation of the effects of possible high resistance joints, &c., the installation may be made at relatively small cost, and usually relieves the acute danger from electrolysis in the immediate neighbourhood. However, a single drained underground piping system becomes a source of serious danger to other systems. If electrical drainage is applied comprehensively to all underground metallic systems it will be very expensive. The large increase in current on underground structures produced by electrically draining them also brings about dangerous conditions at scattered and unknown places, which is a serious objection to this method. In Pittsburgh it is reported that drainage cables aggregating 17,000,000 cir. mils (86 sq. cm.) in cross-section connect to these pipes from the main railway supply station, and that the current drained from these pipes is nearly one-half of the total station current.

To minimise flow of stray current to pipes they should be laid as far from electric railway tracks as practicable. Metallic contacts with the tracks must be carefully avoided. Where the pipes cross steel bridges carrying electric railway tracks in metallic contact with the bridge structure, the pipes should be supported on wooden blocks or otherwise insulated from the metal of the bridge structure. Insulating joints should be installed at the entrance of pipes to car sheds, as it is frequently found that the pipes inside of the sheds are in metallic contact with the tracks through the building structure.

Effects of Electrolysis on Steel Foundations of Buildings, Bridges, &c., and on Reinforced Concrete Structures.

Stray current is most likely to reach steel building structures by means of pipes or cable sheaths entering the structure from underground piping or cable systems. It is, therefore, desirable, where appreciable stray currents are found, to instal insulating joints in such pipes and cable sheaths. Where the tracks over steel bridges are positive in potential they should be insulated from the bridge structure, in order to protect the bridge foundations against possible damage by electrolysis.

To cause damage to a reinforced concrete structure by electrolysis, an electric current must flow between the reinforcing steel and the surrounding concrete. The conditions required for producing electrolysis of steel embedded in concrete are such, however, that this can result, in the case of reinforced concrete structures, only in special situations, for example, where there is an excessive voltage drop through the earth at the foundations of the building, or where stray current is brought by way of service pipes or cable sheaths into the building and to the reinforcing steel, or where there is a direct contact between the reinforcing steel and one side of a direct-current lighting system, the other side of the system being grounded. It is, therefore, a wise precaution to instal insulating joints in all pipes and lead sheaths of cables which enter a reinforced concrete structure. It has been proposed to protect reinforced concrete structures by making the reinforced steel electrically continuous throughout, and connecting it to the negative terminal of the source of stray current or of a low-voltage generator. While this would prevent corrosion of the steel by electrolysis, it may result in destruction of the bond between the reinforcing steel and the concrete, which results when current flows from concrete to steel.

In the Grand Central terminal of the New York Central Railroad in New York City the tracks are insulated as far as possible from the structural steel by being carried on wooden ties embedded in concrete or stone ballast, and the latter is well drained so as to be maintained dry. Pipes and sheathed cables entering the structure are provided with insulating joints. Foreign pipes crossing the terminal at street level are carried on wooden supports embedded in sand, which is maintained dry by draining. Also the voltage drop in the tracks is kept very low by having a sub-station located directly at the terminal, and the structure is electrically drained to the sub-station negative 'bus bars. A careful watch is kept of the entire situation at the terminal.

Status of Electrolysis in Great Britain and Germany.

In Great Britain the Board of Trade regulations limit the P.D. between any two points in the uninsulated return circuit of an electric railway to 7 volts. In practice it is found that British electric railways operate well within the prescribed Board of Trade limits, and in many railways the maximum voltage drop in the track does not exceed 4 volts. Experience has shown that this affords adequate protection to underground structures against electrolysis, and no remedial measures have been applied to underground pipe or cable systems. Practically no cases of electrolytic destruction of underground structures have been reported in Great Britain.

In Germany the subject of electrolysis has been extensively studied during the past decade by a joint committee representing the Deutscher Verein von Gas und Wasserfachmännern, the Verband Deutscher Electrotechniker and the Verein Deutscher Strassenbahn und Kleinbahnverwaltungen, and as a result the following regulations were adopted in 1910: The track network is, for this requirement, divided into an inner and outer, or surburban, district. The P.D. between any two points on the uninsulated return circuit must not exceed 2·5 volts, under average load conditions, in the inner district and on a bordering belt 2 km. (6,560 ft.) wide; outside of this zone, in the surburban districts, the voltage drop must not exceed 1 volt per kilometre (3,280 ft.). Although these regulations have no legal force, they are, nevertheless, recognised as the standard throughout Germany.

Probable Future Tendencies in Electrolysis Mitigations.

The writer believes that the principal measure for relieving electrolysis dangers will in the future be secured by employing such constructions for direct-current electric railways using the running tracks for the return circuit as will minimise stray currents through earth. This will be accomplished by decreasing the voltage drop in the tracks, thereby correspondingly decreasing the voltage drop through earth, and by increasing the resistance from tracks to earth by the following means, given in the order of their importance:—

1. By increasing the number of direct-current supply stations in systems extending over large areas, so as to reduce the radius to which any one station supplies current.
2. By increasing the electrical conductance of the tracks through the use of heavy rails, low-resistance rail joint bonds, cross bonds and other suitable means.
3. By removing current from the tracks by insulated return feeders and by maintaining the negative 'bus bars insulated from ground at the supply station.
4. By increasing the resistance between tracks and earth as much as practicable.

The above railway constructions are already in general use in England and to a considerable extent also in Germany, and during the past few years such constructions have also been employed in a number of American electric railways. Experience has shown that such improvements can be practically carried to a point where stray currents through earth from these railways become negligible. The insulated return feeder system, in conjunction with proper track bonding, usually affords the most feasible means for reducing track voltage drop in an existing electric railway. If the tracks are to be connected to the negative 'bus bar at the supply station, this must only be done through a resistance proportioned so as to give substantially the same voltage drop as exists in the feeders. This system reduces the track voltage drop, and also diminishes the area over which the leakage of current from the tracks takes place. The effectiveness of this system is practically independent of the voltage drop in the feeders, and, consequently, of the weight of copper employed.

The insulated return feeder system is frequently confused with the system of "paralleling the tracks" with return feeders, which has been most commonly used in American electric railways. With copper feeders paralleling the tracks, however, the voltage drop in the tracks is reduced only in the proportion that the conductance of the track circuit is increased, and where the voltage drop in tracks is high this system would require a prohibitive amount of copper to reduce the voltage drop to reasonably low values. With the insulated return feeder system, on the other hand, the voltage drop in the insulated feeders does not occur in the tracks nor in the earth, and therefore may be made as high as economy dictates. With this system the power losses are increased over what they would be if the same amount of copper were employed in parallel with the tracks. This increase in power losses is a necessary expense, however, for the purpose of reducing stray currents through earth, and correspondingly reducing injury to underground structures.

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POWER SUPPLY.

Although the industrial prosperity of a country is dependent upon geographical position, upon abundance of mineral wealth and of raw materials, and upon suitable climatic conditions, as well as upon division of labour, good government and upon the habits of the community, one of the principal factors in ensuring such prosperity is the wide use of labour-saving machinery and tools. Given machinery and a plentiful and inexpensive supply of power, the geographical position of a country is a relatively unimportant factor in trade development, and experience shows that absence of mineral wealth in a country does not prevent the building-up of a very considerable trade by that country.

At one time the view was held by some that the introduction of machinery would displace manual labour, but it soon became evident that machinery gave employment to vastly increased numbers of men, since, on account of greatly reduced cost of manufacture, the commodity could be more widely distributed. A striking example of this is the cloth trade. The many-windowed cottages still standing in various parts of the country remind one of the time when cloth was manufactured by people in their own houses by means of hand looms, and when a suit of clothes was of such value as to be handed on from father to son. They also remind one of the period in our history when men banded themselves together with the sole object of wrecking power-driven machinery, in order that their children might not starve.

Events have shown that power-driven machinery applied to the cloth trade, to take a familiar example, has enabled our manufacturers to produce cloth in such quantity that it is largely the fault of the individual if he is unable properly and decently to clothe himself. In the manufacture of this cloth, and of the machinery associated therewith, it has been found well-nigh impossible to provide the necessary

manual labour; so it has been in every industry in which machinery has "displaced" manual labour. Had man been intended as a power-producing agent it is probable that he would have been endowed with greater physical endurance, and it is not unlikely that his general arrangement would have been different from what it is.

It has long been recognised that an abundant power supply is one of the principal assets of a nation. As long as Britain alone supplied the markets of the world it mattered little whether steam engines were economical or not so long as they did the work for which they were intended, and the development of improved methods of manufacture was not then a matter of vital importance. In course of time competitors entered the field, and this necessitated a revision of old-established practice. The keener and yet keener the competition the more and more urgent is the necessity for such revision in order to minimise cost of production. Examination of many Papers on the subject of power supply shows that, although all emphasise the importance of efficiency, and many indicate directions in which economies may be effected, few, if any, look upon these economies in the same light as posterity will in all likelihood look upon them. It would be idle to deny that immediate cash saving is of itself of sufficient importance to justify the closest investigation, but such saving when coupled with a husbanding of our resources makes close investigation imperative—the more so since, in recent years, the cost of fuel has increased enormously, and will, most probably, be forced still higher in the near future.

Three Papers bearing upon the question were read last month at the International Engineering Congress at San Francisco. One of these, by Mr. F. G. Baum, dealt with the effect of hydro-electric power upon economic and social conditions, with special reference to the United States, and it will be remembered that we gave the substance of this Paper in a recent issue. In another column will be found a Paper by Mr. C. H. Mitchell, dealing with electric power in Canadian industry, in which is given an account of the activities of the Hydro-electric Commission of Ontario, as well as of several other power companies in the Dominion.

The Hydro-electric Commission of Ontario has created a world-wide interest as an experiment in publicly-owned power, and being assisted by complete, effective legislation, it is one of the broadest examples of municipal ownership. A good idea of the extent of the distribution area served by the Commission will be obtained from the figures given in the Paper. The municipalities originally included in the power agreements numbered 15; at the beginning of the present year this number had been increased to 82. In 1912 there were 35,000 consumers, and at the end of 1914 there were nearly 97,000 consumers. Equally remarkable is the growth of the load. From the Paper it appears that in 1908 the municipalities entering into the agreement subscribed for 29,335 H.P.; distribution of power was commenced in 1910, and by 1916 it is estimated that the power will be in excess of 100,000 H.P. in the Niagara system alone. Three features deserve special mention: First, the power is intended to be available for every class of consumer, rural or urban; second, the equipment and general design are selected for most permanent and effective service; and, third, the power is supplied to the municipalities at cost. As pointed out by the author, the sale of power at cost, although eliminating much competition, cannot be said to be creating a monopoly, as several of the established companies were able to reduce their rates to a corresponding amount, and with decidedly less remunerative rates have been able, by greater activity in the handling of business, to maintain a sound financial existence. The selection of the personnel of the Commission has been a judicious one, and to these men, of whom Sir Adam Beck, K.C.B., has been Chairman from the beginning, must belong much of the credit for the present position.

The third Paper on the question of power supply read before the International Congress was by Dr. H. F. Parshall, and dealt with the economics of electric power-station design. We hope to publish this Paper in an early issue. Dr. Parshall considered the constants involved in the general problem, and, in order to illustrate the nature of the problem, he gave particulars of the electric supply of London. These differ materially from those given by Messrs. Merz and McLellan, and lead one to the conclusion that the areas covered are different in the two cases. Is it Dr. Parshall's assertion, namely, that the existing installations consume about 1,000,000 tons of coal per annum, whereas the bulk supply station would not consume more than 450,000 tons of the same class of fuel, deserves the serious consideration of those interested in the welfare of the country, as well as of those whose business it is to govern.

REVIEWS.

[Copies of the undermentioned works can be had from The Electrician Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

A Treatise on Hand Lettering for Engineers, Architects, Surveyors and Students of Mechanical Drawing. By W. J. Lineham, B.Sc. Pp. xii.+282. (London: Chapman & Hall.) 7s. 6d. net.

Considering the very large number of both men and women in this country whose daily occupation is lettering and figuring on mechanical drawings, it is almost incredible that up to the present time no book has been written which would serve as a standard work of instruction and reference on the subject. The absence of such a work has been a long-felt want amongst draughtsmen and students anxious to cultivate neat and correct styles of lettering, and the volume here under review will, therefore, be welcomed and appreciated.

Some are naturally gifted in penmanship, and with but little practice acquire great proficiency in neat lettering; others require a considerable amount of training, and only acquire proficiency after long practice and careful study.

In any case, it is essential in the elementary stages that the student should have instruction and guidance as to the correct formation of letters, the best styles to adopt and also the best methods of arranging the lettering on the drawings, and for lack of tuition, many otherwise excellent draughtsmen find themselves woefully deficient in this very desirable accomplishment.

It will invariably be found that in offices from which neat and accurate workmanship is systematically turned out, the heads of the department are themselves highly proficient in this respect, and insist upon a certain standard of excellence in the work of their subordinates. Such offices provide the best training for beginners. Those, however, who have not the opportunity of obtaining the necessary skilled instruction in the office, will welcome the facilities provided by Mr. Lineham in his new book.

The author shows an extensive knowledge of the best practice obtaining in the various kinds of drawing office work, and has compiled the volume with a view to making it instructive and useful not only as a guide in correct styles of lettering, but also as a book of reference containing practical examples of titles, schedules, finished drawings, &c.

In addition to the more usual and useful styles of hand lettering adopted on drawings, several examples of decorative and quaint lettering are also included.

The commonly adopted but less effective mechanical methods

of lettering, by means of stencils and rubber stamps are dealt with, and reference is made to their uses and limitations. Chapters on zincography and on the preparation of drawings for the Patent Office will be found particularly useful to those engaged in such work. The various photo-printing processes in common use in all drawing offices are described in detail.

The volume is got up in an attractive style, the letterpress is in bold type with ample margins, which, combined with the very concise form of instructions given, will appeal to practical men. J. M. J.

Die Wirtschaftlich Günstigste Spannung für Fernübertragungen Mittelst Freileitungen. By Dr. Helmuth Eimer. (Berlin: Julius Springer.) Pp. 113. Price M.3.60.

This little book was received at the end of July last year, when international courtesies between English and German publishing houses were still possible. In view of the time that has elapsed, it can hardly be said that the present criticisms are hasty or prejudiced. The matter dealt with in the book is limited to the determination of the most economical pressure for overhead power lines carrying heavy loads to great distances and the author treats it in meticulous detail. The enunciation of the problem is simple enough. "The best transmission pressure is that which gives a minimum value for the total annual costs chargeable against the line and its adjuncts." In this figure are of course included the cost of the energy losses in heating, &c., and the annual expenses for interest on capital, depreciation, maintenance and sinking fund

The general conditions for economy are stated analytically, and the effect of the various factors on the final result are carefully considered. Owing to the multiplicity of the factors and the wide variations to which they are subject, it is difficult to arrive at an analytical solution universally applicable. By a proper selection of values for the factors, however, a fair approximation can be made to the best working pressure. In applying the principles laid down to actual practice graphic methods are quickest and most direct, and the author represents most of his results in this form, except where algebraical analysis is distinctly simpler. He gives a good deal of useful information in his study of each factor, such as transformers, sub-stations, switchgear, poles, and their construction, conductors, spans, &c. The direct costs of those of the energy losses in transformers and lines, including the corona losses in the latter, also receive a good deal of attention. He discusses their relative importance and shows graphically how they tend to influence the final result.

The reliability of the supply of power to industrial districts is recognised as vital, and it is pointed out that the question of cheapness *per se* should never predominate in the equipment. On this account allowance is made in all investigations for duplication of the lines and sub-station switches.

The tendency to employ very high pressures without calculation can easily be overdone. This is exemplified in one of the American schemes, where 12,000 kw. are transmitted for 150 miles at a pressure of 140,000 volts, whereas 90,000 would have been the most economical for the working conditions. The saving in the line material at 140,000 volts is more than counterbalanced by the extra cost of transformers and switchgear, and to a still greater extent by the increase in corona losses. So important is the corona effect that it furnishes an upper limit for the economic pressure in the case of any but the very largest loads to be transmitted. Thus, it is best to select such a value for the voltage as to be just insufficient to produce the corona effect. This aspect of the problem is analogous to the application of Kelvin's law to underground cables. As the current density obtained from it is generally more than that permitted by the temperature rise the latter value can be worked up to without any calculations for economy.

On the whole, the author has done his work well, although investigations of this kind are usually antipathetic to English engineers. The latter mostly prefer to do something which previous experience has shown to be satisfactory, without delving over the ground according to the Teutonic method.

J. R. D.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Continued from page* 134.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

General Formula for Mean Value of σ_1.—The general formula already mentioned will now be developed. Let r_1, r_2 denote the numerator and denominator of the ratio S_1/S_2 *when reduced to its lowest terms*. These numbers will be termed the *ratio numbers*.

By working numerous examples the following formulæ will be found to give the exact values of β_m at positions 1 and 2.

At Position 1.

$$\beta_m = \left(\frac{10}{9} + \frac{r_1^2 + r_2^2 + 2}{2r_1r_2}\right) \Big/ S_1S_2.$$

when S_1, S_2 are *both odd*.

$$\beta_m = \left(\frac{10}{9} - \frac{r_1^2 + r_2^2 - 1}{2r_1r_2}\right) \Big/ S_1S_2.$$

when *one* of the numbers S_1, S_2 is *odd* and the *other even*.

At Position 2.

$$\beta_m = \sqrt{3}\left\{\frac{23}{36} - \left(\frac{r_1^2 + r_2^2 - 1}{4r_1r_2}\right) \Big/ S_1S_2\right\}$$

in all cases except where S_1, S_2 *are both even.*

Though the above formulæ do not apply when S_1, S_2 are both even, it will be seen, by comparison of results deduced from the general formula with examples of this particular case obtained by direct calculation, that the formula yet gives, for this case also, a correct value of $\sigma_{1\ \text{mean}}$.

Now when S_1, S_2 are both odd position 1 is the position of true minimum σ_1, while when S_1 is odd and S_2 even, or vice versa, the position of true minimum is at a distance of $\frac{1}{2}$ from position 1 when the pole-pitch is taken equal to the least common multiple of S_1 and S_2—*i.e.*, when $\tau = \frac{S_1}{r_1} r_1 r_2$, or $\frac{S_2}{r_2} r_1 r_2$, so that $\tau^2 = S_1 S_2 r_1 r_2$.

Now, in passing from position 1 to the position of true minimum no rotor slots pass any stator slot, while *at* position 1 the distribution of rotor slots is symmetrical with respect to that of the stator slots.

Under these circumstances a little consideration shows that β_1 remains constant while β_2 and β_3 change from $-\frac{1}{3}$ at position 1 to $-\left(\frac{1}{3} - \frac{1}{\tau}\right)$ and $-\left(\frac{1}{3} - \frac{1}{\tau}\right)$ respectively at the position of true minimum. Therefore, at this position

$$\beta_{m\,\max.} = \sqrt{\beta_1^2 + \left(\tfrac{1}{3} + 1\ \tau\right)^2 + \left(\tfrac{1}{3} - 1\ \tau\right)^2 + \beta_1\left(\tfrac{1}{3} - 1\ \tau\right) - \left(\tfrac{1}{3} - 1\ \tau\right)\left(\tfrac{1}{3} - 1\ \tau\right) - \beta_1\left(\tfrac{1}{3} - 1\ \tau\right)}.$$

$$= \sqrt{\beta_1^2 + \tfrac{2}{3}\beta_1 + 1\ 9 + 3\ \tau^2} = \sqrt{\left(\beta_1 + \tfrac{1}{3}\right)^2 + 3\ \tau^2} = \sqrt{\beta_m^2 + 3\ \tau^2}.$$

Since $3\ \tau^2$ is always small compared with β_m^2, we may expand

the quantity under the radical and, with sufficient accuracy, neglect all terms but the first and second.

Then, $\beta_{m_{\max.}}=\beta_m\left(1+\frac{3}{\beta_m{}^2\tau^2}\right)^{\frac{1}{2}}$,

$$=\beta_m\left(1+\frac{3}{2}\frac{1}{\beta_m{}^2\tau^2}\right)=\beta_m+\frac{3}{2}\frac{1}{\beta_m\tau^2}.$$

Now $\beta_m=\left\{\frac{10}{9}+\left(\frac{r_1{}^2+r_2{}^2-1}{2r_1r_2}\right)\Big/S_1S_2\right\}$,

and the second part of this expression is always small compared with $\frac{10}{9}$. Since also the term $\frac{3}{2}\frac{1}{\beta_m\tau^2}$ is small compared with β_m we may substitute the approximate value $\frac{10}{9}$ for β_m in this term, so that

$$\beta_{m_{\max.}}=\beta_m+\frac{3}{2}\frac{1}{\frac{10}{9}\tau^2}=\beta_m+\frac{27}{20}\frac{1}{\tau^2}=\beta_m+\frac{3}{2}\frac{1}{\tau^2}\text{ nearly.}$$

Therefore, since $\tau^2=S_1S_2r_1r_2$,

$$\beta_{m_{\max.}}=\beta_m+\frac{3}{2}\frac{1}{r_1r_2}\Big/S_1S_2=\frac{10}{9}+\left(\frac{r_1{}^2+r_2{}^2-1}{2r_1r_2}\right)\Big/S_1S_2+\frac{3}{2}\frac{1}{r_1r_2}\Big/S_1S_2,$$

$$=\frac{10}{9}+\left(\frac{r_1{}^2+r_2{}^2+2}{2r_1r_2}\right)\Big/S_1S_2.$$

This shows that $\beta_{m_{\max.}}$ is given approximately by the same formula when one of the numbers S_1, S_2 is even and the other odd, as it is when S_1, S_2 are both odd.

Again, except when S_1, S_2 are both even, position 2 is the position of true maximum σ, so that

$$\beta_{m_{\min.}}=\sqrt{3}\left\{\frac{23}{36}+\left(\frac{r_1{}^2+r_2{}^2-1}{4r_1r_2}\right)\Big/S_1S_2\right\}.$$

In general, therefore,

$$\sigma_{1\text{mean}}=\tfrac{1}{2}(\sigma_{1\min.}+\sigma_{1\max.}),$$

$$=\left(\frac{\frac{1}{2}(\beta_s+\beta_r)-\beta_{m_{\max.}}}{\frac{1}{2}(\beta_s+\beta_r)}\right)+\left(\frac{\frac{1}{2}(\beta_s+\beta_r)-\beta_{m_{\min.}}}{\frac{1}{2}(\beta_s+\beta_r)}\right),$$

$$=2-\left(\frac{\beta_{m_{\max.}}+\beta_{m_{\min.}}}{\frac{1}{2}(\beta_s+\beta_r)}\right),$$

$$=2-\frac{\left(\frac{10}{9}+\frac{23}{36}\sqrt{3}\right)+\frac{(2+\sqrt{3})(r_1{}^2+r_2{}^2)+(4-\sqrt{3})}{4r_1r_2}\Big/S_1S_2}{\left(\frac{10}{9}+\frac{1}{S_1{}^2}+\frac{1}{S_2{}^2}\right)}.$$

Now,

$$\left(\frac{10}{9}+\frac{1}{S_1{}^2}+\frac{1}{S_2{}^2}\right)=\frac{10}{9}+\frac{S_1{}^2+S_2{}^2}{S_1{}^2S_2{}^2}=\frac{10}{9}+\frac{r_1{}^2+r_2{}^2}{r_1r_2},\ S_1S_2,$$

$$=\frac{10}{9}\left\{1+\frac{9}{10}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\Big/S_1S_2\right\}=\frac{10}{9}\left(1+\frac{a}{S_1S_2}\right).$$

$$\therefore\ \sigma_{1\text{mean}}=2-\frac{\frac{9}{10}(b+c/S_1S_2)}{(1+a/S_1S_2)},$$

where $a=\frac{9}{10}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)$,

$b=\left(\frac{10}{9}+\frac{23}{36}\sqrt{3}\right)$,

and $c=\frac{(2+\sqrt{3})(r_1{}^2+r_2{}^2)+(4-\sqrt{3})}{4r_1r_2}$.

$$\therefore\ \sigma_{1\text{mean}}=2-\frac{9}{10}\left(b+\frac{c}{S_1S_2}\right)\left(1-\frac{a}{S_1S_2}+\frac{a^2}{S_1{}^2S_2{}^2}\right),$$

neglecting powers of $\frac{1}{S_1S_2}$ higher than the second.

$$\therefore\ \sigma_{1\text{mean}}=2-\frac{9}{10}\left\{b+\frac{(c-ab)}{S_1S_2}-\frac{a(c-ab)}{S_1{}^2S_2{}^2}\right\}.$$

Let S denote $\frac{1}{2}(S_1+S_2)$.

Then, since $r_1r_2=S_1S_2$,

$$\therefore\ (r_1+r_2)r_2=(S_1+S_2)S_2=2S^2-S_1S_2\text{ and }(r_1+r_2)^2=4S^2-2S_1S_2,$$

$$\therefore\ \frac{1}{S_1S_2}=\frac{(r_1+r_2)^2}{4r_1r_2}-\frac{1}{2}$$

$$\therefore\ \sigma_{1\text{mean}}=2-\frac{9}{10}\left\{b+\frac{(r_1+r_2)^2}{4r_1r_2}(c-ab)-\frac{(r_1+r_2)^2}{8r_1r_2}(c-ab)\right\}$$

Now

$$(c-ab)=\frac{(2+\sqrt{3})(r_1{}^2+r_2{}^2)+(4-\sqrt{3})}{4r_1r_2}-\frac{9}{10}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left(\frac{10}{9}+\frac{23}{36}\sqrt{3}\right)$$

$$=\left\{(1-\tfrac{1}{4}\sqrt{3})-\frac{(r_1{}^2+r_2{}^2)}{r_1r_2}\left(\frac{1}{2}+\frac{13}{40}\sqrt{3}\right)\right\}.$$

$$\therefore\ \sigma_{1\text{mean}}=\left(1-\frac{23}{40}\sqrt{3}\right)+\frac{9}{10}\frac{(r_1+r_2)^2}{4r_1r_2}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left(\frac{1}{2}+\frac{13}{40}\sqrt{3}\right)-\frac{(1-\frac{1}{4}\sqrt{3})}{r_1r_2}$$

$$+\frac{\frac{81}{1,600}\frac{(r_1+r_2)^4}{r_1{}^2r_2{}^2}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left\{\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left(\frac{1}{2}+\frac{13}{40}\sqrt{3}\right)-\frac{(1-\frac{1}{4}\sqrt{3})}{r_1r_2}\right\}}{S^4}.$$

The last term is, for $S=or>9$, so small compared with the second term that, if we write the expression in the form

$$\sigma_{1\text{mean}}=a-\frac{b-c/S^2}{S^2},$$

we may take the mean value of $(b-c/S^2)$ (regarded as a function of $1/S^2$), between $1/S^2=0$ and $1/9^2$ as a constant coefficient B, so that

$$\sigma_{1\text{mean}}=a+\frac{B}{S^2}=\left(1-\frac{23}{40}\sqrt{3}\right)+\frac{B}{S^2}=0{\cdot}004-\frac{B}{S^2},$$

where

$$B=\left[\frac{9}{40}\frac{(r_1+r_2)^2}{r_1r_2}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left(\frac{1}{2}+\frac{13}{40}\sqrt{3}\right)-\frac{(1-\frac{1}{4}\sqrt{3})}{r_1r_2}\right.$$

$$\left.-\frac{1}{3,200}\frac{(r_1+r_2)^4}{r_1{}^2r_2{}^2}\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left\{\left(\frac{r_1{}^2+r_2{}^2}{r_1r_2}\right)\left(\frac{1}{2}+\frac{13}{40}\sqrt{3}\right)-\frac{(1-\frac{1}{4}\sqrt{3})}{r_1r_2}\right\}\right].$$

$$=\frac{(r_1+r_2)^2}{r_1r_2}\left\{0{\cdot}24\frac{r_1{}^2+r_2{}^2}{r_1r_2}-\frac{1}{8r_1r_2}\right\}\left\{1-\frac{1}{720}\frac{(r_1-r_2)^2(r_1{}^2+r_2{}^2)}{r_1{}^2r_2{}^2}\right\}.$$

All the terms in this expression for B except one depend only on the ratio r_2/r_1. The term $1/8r_1r_2$, which depends on the values of r_1, r_2—not merely on their ratio—is negligibly small, except for comparatively small values of r_1, r_2.

In Table II. are given the values of B for various values of r_1, r_2.

For values of r_1, r_2 greater than those shown, B is given for a number of different ratios r_2/r_1, on which alone it then depends.

Table II.—*Values of B.*
$(\sigma_1=0{\cdot}004+B\ S^4)$

r_1.	r_2.						
	1	2	3	4	5	6	7
1 (S odd	1·4	2·4	...	...	...	...	...
1 (S even) ...	1·3						
2.....	...	...	2·05	...	...	...	...
3.....	...	...	...	1·95	2·25	...	...
4.....	...	...	...	...	1·95	...	2·35
5.....	...	...	...	...	...	1·95	2·05
6.....	...	...	...	...	...	...	1·90

Ratio $\frac{r_2}{r_1}$.	B (for values of r_1, r_2 not given above).	Ratio $\frac{r_2}{r_1}$.	B (for values of r_1, r_2 not given above).
1·0	1·90	1·6	2·2
1·1	1·90	1·7	2·3
1·2	1·95	1·8	2·4
1·3	2·0	1·9	2·5
1·4	2·05	1·95	2·6
1·5	2·1	...	...

In Table I. are shown in the last column values of $\sigma_{1\text{mean}}$ calculated by the formula, and it will be seen that these agree very closely indeed with the results obtained by direct calculation of each individual example.

The case S_1, S_2, both even, was omitted in the development of the general formula, but the comparison of Table I. shows that in this case also the agreement is equally close.

It will be noticed that for the same number of slots in stator and rotor (*i.e.*, $r_1=r_2=1$) Table II. gives different values of B for S even and S odd. The value of B for S odd has been calculated from the general expression for B.

The value of B for S even has been calculated by another method which it is not worth while to give here, as, of course, in practice the numbers of stator and rotor slots are never the same.

Influence of the Slot Ratio on σ_1 mean.—While the general formula shows that the value of σ_1 mean diminishes rapidly with an increasing mean number of slots, Table II. shows that the more closely the ratio r_2/r_1 approaches unity the lower becomes the value of B tending (if we exclude the case of equal numbers of stator and rotor slots) to the limit 1·9. It is thus advantageous to have a number of rotor slots only slightly different from the number of stator slots. There is the additional advantage in this that the number of positions where stator and rotor slots coincide is greater for a given mean number of slots, the more nearly the numbers are equal, thus reducing the magnitude of the *local* variations of σ_1. Moreover, not only the *local* but the *total* variation also, becomes less the more nearly S_1, S_2 are equal, always excluding the case of actual equality. This will be seen from an inspection of Table I.

Calculation of σ_1 when the Number of Slots per Pole per Phase is not a Whole Number.—So far the numbers of slots per pole per phase in both stator and rotor have been assumed to be whole numbers. While this is usually the case with the stator, the rotor frequently has neither a whole number per pole per phase, nor even per pole, and this may be so whether the windings be of the hemitropic form, or the rotor wave-wound or of the squirrel-cage type.

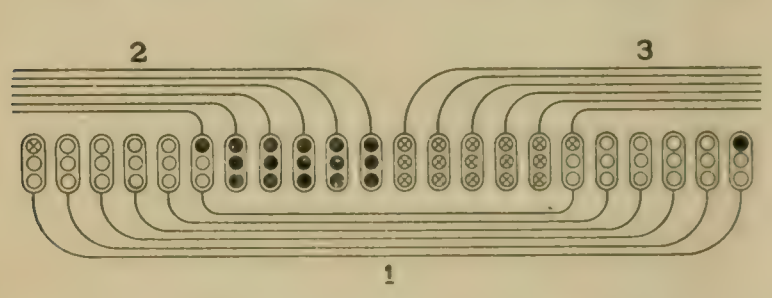


FIG. 12.—CASE OF 16 ROTOR SLOTS PER POLE. FIRST METHOD OF WINDING.

Let us consider the first type of winding—the hemitropic arrangement.

Take, for example, a motor having 12 stator and 16 rotor slots per pole. The number of rotor slots per pole being a whole one, the complete coil per pair of poles may be regarded as made up of a number of individual coils, *each of which spans an exact pole-pitch.* The linkage with any one of these individual coils due to a current in any other coil is given as before by the formula

$$(\tau-2x).$$

It will be supposed in the first place that all slots contain the same number of conductors, and that all slots are wound. For this to be so some slots must contain conductors of two different phases.

It is convenient to assume three conductors per slot. The arrangement of such a winding is shown in Fig. 12.

This is the most symmetrical arrangement possible. Position 1 is to be regarded as the position in which the centres of the coils of phases 1 of stator and rotor coincide, while position 2 is, as before, one-sixth of a pole-pitch from position 1.

With a whole number of slots per pole per phase β_r is the same for rotor coils of all phases and β_m is the same for every stator and rotor coil. With the want of symmetry of the above rotor winding, however, β_r is not the same for all phases, while β_m is neither the same for all rotor nor even for all stator phases.

We shall take as the value of β_r, therefore, the mean of the values obtained for the three rotor phases, and for β_m the mean of those for the three stator and three rotor phases.

$$\therefore\ \beta_r=\tfrac{1}{3}(\beta_{r1}+\beta_{r2}+\beta_{r3}),$$

and

$$\beta_m=\tfrac{1}{6}(\beta_{m1}+\beta_{m2}+\beta_{m3})+(\beta'_{m1}+\beta'_{m2}+\beta'_{m3}).$$

β_s is, of course, the same for all stator phases.

$$\beta_s=\frac{10}{9}-\frac{2}{12^2}=\frac{864}{768}.$$

Calculation of β_r.—$\tau=16$.

For β_1.

$$\Sigma x=2\left\{\begin{array}{r}2\times3(1+2+3+4)+2\times2\times5\\+3\times2+3\times3(1+2+3)+3\times2\times4\\+3\times2\times2+3\times3(1+1+2)+3\times2\times3\end{array}\right\}$$
$$=2(80+84+66)=460.$$

Here account has been taken of the fact that some slots contain only two conductors of the same phase, while others contain three.

$$\therefore\ \beta_1=\left(1-\frac{2\times460}{16\times16\times16}\right)=\left(1-\frac{115}{512}\right)=\frac{397}{512}.$$

For β_2 $\quad\Sigma x=16\times15\times5\tfrac{1}{2}+16\times2\tfrac{1}{2}=16\times85=1.360.$

$$\therefore\ \beta_2=-\left(1-\frac{2\times1,360}{16\times16\times16}\right)=-\left(1-\frac{340}{512}\right)=-\frac{172}{512},$$

the minus sign being prefixed because Σx has been reckoned for convenience between the left-hand side of coil 1 and the right-hand side of coil 2.

$$\beta_2=\beta_3\quad\therefore\ \beta_{r1}=(\beta_1-\beta_2)=\frac{569}{512}=\frac{853\cdot5}{768}.$$

In a similar manner we obtain

$$\beta_{r2}=\beta_{r3}=\frac{854\cdot2658}{768}.$$

$$\therefore\ \beta_r=\tfrac{1}{3}(\beta_{r1}+\beta_{r2}+\beta_{r3})=\frac{854\cdot0105}{768}.$$

$$\therefore\ \tfrac{1}{2}(\beta_s+\beta_r)=\frac{859\cdot0052}{768}.$$

Calculation of β_m and σ_1.—The value of β_m, of course, depends on the position of the rotor relative to the stator. The position of maximum β_m is distant $\frac{1}{2}$ from position 1 (when $\tau=48$), while position 2 is the position of minimum β_m.

For position of minimum σ_1—

$$\beta_{m1}=\frac{853\cdot4500}{768}\qquad\beta'_{m1}=\frac{855\cdot4490}{768},$$

$$\beta_{m2}=\frac{855\cdot3438}{768}\qquad\beta'_{m2}=\frac{854\cdot5074}{768},$$

$$\beta_{m3}=\frac{856\cdot5675}{768}\qquad\beta'_{m3}=\frac{855\cdot3946}{768}.$$

$$\therefore\ \beta_m=\frac{855\cdot1187}{768}.$$

$$\therefore\ \sigma_{1min}=\frac{2(859\cdot0052-855\cdot1187)}{859\cdot0052}=0\cdot0090.$$

For position of maximum σ_1—

$$\beta_{m1}=\frac{849\cdot5705}{768}\qquad\beta'_{m1}=\frac{851\cdot7363}{768},$$

$$\beta_{m2}=\frac{851\cdot7422}{768}\qquad\beta'_{m2}=\frac{849\cdot5705}{768},$$

$$\beta_{m3}=\frac{851\cdot7422}{768}\qquad\beta'_{m3}=\frac{851\cdot7363}{768}.$$

$$\therefore\ \beta_m=\frac{851\cdot0163}{768}.$$

$$\therefore\ \sigma_1=\frac{2(859\cdot0052-851\cdot0163)}{859\cdot0052}=0\cdot0186.$$

$$\therefore\ \sigma_{1mean}=\frac{0\cdot0090+0\cdot0186}{2}=0\cdot0138.$$

In Table III. are shown the values of σ_{1mean} calculated in the manner just described, for several different cases, the number of rotor slots per pole being a whole number not a multiple of 3.

Table III.—*Values of σ_1. Number of Rotor Slots per Pole a Whole Number, but not a Multiple of 3.*

S_1.	S_2.	$\sigma_{1min.}$	$\sigma_{1max.}$	$\sigma_{1mean.}$	$\sigma_{1mean.}$*
12	16	0·0090	0·0186	0·0138	0·0140
12	20	0·0080	0·0177	0·0129	0·0128
15	20	0·0058	0·0148	0·0103	0·0104

In the last column are shown the values for σ_{1mean} calculated by means of the general formula $\sigma_1 = 0{\cdot}004 + \frac{B}{S^2}$, where B is obtained from Table II.

It will be seen that the values so obtained agree very closely with those obtained by direct calculation for each individual case.

This shows that where the number of rotor slots per pole per phase is not a whole number, but the number of rotor slots per pole *is*, the general formula for σ_{1mean} holds good in spite of the fact that the conductors of the different phases overlap, so that some slots contain conductors of two different phases.

(*To be continued.*)

SCIENCE IN THE WAR AND AFTER THE WAR.

In a lecture bearing this title, to which we referred briefly in our issue of October 8th, Dr. J. A. Fleming made the following interesting remarks in regard to difficulties in using wireless telegraphy in aerial warfare :—

In the case of aeroplanes, the first of these difficulties is the weight of the apparatus. The military aeroplane is already loaded to its fullest extent. In addition to the pilot and observer and the bomb ammunition, it carries in nearly all cases some gun equipment. Hence any wireless apparatus must be made as light and compact as possible. The source of E.M.F. is generally a small dynamo or alternator, which is coupled to the engine, and the voltage or pressure is raised to 30,000 volts or so by a small transformer sealed up in oil in a box. The condenser consists of metal plates sandwiched between sheets of glass or ebonite, and the spark balls between which the spark passes are also enclosed. The weight of the whole apparatus has to be kept below 100 lb., and such apparatus has been designed having a weight of not more than 30 lb. The French use a set weighing about 70 lb. One of the difficulties is to dispose the aerial wire conveniently and safely. It is sometimes made of aluminium and stretched on insulators carried by light supports on the wings, but the difficulty is to obtain in this way sufficient length. One plan adopted is to coil the wire on a reel, which the observer can uncoil and let it float out behind the aeroplane.

The wire must be connected to the reel by a safety catch so as to be released at once if it catches in trees or buildings. By this means an aerial wire of 100 ft. in length can be employed. The observer has near his hand a key by which he controls the spark discharges, and so sets up in the aerial wire groups of electric oscillations which create electric waves in the ether, and signal the message in Morse code. In this manner there is not much difficulty in equipping aeroplanes with transmitters which will send messages 30 miles or so to a corresponding earth station.

The receiving arrangements used on aeroplanes comprise a head-telephone, which is worn by the observer associated with some simple form of detector, such as a carborundum crystal, aided by which the observer hears the signals sent to him in Morse code as long and short sounds in the telephone. The noise of the aeroplane engine and that of the rush of air renders this method of aural reception a matter of great difficulty, especially as the messages must be sent in secret code, and the observer must, therefore, hear every letter distinctly if the message is to be intelligible. Great efforts have been made to devise methods of reception which shall appeal to the eye by a visual signal rather than to the ear, but the exceedingly small electric currents set up in the aerial wire by the arriving waves make this a matter of extreme difficulty, and the problem has not yet been completely solved. There is then the difficulty caused by "jamming." If the signals from an aeroplane are picked up by a hostile station, this latter at once sends out powerful but unmeaning signals, the object of which is to blur and drown out the reception or sending of signals by this aeroplane. Moreover, the sending of wireless signals by an aeroplane reveals its presence to hostile earth stations before it can be seen by the eye.

* Calculated by general formula.

Hence wireless telegraphy may be a means of revealing the enemies' scouts, and it involves a certain kind of war in the ether as well as war in the air.

In the case of airships there are other difficulties as well, and it is interesting to note that there are special difficulties in connection with Zeppelins. These aerial monsters are, as everyone knows, constructed with a framework of aluminium, containing in its interior the 18 or 20 balloons inflated with hydrogen. Now as we rise upwards in the air the electric potential increases rapidly, and if a conducting body at a height gives off water drops or products of combustion it is rapidly brought to the potential of the air at the place where it is. In the case of Zeppelins this equalisation is no doubt brought about by the escape of products of combustion produced by the engines. When the conducting body is brought down suddenly to earth again there may be a great difference of potential between it and the objects on the earth. If it is a good conductor a spark may pass, and if it is, as in the case of a Zeppelin, a conducting body containing a highly inflammable gas, leakage of which cannot altogether be prevented, this spark may cause an explosion and destruction of the airship. Again, the violent electric oscillations created in all metal objects near powerful radiotelegraphic apparatus may cause sparks to jump between metal parts, and hence may inflame a hydrogen leak.

It has, therefore, been recognised that there are special electrical difficulties in connection with the working of wireless on rigid airships with metal frames, and also in connection with the use of spark apparatus. However carefully the actual working spark is enclosed, there is always risk of induced sparks. There is room, therefore, yet for much research and experimenting in connection with the use of wireless telegraphy on aeroplanes and airships, and the practical problems are by no means completely solved.

Passing on to the importance of engineering in warfare, Dr. Fleming remarked : The 42 cm. Krupp gun which smashed in a few days the fortifications of Liége, Namur and Antwerp, which were confidently expected to hold out for months, is only a piece of heavy engineering. The complete gun weighs 87 tons, and the foundations or carriage 37 tons. Two hundred men are necessary to erect and work each gun, which requires 12 railway wagons for its transport and is composed of 172 parts. It takes 25 to 26 hours to erect in place. The projectile or shell weighs 8 cwt., and is 5 ft. 4 in. long and 16½ in. diameter. It is fired electrically from a distance of about ¼ mile, and each shot costs £550. The range at which the Liége forts were destroyed was 14 miles. The mere transport and erection of this gun, let alone its manufacture, demands engineering knowledge of a special kind. It is the same with smaller arms. The rifle, except as a support for a bayonet, has almost become obsolete in face of the machine gun.

To win this war we have to achieve engineering feats. The mammoth howitzer, the great armoured triple-engined aeroplane, and the quick-firing machine guns are all products of the engineer's workshop, and the pivot round which all Germany's maleficent power turns is Krupp's works at Essen and the chemical and ammunition factories in Westphalia. The knock-out blow will be given at those points, and they must be reached through the air if trench work proves too slow.

CORRESPONDENCE.

BATTERY VEHICLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Mr. W. H. L. Watson, of Edison Accumulators (Ltd.), has read before the meeting of the Tramways and Light Railways Association an excellent Paper on the subject of "Battery Vehicles as an Adjunct to Tramways," of which an abstract appears in your issue of July 23rd last, p. 591.

Whilst in complete agreement in the main issue with Mr. Watson, strong exception must be taken to the result of his comparison between the three different types of batteries mentioned. Mr. Watson maintains that for equal capacities the total costs of operation of a flat plate, and Ironclad Exide and an Edison battery for a service of 60,000 miles have the approximate relative values of 2, 1·7 and 1. The object of this letter is to show that this conclusion is entirely erroneous, as will be seen from the following facts and figures.

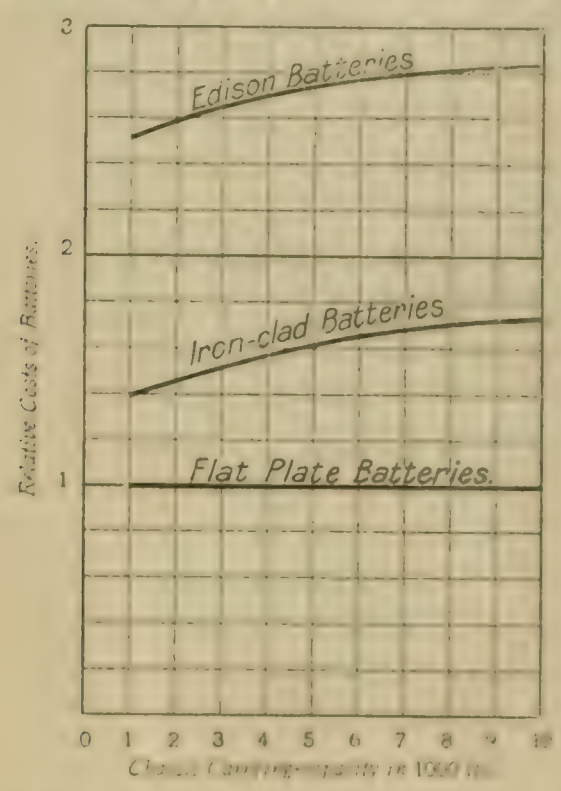
Mr. Watson starts in a doubly misleading manner by taking as a basis for comparison the catalogue prices of the batteries, and by selecting a small size of battery for which there is not

much field at present, and for which the ratio of catalogue prices is the most advantageous for the Edison battery.

It is obvious to anyone that what matters to the buyer is not the catalogue price but the market price. At the present moment Edison batteries are, in this country, a proprietary article sold with chassis of mostly American make, so that it is not easy to determine the proper market value of the battery alone in relation to the catalogue price. Flat plate and Ironclad batteries can be obtained without chassis direct from the manufacturers, and their market value bears a fairly well-defined relation to the catalogue prices. However, even if we admit that the catalogue price bears in each case the same relation to the market value it is unfair to generalise from figures obtained with the particular size of battery selected by Mr. Watson.

In the attached diagram the relative value of the catalogue prices of similar batteries have been plotted from the catalogues of the General Motor Co., of Pontiac, U.S.A., whose vehicles are sold in America with either Edison, Ironclad or flat-plate batteries, and are, we believe, sold in England by the Edison Company. In every case the price of the flat-plate has been taken as unity, and the prices are plotted in terms of the vehicle capacities, so that we have a comparison of the costs of batteries, which, if placed on the same vehicle, would give the same mileage per charge.

Considering that the demand is now for vehicles between two and three tons capacity, it would have been fairer to com-



pare batteries of about 20 kw.-hour capacity than of 11 kw.-hour as chosen by Mr. Watson, and it will be seen that for this size the Edison battery appears in a much more favourable light.

The figure of 1·5d. per car-mile mentioned by Mr. Watson with regard to flat-plate maintenance is greatly exaggerated. We do not know, of course, to what particular make of battery it applies, but it will be sufficient to state here that the Tudor Company is prepared to quote for a battery of similar capacity operated on a vehicle of approved make considerably below 1·5d. per car-mile, and this includes the supply of all material (not only plates) and labour to keep the battery in first class condition during a period of 5 to 10 years. As stated below, this figure can be reduced further when the owner is in a position to supply the labour to make the necessary repairs.

Mr. Watson does not seem aware that the Ironclad Exide batteries of the Chloride Electrical Storage Co. (Ltd.) are sold under a two years' guarantee irrespective of mileage, or alternatively, under a maintenance agreement.

Mr. Watson omits to mention the fact that Edison batteries are considerably less efficient than lead batteries, and fails to take this important factor into consideration. In a 2 to 2½ ton vehicle the difference is of the order of nearly ½d. per car mile with current at 1d. per unit.

Mr. Watson omits to mention that, however little maintenance Edison batteries require, still some is necessary. In fact, his company quotes 0·21d. per car-mile for a 300 ampere-hour battery suitable for a 2 to 2½-ton vehicle.

Bearing all these points in mind, the following table may be drawn up for the total costs of operation of a 60,000 miles' service for the three types of batteries suitable for a 2 to 3-ton vehicle, the above mileage being covered in a period of five years :—

	Market value.
60 cells A. 8 Edison (300a.+65)—19·5 kw.-hour.....	£350
40 cells IMV. 7 Ironclad (226a.+80)—18·1 kw.-hour.....	165
40 cells KYB. 15 Tudor (280a.−78)—21·8 kw.-hour.....	115

	Tudor.	Ironclad Exide.	Edison.
Original cost	£115	£165	£350 0
Tudor maintenance, 1·75d. per car-mile—60,000 × 1·75 240	437	...	...
Chloride maintenance taken from a recent quotation (for 60,000 miles).....	...	317	...
Excess current taken by Edison battery	...	...	£100 0
Edison battery maintenance	...	...	52 10
Interest on capital expenditure at 5 per cent. per annum for five years	29	42	92 0
Total cost at completion of 60,000 miles.....	£581	£524	£594 10

It should be noted that according to the above assumptions, the two lead batteries are left in good condition, and may be continued in service indefinitely under renewed maintenance contracts, whereas the Edison battery, although it may still be capable of further service, is no longer under guarantee.

It may be stated that the figure 1·75d. per car-mile can be improved upon where a fleet of vehicles is in operation, and when the owner carries out the repairs himself, and in any case, would be very much lower when several vehicles are in use and garaged together, and undoubtedly this applies also to the Ironclad Exide types.—I am, &c.,

P. A. Mossay.

Westminster, Oct. 28.

"SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As one of those who—to quote Prof. Howe— are no longer students except in the wider sense of the word, I have read his article on electromagnetic induction with very great interest. There appear to me, however, to be one or two doubtful statements made in regard to which a few remarks may not be out of place.

Prof. Howe says (*see* p. 169, top of column 2): "The peculiar condition of the ether which we call the maguetic field is absolutely constant in direction and magnitude at every point, whether the solenoid is at rest or rotating about its axis, and it seems impossible to attach any definite meaning to the question as to whether this peculiar condition of the ether is rotating or not."

If this is true then it is equally impossible to attach any definite meaning to the question whether a magnetic field which remains constant in magnitude and direction at every point of a *limited* space during a *limited* interval of time has any motion or not during that interval of time.

For example, the field in the air-gap of an alternator with moving poles so designed that the flux density is constant over a certain portion of the pole are remains constant in magnitude and direction over a limited space for a limited time. If we consider only points in this limited space during a certain limited interval of time we should according to Prof. Howe, be making a meaningless statement if we said that the magnetic field was in motion. But nothing is more certain than that an E.M.F. would during that interval of time, be induced in a conductor at rest in that space, and since the conductor is at rest this proves that the magnetic field, which during that time is constant in direction and magnitude at every point of the space considered, is actually in motion.

It would appear then that we may legitimately talk of a

rotating magnetic field even though that field remains constant in magnitude and direction at every point.

In the example of the Lorenz apparatus Prof. Howe seems to think that if the magnetic field could be said to rotate with the solenoid then a current should be induced in the galvanometer circuit, because it is known that if the solenoid is stationary and the disc rotates a current *is* induced. He says one is tempted to argue so because the relative motion is unchanged. But it is only the relative motion of the disc and solenoid or disc and magnetic field (assuming the latter rotates with the solenoid) which remains unaltered, and this is not sufficient to reproduce identity of conditions. There must be unchanged relative motion of solenoid (or magnetic field) and *the entire galvanometer circuit*. Now, when the disc alone rotates the only relative motion between field and galvanometer circuit is in that portion of the latter which lies in the disc, but when the solenoid and field rotate there is relative motion between the field and the *whole* of the galvanometer circuit, so that the E.M.F. induced in the disc portion of it is exactly balanced by the E.M.F. induced in the rest of the circuit, since the total magnetic flux through the circuit remains unaltered.

If we did exactly reproduce the state of relative motion by giving the galvanometer circuit, excluding the disc, the same rotation as the solenoid, I think it is unquestionable that a current would be induced, just as it is when the disc only is rotated. Moreover, this current would be induced whether we consider the field rotates with the solenoid or not. For if it does rotate it has no motion relative to the rotating galvanometer circuit except to that portion of it lying in the disc left at rest, while if the field does not rotate there is relative motion between it and the galvanometer circuit, excluding that portion lying in the disc. In both cases the same E.M.F. would be induced. Also if the solenoid rotates and the whole galvanometer circuit is at rest, then obviously no E.M.F. is induced if the field does not rotate with the solenoid, while if it does E.M.F.'s *are* induced in the galvanometer circuit, but their integral over the complete circuit vanishes. This, I think, is the correct explanation of these experiments and it is clear that so far they throw no light on the question as to whether the field rotates or not; but, on the other hand, they certainly do not warrant our saying that no definite meaning can be attached to that question.

These last remarks apply equally to the rotating bar magnet. If the field does rotate with the magnet the E.M.F. is certainly induced in the wire; if it does not rotate with the magnet the seat of the induced E.M.F. is in the magnet.

I am, however, quite unable to agree with Prof. Howe when he says that the seat of the phenomenon is the surface of the magnet. If one side of his rectangle is outside the magnet and the field does not rotate, as he assumes, then, *wherever* in the magnet he takes the other side of his rectangle, this side being supposed to move with the magnet, an E.M.F. is obviously induced in the rectangle owing to the change of flux through it. On his own assumption of motionless flux this E.M.F. cannot be induced in the fixed portion of the rectangle outside the magnet. It is, therefore, induced in the portion inside the magnet, which portion by hypothesis *is not restricted to the surface.*

I think there can be no doubt that Prof. Howe is correct in the view he takes as to the potential gradient as shown by Fig. 9 (*d*) for the rotating disc of Fig. 8.

Finally, with regard to the question of "cutting of lines" versus "change of flux through a circuit" as the actual cause of an induced E.M.F. Prof. Howe thinks that this depends on circumstances—that if a conductor moves in an unchanging magnetic field cutting of lines is a true physical conception of the cause of the induced E.M.F., but if we have a fixed circuit and a changing flux through it then "it seems physically incorrect to say that the peculiar condition of the ether which we call a magnetic field is cutting the conductor."

This view is, I think, open to several objections. In the first place how can there be two entirely different true physical conceptions of one and the same phenomenon, namely, the magnetic induction of electric force? Again, it is a well-known fact that lines or tubes of magnetic induction always form closed circuits—they have neither beginning nor end. Consequently, if a magnetic flux is created through a closed circuit it must either be regarded as being created in situ or else as having cut across the conductors forming the circuit. That the latter is the true conception is the fundamental principle in the universally accepted theory that all electromagnetic disturbances are propagated with finite speed.

The tubes of magnetic induction are regarded as due to the motion of Faraday's electric tubes of force. The creation of a magnetic flux implies that electric tubes of force have been set in motion, or at least that their motion has been altered. In general these tubes are set in motion by setting in motion the electrons from which they originate, *i.e.*, by creating a current, but according to the principle mentioned above the tubes are not instantaneously set in motion throughout their whole length owing to their possessing electromagnetic inertia. They, therefore, become bent, so introducing a component perpendicular to their original direction, which component travels outwards from the electron along the tubes with the speed of light, producing by its motion a magnetic field which travels with it and goes to form the magnetic flux which is finally found linked with the closed circuit.

We have here a picture of the creation of a magnetic flux through a closed circuit, which, if a true one—and it is, I believe, generally accepted as being so—shows that a changing magnetic flux through a circuit is bound to be accompanied by a cutting of magnetic lines by the conductors forming that circuit. We are certainly justified therefore in this case also in regarding the E.M.F. induced as being due to the cutting of magnetic lines.

I may add one more reason why I think the cutting of lines should be regarded as the essential factor in the induction of electric force—this being one founded on experiment.

Consider the Lorenz apparatus with only the disc rotating. The closed circuit consists of the galvanometer and its leads which are at rest, and certain paths in the rotating disc which are the lines of flow of the induced current. Now with constant velocity of rotation these paths, though varying in position with respect to the disc itself, are fixed as regards their position in space. There can thus be no change of flux through the closed circuit, though there *is* relative motion between the flux and a certain portion of the disc which coincides at any instant with the position of the lines of current flow in it. Here is a case, therefore, where we have cutting of lines by, but no change of flux through, a circuit—and experiment shows that an E.M.F. *is* induced, so that cutting of lines is here essentially the cause. The cause in one case must, in my opinion, be the cause in all cases, so that the true physical conception of the cause of the induction of electric force is the cutting of magnetic lines by a circuit, or *vice versa*.—I am, &c.,

Bedford, Nov. 8. E. A. BIEDERMANN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Prof. Howe's article on "Some Problems of Electromagnetic Induction," published in your number of the 5th inst., the first case given appears capable of explanation on ordinary elementary principles. For when the solenoid (C, Fig. 1) rotates then, if its field rotates with it, the E.M.F. induced in the disc will be balanced by an equal but opposite E.M.F induced in the leads joining the galvanometer (G, Fig. 1) to the sliding contacts. Thus, the experiment gives no information on the question of whether the field of the solenoid rotates when the solenoid itself does so. The truth of the above may be further illustrated by noting that if the solenoid and the galvanometer and its leads are rotated together, while the disc (D, Fig. 1) is stationary, the same E.M.F. is produced as by rotating D in the opposite direction while the coil and galvanometer are stationary. If in the former case the coil is stopped while G continues to be rotated no change is caused in the E.M.F. even on the supposition that the field rotates with the coil.

Turning to the case of a magnet rotating about its own axis (Fig. 6), Prof. Howe might inform us whether there is experi-

mental proof of his statement that "external to the magnet there will be an electric field due to the charges on the magnet." If this is true it appears to be a proof that the field does not rotate with the magnet. But it appears to be difficult (if not impossible) to devise a test for the presence of this field which will show a result different from what would occur on the supposition that the field does rotate with the magnet.

Thus, apparently we must be content with the conclusion that it makes no difference in any practical case which of the alternative suppositions be adopted.—I am, &c.,

Nov. 8. W. TOLMÉ MACCALL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find that a statement made in my article on this subject in your last issue was worded in a way likely to lead to some misunderstanding. In the middle of the first column on p. 170, in discussing the arrangement shown in Figs. 3 and 4, I say "the line is skewed in passing from disc to disc, and does not come back to the point from which one started, so that the lines considered individually do not form closed curves." By this I did not intend to suggest that any line of force was not ultimately a closed curve. At no load each line of force is a simple closed loop, but when current flows, the lines pursue a spiral path, gradually working round the machine, like the winding of a Gramme ring armature. Ultimately, after going round, it may be, an infinite number of times, it will presumably arrive at the exact point from which it started, and thus form a closed curve.—I am, &c.,

London, Nov. 9. G. W. O. HOWE.

THE DIRECTION FINDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter sent on September 22nd last to THE ELECTRICIAN and in your issue of October 15th, Engineer Ettore Bellini calls in question the deed of April 5, 1912, drawn up by the Notary Public Rolando.

Now, such deed in its paragraph 3 expressly states that Eng. Bellini, as well as Messrs. Agnelli and Scarfiotti, bind themselves not to contest, even in future, the reasons of Prof. Artom concerning the property and the priority of the invention protected by patent No. 88,765 of April 11, 1907, referring to directive aerials Artom.

Consequently, Eng. Bellini cannot write without disavowing what he has already recognised, and what he has already bound himself to (as he now writes), that the claims made by Prof. Artom in reference to the invention of the device protected by such patent No. 88,765 are without foundation.

The same deed in paragraph No. 6 states that Eng. Bellini, Mr. Agnelli and Mr. Scarfiotti are under obligation to abstain not only from any legal action, but also, and above all else, from every form of publication and advertising which might throw doubt on Prof. Artom's right to the property and the free disposal of his inventions and patents.

The interpretation of the meaning of this paragraph was precisely the object of the suit which was brought before the Tribunal, before the Court of Appeal and before the Court of Cassation of Turin.

In such a legal suit before the Tribunal Engineer Ettore Bellini intervened, not because he was summoned but of his own free will, and thus he became a party to it, so that the decision given in that suit applies also to him.

Now, the verdict of the Court of Appeal that modified the one given by the Tribunal, which after rejection by the Court of Cassation remains unaltered, clearly declared that paragraph 6, as quoted above, of the deed of April 5, 1912, necessarily refers to the invention protected by patent No. 88,766, that is to say, the radiogonometer, which thus was recognised by Messrs. Agnelli, Scarfiotti and Bellini as due to the inventive skill of Prof. Artom. Engineer Bellini cannot be ignorant of the decision given in a judgment in which he has taken part, nor can he be ignorant of the one sentence made in the Court of Appeal in Turin, which was notified to him on October 22, 1914.

Consequently, Eng. Bellini can no longer write that the inventor of the device protected by Artom's patent No. 88,766 (the radiogonometer) is himself and not Prof. Artom. Nor can he raise a discussion by putting forward a claim already disallowed by paragraph 6 of the public deed April 5, 1912, signed by him, and the sense of which cannot be discussed after the decision pronounced by the Court of Appeal which remained unaltered by the rejection of the appeal by the Supreme Court of Cassation of Turin.—I am, &c.,

Turin, Oct. 20. ALESSANDRO ARTOM.

NOMENCLATURE OF ELECTRICAL ILLUMINATION.

The last edition of the Standardisation Rules of the American Institute of Electrical Engineers was given in some detail in THE ELECTRICIAN of Nov. 13, 1914. These were again revised in June last, and the present edition takes effect from July 1, 1915. There are many alterations in detail, but none of great importance. The tables giving permissible temperatures for insulating materials have been simplified by omitting one of the classes. Detailed directions are given for the size and measurement of sphere gaps for the measurement of high voltages. A table is now included showing the stranding of flexible cables, and modifications have been made in the rules relating to traction motors. The table given below includes photometric units and abbreviations as recommended by the Nomenclature and Standards Committee of the Illuminating Engineering Society adopted by the Institute.

Photometric Units and Abbreviations.

Photometric Quantity.	Name of unit.	Abbreviations, symbols and defining equations.
1. Luminous flux	Lumen.	F. Ψ
2. Luminous intensity	Candle.	$I = dF\ d\omega, \Gamma = d\Psi\ d\omega$, cp
3. Illumination	Phot, foot-candles, lux	$E = dF\ dS = I\ r^2 \cos\theta\ .\ \beta$
4. Exposure	Phot-second.	Et
5. Brightness	Apparent candles per sq. cm.	$b = dI\ dS \cos\theta$
	Apparent candles per sq. in.	
	Lambert	$L = dF\ dS$
6. Normal brightness	Candles per sq. cm. / Candles per sq. in.	$b_0 = dI\ dS$
7. Specific luminous radiation	Lumens per sq. cm. / Lumens per sq. in.	$E' = \pi b_0\ .\ \beta'$
8. Coefficient of reflection		$m = E'/E$
9. Mean spherical candle-power		scp
10. Mean lower hemispherical candle-power		lcp
11. Mean upper hemispherical candle-power		ucp
12. Mean zonal candle-power		zcp

13. 1 lumen is emitted by 0·07958 spherical c.p.
14. 1 spherical c.p. emits 12·57 lumens.
15. 1 lux = 1 lumen incident per sq. metre = 0·0001 phot = 0·1 milliphot.
16. 1 phot = 1 lumen incident per sq. cm. = 10,000 lux = 1,000 milliphot.
17. 1 milliphot = 0·001 phot = 0·929 ft.-candle.
18. 1 ft.-candle = 1 lumen incident per sq. foot = 1·076 milliphot 10·76 lux.
19. 1 lambert = 1 lumen emitted per sq. centimetre.*
20. 1 millilambert = 0·001 lambert.
21. 1 lumen emitted, per sq. foot* = 1·076 millilambert.
22. 1 millilambert = 0·929 lumen, emitted, per sq. foot.*
23. 1 lambert = 0·3183 candle per sq. cm. = 2·054 candles per sq. in.
24. 1 candle per sq. cm. = 3·1416 lamberts.
25. 1 candle per sq. in. = 0·4868 lamberts = 486·8 millilamberts.

Symbols.—In view of the fact that the symbols heretofore proposed by this committee conflict in some cases with symbols adopted for electric units by the International Electrotechnical Commission, it is proposed that where the possibility of any confusion exists in the use of electrical and photometrical symbols, an alternative system of symbols for photometrical quantities should be employed. These should be derived exclusively from the Greek alphabet, for instance:—

Luminous intensity	Γ
Luminous flux	Ψ
Illumination	β

* Perfect diffusion assumed.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	211	Carron Fire Elements. Illustrated	41
Imports and Exports of Electrical Manufactures	212	"Ediswan" Anti-Zep. Shades. Illustrated	42
Parliamentary Intelligence	212	Conduit Spacing Support. Illustrated	43
Legal Intelligence	212	A New Desk Pad	43
Educational Notes	213	Magnet Electric Fires. Illus.	43
Business Notices	213		
Bankruptcies, &c.	213	Miscellaneous Notes	217
Electricity Supply	213	Tenders Invited	217
Lighting and Power Notes	214	Tenders Received & Accepted	218
Traction Notes	215	Municipal Accounts	219
Telegraph & Telephone Notes	215	Companies' Meetings and Reports	219
Empire Notes	215	New Companies, &c.	221
Foreign Notes	216	City Notes	221
The Round Table	39	Electrical Companies' Share List	221
Tumbler Switch Controls for Automobiles. Illustrated	40		
Inspection Lamp for Shells. Ill.	41		

COMMERCIAL TOPICS.

E.C.A. Activities. We gather from the current issue of the "Electrical Contractor" that the E.C.A. does not propose to take lying down the recent decision of the Board of Trade regarding their guarantee wiring scheme. It will be recalled that the B.O.T. decided that a scheme of this nature did not come within the scope of the charter of the Association. In these circumstances it was not prepared to commit what it considered to be an enterprise which would give undue preference to the members of the E.C.A. over and above those of the installation trade who are not within the fold of the Association. It is now proposed to form three organisations, each of which will be entrusted with a certain useful and specific work which it will perform in its own particular sphere. The first of these organisations will be the original E.C.A., which will handle the Parliamentary work of the Association and be engaged in similar activities within the scope of the present charter. The second organisation is to be, to quote our contemporary, "a limited trading concern, possessing very wide powers, which will be capable of carrying on all the activities of the Association which are at present under suspicion as being outside the scope of the original charter." It is to this particular one of the three new organisations that the guarantee scheme will be entrusted. In addition, the limited company will carry on the present trade agreements, &c., entering into fresh agreements where necessary, buy goods in bulk, somewhat after the style of the co-operative movement, and, if necessary, to manufacture. The third organisation, again to quote our contemporary, is to consist of "a trade organisation which may or may not be registered as a trade union. This third organisation will have for its object the general improvement of trade relations; it will seek to protect the manufacturers, contractor and retailer against individuals or firms who seek to maintain unfair trading conditions, and it will be in an admirable position for dealing with labour troubles and workmen's organisations in general." Needless to say, we wish the Association every success in these new endeavours to show that it means to remain very much alive, in spite of officialdom. We shall follow with interest the development of these interesting methods.

* * * *

Electric Fires. Our readers will have noticed that during the past few weeks we have described a number of new designs of electric fires which are being introduced for the coming winter and early spring season. The majority of the manufacturers appear to favour the use of fireclay as the supporting medium for the heating element, and with one notable exception—the Bastian fire—this is the standard combination. There still seems to exist a little doubt as to what shall be the standard loading of the firebar units, but it is interesting to note that several manufacturers have definitely pinned their faith either to the ½ kw. or the 1 kw. bar. This in itself is [illegible] indicates that the fires are being made in considerable quantities, a fact which is a sure index of the stability of the public demand. In spite of the increase in the charges for electrical energy, which, unfortunately, it has been found necessary for [illegible] to make, the electric fire is increasing in popularity. Up to the present it has not been found necessary to undertake anything in the nature of a newspaper advertising campaign, the fires practically sell or are hired at sight when displayed in the showrooms of central station engineers or contractors. Once they get into use in a district, merits are passed along and certain classes of consumers strongly object to being behind their neighbours in matters electrical, and they help to keep the ball rolling. From a technical point of view, most of the initial difficulties with the fires have been overcome, and in the majority of cases each maker is prepared to back his element with a guarantee of one or more years.

* * * *

Electric Power in Industrial Districts. From our report of the proceedings in connection with the starting up of a new 5,000 kw. turbo-generator and two 1,500 kw. rotary converters at Bradford last week, it will be seen that the power load is increasing at an exceptionally rapid rate. It is satisfactory to note that the textile trade generally is using electric power, while nearly all engineering works, which are working at high pressure at present, are dependent upon the electric supply department for energy for power purposes. Recently several important consumers have been secured, including mills of 26,000 spindles, and 1,000 kw. for electric furnaces, and it would appear that the capacity of the new plant will be soon exhausted. We hear the same story from Sheffield, Birmingham, Coventry, Walsall and many other districts, the difficulty being to keep pace with the demand for power. As the great majority of the consumers are engaged on the manufacture of munitions or on war work of some sort, it is essential that there should be no failure of supply. The execution of contracts for new plant is not easy under present conditions, and takes much longer than usual. Therefore it would be well for supply undertakings to look well ahead and to obtain authority for placing their orders in good time.

* * * *

Business(?) as Usual. From time to time we have referred to the reckless extravagance of Government Departments. According to the "Glasgow Herald" the War Office is sending out large consignments of reading lamps of the kind in which candles are the illuminant, and in order to assure their safe arrival at the front strong cases for packing were quite rightly considered necessary. Two lamps and a number of candles were to be packed in each case, and a contractor was approached for the supply of the boxes. The boxes were to be the size of a fairly large attaché case, but the contractor was astonished to find that the specification contained provision for what are technically known as leather "corrugations" in which the candles were to be placed. Even the opportunity of doing good business could not prevent the contractor from asking, "Why leather? Would not thin wood be as stable and much cheaper?" "It would," replied the official lawyer, "but my instructions are leather, and leather it must be. The authorities have never used wood for this purpose." The reading lamps cost under 3s. 6d. per pair, the case for the packing 10s. 6d.! so that, apart from the transport charges, the country is paying 10s. 6d. to send goods which, including a few candles, are worth not much over half of that amount. No one will grudge the cost, but the public are entitled to point out to the Government that economy, like charity, begins at home, though it need not stop there.

* * * *

The Russian Market. We have recently drawn attention to the potentialities of the Russian market for electrical supplies, and we are pleased to note that there are already signs of an increasing demand from that great but comparatively undeveloped empire. Hitherto Germany has had practically a monopoly of the Russian market for electrical plant and

machinery, but it is evident from a note in another column that electrical and other companies are desirous of turning to this country for their future supply of goods. The Russian Society for Electrical Enterprises (Ltd.), which has opened a supply branch, wants not only electrical machinery and apparatus, but steam and oil engines and water turbines. Though all our manufacturers are at present very busy, and it may not be easy to meet the company's requirements, we suggest that it would be good business to get into touch with the company, as there is sure to be a great demand in Russia when the war is over and things begin to settle down again.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Nov. 1, 1915, *to* Nov. 6, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. carbons, 36 pkgs.; elec. meters, 4 pkgs.; unenumerated, 46 pkgs.
GRIMSBY.—*Denmark:* Carbon electrodes, 72 pkgs.
LIVERPOOL.—*U.S.A.:* Unenumerated, 160; pkgs. *Spain:* Elec. carbons, 118 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £563; carbon candles, £6,595; elec. lamps, £286; telephone materials, £129; lamp parts, £175; unenumerated, £347—281 pkgs. *Holland:* Elec. lamps, £992—23 pkgs.; unenumerated, £374 *France:* Unenumerated, £4,503—24 pkgs. *Denmark:* Elec. machinery, £1,770. *Italy:* Wire and cable, £260; elec. wire, 37 pkgs.
CANADA.—Wire and cable, £180.
SWITZERLAND.—Elec. machinery, £28; unenumerated, £385.
MANCHESTER—*U.S.A.:* Insulating material, 19 pkgs.; unenumerated, 7 pkgs.
SOUTHAMPTON—*France:* Elec. lamps, 13 pkgs.; unenumerated, 39 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £178; unenumerated, £191. *Melbourne:* Wire and cable, £5,555; elec. machinery, £144; telegraph material, £852; unenumerated, £959. *Sydney:* Elec. machinery, £510; wire and cable, £3,191; unenumerated, £1,459. *Wellington:* Elec. machinery, £152; wire and cable, £3,278; unenumerated, £470. *Brisbane:* Elec. machinery, £184; wire and cable, £130; unenumerated, £316. *Christchurch:* elec. machinery, £517; wire and cable, 448; unenumerated, £121. *Dunedin:* Unenumerated, £88. *Lyttelton:* Wire and cable, £85; unenumerated, £74. *Adelaide:* Elec machinery, £394. *Fremantle:* Unenumerated, £122. *Invercargill:* Unenumerated, £10. *Perth:* Elec. machinery, £87; unenumerated, £228. *Napier:* Unenumerated, £36.
AFRICA.—*Durban:* Wire and cable, £400; elec. machinery, £342; unenumerated, £467. *Port Elizabeth:* Unenumerated, £316 *Cape Town:* Wire and cable, £40; elec. machinery, £37; unenumerated, £299. *Delagoa Bay:* Telegraph cable, £91; unenumerated, £248. *Mombasa:* Unenumerated, £18.
EGYPT.—*Port Said:* Unenumerated, £110. *Alexandria:* Unenumerated, £158.
ADEN.—Unenumerated, £30.
SOUTH AND CENTRAL AMERICA. *Valparaiso:* Unenumerated, £408. *Rio de Janeiro:* Unenumerated, £1,409. *Monte Video:* Unenumerated, £43. *Rosario:* Unenumerated, £123; *Buenos Ayres:* Unenumerated, £328. *Santos:* Elec machinery, £216 *Pernambuco:* Unenumerated, £16. *Mejillones:* Elec. wire, £39. *Pelotas:* Elec. machinery, £247; wire and cable, £145. *Maroados:* Unenumerated, £44. *Bahia:* Unenumerated, £100. *Ferrol:* Unenumerated, £27.
U.S.A.—*New York:* Unenumerated, £132 *Philadelphia:* Unenumerated £27.
CANADA.—*St. John's:* Telegraph material, £615.
HOLLAND.—*Amsterdam:* Wire and cable, £587; elec. machinery, £50; unenumerated, £204. *Rotterdam:* Wire and cable, £1,465; unenumerated, £218. *Haarlem:* unenumerated, £75.
SPAIN.—*Bilbao:* Elec. machinery, £330; unenumerated, £392. *Vigo:* Telegraph material, £26.
SWEDEN.—*Gottenburg:* Wire and cable, £522; telegraph material, £71. *Stockholm:* Wire and cable, £241.
NORWAY.—*Christiania:* Wire and cable £6,251; unenumerated, £560
PORTUGAL. *Lisbon:* Unenumerated, £107; *Oporto:* Unenumerated, £64
GREECE. *Piræus:* Telegraph material, £18
RUSSIA.—*Archangel:* Unenumeratsd, £30. *Petrograd:* Wire and cable, £2,513; unenumerated, £782 *Vladivostock:* Unenumerated, £76
PEELAWAN DELI.—Unenumerated, £20.
INDIA, CEYLON, INDO-CHINA. *Bombay:* Elec machinery £118; wire and cable, £1,506, unenumerated £474 *Calcutta:* Elec machinery £38[illegible]; wire and cable £2[illegible]7, unenumerated, £93 *Madras:* Elec machinery, £11 wire and cable, £182; unenumerated, £[illegible] *Colombo:* Unenumerated, £30 *Rangoon:* Elec. machinery, £66; unenumerated, £[illegible] *Penang:* Wire and cable, £10 unenumerated, £6; unenumerated £17 *Port Swettenham:* Unenumerated, £11 *Singapore:* Wire and cable, £136; unenumerated, £[illegible]
CHINA.—*Shanghai:* Wire and cable, £1,319, elec. machinery, £83; unenumerated, £[illegible] *Hong Kong:* Elec. machinery, £22; unenumerated, £305.
JAPAN.—*Yokohama:* Unenumerated, £3,443 *Nagasaki:* Unenumerated £4 *Kobe:* Unenumerated, £53
WEST INDIES. *Bahamas:* Elec machinery, £415 unenumerated £9 *Curaçao:* Unenumerated, £10 *Trinidad:* Unenumerated £73
MALTA.—Unenumerated, £13.
GIBRALTAR. Telegraph material, £19; unenumerated, £12
FRANCE. *Dieppe:* Unenumerated £111 *Paris:* Unenumerated £74 *Bordeaux:* Elec. machinery, £38; unenumerated, £35. *Treport:* unenumerated, £340

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £15. *Calcutta:* Unenumerated, £7 *Durban:* Unenumerated, £86. *Cape Town:* Unenumerated, £1 *Malaga:* Unenumerated, £[illegible] *Rotterdam:* Unenumerated, £58. *New York:* Unenumerated, £115. *San Sebastian:* Unenumerated, £29. *Smyrna:* Unenumerated, £21

IN TRANSIT.

Shanghai: Elec. lamps, £305. *Napier:* Elec. lamps, £140.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

PARLIAMENTARY INTELLIGENCE.

FINANCE BILL.

Last week the House of Commons resumed consideration of this Bill. On clause 35, which provides that all trades and businesses carried on in the United Kingdom or owned or carried on in any other place by persons ordinarily resident in the kingdom shall be subject to excess profits duty, except husbandry in the United Kingdom, offices, or employments and any profession the profits of which depend mainly on the personal qualifications of the person by whom it is carried on,

Mr. LOUGH moved the omission of any railway, tramway, gas, electric light, or other company working under any special Act of Parliament. He pointed out that some of this class of companies were under liability to be bought up by local authorities.

Mr. MCKENNA said they were going to add to clause 38 words which would include sub-classes of trades or businesses to be dealt with by the Board of Referees on the ground that there were special circumstances. He thought that would meet the case of these companies.

The amendment was then negatived.

Mr. LOUGH then moved to exempt from the tax any enterprise in the nature of a trade or business carried on by municipal authorities.

Mr. MCKENNA said he could not accept the amendment. The profits of municipal authorities were already subjected to income tax, and municipal undertakings were often in competition with private businesses and Parliament had decided that those undertakings should be placed on an equal footing in regard to taxation.

The amendment was negatived.

In regard to the appeal allowed in certain cases from the Commissioners of Inland Revenue to a Board of Referees appointed by the Treasury, Mr. BRYCE moved that the Board ought to consist of three members, one appointed by the Treasury, one by the Bankers' Clearing House and one by the Institute of Chartered Accountants.

The CHANCELLOR OF THE EXCHEQUER (Mr. McKenna) explained that he was in uncertainty as to the size of the Board, for he did not yet know exactly what duties the referees would have to perform. Already more duties had been imposed upon them than were originally contemplated, and in consequence the Board would have to be enlarged. Probably a Board of not fewer than 15 members would be necessary, and it would have to be divided into panels. It would contain persons qualified to deal with all trade questions that might be raised; the members would be men of experience in the varieties of trades which would come before them, and there would be a certain number of experienced lawyers.

Clause 36, as amended, was then agreed to.

On Clause 38, which provides that when a prima facie case is made out to the Commissioners of Inland Revenue for an increase of the percentage standard or for an alteration of the pre-war standard of profits, the Commissioners shall refer the case to the referees.

Mr. LOUGH moved that it should not be necessary for traders to make out a prima facie case to secure a reference from the Commissioners. He argued that the clause should operate wherever an application to go berore the referees was made.

Mr. MONTAGU, who opposed, said the result of accepting it would be that the Commissioners would be overwhelmed with individual applications, a state of affairs that would not be in the interests of traders generally. If the Commissioners were to refuse arbitrarily to allow cases to go before the referees their conduct could be challenged in Parliament.

After further discussion, the CHANCELLOR OF THE EXCHEQUER promised before Report stage to find some form of words more in harmony with the views expressed by the Committee, and the amendment was then withdrawn.

The clause as well as clauses 39 and 40 were agreed to as amended.

Celluloid Regulations.—The London County Council (Celluloid, &c.) and the Glasgow Corporation (Celluloid) Bills, which deal with the storage and uses of celluloid have been read a third time in the House of Commons

LEGAL INTELLIGENCE.

Workmen's Compensation.

At Gateshead County Court on Tuesday Private J. J. Lewis applied for an award of compensation from the Redheugh Iron & Steel Co. for the death of his son.

Mr. T. H. SAYER (for respondents) said that applicant had been offered £20, which he had refused. There appeared to be a doubt as to whether he was entitled to any compensation, but the company was still prepared to pay £16 18s. The boy had been working for the company, when one day he was told that as Zeppelins were coming the lights of the premises would be put out. He rushed up a hill some distance from the works, and proceeded to climb a pole, at the top of which was an electric wire. In doing so he interfered with the suspension wire of a lamp, and received an electric shock which caused death. It was, therefore, a question whether the accident happened out of his employment.

APPLICANT contended that the amount was insufficient.

His Honour (Judge GEEKSWELL) awarded £16. 18s., and said he thought it was very reasonable, especially as he doubted whether applicant was entitled to receive anything.

EDUCATIONAL NOTES.

University of London (University College).—Mr. A. H. Barker, B.Sc., lecturer in heating and ventilating engineering, will give a lecture on "The Methods of Evaluation of Standard Coefficients in Heating Engineering," in the Physiology Theatre at University College, on Tuesday, Nov. 23, at 7 p.m. The lecture will be open to the public without ticket, and is especially intended for engineers and others concerned in practical work in heating and ventilating.

Crystal Palace School of Practical Engineering.—At the first annual meeting of the Crystal Palace Trustees last week the chairman (Sir D. Burnett) in the course of his remarks, said that if they did not get help from the Corporation, the London County Council, or the Guilds, the trustees would regretfully have to close the School of Practical Engineering. For over 40 years the school had been in useful operation, and many eminent engineers had been trained there.

BUSINESS NOTICES.

The new Hull branch offices of the Edison & Swan United Electric Light Co., at 54, King Edward-street, were opened on Tuesday.

Mr. R. J. Hebbert is leaving the measuring instrument department of Messrs. Siemens Bros. & Co. at the end of the month in order to take up a position on the staff of the British Westinghouse Co., at Trafford Park.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by auction at Holy Trinity Church Schools, Beresford-street, near the Royal Arsenal, Woolwich, on Thursday, Nov. 18, by order of the Secretary of State for War, at 11 a.m., unserviceable and obsolete stores, including iron, steel scrap, electric cable, cupro-nickel, lead, &c., steam lorry, motor car, motor-car bodies, rubber tyres, canvas, leather, &c. Catalogues from Armament-buildings, Whitehall-place, Westminster, S.W.; Imperial House, Tothill-street, S.W.; Ordnance Office, Tower; and Ordnance Office, Royal Arsenal, Woolwich. *See also an advertisement.*

Patent Development.—The proprietor of patents Nos. 24,702/1908 and 24,708/1908, for "Improvements in seal fastenings," desires to enter into arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C.

BANKRUPTCIES, &c.

A receiving order has been made against J. W. Dewhurst, electrical engineer, North End-road, West Kensington, London, W.

Arthur Nicholas Pazolt, electrical engineer, Albemarle-street, London, W., applied for his discharge at the London Bankruptcy Court on Friday last. The Official Receiver stated that the bankrupt was an American citizen, and that his failure was due to extravagance. Unsecured liabilities were £696, and assets £36. Discharge suspended for two years.

ELECTRICITY SUPPLY.

EXTENSIONS.

Ayr.—The Dean of Guild Court has passed plans for the erection of a switchboard platform at the electricity works at a cost of £700.

Bo'ness.—Negotiations are proceeding between the Council and the National Electric Construction Co. as to temporary extensions at the electricity works.

The estimated cost of the extensions is between £6,000 and £7,000, and the company suggests that the payment for the work be allowed to stand over until after the war, the Council to apply for borrowing powers three months after peace is declared. Until borrowing powers are obtained the company is to receive 6 per cent. per annum on the capital outlay, which would be a charge on the profits of the undertaking. The Council have asked the company to state specifically whether loss arising through temporary expenditure would be charged to capital account and not to the Council, and whether the company would be prepared to pay if need be a higher rate of interest than the stipulated 6 per cent. to cover interest and sinking fund on the future sum to be borrowed by the Council for the permanent extensions.

Coventry.—The Electric Light Committee has received sanction from the L.G. Board to borrow sums amounting to £80,088 for extensions of the electricity works.

The Committee has considered the question of the further extensions necessary in order to comply with the additional demand for power anticipated shortly from the Daimler Company and other firms, and the chairman and the manager reported as to an interview between the Ministry of Munitions and themselves upon the matter. An estimate of cost amounting to £30,278 was submitted. The Committee recommended that, subject to the Ministry of Munitions coming into an arrangement similar to that made in reference to the extensions now in progress, the Council give authority for carrying out further extensions at an estimated cost of £30,278 stated above, that application be made to the L.G. Board for sanction to raise the necessary loan, and that, subject to such sanction, the matter be remitted to the Committee, with authority to affix the corporate seal to all necessary documents, &c.

The Town Clerk, in accordance with the Committee's instructions, communicated with the Ministry of Munitions in reference to the special police guard at the electricity works, but in reply it was announced that the Ministry were not prepared to bear any portion of the cost. It was resolved that application be made to the Ministry of Munitions to place the electricity undertaking under Government control, in accordance with the provisions of the Munitions of War Act, 1915.

At Tuesday's meeting of the City Council it was decided, subject to a satisfactory arrangement with the Ministry of Munitions, to authorise the Committee to start work on the further extensions. The Ministry of Munitions had requested that the necessary resolution should be passed that day.

The Council also approved of a scheme for the erection of 600 houses, the Government agreeing to make a contribution of 20 per cent. of the cost. The Council have acquired 200 acres of land for the houses.

Finchley.—The electric supply mains are to be extended at an estimated cost of £240.

The electrical engineer (Mr. E. Calvert) recently reported that the department usually required seven days' notice before connecting a new consumer, this being approximately the time required under normal circumstances for taking up a consumer's references and organising the labour for making the connection. Many consumers do not send in an application until they have entered into occupation of the premises, and there is often disappointment that supply cannot be connected on the same day. In the present circumstances, with the difficulties in obtaining material, particularly house services cut-outs and meters, together with the material reduction of available labour, it was impossible to connect consumers within seven days of receipt of the application, and he asked that mention of the matter should be made in the Council.

Luton.—The Electricity Committee has been authorised to utilise a portion of the highways depot for the erection of an additional cooling tower.

West Bromwich.—The Corporation have approved the purchase of a 1,000 kw. turbo-alternator and condensing plant.

It is proposed to extend the engine room and to install another boiler, with economiser, steel chimney, &c. The Electricity Committee reported that they had submitted their proposals to the Ministry of Munitions, who agreed with the urgent necessity of the proposed extensions. The estimated cost of the extensions is £8,850, and application has been made to the L.G. Board for sanction to borrow this sum.

It is proposed to make an arrangement with Messrs. J. Brockhouse & Co., to give a considerably increased supply of current, the company to install rotary converter plant, the Corporation bearing part of the cost. The Committee thinks that this arrangement will save considerable outlay upon mains, and the expenditure on the plant which the Corporation will make is amply covered by the guaranteed additional consumption, and the undertaking by the company to repay to the Council the sum they are finding (less 10 per cent. depreciation) if the actual consumption falls below the guaranteed consumption in any year during the next 10 years. The company is also to have an option of purchasing the interest of the Corporation in the plant.

Wigan.—The L.G. Board have sanctioned a loan of £6,700 for new boilers, &c., at the electricity works.

GENERAL.

Amble.—The Urban Council has referred to the Lighting Committee a scheme, prepared by Mr. C. H. Best, of Bradford, for the erection of electricity supply works in this district.

Battersea (London).—In order to secure the increased charge of 10 per cent. on the accounts for the supply of energy through prepayment meters, the Electricity Committee recommends that a meter rent of 9d. per quarter be charged rather than incur the expense of altering the whole of the prepayment meters.

Beckenham.—The Council have decided that, as some electric supply consumers did not receive official notice of the increased price of current until the middle of July, the increase will take effect as from Aug. 1 and not from June 24 as originally intended. The Electricity Committee has also been instructed to deal with consumers having fixed price contracts.

Belfast.—At the meeting of the Corporation last week, Ald. Tyrrell, in moving the minutes of the Tramways and Electricity Committee, said that he would like the members of the Council to read carefully the report submitted by the city electrical engineer (Mr. Bloxam) in reference to the capacity of the plant at East Bridge-street station.

Mr. Bloxam had reported that "provided all the machines are available for service at the peak load time, there is still a small margin for each class of supply," and he and the committee were putting forward a request that users of electricity should curtail the consumption as much

as possible between 4 p.m. and 5:30 p.m. during November and December. He was sure that when the circumstances were explained to them consumers would be only too pleased to co-operate with the committee in effecting a saving in the direction named.

Blackburn.—Of the employés of the tramways department 64 have joined H M. Forces, while 37 men have gone from the electricity department.

The tramways department thinks it can spare 20 and the electricity department six more men. Women conductors are to replace men, and nearly 400 applications have been received. The latter are to be paid at the same rate as the men.

Cheadle and Gatley.—The Urban Council have asked Manchester and Stockport Corporations to submit terms for a supply of electricity to the district.

Cheltenham.—Last week the Electricity and Lighting Committee reported that the last instalment of the deficit loan of £16,870 had been paid off.

Owing to the reductions made in public electric lighting, the charge for lighting has been reduced to £6,900 for the current year.

Downham.—The Urban Council has notified Mr. C. H. Best that it will consider his proposed scheme for the formation of a local electric supply company if particulars are submitted.

Fakenham (Norfolk).—The Parish Council will not oppose the proposal of Mr. C. H. Best to form a local company to establish electric supply works in the district.

Hackney (London).—For some time past the Electricity Committee has been in negotiation with Messrs. Dick, Kerr & Co. (on behalf of the Minister of Munitions) in reference to the supply of energy for the new National projectile factory in course of erection.

The conditions now agreed upon (subject to confirmation by the Council) include the provision of the necessary additional switchgear, instruments, &c., at the generating station and the laying of the requisite cables and control cables from the station to the factory. The work will be carried out by the Council at the expense of Messrs. Dick, Kerr & Co., who will repay the cost in monthly instalments as the work proceeds.

Horbury.—The Council has been notified by the Yorkshire Electric Power Co. of its intention to lay electric supply mains in some thoroughfares in the district, and the Electrical Distribution of Yorkshire (Ltd.) has also notified its intention to apply for an electric lighting order.

Hove.—Of the employés of the electricity department 10 men have joined H.M. Forces, and the electrical engineer (Mr. C. B. Smith) has been obliged to take on a number of untrained youths and two women clerks. Of the six of military age now on the staff, four are at present indispensable.

Islington (London).—At the meeting of the Council last week, on the presentation of the minutes of the Lighting Committee, Mr. Copeland moved an amendment that the men receive a war bonus of 4s. per week.

He argued that it would be an insuperable difficulty to replace these men at present and he asked the Council to adopt the rule of private employers and to pay an adequate war bonus.

The chairman (Ald. Vorley) said since the war broke out, several increases in trade union rates had been paid by the Lighting Committee, and they had come to the conclusion that a graduated scale of bonus, which gave to those earning the least money the highest bonus, was the proper attitude to adopt.

Ultimately the Committee's recommendation was modified and then agreed to.

Malvern.—On the recommendation of the Gas and Electricity Committee it has been decided, in regard to the supply of electricity to stages and cinema shows, that when current is taken off the lighting and not the power circuit, a discount of 1½d. per unit will be allowed off the lighting price and also for stage lighting.

Monaghan.—A local company is being formed for the erection of electricity works to supply electrical energy for public and private lighting. Mr. Wm. Martin is solicitor for the company.

Portsmouth.—In a recent report the Electric Supply Committee stated that during the present year 7,588 tons of coal were purchased, compared with 7,386 in the corresponding period of last year, and the total cost had gone up from £5,942 to £9,565.

Provisional Orders.—The Board of Trade give notice to parties contemplating the promotion of provisional orders in respect of electric lighting, gas and water, piers and harbours and tramways, that for the duration of the war they will not be prepared to entertain such applications except in cases in which they are satisfied that extreme urgency exists.

Rochdale.—Instead of granting a war bonus it is proposed to increase the wages of tramwaymen earning 30s. a week and under by ½d. an hour, and those receiving over 30s. by ¼d. per hour. The increase will amount to about £1,110 a year.

Southport.—The report of the borough electrical engineer, Mr. A. S. Black, on the Corporation's electricity undertaking for the last financial year states that the net result of the year's working was a profit of £2,213 (increase £350 over the previous year).

Coal cost £380 more than in the previous year, £132 was paid as war allowances, and wages increased £115. Had a normal period followed the introduction of the new tariffs and the publicity given to same there would have been an additional revenue of at least £3,500. Notwithstanding the abnormal times revenue from private consumers increased by £1,501. The number of private consumers increased by 194, and the connections by 20,300 lamps.

Stretford.—The Council will supply current to the United Brass Founders (Ltd.), the minimum consumption for the period ended June 30 next being 580,000 units.

Warminster.—The period of the Council's provisional electric lighting order has been extended for another year.

Winchester.—It was reported to the City Council by the Electricity Committee last week, that owing to the contractors for the new plant at the station generating being entirely engaged on war work, no definite date could be given when the plant, which was to have been in running order last month, could be delivered, the committee had been obliged to purchase a 200 kw. second-hand generating set for £760. The cost of erecting the set would be about another £50, making £810 in all.

After Dec. 31 the committee do not propose to retain consulting engineers, and in future consulting engineers will only be engaged as and when they deem it necessary for particular work.

Ald. Dyer, who moved the adoption of the report, said that, owing to the increased demand for current and for the maintenance of the supply, it became necessary to buy new plant. That plant was due to have been delivered in July, and was expected to have been in running order by Sept. 1, but owing to circumstances over which they had no control, the plant had not been delivered, nor was there any likelihood of its coming. After much consideration they had come to the conclusion that the right thing to do was to maintain the supply of current, and they had been fortunate in getting second-hand plant, which would be running in order in two or three weeks.

Wirksworth.—The Lighting Committee of the Urban Council is considering a draft of an electric supply scheme submitted by Mr. Best, of Bradford.

Wolverhampton.—The annual report of the Electricity Committee, which was adopted by the Corporation last week, stated that during the past year the extensions of plant at the Commercial-road generating station were practically completed and put into operation.

The war made a considerable difference in the financial result. The units sold were 13,184,494, against 13,479,087 in 1914.

Yorkshire Electric Supply Scheme.—Hoylandswaine Urban Council have decided to support the scheme of the Electrical Distribution of Yorkshire (Ltd.) for the supply of electrical energy in Penistone, Thurlstone, Hoylandswaine and Dodworth, provided a clause is included in the provisional order giving local authorities the option of purchase at the end of 21 or 35 years.

LIGHTING & POWER NOTES.

Dover.—A fresh agreement has been made for the supply of electrical energy to the Post Office.

The Post Office authorities guarantee a consumption of 12,000 units per annum, at 4½d. per unit. Under the present circumstances the agreement will be from year to year.

In regard to the supply of electric current to the East Cliff Dockyard, a small committee will deal with the question.

The Electrical Engineer has reported that the electric lighting of garages is very unprofitable. The average is 24 units a year, and the capital charges are 16s. 8d. a year. In future a minimum of 10 units will be charged for each quarter. In regard to persons supplied through prepayment meters the position was even worse, as there was no payment for the meters supplied. The meters cost £2. 8s. 4d. each, and they lost money on those consumers. In future there will be a minimum of 20 units a quarter charged to consumers using prepayment meters. The charge for motor meters will in future be 3s. for the meter, plus 1d. for each horse-power.

Electricity in Collieries.—At the Victorian State Coal Mine at Wonthaggi it is reported that electric coal cutters are employed extensively, and electricity is being utilised as much as possible for power and lighting.

Newport (Mon.).—In order to effect economies the Electricity Committee recommend that all the public electric light and gas lamps be put out at midnight, and that the total number of those lit be reduced by one-third.

TRACTION NOTES.

Halifax.—It is proposed to reconstruct the North Bridge electric tramway route, at a cost of over £1,800.

London County Council.—On Tuesday the Highways Committee recommended, and it was agreed, that the rate of pay of wiremen in the electrical section of the tramways department engaged on wiring tramway depots be increased from 10d. to 11¼d. an hour.

Newcastle-on-Tyne.—Owing to the reduced lighting the tramcars now cease running at 9:30 p.m.

Railway General Managers.—Mr. Frank Potter, general manager of the Great Western Railway, has been unanimously elected chairman of the Railway Managers' Conference for 1916.

Rotherham.—It was reported to the Council last week that there was excessive overcrowding on the tramcars.

The Tramways Committee is continuing the tramway service between Thrybergh and Rotherham.

The whole of the municipal cars are now carrying close upon a quarter of a million passengers per week over and above those carried on the petrol omnibuses and trolley omnibus cars. No more cars can be obtained from manufacturers at present.

Women Tramcar Conductors.—London County Council have decided to employ women as tramcar conductors and the wages will be the same as for men, namely, 5s. a day, with a war bonus of 3s. a week.

The women will be provided with uniforms. Women labourers are also to be employed in the car repair depot and as porters in the stores department of the Council.

Leeds and Blackburn Corporation, who are also employing women conductors, have decided to pay them on the same scale as men.

Women are also now employed on the Birkenhead, Darwen, Edinburgh and Southport tramways.

TELEGRAPH & TELEPHONE NOTES.

Municipal Telephony.—Hull Telephone Committee met last week to consider questions of economy, &c.

The engineer (Mr. T. HOLME) stated that all underground extensions could cease, and they would use whatever spare plant they had to join up subscribers as economically as possible. It would reduce their expenditure to about £2,000 in 12 months, and the only way of getting rid of part of that would be to charge the subscribers for installation. The Post Office were doing it outside of Hull. With respect to the men in the telephone department who had volunteered their services as munition workers, he reported that on Oct. 15 he received a telegram from the Ministry of Munitions to the effect that the removal of the volunteers would be proceeded with. He replied stating that the withdrawal of the men would in the long run bring the service to a standstill, and cut off not only the military lines in the district, but all the firms engaged on munition work. On that representation the Ministry of Munitions telegraphed that the volunteers would be instructed not to leave the Corporation's employ pending further consideration of the case, and all future transfers would be suspended pending inquiry.

Radiotelegraph Notes.—Reports from the Congo show that a number of new radio stations have been completed, and that communication is now possible between the most important places in the Congo area. These include Banana, Basankusu, Basoko, Boma, Coquilhatville, Elisabethville, Kikondja, Kindu, Kinshasa, Kongolo, Lisala, Lusambo, Stanleyville.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard", says the Victorian Hydro-Electric Co. has submitted to the Minister of Water Supply its scheme for utilising the power of Kiewa River.

It is proposed to spend about £1,000,000 on the scheme which is intended to provide cheap electric power for Melbourne. It is intended to circulate the water from the river, utilising its power and returning the water lower down the stream, and the estimate is that about 500,000 E.H.P. will be produced at the head works, and that the company will be able to provide 50,000 H.P. or 60,000 H.P. for consumption in the metropolis at less than 1d. per unit. The company has asked for a concession for at least 50 years. As the proposal involves the utilisation of a national asset by a private corporation, as well as the practical abrogation of statutory powers of the Water Commission, the Minister will have to consult the Cabinet on the matter.

In response to a request from the municipalities concerned the Preston and Malvern (Victoria) Tramways Trust has forwarded a report on proposed extensions and new lines to be operated by the Trust, about 22 miles in all. The report says: "In view of the abnormal conditions consequent upon the war, the increase in the cost of imported materials, and a diminution of the spending power of the people, combined with increasing difficulty in obtaining money on advantageous terms, the Trusts is of opinion that no proposals for tramway extension beyond those already arranged for should be entertained until normal conditions prevail. The electrification of the suburban railways may also adversely affect electric tramway traffic, and the report states: 'It may be safely assumed that unless a district is sufficiently populous to support a tramway service of an average interval of 10 minutes the capital outlay entailed is unjustifiable. The revenue required per car-mile is 15d., or £4,375 per route-mile per annum. On the basis of an average service of 10-minute interval, and a revenue of 15s. per head, a population of about 5,800 per mile of route is one of the essential requirements for a paying line.'" The construction cost per mile of double track rose from £11,300 per mile in 1912 to £12,500 in 1914, before the outbreak of war. The cost at present would probably be £14,000. Operating costs have risen from 8·458d. in 1911 to 10·72d. in 1915. The only proposal which the Trust countenances is for a line of 1 mile along Toorong-road, Malvern, to connect the Wattletree and Waverley-roads lines, which would cost about £14,500.

The accounts of the Melbourne City Council's electricity department for 1914 showed the largest increase of output since the business was undertaken. Units sold were 17,163,000, an increase 2,950,387 (20·76 per cent.) Revenue was £164,788 (increase £14,433), general expenditure was £79,991 (increase £5,915) leaving gross profit £84,797 (increase £8,516). After providing for capital and other charges, net profit was £21,050. Capital expenditure for the year was £105,234, including generating plant, £52,267; switchboards, £9,596; mains, £22,037; buildings, &c., £12,722. The Electric Supply Committee has obtained the authority of the Council to call for tenders for further large additions to plant, to include a 5,500 kw. turbo-generator, which has been ordered from the British Westinghouse Co., and which will cost about £20,800. Tables compiled by the City electrical engineer (Mr. H. R. Harper) show that the most marked feature of the sales for last year was the great increase in the demand for power and heating in comparison with that for light, 32·28 per cent. and 2·46 per cent. respectively. The introduction of modern lamps is decreasing the consumption for lighting, while there is a considerable field yet to be developed in connection with heating. The number of consumers has increased by 807. Motors connected show an increase of 3,260 H.P. (32·7 per cent.), the greatest amount connected in any one year.

During the past 12 months the revenue of the Nunawading (Victoria) Council's electric supply department from sale of electricity and hire of meters was £800. 12s. 5d., and from street lighting £605. 0s. 3d., total £1,405. 12s. 8d. Expenditure was £1,349. 6s., including £515. 7s. for purchase of electric current, leaving a gross profit of £56. 6s. 8d. 482 private consumers have been connected.

The Queensland Government is taking steps towards the construction of tramways in the Cloncurry district. An engineer is to report on the cost of lines to the Warwick Castle, Mighty Atom and Trekalona mines, and an extension of the Mount Cuthbert line towards Mount Oxide will also be considered.

A conference of Melbourne, Brunswick and Coburg Councils has instructed Mr. V. J. Crowley to prepare a scheme for an electric tramway from Melbourne to West Coburg. Mr. V. J. Crowley is also to report on an electric lighting undertaking for Berrigan (N.S.W.).

The N.Z. correspondent of the "Mining Journal" says new electric pumps are being installed in the 12th level chamber of the Waihi (N.Z.) gold mine.

"Tenders" (Melbourne and Sydney) says Queenscliff (Victoria) Council recently took a poll of the ratepayers on the proposal to borrow £4,500 for an electric lighting scheme. The requisite majority in favour of the scheme was not obtained, so the scheme is deferred.

A progress association, of which Mr. W. Stringer is hon. secretary, has placed before the Sorrento (Victoria) residents a proposal to establish electricity works for the town.

The owners of Heyfield (Victoria) Butter Factory have applied for an Order-in-Council to authorise the supply of electricity in the town.

South Perth (W. Australia) Council recently considered the proposal of Leslie & Co. to construct a light tramway system in the town. The following recommendations were deferred for further consideration: The concessionaires to pay the Municipality 3 per cent. on gross earnings, commencing three years after signing contract, the concession to be for 25 years, the Council to have the right to purchase the undertaking at valuation at 10, 15 or 20 years, and at 25 years the undertaking to become the property of the Council free of cost.

Berrigan (N.S.W.) Shire Council has asked Mr. V. J. Crowley, consulting engineer, Melbourne, to prepare a report on an electric lighting scheme.

Bexley (N.S.W.) Council has approved of a proposal to extend Sydney Council's electric mains to Bexley, and it has been decided to approach the Councils of Rockdale, Kogarah and Hurstville, with a view to joint action being taken.

Footscray (Victoria) Council are considering the question of a local electric tramway service. Messrs. McCarty, Underwood & Co. have been retained as consulting engineers.

Representatives of Ipswich (Queensland) Council recently waited on

the Minister of Public Works with reference to an electric supply scheme for the city and its suburbs. They asked that an Order in Council should be granted to a company which has been formed. There were difficulties in the Local Authorities Act, whereby the local authority could not be a competitor with the gas company. The Minister stated that the Government favoured the local authority establishing such enterprises and would assist in endeavouring to bring about a greater Ipswich scheme, under the control of one local authority or a trust, on which all the local authorities interested would have representatives. With respect to entering into competition with the gas company, the Government intended to remove that disability. If a reasonable scheme was propounded the Government would endeavour to finance it.

It has been decided by the Government to appoint an electrical engineer to inquire into and report upon the advisability of establishing a Government power station for the supply of current to South Brisbane, New Farm and Ipswich, and to report on the utilisation of waste gases from the coke ovens, the practicability of transmitting power to the City of Brisbane, &c.

Katoomba (N.S.W.) municipality, which is taking steps to augment the local water supply, is considering the question of utilising electric current for pumping. The Katoomba Electric Supply Co. have quoted 1½d. per unit for a 10 years' contract.

Moorabbin (Victoria) Council has agreed to an order in council being granted to the Beaumaris Tramway Co. to authorise the use of petrol or electric cars.

The Victorian Government propose to spend £10,000 on draining the three lines of reef at Bendigo, provided the companies agree to share the cost of the scheme. It is proposed to erect an electric power station for supplying the shaft head of every mine with power to work pumping plant. The Minister of Mines has agreed to submit a report on the matter to a special board of mining experts.

Burma.—At the adjourned meeting of the Burma Corpn. on Monday the chairman (Mr. R. T. Smith) said that if the wealth of the community was increased by the utilisation of any dormant asset it was difficult to understand why heavy impositions should be exacted unless in the case of competition.

In that case he maintained that the decision should not be based on which would pay the larger amount, but on which would benefit the community to the greater extent. An instance of the unnecessarily heavy charges was found in the question of their use of water-power. An official who had had charge of that question was endeavouring to obtain from the company the uttermost farthing, without reference to the consideration due to them for the advantages they had brought to the district. They had felt the attitude deeply, and they were compelled to turn their attention to the uses of oil-engines for the generation of electric power and ultimately compelled to go to Switzerland for the purchase of a Sulzer-Diesel oil-engine, which was now in course of erection. They were quite desirous of assisting in the development of the district and its administration charges, but they considered that they were doing more than was legally required of them in improving the condition of employees and the population of the country in which they were carrying on operations.

India.—"Indian Engineering" says at the recent railway conference at Simla, the revision of the design and position of electric coupling on trains was considered. The Railway Board consider this subject of much importance in view of their decision to adopt electric lighting exclusively for State-worked railways. The matter was referred to the Locomotive and Carriage Superintendents' Committee prior to action being taken.

The United Provinces Electric Supply Co. (Ltd.) is being floated, with Messrs. Martin & Co. as local managing agents. The capital is to be Rs.15,50,000, and the company will take over existing licenses for the supply of electricity in Allahabad and Lucknow. Two-thirds of the capital has already been subscribed.

"Indian Industries and Power" says the electrical adviser to the Indian Imperial Government (Mr. J. W. Meares) is advising the Government of the Madras Presidency on its various hydro-electric projects. The scheme for Ootacamund municipality is in the hands of Walker & Co., of Colombo. A more comprehensive scheme is that for supplying electrical energy to Ootacamund, Coonoor and Willington from the Pykara Falls. Rough estimates have also been worked out for the Siruvani project in Coimbatore district, and indications show that the project is fairly promising.

Simla Municipal Board are approaching the Government for another loan to extend the hydro-electric works. Larger transformers are being installed in all the sub-stations in Simla, while at Chabba arrangements are being made for the erection of a new 500 k.v.a. alternator, which is expected to arrive shortly. The municipality hope shortly to be in a position to meet all demands for current.

Jamaica.—It is reported that the Jamaica Telephone Co. has received from the Government an extension of its licence for 10 years.

In return for the extension of their licence the company has agreed to make certain concessions, including a reduction of the rates for the rental of telephones, and as soon as the new licence has been ratified by the Privy Council, the directors of the company will make a large outlay to modernise the exchange.

South Africa.—A representative conference of engineering and industrial experts has been summoned by the Government to consider the engineering potentialities of South Africa, with a view to relieving British workshops of the work now done for the Union, thus enabling the latter to concentrate on munitions.

It has been decided to appoint a central and local committees to collate particulars with reference to engineering, and also as to what articles at present imported could be made locally. It was further decided to take a census of the machinery and supplies of material available in the Union for engineering or consumption requirements.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says an electric power station is to be established at Dehiza (Province of Cordoba).

The Argentine Ministry of Public Works has approved the conditions of tender invited by the General Irrigation Board for the supply of generating plant, cables, transformers, &c., for the electric power house to be erected at the irrigation works at Andalgala (Catamarca). The estimated cost is $81,253 m/n (about £7,050).

Señor R. Tarrio has been authorised to establish a telephone service between Bernassoni, Villa Alba and Jacinto Aranz (Pampa Central).

A concession has been granted to Don Américo Demaria for establishing and working of a public telephone service in the districts of Zarate and Campana and its connection with the system of Buenos Ayres.

The Department of Posts and Telegraphs has authorised the addition of two conductors to the telegraph line from Buenos Ayres to Santa Fé, via Rojas, a distance of nearly 300 miles.

Chili.—The "Review of the River Plate" states that the English telephone company at Santiago are to change their system from overhead to underground within two months.

Corea.—A consular report on the trade of Corea for 1914 states that a power plant comprising two 1,000 kw. sets was put into operation at Pingyang in January last to supply power to the Suan mines, 60 miles distant, which are operated by an American corporation.

At the end of 1914 there were 4,202 miles of telegraph lines in Corea; 53 new telegraph offices were opened during 1914.

Dairen.—A report on the Dairen district, which comprises the Kwantung leased territory, now occupied by the Japanese, states that German electrical materials are being replaced by the output of a factory in Japan, which is a branch of large electrical works in America. The last supply of tramcar bogies came from Germany, but future orders will probably go to the United Kingdom, the original source of supply.

The South Manchuria Railway Companies' receipts in 1914 included £108,261 from electrical enterprises.

Imports of electrical materials and fittings in 1914 were valued at £74,130 (compared with £51,000 in 1913). Amongst the sources of these were Japan £42,047, Germany £25,667, United Kingdom £2,038 and U.S.A. £1,699. Railway and tramcars and materials imported were valued at £20,202 (against £52,738 in 1913), from Japan £3,959, United Kingdom £5,119, Germany £1,635, U.S.A. £10,178 and Netherlands £1,002.

Germany.—It is announced that an exact inventory of all alien enemy property in the Empire is being taken.

Between now and Dec. 15 everyone having any connection with alien enemy property, all managers of businesses with which alien enemies are connected, and all persons with money owing to them by alien enemies, must report to the Government.

The scarcity of petroleum is compelling an increasing number of households to provide themselves with electric light. Statistics of the German electrical industry show that women are being increasingly employed in order to liberate more men for military service. Eighteen sick funds associated with the industry had, on Oct. 1, 21,433 male and 24,094 female members.

Guatemala.—A recent presidential order provides that the Government alone shall have the right to import telegraph and telephone apparatus. The right to import electrical material and supplies for installation work is likewise restricted to the Government, but their importation may be permitted, "if they are necessary," for other installations. Telephone and telegraph companies already established and operating under contract or concession must make application to the secretary of Fomento for authority to import apparatus or supplies.

Italy.—In a report by the United States Consul at Florence particulars are given of the lignite deposits at Castiglia, in the province of Arezzo.

A plant for supplying electrical energy for power and light has been erected at the mine to utilise the poorest fuel and waste. The lignite is broken down by hand and loaded in small mine tubs. An inclined plane runs from the surface to the level, and after a sufficient number of tubs are collected at the foot of the incline, they are coupled together and hauled up the incline by cables operated by electric motors. No other machinery is used in the mine except a few pumps operated by electric motors. There are about 700 miners, and the output is 1,200 tons per day.

Licensing Wiring Contractors.—The New York Commissioner of the Department of Water Supply, Gas and Electricity (Mr Wm. Williams) has appointed a board of seven persons to determine the

fitness of applicants for licenses for installing and repairing electric wiring and appliances for light, heat and power in buildings.

The members of the board are: Hubert S. Wynkoop (chairman), electrical engineer, Bureau of Gas and Electricity; John P. Ryan, electrical contractor; Paul McNally, journeyman electrician; Joseph C. Forsyth, electrical inspector; Arthur A. Pope, electrician New York Edison Co.; Fred G. Webber, practical builder, and Elmer D. Coulter, real-estate owner. The board will draw up a code of rules governing the issue of licenses, but these rules must be approved by the commissioner.

Mexico.—It is announced that the Mexican Northern Power Co. commenced the supply of electrical energy to the Alvarido Mining & Milling Co. on Sept. 28.

Morocco.—A consular report on the trade of Morocco in 1913 states that imports in 1913 included machinery valued at £2,373,319, including £403,990 (against £144,384 in 1912) from the United Kingdom, £1,219,897 (£444,574) from France and £544,455 (£279,234) from Germany.

Russia.—The Russian Society for Electrical Enterprises (Ltd.) of Petrograd informs us that it is the concessionaire of electric lighting stations in Pawlowsk, Uman, and Kamenetz-Podolsk and tramways in Elizabethgrad and Uman, and that it has opened a branch for the resale of electrical machines and apparatus and insulating materials, and also of steam and naphtha engines, as well as of water turbines. The company desires to enter into relations with first-class factories in this country producing these goods with the view of becoming their agents in Russia. The company belongs to the Russian and French Bank, whose guarantee is offered for the performance of the company's obligations.

MISCELLANEOUS NOTES.

Agencies Wanted in France.—H.M. Consul-General in Paris (Mr. W. R. Hearn) reports that an electrical engineering firm in Paris desires to secure the agencies of United Kingdom manufacturers of electrical supplies of all kinds. It is anticipated that there will be a great demand after the war for electrical supplies for repairing the factories and lighting plants in those parts of France at present invaded.

Municipal Employees' Enlistment.—At the meeting of the Corporation on Tuesday the General Purposes Committee reported on the letter from Lord Derby to the secretary of the Association of Municipal Corporations, asking for assistance in the present great crisis, and suggesting that municipal corporations could help by liberating their men for enlistment.

The Corporation had already expressed their willingness to allow their employés to enlist in H.M. forces, and had undertaken to pay allowances to those who joined with their approval. The committee said every encouragement should be given to the Corporation employés to enlist under Lord Derby's scheme. In view of the national importance of maintaining the supply of electricity and gas to the city, the committee think representations should be made to the Government that electricity generating stations and gas works should be placed under the same regulations as regards recruiting as munition works.

Munition Works.—Announcement is made that under sect. 4 of the Munitions of War Act, 1915, there are now 1,679 establishments under Government control.

Prohibited Exports.—A new Order in Council prohibits the export to all destinations of metal cylinders, such as are used for containing compressed oxygen or hydrogen; aluminium, manufactures of aluminium and alloys of aluminium.

It is prohibited to export to all foreign countries in Europe and on the Mediterranean and Black Seas, other than France, Russia (except through Baltic ports), Italy, Spain and Portugal—creosote and creosote oils (including blast furnace oil).

Exporters of coal and gas coke now require a revised form of application for a licence to be used. Applications cannot be considered by the Coal Exports Committee unless the new form (dark blue), containing a declaration that the proposed shipment is in pursuance of an existing contract or in execution of a definite order, is used. The new forms are obtainable at the Custom-house at coal ports.

A recent Royal Proclamation forbids the export of steel containing tungsten or molybdenum, or both, and of any tools or articles made from such steel, without licence by the Government's War Trade Committee.

TENDERS INVITED.

Turbo-Alternator and Induced Draught Plant.

MANCHESTER Electricity Committee require tenders by 10 a.m. Nov. 17 for Turbo-alternator Plant and Induced Draught Plant. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Tramway and Electrical Stores.

DUBLIN UNITED TRAMWAYS Co. (1896) require tenders by Nov. 15 for 12 months' supply of General Stores, including Car Fittings, Iron, Steel, Electric Supplies, &c. Forms of tender from the Secretary, 9, Upper Sackville-street, Dublin.

MANCHESTER Tramways Committee require tenders by 10 a.m. Nov. 16 for Steel Girder Tram Rails, Special Track Work and Tongues and Crossings. Specifications, &c., from the General Manager, 55, Piccadilly, Manchester.

CHATHAM Corporation require tenders by 10 a.m. Nov. 24 for one year's supply of Stores and Materials, including incandescent Electric Lamps, &c. Specifications from Borough Surveyor.

Wiring, Fittings, &c.

GLAMORGAN County Council require tenders by Nov. 15 for the Electric Lighting of the Upper Loughor new school. Forms of tender from the County Hall, Cardiff.

ATHY (co. Kildare) Urban Council require tenders before 11 a.m. Dec. 6 for the electric lighting of the town on a three years' contract. About 50 Lamps of 50 c.p. each will be required for public lighting, and it is estimated that 300 private consumers can be obtained.

Telegraph and Telephone Material, &c.

The CHESHIRE LINES COMMITTEE require tenders by 10 a.m. Nov. 24 for one year's supply of Telegraph Materials, Carbons, Metals, Wire, Oils, Paints, &c. Specifications, &c., from the Stores Superintendent, Cheshire Lines, Warrington.

The SLIGO, LEITRIM & NORTHERN COUNTIES RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Stores, including Telegraph Materials, Rubber Goods, Lead, Oils, &c. Forms of tender from the Secretary, Enniskillen.

Telegraph and Telephone Material, &c.

THE GREAT NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m. Nov. 25 for six or 12 months' supply of Stores, including Telegraph Material, Ironmongery, Rubber Goods, Belting, Packing, Waste, Oils, &c. Forms of tender from the Stores Superintendent, 80, Guild-street, Aberdeen.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited for the supply of 294 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms, &c., from the Commonwealth Offices, 72, Victoria street, London, S.W. Tenders to Deputy Postmaster-General, Perth, W. Australia, by 3 p.m. Dec. 8.

Tramway Crossings.

SALFORD Corporation want tenders for Manganese Steel Crossings. Forms of tender from the General Manager, Corporation Tramways, 32, Blackfriars-street, Salford.

Electric Pumps, &c.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Dec. 20 for supply of three Centrifugal Pumps and Electric Motors, each to pump 6,300 gallons per minute and one to pump 15,100 gallons per minute, with switchboards, starters, &c., and spare parts. Specification, &c., from the Board's offices, 341, Pitt-street, Sydney, N.S.W.

Electric Cables, Transformers and Switchgear.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

Boilers, &c.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c, of two Water-tube Boilers and Accessories at Newcastle. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

LONDON COUNTY COUNCIL.—The following tenders have been accepted :—

Colley, Meikle & Co., heating and ventilation installation at central car depot, £1,495 ; A. F. Goodwin & Co., electrical sundries for asylums, £145. 0s. 4d. ; Pope's Electric Lamp Co., electric lamps for asylums, £182. 11s.

RAWTENSTALL.—The Council have accepted the tender of Davidson & Co. for an induced draught fan and that of the British Thomson-Houston Co. for a motor.

PEMBROKE (DUBLIN).—The Urban Council received five tenders (varying from £339 to £598) for the erection of a cooling tower, and that of W. Beckett & Son (at £374) has been accepted.

STRETFORD.—The tender of W. T. Glover & Co. (at £302. 3s.) has been accepted by the Council for the supply of cables.

WEST BROMWICH.—The following tenders have been accepted by the Corporation :—

Babcock & Wilcox, boiler and accessories ; J. Thompson, steel chimney ; E. Green & Son, economiser ; J. P. Hall & Sons, feed pump ; New Conveyor Co., coal bunker ; J. Proctor (Ltd.), coal elevator ; British Westinghouse Electric & Mfg. Co., e.h.t. switchgear.

STEPNEY (LONDON).—The Electricity Committee has accepted the following tenders :—

E. Foster & Co., for 100 tons of Walsall wood washed beans, at £1. 1s. 7d. per ton, and 3,000 tons of Ebstock D.S. nuts, at £1. 2s. per ton. The latter offer is subject to a proviso that the contract shall terminate Dec. 31, 1916, or six months after the termination of war, whichever date turns out to be the earlier, and also to any advance in price that may come into force through the amendment of the Price of Coal (Limitation) Act.

WATFORD.—The Council has accepted the tender of Connere & Co. (at £226. 13s. 6d.) for wiring the pumping station.

BAWNBOY (Co. CAVAN).—The Rural Council has accepted the tender of the Ballyconnell Electric Light Co. for the public lighting.

MELBOURNE (VICTORIA).—The Council have accepted the following tenders :—

Vacuum Oil Co., transformer oil, 2s. per gallon. Edison & Swan United Electric Light Co., Ferranti Ltd., Reason Mfg. Co., General Electric Co. and British Westinghouse Co., meters and m.d. indicators. W. T. Henley's Telegraph Works Co., insulated wires and cables, £133. 4s. Noyes Bros., twin flexible copper wire, £8. 1s. 6d.

The Council also authorised the purchase from British Insulated & Helsby Cables of 142 end connections, from Campbell & Sons steel framework for sub-station switchgear, from Thomas Bros. 1 ton electric hoist, from Ingram Bros. an international time recorder for electric supply station, and from British General Electric Co. 10 h.p. motor, &c.

SYDNEY (N.S.W.).—The following tenders have been received by the City Council :—

Andrew Thomson & Sons, transformer kiosks, £92 each (*recommended for acceptance*) ; Gordon Marr & Sons, £180 each. N. Guthridge (Ltd.), contact and suspension gears, 2-pole gears, £5 each, 3-pole gears, £6 each. Lawrence & Hanson Electrical Co., 2-pole gears (their 5B coupling), £1. 15s. each, 3-pole gears (5B coupling), £2. 17s. each. No. 4 gear, 2-pole, £2. 3s., 3-pole, £2. 17s. each (*recommended* for 50 2-pole gears No. 4B coupling, at £2. 3s. each, and 3-pole gears, 4B coupling, at £2. 17s. each.

Time switches : W. G. Watson, single pole and double pole (*recommended for acceptance*), three pole, no tender ; Crompton & Co., s. pole, d. pole, and (*rec. for acceptance*) three pole ; Oulsnam & Co., s. pole and d. pole ; three pole switches, no tender.

The Electric Lighting Committee also recommended that the following material be ordered under existing contracts : W. G. Watson & Co., 20,000 type C straight stem insulators, £790 ; F. S. Lee, 12,000 10,000-volt straight-pin insulators ; 6,000 10,000 volt strain insulators, 2,000 33,000 volt straight pin insulators, £4,350 ; Australian General Electric Co., 6,000 33,000-volt strain insulators, £2,250.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—British Insulated & Helsby Cables, 8 tons copper wire, £113. 10s. per ton ; Western Electric Co., 3 tons g.i. wire, braided, £75. 10s. 6d. per ton ; Siemens Bros. Dynamo Works, 50 miles wire, £7. 15s. per mile ; Callender's Cable & Construction Co., 100 miles ditto £16. 5s. per mile, 4 tons ditto £175 per ton ; McPherson's Ppy., g.i. cross-arm straps, tie plates, &c., £1,837. 1s. 9d.

Postmaster-General's Dept., Sydney.—Jas. Paton & Co., 50 induction coils 3s. 9d. each, 1,000 keyhole escutcheons 1d. each, 150 c.b. switches £1. 15s. each, 150 pilot lamps 1s. 7d. each ; British Insulated & Helsby Cables, 15 cwt. resin-cored solder, £9 per cwt. ; Western Electric Co., 200 caps for pilot lamp 3d. each, 1,000 ditto for line lamp £1. 1s. 3d. per 100, 8,000 jointing sleeves 6s. 7d. per 100, 2,000 ditto 7s. per 100, 2,000 ditto 7s. 7d. per 100, 1,000 ditto 11s. 1d. per 100 ; India Rubber, Gutta Percha & Telegraph Works Co., 5,000 copper binders 6s. 3d. per 100, 15,000 ditto 7s. 6d. per 100, 4,000 ditto 8s. 10½d. per 100, 60,000 ditto 2s. 1½d. per 100, 30,000 ditto 2s. 4½d. per 100, 25,000 ditto 3s. 4½d. per 100, 25,000 ditto 3s. 10½d. per 100, 60,000 copper tapes 2s. per 100 30,000 ditto 2s. 9d. per 100, 26,000 ditto 2s. 10½d. per 100, 25,000 ditto 4s. 5d. per 100, 10,000 ditto 6s. 1d. per 100, 20,000 ditto 7s. per 100, 3,000 ditto 8s. 9d. per 100 ; Lawrence & Hanson Co., 1,000,000 steel staples, 5s. per 1,000.

Postmaster-General's Dept., Adelaide.—A. J. Todd & Co. (agents for F. B. Cook Co.), 5,000 jointing sleeves 67s. 9d. per 1,000, 5,000 ditto 71s. 9d. per 1,000, 5,000 ditto 90s. 4d. per 1,000, 2,000 ditto 119s. 7d. per 1,000, 5,000 ditto 112s. 5d. per 1,000, 5,000 ditto 32s. 1d. per 1,000 ; Grant Bros., 1,000 gal. steel spindles 1s. 3d. each, 12,000 ditto 1s. each, 15,000 ditto 4¼d. each, 5,000 ditto 5d. each, 3,000 ditto 7⅞d. each, 10,000 ditto 4d. each (£71. 14s. 2d. was added to these five items).

Victorian Railways.—W. T. Henley's Telegraph Works Co. and Warburton Franki, electric lighting material for Jolimont car-repair shop, at rates ; Noyes Bros. and Australian Gen. Elec. Co., l.t. switchgear and instruments for Ballarat and Bendigo workshops, at rates ; British Insulated & Helsby Cables, h.d. copper cable, £108. 5s. 4d.

Public Works Dept., Melbourne.—Clayton, Joel & Co., electric generator, £225.

New Zealand Government Contracts.—The Public Service Tender Board have accepted the tenders of Lawrence & Hanson for 3,500 three-conductor cords, £489 ; B. L. Donne, 3,000 B.B. wall telephones £8,250 (eight tenders received, from £7,900 to £10,597) ; Hughes & Cossar (lowest) 25 miles cable, £237 (four tenders ; highest £315).

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

14,146 PICKETT. Electric switching devices.

14,224 FEBNY. (Fabrik Elektrischer Zunder Ges.) Electric blasting fuzes or the like.

16,343 MARKS. (International Quadruplex Co.) Telegraphy.

A system of "duplex" or "quadruplex" telegraphy in which a line has impressed upon it a current of positive pulses to denote a signal, a series of negative pulses to denote a signal, and a series of positive and negative pulses to denote two signals, means being provided to ground the line normally and to open said ground automatically as soon as one or other of the transmitting keys are operated.

18,511 MUSSO. Transmission of electrical impulses over telephonic circuits of high electrostatic capacity. (Patent of addition not granted.)

A system of telephony wherein the main line is provided at each end with a home circuit containing a battery, a transmitter and an inductance, the main line ends being connected at a point between the battery and the transmitter whereby the batteries maintain a charge on the line, upon which is superimposed secondary and tertiary waves induced in the inductance for respectively neutralising and overcoming the electrostatic capacity and the ohmic resistance of the line.

20,714 WEBB & WILLIAMS. Apparatus for bleaching by electrolysis.

20,721 QUAIN. Electric heaters for mining and for other purposes.

20,896 HEATH & KEITH. Electric automatic tumbler switches.

[illegible] (1913) & Cox. Sparking-plugs for internal-combustion [illegible]

22,062 SMYTH. Electric generators for lighting mechanically-propelled vehicles.

[illegible]

[illegible] & BANHAM & CANTER (LTD.) Looped-in system of electric wiring and [illegible]

[illegible] & HELSBY CABLES (LTD.) & HARRISON. Telegraph systems [illegible]

[illegible] maximum speed.

[illegible]

1915 SPECIFICATIONS.

[illegible] & HALLAWAY. Arc lamps. (10.12.14.)

[illegible]

[illegible] & MARX. [illegible] for extracting foreign substances from [illegible]

[illegible] & Co. Manufacture of electric condensers. (23.7.14.)

[illegible] & Electrical Appliance Co. Electrical fire-alarm systems. (1.8.14.)

[illegible] Electric [illegible] mechanically-propelled vehicles. (Divided [illegible] 22.2.14. Nov. 5.)

[illegible] & Co. Electric [illegible]. (13.7.14.)

[illegible] [illegible] for controlling [illegible] or other motors.

[illegible]

10,251 [illegible] (Addition to 19,596/14.)

11,139 [illegible] & MURRAY. Switch devices for car-lighting and like [illegible]

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Barrow-in-Furness.—The accounts of the electricity supply department for the year ended March 31 show total capital expenditure £158,480 (increase £19,308).

Revenue was £26,584 (compared with £20,148 in previous year), working costs were £13,867 (£11,460), leaving gross profit £12,717 (£8,688). Interest required £3,658 (£3,174), sinking fund £5,896 (£5,000), and net profit was £3,162 (£513). Average price obtained (for all purposes was 1·742d. (2·272d.), and total costs, exclusive of capital charges, were 0·925d. (1·321d.). Units generated were 4,498,191 (2,679,985) and sold 3,597,410 (2,081,317). Maximum load was 2,285 kw. (1,322 kw.), and load factor 17·97 (17·99) per cent. Total connections are equal to 190,647 (132,929) 30-watt lamps.

Mr. H. R. Burnett (borough electrical engineer) says in his report that although large extensions of plant and mains were only completed early in 1914, the conclusion of an agreement in October last with Messrs. Vickers for supply to their naval construction works made it necessary to proceed at once with further large additions to the plant and mains, and the following plant, &c., has been purchased in connection with this and other supplies: 2,000 kw. turbo-alternator, with switchgear, &c., by British Thomson-Houston Co., condensing plant and exhaust and circulating pipes by Cole, Marchent & Morley; water-tube boiler, with underfeed mechanical stokers, capable of evaporating about 30,000 lb. of water per hour, by Stirling Boiler Co.; economiser by Messrs. E. Green & Son; steam and feed pipes by Messrs. Aiton & Co. The erection of the turbo-alternator was sufficiently completed to enable this machine to be run on the supply, for the first time, by March 12, only 4½ months from the date when the committee authorised the extensions, and Mr. Burnett thinks it constitutes a record for an extension of that size in a municipal electrical undertaking. Various repairs and renewals of plant were also carried out. The most important extensions of mains were the extensions of the e.h.t. main from the Furness Railway locomotive works to Messrs. Vickers' high-level bridge and Bridge-road sub-stations. The further extension of these mains from the electricity works, via Buccleuch-street and Bridge-road, to Messrs. Vickers' Bridge-road sub-station has also been completed. The total length of mains laid during the year was 9·3 miles, which is considerably in excess of any preceding year. The 150 kw. rotary converter and switchgear erected at the locomotive works sub-station resulted in a great improvement in the regulation of the supply. E.h.t. switchgear has been installed at the High Level Bridge sub-stations, where Messrs. Vickers have installed two 500 kw. rotary converters, also at the Bridge-road sub-station, where one 500 kw. rotary converter has been completed. Provision has been made in each of these sub-stations for three 500 kw. machines, and these will be completed during the present year. At the sewage pumping station one 150 k.v.a. static transformer has been installed, and practically the whole of the pumping at these works has been done by electricity since November last. At the Abbey sub-station a balancing transformer and switchgear have been installed. In Michaelson-road all the arc lamps have been replaced by 500 watt half-watt lamps, and on the promenade at Vickerstown, 300 watt half-watt lamps are in use. The demand for apparatus on hire continues to make steady progress, and there is no doubt that the large increase in output for domestic purposes is attributable to the educational and other works carried out in this department, whose usefulness would, however, be greatly increased by the opening of a showroom in the centre of the town. Costs per unit show a total reduction of 0·396d., or 30 per cent., and cost of coal per unit was reduced 0·125d., although the average price paid for coal increased from 13s. 7¼d. to 14s. 4d. per ton. The department is contributing directly and through the rates £1,210 per annum to the various funds of the borough. £951 has been expended on the purchase of meters and other work of a capital nature. A large proportion of the management expenses included in the revenue account was also incurred upon capital work. A further large increase in the cost of coal, &c., must be anticipated, but a further phenomenally large increase in output during the current year is assured.

Birkenhead.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £373,545 (increase £2,448), of which £230,333 is outstanding.

Revenue was £65,785 (against £68,608 in previous year), working expenses were £39,467 (£41,392), interest required £12,018 (£11,993) and sinking fund, &c., £9,760 (£9,499), and the net profit was £4,500 (£5,712). Average total revenue per car-mile was 13·05d. (12·65d.), and working expenses, including power, were 7·83d. (7·63d.). Average ordinary fare charged per mile was 0·66d. Passengers carried were 14,822,697 (against 15,167,958), car-miles run 1,209,117 (1,300,717), and units used 2,341,009 (2,672,599).

Mr. Cyril Clarke (tramways manager) says in his report the net profit has only been exceeded once in the history of the undertaking, in spite of the difficulties caused by men leaving to join the Colours and to do munitions work. Up to March 31 £1,157 was paid to relatives of men serving in H.M. Forces and £74 in war bonuses to employés. The gross profits during the 14 years the tramways have been in operation have been approximately £310,346. There have been no serious accidents during the year.

Edinburgh.—The accounts of the electric lighting department for the year ended May 15 show total capital expenditure £1,145,167 (increase £45,610), of which £555,653 has been repaid.

Revenue was £133,799, and working, miscellaneous and special expenditure amounted to £75,569, leaving gross profit £58,230. The balance brought forward from previous year (£3,834) has been transferred towards relief of rates, and the gross profit (£58,230) and £9,187 taken from reserve were required to meet interest, £17,515, contribution to liquidation of debt £44,129, and income tax £2,762. The reserve fund now amounts to £107,049. Units generated were 21,656,078, against 22,796,547 in previous year, and sold 17,875,406 (18,940,948). The reduction is more than accounted for by decreases of 751,109 in street and stair lighting, and 566,822 in private lighting.

Marylebone (London).—The revenue account of the electric supply department for the quarter ended June 30 shows revenue £36,180 (compared with £37,425 in the corresponding quarter of 1914).

After providing for working and general expenses the credit balance was £15,872 (against £17,306).

The report of the Electric Supply Committee, presented with the revenue account at last week's Council meeting, states that units sold were 3,067,675 (decrease 9·6 per cent. compared with the corresponding quarter of last year). Of the expenditure, £16,873 (against £15,716), £1,092 was special war expenditure. Total costs, other than capital charges, were 1·318d. (1·111d.) per unit sold. Almost every item of expenditure was adversely affected by the abnormal cost of labour, raw materials, &c. The net cost of the sales and publicity department was £216 (against £844). In December, 1913, it was decided that inquiries received by the department's representatives for installation works should be passed on to an appointed district contractor, the district contractors on their part undertook to purchase supplies from the Council. Purchases of stores from the department by contractors have been comparatively small, the advantages arising out of the arrangement have not been fully realised. It has led to the impression that the department recommend the contractor and take responsibility for the work. From the department's own point it is desirable that this impression be removed, and the committee have given instructions that in future, other than in very exceptional cases, the department's representatives are not to name a contractor when customers require installation works carried out, but to leave customers to select their own contractor.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.)

The eighty-second ordinary general meeting was held on Wednesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the message receipts have afforded an additional revenue of nearly £74,000 for the period under review, which included eleven eventful months of war with a resultant stoppage in the case of our Company of telegraphic traffic with Belgium, Germany and Austria. The closing of these sources of revenue has however, so far been compensated by increased earnings due to the obligatory use of plain language enforced by the several Governments under whom we work. These restrictions were latterly modified, permission having been given in the early part of this year for the use of certain well-known codes with South American countries, which has been much appreciated by the telegraphing public. Congestion of lines beyond this Company's system necessitated the suspension on the 5th August last year of "deferred" and "week-end" telegrams. The former were re-introduced on 1st October, 1914, and advantage was quickly taken of the restoration of this facility. No damage to the Company's cables has been experienced in consequence of the war. The sections in North Brazilian waters were interrupted by normal circumstances for four months, and owing to the exceptional conditions then and there prevailing, our cable-repairing steamer was unable to attempt their restoration until March last. Communication during the interruption was maintained with the Northern States of Brazil by the Brazilian Government landlines. The general expenses show a decrease of nearly £9,000, principally due to three causes, the first being the occupation of our own offices and staff quarters at Buenos Aires and Montevideo, thus effecting a considerable saving under the head of rent. The second was our inability, owing to the war, to obtain the usual annual supply of forms and stationery until after the close of our financial year. The third cause was the fall in the value

of the Brazilian milreis, which affected all our payments in that currency. There was also the very considerable decrease of over £40,000 in the cost of the maintenance of the cables, but income tax was higher by close on £15,000. I feel sure that the shareholders will endorse the action of the Directors in subscribing to the War Relief Funds.

After providing £32,747 for debenture stock interest, and £33,348.14s.9d. for income tax, there remains a balance of £578,273. 10s. 9d., to this is added the sum of £33,157. 9s. 8d. brought forward from June 30, 1914, making a total of £611,431. 0s. 5d. Three interim dividends, amounting to £93,568. 10s. have been paid. £150,000 has been applied towards the reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued. £150,000 transferred to the general reserve fund, £30,000 to the land and buildings depreciation fund, and £50,000 to the provision on account of investment fluctuations. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year; also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £51,982. 10s., leaving a balance of £85,880. 0s. 5d. to be carried forward. This is considerably larger than usual, but our message revenue for the current year since July 1 last shows a decrease of over £25,000 and it is not yet known whether and to what extent the proposed taxation of profits will affect the Company.

Before moving the formal resolutions I must mention that very great difficulty has been experienced in restraining the younger members amongst our technically trained staff from joining the fighting forces of the Empire, but they have, with a few exceptions, accepted the ruling of the Army Council that they are best serving their country, being specially trained men, with technical knowledge and experience, in remaining at their posts and carrying on the work of state and commercial telegraphic communications. It will interest you and our staff to know that a letter was recently received from the War Office stating that the Council fully realise the importance of the work on which the employees of the Company are engaged, and appreciate the efforts which are being made by them in the present emergency. The Council wished the staff to know that it is fully recognised that they in carrying out their important duties promptly and efficiently are doing their duty for their King and Country equally with those who have joined the Army for service in the field. I now move the adoption of the report and accounts and the declaration of the dividend and bonus therein set out.

The DEPUTY-CHAIRMAN (Sir John Denison-Pender, K.C.M.G.) seconded the motion, which was carried unanimously.

The retiring Directors, the Right Hon. Viscount Middleton, Sir Albert J. Leppoc Cappel, K.C.I.E., and Mr. John George Griffiths, and the auditors, Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. Gane, Jackson, Jefferys & Freeman, were re-elected.

A cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

West India & Panama Telegraph Co. (Ltd.)

The seventy-seventh ordinary general meeting was held on Wednesday, Sir ALEXANDER FREEMAN KING, K.C.B., presiding.

The SECRETARY (Mr. J. Winser) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Our chairman is under medical treatment, and is unable to attend. At our half-yearly meeting last May the chairman referred to the unusual conditions under which we were obliged by force of circumstances to carry on our enterprise, and mentioned that in order to comply with the requirements of the Home and the Colonial Governments it had been necessary to keep our stations open day and night, instead of during the ordinary business hours in normal times, thus incurring considerable extra outlay. This additional outlay is reflected in the accounts. Additional expenditure amounts to more than £7,000. As a partial set-off, the expenses attending maintenance of cables are much below the average. When the special services we are now rendering to the Government are no longer necessary it is our intention to apply to the authorities for such refund in respect of the overtime as they may deem reasonable. The increase in the cost of renewal of instruments is exceptional, and not necessarily of a recurring nature. I will conclude by suggesting that, with your sanction, the company should subscribe 50 guineas to the fund which is being raised under the auspices of the Secretary of State for the Colonies to provide for the comfort and welfare of those men who have come from the West Indies to the Mother Country in order to join the new armies. I now move the adoption of the report and accounts, and the declaration of the dividends therein set out.

Mr. HARRY WILLIAM BIRKS seconded the resolution, which was carried unanimously.

Mr. S. P. ADAMS inquired whether the Marconi station, which he read in the newspapers a few days ago, had been established at St. Lucia, would be in connection with the company or opposed to it, and whether it was likely to affect the company's income.

The CHAIRMAN: So far as I understand, the work of that wireless station will not interfere with the work of this company in any way.

A vote of thanks to the chairman, directors and staff at home and abroad brought the proceedings to a close.

AMAZON TELEGRAPH CO. (LTD.)—For the year ended June 30 the gross revenue amounts to £57,933 and the working expenses to £34,938. After providing £22,888 for debenture interest and sinking fund there remains £107, which, added to £5,840 brought forward, makes the balance to be carried forward to next year £5,947.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—Mr. C. G. Tegetmeier, who presided at the meeting on Monday, said that was the first time since the company started electrical running in 1902 that they had not been able to point to an increase in revenue over that of the preceding year; but the war had affected their business in Auckland. The accounts covered a period of 11 months of war time, and, closely following upon the outbreak of war, there was a noticeable general decline on traffic. The total traffic receipts amounted to £267,793, a decrease of £3,908. The whole of the decrease, however, was in respect of their motor omnibuses, the receipts from the tramways being a few hundred pounds more than in the preceding year. They had restricted construction expenditure to work that was immediately necessary, and they were still pursuing that policy, but a time came when it was false economy to postpone reconstruction, and it was essential that their renewals account should be adequate to meet the expenditure when the need for it arose. Out of last year's revenue they were allocating £22,500 to renewals and depreciation account. The balance available for distribution was £59,280, or £1,221 less than in 1914. The dividend on the preference shares was unaltered at £9,000, and the directors proposed to pay the same dividend of 1s. 7d. per share for the year on the ordinary shares, but they proposed to pay it less tax instead of tax free, as they had done for the past three years. The company had to pay English income tax upon the whole of its profits, notwithstanding the fact that its profits were earned exclusively in New Zealand, and were heavily taxed there. That was one of the many anomalies in connection with income tax law that pressed very hardly upon companies such as theirs, and which in its ultimate effect must be detrimental to the interests of the State.

DELAGOA BAY DEVELOPMENT CORPN. (LTD.)—It was announed at the recent meeting that of the capital expenditure during the year £1,884 was spent on the electric tramways undertaking. The installation of additional electric power plant was absolutely necessary, as the demand for power still showed signs of increasing, and the expenditure was unavoidable if the present and future requirements in that direction were to be met with safety. Expenditure of that description must be made in a concern carrying on a business such as theirs, but they would not spend more than they could help.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—For the year ended June 30, after providing for interest on both classes of debenture stock and depreciation upon freehold properties and plant, the net profit is £14,146. 17s. 11d., which, added to £5,731. 18s. 4d. brought forward, makes a total of £19,878. 16s. 3d., which the directors propose to deal with by transferring £15,000 to reserve account and carrying forward the balance of £4,878. 16s. 3d. The report states that it is absolutely essential in the interests of the company that a substantial reserve account be created, and for this reason the directors regret that they are unable to recommend payment of a dividend upon the shares. The increased turnover of the business, coupled with the rise in the cost of all raw materials and labour, have severely taxed the capital resources of the company during the year, and additional working capital is required in consequence. This can only be provided out of profits, and therefore the directors recommend the allocation of the amount standing to credit of profit and loss as above. Marked progress has been made during the year, and the results would probably have been still more satisfactory had it not been for the abnormal rise in the price of raw materials, labour and carriage. Whilst on the engineering side of the works this extra cost has been partially met by a corresponding rise in selling values, the lamp side of the works has been materially affected, and, it being impossible to raise the selling price of drawn wire lamps, the increased cost of manufacture has materially reduced the profit on sales. In spite of the difficulties attending the shipment of goods for abroad, the directors are pleased to report that the export business, particularly to the British colonies and India, has shown a marked increase, and they look for considerable development in this direction when times become normal. A resolution will be submitted to the meeting for election to the board of Mr. John Cross.

UNITED ELECTRIC TRAMWAYS CO. OF CARACAS (LTD.)—For the year ended June 30 the disposable balance (including £1,206 brought forward) was £15,749, out of which the directors recommend a dividend for the year of 7 per cent. and a bonus of 1¼ per cent. (less tax), leaving £1,299 to be carried forward. The profits of the local company have been adversely affected by the European war, and it only requires the re-establishment of peace to enable the company to resume its prosperous career. The local company, after providing for mortgage interest payable to this company (£10,200) and providing for reserve and renewal funds and paying as dividend the whole of the balance of the profits, carry forward the same amount as in previous year (Bs.539,809.22). The percentage of operating expenses is 51·38, or 3·10 per cent. more than the previous year, due to the larger mileage run with less receipts.

UNITED RAILWAYS INVESTMENT CO. (LTD.)—In the report for the year to June 30 it is stated that the Pittsburgh district has fully recovered from the effects of war depression. The Duquesne Light Co. has reduced the cost of the production of electrical energy by adding extensive and up-to-date equipment.

VERA CRUZ ELECTRIC LIGHT, POWER & TRACTION (LTD.).—The net profit for 1914 in Mexico amounted to $486,057 (Mex.), an increase of $107,754. These earnings, converted at the parity of exchange, leave a balance, after meeting all expenses and debenture interest, of £34,980, but, owing to the heavy loss in exchange of £33,960, the available balance of profit is reduced to £1,020, to which should be added the balance brought forward of £12,997, making £14,017, which, owing to the present

conditions in Mexico, the directors propose to carry forward. The directors report that, notwithstanding the continued political disturbance in Mexico, the property of the company has suffered no damage. The supply of power from the Puebla Tramway Light & Power Co. commenced in January, 1915, and practically the whole of the company's power is now obtained from that company. The extension of the tramway system has now been completed and is working satisfactorily.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

W. J. ADDISON (LTD.) (141,989).—Reg. Oct. 29, capital £1,000 in £1 shares, to carry on the business of ironfounders, electrical and mechanical engineers, manufacturers of agricultural and other machinery, &c. Private company. Reg. office, 9, Broadway, Streatham, S.W.

ARMY & NAVY MFG. AIRCRAFT (LTD.) (142,026.)—Reg. Nov. 3, capital £100 in £1 shares to manufacture and deal in aerial conveyances and aircraft of all kinds, and to carry on the business of mechanical and electrical engineers, tube makers, metallurgists, &c. Private company.

EDOUARD DUBIED & CO. (LTD.) (142,049.)—Reg. Nov. 5, capital £20,000 in £1 shares, to carry on in the U.K. or elsewhere the business of mechanical and metallurgical engineers, machinists, tube makers, manufacturers of steam, electrical and other engines, &c. Private company. First directors are P. E. Dubied, J. S. King and E. A. Dubied.

HADARS (LTD.) (142,017.)—Reg. Nov. 2, capital £2,000 in £1 shares. to carry on the business of mechanical, electrical and general engineers, machinists, tool makers, manufacturers of and dealers in machines, machine tools, motors, motor cars, airships and flying machines, india-rubber manufacturers, &c. Private company. Reg. office, 8, St. George's-terrace, Brearley-street, Birmingham.

M. HOWLETT & CO. (LTD.) (142,019.)—Reg. Nov. 2, capital £20,000 in £1 shares, to carry on the business of manufacturers and vendors of incandescent and other gas burners, electrical sundries, workers in porcelain and general brassfounders formerly carried on as M. Howlett & Co. Private company. First directors are A. Rose and W. Bellamy (both permanent). Secretary, T. Harrison, 46, Albion-road, Handsworth.

LONDON & BURMESE WOLFRAM CO. (LTD.) (141,961.)—Reg. Oct. 27, capital £40,000 in £1 shares (10,000 cumulative part preference), to acquire any mines, mining rights and metalliferous land in Burmah or elsewhere, to crush, quarry, smelt, calcine, refine and prepare for market wolfram ore, metal and mineral substances of all kinds. Private company. Secretary, E. J. Hayman. Reg. office, 18, St. Swithin's-lane, E.C.

MOTOR ENGINEERING CO. (NOTTINGHAM) (LTD.) (141,963.)—Reg. Oct. 26, capital £200 in £1 shares, to take over the business of a motor engineer and munition maker carried on by E. Burton as Welton & Co. and the Electric Power Co. Private company. E. Burton is sole permanent director. Secretary, H. Harris. Reg. office, 2, King-street, Nottingham.

TELEPHONE MFG. CO. (LTD.) (142,023.)—Reg. Nov. 2, capital £25,000 in £1 shares (10,000 7 per cent. cumulative preference), to take over business carried on by F. T. Jackson as the Telephone Mfg. Co., to carry on the business of making, selling, hiring out, erecting, maintaining and working (so far as they lawfully can) private and other telephones and telegraphs, &c. Private company. F. T. Jackson is permanent governing director. Reg. office, Hollingsworth Works, Martell-road, W. Dulwich, S.E.

MORTGAGES AND CHARGES.

ELECTRICAL OIL REFINING CO. (LTD.)—At Sept. 10 capital was £5,000 in £1 shares. 4,375 shares taken up and £882 paid. £3,493 considered as paid. Mortgages and charges: Nil.

ELECTRO-FLEX STEEL CO. (LTD.)—Issue on Oct. 26, 1915, of £200 debentures, part of series of which particulars have already been filed.

MAXIM LAMP WORKS (LTD.)—Debenture dated Oct. 18, 1915, to secure £500, charged on company's undertaking and property, present and future. Holders, Imperial United Lamp Co.

W. A. & R. J. JACOBS (LTD.)—Particulars of £1,000 debentures created Oct. 23, 1915, have been filed, amount of present issue being £300 Property charged, company's property, present and future. No trustees

RECEIVERSHIP.

BRITISH ELECTRIC AUTOMATIC MACHINES (LTD.)—D. Johnston, 1, Broad-street-place, E.C., ceased to act as receiver or manager on Oct. 14, 1915.

JOHNSON-BILLINGTON ELECTRICITY METERS (LTD.)—Notice of appointment of J. J. Ure, Albion House, New Oxford-street, W., as receiver on Oct. 15, 1915, under powers contained in debentures dated May 21 and 23, 1913, has been filed.

NORTH-EASTERN ELECTRIC SMELTING CO. (LTD.)—Notice of appointment of R. Temperley, Milburn House, Newcastle-on-Tyne, as receiver on Oct. 26, under powers contained in mortgage dated April 16, 1915, has been filed.

STANLEY GOODWIN & CO. (LTD.)—Notice of appointment of F. H. Hardwicke, Sutherland-chambers, Stoke-on-Trent, as receiver on Oct. 22, under powers contained in first mortgage debentures dated March 10, 1915, has been filed.

CITY NOTES.

MEMORANDA (Nov. 10).—Bank rate 5 per cent. (since Aug. 9, 1914). Consols 65. Consols Pay Day Dec. 1. Stocks and Shares Pay Day Nov. 25. Pay Day Nov. 26. Price of silver, 24 1/4.

BRITISH ELECTRIC TRACTION CO. (LIMITED AND REDUCED)—A petition for confirming a resolution reducing the capital of this company from £4,000,000 to £2,998,397 will be heard by Mr. Justice Astbury on Nov. 16.

BRUNNER, MOND & CO. (LTD.)—An interim dividend has been declared on the ordinary shares for the half year ended September 30 at the rate of 22½ per cent. per annum (less tax), compared with 20 per cent. last year and 25 per cent. interim in 1913.

CENTRAL ARGENTINE RAILWAY CO.—The chairman (Sir Joseph W. Todd, Bart.) stated at the recent meeting that the electrification of suburban lines, as far as at present in hand, should be ready for inauguration during 1916. The new Gorton workshops were also progressing favourably.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books of this company will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due Dec. 1.

NEW BRITISH EVER-READY CO. (LTD.)—A dividend at rate of 10 per cent. per annum has been declared on the preference and ordinary shares for the half-year ended Sept. 30.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER CO.—An extraordinary general meeting will be held on Nov. 19th to sanction the creation and issue of £100,000 5½ per cent. debenture stock.

"Z" ELECTRIC LAMP MFG. CO. (LIMITED AND REDUCED)—A petition for confirming a resolution reducing the capital of this company from £150,000 to £15,000 will be heard by Mr. Justice Astbury on Nov. 16.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 9. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Nov. 9.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9¾	7 2 8	Mar. Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 6	Feb. Aug
10	6%	Do. 6% Cum. 2nd Pref.	9¾	6 0 7	Feb Aug
5	10%	Brompton & Kensington Ord.	3⅛	6 0 2	Mar. Sept
5	7%	Do. 7% Pref.	7	5 [illegible]	Mar. Aug
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	85½	4 15 10	Jan. July
5	2/3	Do. 4½% Pref.	3⅛	6 7 9	..
5	5%	Do. Ord.	4	6 5 0	Aug. Feb
5	4½%	Do. City Pref.	3⅛	5 13 5	[illegible]
10	9%	City of London Elec. Lt. Ord.	11⅛	7 11 7	Feb. Aug
10	6/0	Do. 6% Pref.	12½	4 17 0	Mar. [illegible]
St.	5%	Do. 5% Deb. St.	99½	5 0 0	Jun. Dec
St.	4½%	Do. 4½% Debs.	95	4 11 10	[illegible]
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	11½	5 0 5	Feb. Aug
St.	4½%	Do. 1st Deb.	91	4 18 11	[illegible]
St.	4½%	Do. 2nd Deb.	97	4 12 9	May Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	7e½	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	9⅛	7 5 5	Feb Aug
St.	4%	Do. Deb. St.	8e	4 13 0	Jan. July
5	3/0	London Elec. Supp. 6% Pref.	4½	6 1 0	..
St.	4%	Do. 4% Mort. Debs.	8e½	4 11 11	Jan. July
5	3½%	Metropolitan E. Supp. Ord.	9⅛	7 15 0	Mar. Aug
St.	4½%	Do. 1st Mort. Deb.	98½	4 14 0	Jan. July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	[illegible]
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 7	Mar. Sept
St.	5%	Newcastle-on-Tyne E.S.5% 2d Mt. Db. St.	100	5 0 0	Mar. Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	6 3 10	Apr. Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar. Sept
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 3 10	Apr. Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅛	7 2 3	Mar. Aug
5	9%	Westminster E.S. Corp. Ord.	9	7 10 0	Mar. Sept
5	4½%	Do. 4½% Cum. Pref.	4⅛	5 7 3	Jan. July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	77	6 8 7	Apl. Oct
St.	6%	Do. 6% Cum. Pref.	99	6 0 8	Feb. Aug
St.	4%	Central London Guar. Assented Ord.	88	5 17 4	..
St.	4%	Do. do. Assented Def. Ord.	88	5 17 8	..
St.	4½%	Do. 4½% Pref.	100	4 10 0	[illegible]
St	4%	Do 4% Deb. St.	89½	4 9 9	[illegible]
St.	4%	City & S. London Deb.	89½	4 [illegible] 5	May Nov
St.	5%	Do. Pref. 1890	80	6 5 0	Feb. Aug
10	1%	London Electric Ry. Ord.	1⅛	8 17 4	Jan. July
St.	4%	Do. 4% Pref.	5½	7 4 3	Mar. Sept.
St.	4%	Do. 4% Debs.	86	4 14 4	Jan. July
St.	1%	Metropolitan Ry. Con. Ord.	20½	5 15 [illegible]	Feb. Aug
St.	3½%	Do. 3½% Pref.	76½	4 12 4	Feb. Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb. Aug
St.	3½%	Do. 3½% A Debs	81½	4 4 0	Jan. July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan. July
St.	..	Metropolitan Dist. Ry. Ord.	14½	..	Feb. Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May. Nov
St.	4½%	Do. 4½% First Pref.	99	6 10 5	Feb. Aug
St.	6%	Do. 6% Perp. Debs.	115	5 4 4	Jan. July
St	4%	Do. 4% Debs.	89½	4 10 4	Jan. July
St.	4%	Do. 4% Debs. (1903-5)	89½	5 16 0	Jan. July
St.	4%	Do. 4% Guar. Stock	89½	5 0 0	Mar. Sept
10	..	Underground E. Rys. of London Shares.	11⅛	..	..
1/0	..	Do. A Ord.	1	..	..
St.	6%	Do. 6% Inc. Debs.	104½	5 14 1	Mar. Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price, Tues., Nov. 9	Rate per cent. Yielded.	Dividend Due
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	71½	8 8 9	Mar, Sept
..	4½%	Do. 4½% Bds.	98½	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	¾	..	March
5	6%	Do. Pref.	4 7/16	6 15 3	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2 5/16	6 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1 1/32	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1 3/32	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	92½	8 8 1	Jan, July
1	6%	Do. 6% Pref.	⅞	6 13 4	Jan. July
5	15%	Brit. Insulated & Helsby Ord.	10 1/16	7 5 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5¼	5 14 3	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	11/16	6 6 4	Mar, Sep
2	7½%	Brit. Westinghouse Pref.	1 13/16	8 5 6	April
100	6%	Do. 6% Prior Lien Debs.	101⅜	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70½	5 10 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10¼†	7 6 4	Jan, July
5	2/6	Do. 5% Pref	4 1/16	6 3 1	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	15%	Castner Kellner	3	5 0 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	9 1/16	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	1 5/16	..	Feb, Aug
St.	4%	Do. 4% Deb.	62	6 9 0	Jun, Dec
1	6%	Elec. Construction Ord.	3/16	9 2 10	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan. July
10	10%	General Electric Ord.	10 1/16	9 12 3	July
10	6%	Do, 6% Pref.	9⅜	6 7 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅞	7 14 4	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4¼	4 14 9	..
St.	4½%	Do. 4½% Db.	92½	4 17 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8	6 5 0	Feb, Aug
10	5%	Do. Pref.	8⅝	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34	7 1 2	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1 21/32	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	1	5 0 0	May, Aug
St.	4%	Do. 1st Debs.	82½	4 17 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100⅜	4 9 2	Jun, Dec
		Telegraphs.			
St.	15/0	Anglo American 6% Pref. Ord.	101†	5 18 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23	6 19 5	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	68½	5 16 9	Ja.Ap.Jly.O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	6 1/16†	6 11 11	Ja.Ap.Jly.O
St.	7%	Eastern Tel. Co. Ord.	123½	5 13 4	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	t5½	5 6 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80½	4 19 8	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11 13/16	5 18 6	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	5 19 5	Ja, My, Jly
25	13%	Indo-European	46½†	7 0 2	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1 1/32	5 19 0	April
1	7%	Do. 7% Pref.	1 1/16	3 19 0	July
10	1%	West India & Panama Ord.	1 1/16	8 8 5	May, Nov
10	6%	Do. 1st Pref.	8⅜	7 2 10	May, Nov
10	7%	Western Telegh. Co.	12 3/32	5 12 3	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	81	4 18 9	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135½	5 7 10	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	75	6 13 4	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅝	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	100½†	4 8 8	May, Nov
1	10%	*Oriental Telephone Ord.	1 1/16†	5 4 11	Apl, Oct
St.	4%	Do. Db. St.	81	4 18 9	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	5 3/16†	7 1 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10 1/16	5 19 3	Sp.Dc.Mr,Jn
10	6%	Do. 6% Pf.	10 1/16	5 16 4	Sp.Dc.Mr,Jn
100	5%	Mackay Companies' Common	86½	5 15 7	Ja, Apl, Jly.O
..	4%	Do. $100 Pref	68¾	5 16 4	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	121	5 16 9	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	78½	6 7 5	Jun, Dec
St.	4½%	Do. 4½% Debs	75½	5 19 2	Jan, July
St.	4%	Do. 4% Debs.	75⅜	5 5 5	Jan, July
5	2/9	Do. 5½% 1st Pref.	3⅜	7 17 2	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅜	7 10 6	Jan, July
100	2%	Brazilian Traction Ord.	57½†	6 11 0	Fb.M.Aug.N
100	$1½	Do. 6% Pref.	92	6 10 5	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6½†	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4⅜	5 5 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62½	6 17 1	..
5	9½%	Calcutta Elec. Trams. Ord.	6 1/16	7 16 11	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	88½	5 13 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅛	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	39	..	Fb.M.Aug.N
..	5%	Do, 5% Bds	39½	10 1 0	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922).	95	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 50 yr. Bd	76½	6 10 9	Jun. Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4 1/16	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	97	5 3 1	Jun, Dec
10	6/-	Bombay E S & T 6% Pref.	10½	5 18 6	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan. Jly
5	9%	Calcutta E S. Corp. Ord	5 1/16†	7 16 11	May, Nov
5	5%	Do 5% Pref	4⅞	5 4 4	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	123	5 11 1	Ja.Ap.Jly.O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Deb	93	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oc
..	..	Mexican Light & Power Ord.	29	..	Ja.Apl.Jly.O
..	..	Do. Pref.	42½	..	May, Nov
..	5%	Do. 5% Bds.	49	10 4 1	Jan, Jly
..	5%	Shawinigan Water & Power 5% Bds.	102	4 18 10	Jan, July
..	6%	Do. Cap. Stock	141½	4 4 10	Ja.Apl.Jly.O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	86	5 1 2	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	1⅝	..	Jan, July
—	5½%	Do. 5½% 2nd Mort. Debs.	92½	5 17 7	Jan, July

* And 13½% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 10, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	13½d.	English Lead	£25 15 0
Solid Drawn Copper Tubes	13½d.	Antimony	Nominal.
Brazed Copper Tubes	13½d.		
Brazed Brass Tubes	15½d.	**Old Metals:**	per ton.
Brass Wire	13½d.	Clean Scrap Copper	£71 0 0
Copper Wire	12½d.	Braziery Copper Scrap.	£64 0 0
Rolled Brass	12⅝d.	Clean Scrap Brass	£58 10 0
Brass Sheets	13⅝d.	Old Lead	£22 0 0
		Old Zinc	£45 0 0
	per ton.	Hollow Pewter	£120 0 0
Copper Sheets	£107 0 0	Black Pewter.	£80 0 0
Spelter	£82 0 0	Gun Metal	£62 0 0

Mr. A. Joseph, Earl-street. London-road, Southwark. London, S.E., quotes under date Nov. 9, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£95 0 0	Old Lead	£22 5 0
Clean Mixed Brass	£55 0 0	Tea Lead	£20 5 0
Clean Copper	£70 0 0	Old Zinc	£52 0 0
Braziery Copper	£63 0 0	Hollow Pewter	£115 0 0
Gun Metal	£62 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £72; Commercial Tinman's Solder, £92; Blowpipe Solder, £102.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 3	1,838	+ 237	22	40,953	+ 2,107
Anglo-Argentine	,, 4	54,194	+ 1,794	22	2,240,293	— 135.103
Ashton-under-Lyne	,, 6	440	+ 41	32	15,647	+ 1,102
Ayr Corporation	,, 6	239	+ 15	25	11,122	+ 590
Birkenhead Corporation	,, 7	1,317	+ 101	32	43,862	+ 3.425
Birmingham Corporation. Trams	Oct. 30	15,019	+ 3,125	31	429,210	+ 54,840
Birmingham Corporation. Buses	,, 30	815	+ 93	31	26,432	+ 17,276
Blackburn Corporation	Nov. 3	1,100	+ 11	32	42,235	— 450
Blackpool Corporation	,, 4	696	+ 70	32	63,654	+ 1.255
Blackpool and Fleetwood	,, 6	428	+ 3	44	36,720	— 257
Bolton Corporation	,, 7	2.600	+ 92	32§	86.217	— 2.204
Bournemouth... Trams	,, 3	1,764	+ 131	31	68,921	+ 3.701
Bournemouth... Buses	,, 3	7	..	31	864	— 102
Bradford Corporation	,, 6	6,482	+ 654	31	209.700	+ 8,984
Brighton Corporation	,, 7	951	+ 15	32§	37.821	+ 64
Bristol Trams Trams	,, 5	4,814	+ 435	44	207,034	+ 1,766
Bristol Trams Buses,&c	,, 5	4,837	+ 953	44	215,190	+ 38.187
Burmah E. Trams & Ltg.	,, 6	R3,964	+ R3.372	..	..	+ R240
Burnley Corporation	,, 6	1,492	+ 98	5	7,785	+ 1,146
Burton Corporation	,, 7	269	— 15	32	9,281	— 406
Bury Corporation	,, 7	1,252	+ 53	32§	44,180	— 697
Calcutta Tramways Co.	,, 6	R60,188	— R3,498	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	Oct. 30	2,490	+ 37	30	83,958	— 2,933
Cork Electric Trams Co.	Nov. 4	461	+ 2	44	22,300	+ 30
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	Oct. 30	975	+ 41	30‖	32,605	+ 844
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	Nov. 5	126	+ 12	18	2 957	+ 110
Dublin United	,, 5	5,784	— 107	44	270,661	+ 10,403
Dundee Corporation	,, 3	1,354	+ 113	25§	34,096	+ 1 895
East Ham Council	,, 6	1,195	— 17	31‖	41,779	+ 5,634
Exeter Corporation	,, 5	333	+ 10	31	12,361	+ 715
Glasgow Corporation	,, 6	21,877	+ 1,382	23‡	498.511	+ 37,619
Glossop Trams	,, 6	122	+ 22	45	5,656	+ 146
Gloucester Corpn.	,, 3	301	— 2	31	10,689	+ 110
Halifax Corpn. Trams	,, 2	2,039	+ 45	31	71,729	+ 943
Halifax Corpn. Buses	,, 2	40	— 4	31	1,595	+ 9
Hastings Elec. Trams Co.	,, 4	761	— 43	44	43,795	— 101
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	,, 6	3.139	+ 124	31	99,786	— 3,488
Ilford District Council	,, 6	590	— 10	31	20,836	+ 2.870
Ilkeston Corporation	,, 3	123	+ 5	31	4,237	+ 111
Ipswich Corporation	,, 6	473	+ 67	30	18.014	+ 2.842
Isle of Thanet Co.	,, 6	250	— 107	5¶	1.569	— 654
Kilmarnock Corporation	,, 6	153	+ 2	25	4,328	+ 127
Lanarkshire Trams Co.	,, 4	2.144	+ 435	44	87.468	+ 4.298
Lancashire United	,, 3	1,613	+ 102	44	77,182	+ 4.773
Leeds Corporation	,, 6	8,735	+ 671	32	286,236	+ 22,426
Leicester Corporation	,, 6	3.009	+ 197	45	134.806	+ 7,420
Leith Corporation	,, 6	738	+ 23	25	19,740	+ 1.179
Lincoln Corporation	,, 6	132	+ 13	32	4,510	— 490
Liverpool Corporation	Oct. 30	12,963	+ 555	43¶	579.381	+ 7,658
Llandudno&Colwyn BayR.	Nov. 5	213	+ 5	49	16,745	+ 1.688
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	,, 4	187	— 5	31	7,166	+ 52
Manchester Corporation	,, 6	17,151	+ 213	31	570,471	+ 18.579
Nelson Corporation	,, 6	173	+ 32	31‖	6,267	+ 98
Newcastle-on-Tyne Corpn	..	..	..	..	..	..
Newport (Mon.) Corpn.	,, 6	773	+ 21	32	26,819	+ 183
Northampton Corporation	,, 5	635	+ 27	31¶	23,478	+ 4,491
Nottingham Corporation	,, 4	3,478	+ 134	31	117,906	+ 7.869
Oldham Corporation	,, 7	2,148	+ 194	33	76,429	+ 3,025
Portsmouth Corporation	,, 6	2,126	— 97	32	82,937	..
Preston Corporation	,, 3	941	+ 82	31••	30,310	+ 723
Rochdale	..	..	..	..	..	..
Rotherham Corporation	,, 3	1,274	+ 190	31	36,341	+ 3.738
Salford Corporation	,, 8	4.928	+ 172	32‡	167,612	+ 6,326
†Sheffield Corporation	,, 7	9,275	+ 1,454	31‖	272.896	+ 3[illegible]92
Southampton Corpn.	,, 3	1,451	+ 205	31	47,806	+ 4.815
Southend Corporation	,, 3	607	— 106	31	27,975	— 7.563
South Shields	Oct. 30	761	+ 66	30‖	24,924	+ 932
St Helens, Hyde, &c., Jt. B	..	..	..	..	..	..
Sunderland Corporation	Nov. 7	1,469	+ 127	32	48,068	— 7
Sunderland District	,, 3	544	+ 26	1	544	+ 611
Swindon Corporation	,, 3	179	— 5	31	4,312	+ 611
Tyneside Tram Co.	Oct. 27	539	— 91	17	10,951	— 503
Wallasey Corporation	Nov. 7	1,080	— 22	31‖	41,972	+ 278
Walsall Corporation	.. 6	762	+ 89	45	33.052	— 4 995
Walthamstow	Nov. 6	703	— 41	32	29,758	+ 3,282
Warrington Corporation	Oct. 28	448	+ 33	30	13,835	+ 600
West Ham Corporation	..	..	..	..	..	..
Wigan Corporation	Nov. 5	1,515	+ 131	31	48,259	+ 2.074
Wolverhampton Corpn.	,, 4	1,106	+ 86	5	5,386	+ 309
Yorkshire W.R. Trams	,, 7	1,715	+ 218	45	71,419	+ 5.966

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days. § Plus 1 day. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 223
Arrangements for the Week .. 26
The Dependence of the Light of the Hefner Lamp on Atmospheric Conditions—More Especially Atmospheric Pressure. By Dr. E. Ott. Illustrated 227
Foundations for Trasmission Line Towers and Tower Erection. Illustrated 230
Simple Thermal Instruments for the Measurement of Current. By W. H. Eccles, D.Sc., and A. J. Makower, M.A. Illustrated 233
Physical Society 234
The Production and Properties of Electrolytic Copper. By B. Welbourn 235
Chairman's Address to the Yorkshire Section of the Institution of Electrical Engineers 238
Dielectric Losses in Various Insulators 239
THE B.E.A.M.A. AND THE STRUGGLE AFTER THE WAR .. 240
REVIEWS 241
Continuous Current Electrical Engineering [Maccall].
REVIEWS—*Continued.*
Arithmetic of Alternating Currents [Crapper].
Recherches sur la Commutation [Rezelman].
The Mathematical Investigation of Voltage Waves Obtained in Testing Iron. By N. W. McLachlan, B.Sc., Eng. Illustrated 242
The Starting of Rotary Converters. By W. Linke 243
German Business Methods .. 245
Protection of Life and Property against Lightning. By O. S. Peters 246
Resistance of Radiotelegraphic Antennæ. By L. W. Austin 246
CORRESPONDENCE 247
The Passing of the Small Turbine (William P. Durtnall).
The Corona in Air at Continuous Potentials and Pressures Lower than Atmospheric By Donald Mackenzie. Illustrated 247
The "Electrician" Commercial and Industrial Section .. 251–262

NOTES.

The Technical Man.

IN these days it is well that men should be stoical, and that they should cultivate the art of imperturbability. When our great engineering institutions are regarded by those in authority as glorified trades unions, and when our technical societies are set at nought, we confess that we find example more difficult than precept. Last week a statement was made in the House of Lords by Viscount PEEL to the effect that the wages paid to technical men were out of all proportion to what they earned in civil life; and to illustrate his meaning his lordship stated that chauffeurs earning 30s. a week in time of peace got £3 a week on joining the Army As a further illustration of extravagance, it was stated that hospitals could formerly get good house surgeons at £200 a year, whereas the Government offered them £365 a year! We can leave the surgeons to answer the charge at their leisure; but the sum named is not out of all proportion to the services rendered, nor is it likely that the surgeon will be better off under the new conditions. To many it will come as a surprise to learn that a large number of our technical men—engineers, chemists and scientists—are giving their services free.

To those of cramped vision and warped judgment who believe that chauffeurs are technical men we would say that chauffeurs are no more entitled to be classed as technical men than are cabdrivers. Since the war is resolving itself into a series of engineering problems, it is well that those whose business it is to govern should at least know what engineering means. The late hon. secretary of our premier engineering institution used to insist that an engineer is "anyone who [illegible] in his mind, who sees his mental powers in action, in order to discover or devise some means of succeeding in a difficult task he may have to perform." Though expressed differently, similar views are held in America. An eminent American defined an engineer as a man who can do work for 100 dollars on which a fool would spend 200 dollars. The latter definition is singularly appropriate at the present time. Amateurism and dilettantism have brought us into chaos, the like of which has never been seen before, and for which the amateur and dilettante will be held responsible.

Taxation of Excess Profits.

IN our issue of the 5th inst. we commented upon the Finance Bill for regulating the taxation of excess profits due to the war, and we drew attention to the fact that the proposed maximum of 6 per cent. was too low to be satisfactory. We are glad to note that this limiting figure has now been raised to 7 per cent., and that only profits above this limit will be subject to taxation as excess profits. This is a move in the right direction, though in our opinion the figure, even now, is not sufficiently high, more particularly when it is remembered that the profits will not be arrived at on ordinary commercial lines, but in accordance with Inland Revenue standards, which do not permit of allowances for wear and tear, except on a very low scale, or depreciation or the writing off of capital expenditure. While we heartily agree with the principle that no one should be allowed to enrich himself out of the war, we think that even now 7 per cent. is too low a yield for capital invested in any commercial undertaking, but it is certainly insufficient in the case of a company having a limited tenure and liable to be purchased on the terms of the Tramways Act, 1870. Moreover, we think there is a clear distinction between, say, an electric supply company and an ordinary manufacturing firm. Usually, the former only makes a very modest profit, and probably the average return on its capital since its formation is not greater than the present bank rate. On the other hand, some manufacturing firms, and especially those engaged on war work, have made large profits. This extra profit in the case of a manufacturing company is the direct result of the war, but only a small proportion of an electric supply company's receipts are due to this cause, and any extra revenue may be swallowed up by the increased cost of coal, stores and the higher wages and war allowances. Moreover, it must be remembered that electric supply companies are performing an important public service—the supply of electrical energy for power and lighting—under strict statutory requirements; they must make proper provision to meet any sudden demand for power, and if necessary they must put in temporary plant. The latter may involve a company in a serious loss, for, apparently, only the ordinary income tax allowance for depreciation will be made!

Excess Profits of Municipalities.

THERE is some trepidation at Sheffield as to what the effect upon municipalities will be of the excess profit clauses in the Finance Bill. As things stand at present it appears that the various undertakings of municipalities, such as tramway, electricity and water undertakings, will be treated as separate concerns. Consequently, if one particular department is making an excess profit, this profit will be taxed, and profits will not be available to the same extent as was anticipated for helping other less prosperous departments. Undoubtedly the matter is one open to some argument. It is pointed out that in the case of industrial undertakings the various departments are taken together, instead of separately, in determining the profits. We think it may be pointed out, however, that whereas there may be considerable difficulty in arriving at the profits of individual departments of a commercial undertaking for the purpose of taxation, there is no such difficulty in the case of the various undertakings of municipalities. They are essentially separate concerns and are similar to affiliated companies, which presumably will be taxed separately. Apart from this, we think there might be some possibility of a municipality relying upon the excess profits of a progressive department to make up for the deficiencies of another undertaking run on unsatisfactory lines. The plea may be put forward that there is much additional expenditure on account of increased wages and war bonuses, but commercial concerns are equally burdened with increased wages, and in very many cases also with war bonuses. On the whole, therefore, we do not think that a good case can be made out for the treatment of the various trading departments of a municipality as separate concerns.

The Properties of Copper.

WE note with pleasure that in his address to the Manchester Section of the Institution of Electrical Engineers, Mr. B. WELBOURN steered clear of the difficulties of preparing an address on a worn-out topic by taking as his subject the Production and Properties of Electrolytic Copper. It is not unlikely that those whose good fortune it was to attend the meeting much preferred the lecture on a technical subject by a well-known authority to the re-hash of the worn-out topic. There is no reason why such an address should not deal with technical matter so long as it is kept on non-contentious lines. From the abstract, which we give elsewhere, it will be seen that Mr. WELBOURN dealt at some length with hard-drawn copper. It is curious that up to the present no reliable definition of this material has been given. To be really satisfactory, tensile strength, elongation, elastic limit, modulus of elasticity and ohmic resistance should be embodied in the definition. The subject is one which comes within the sphere of activity of the Engineering Standards Committee, and is one with which the Committee is well able to deal. In view of the extensive and increasing use of copper conductors for overhead lines and for traction purposes, it is desirable to have, in convenient form, an account of the elastic properties of copper conductors, and we think that Mr. WELBOURN's suggested research will be welcomed by the Research Committee of the Institution of Electrical Engineers. Reference is also made to the effect of temperature on the strength of hard-drawn copper, and the importance is emphasised of straining the conductors on all forms of overhead line to a tension higher than that at which they will be permanently sagged. The latter is a most important point, and we do not remember having seen it mentioned elsewhere.

The Hefner Standard.

FOR some time there has existed an uncertainty as to the corrections to be made in the candle-power of the Hefner standard lamp for variations in the barometer and other atmospheric conditions. A formula has been proposed by Dr. E. LIEBENTHAL, but this is not in agreement with the formula suggested by Messrs. W. J. A. BUTTERFIELD, J. S. HALDANE and A. P. TROTTER. The English formula contained a correction for the effect of carbon dioxide three times as great, and for the effect of fluctuations in atmospheric pressure a correction four times as great, as the German formula. The International Photometric Commission, therefore, thought it desirable that further experiments should be made. These have now been carried out by Dr. E. OTT, and the work will be found described on another page of our present issue. It was first intended to make experiments at various altitudes in order to obtain the required differences of atmospheric pressure; but as this necessitated observations at places some distance apart, and as the preliminary work was not very consistent, measurements were finally made in a compression chamber in which the conditions could be easily varied.

THE results showed that neither of the proposed formulæ was entirely correct. One point of difference is due to the fact that the addition of carbon dioxide to the air does not have the same effect as the production of carbon dioxide from the air itself by combustion, because in the latter case some of the oxygen is consumed in the process. Consequently, the experiments by Dr. LIEBENTHAL do not represent what actually takes place. On the other hand, the variations due to change of barometric pressure over the range 816-717 mm. are not as large as those found by Messrs. BUTTERFIELD, HALDANE and TROTTER, though at lower pressures the variation is much greater, and does not follow the straight-line law that is now suggested. One of the inevitable conclusions of the investigation is that photometric work should be carried out in well-ventilated rooms if flame standards are used, so that the corrections are reduced simply to those for barometric pressure and the usual atmospheric humidity. Owing to its less suitable colour and small candle-power, there is little probability that the Hefner lamp will be so generally used as the Harcourt pentane lamp, for which corresponding formulæ were determined by Mr. C. C. PATERSON some years ago, and later by Messrs. BUTTERFIELD, HALDANE and TROTTER; but, in any case, it is desirable to have a matter of this kind authoritatively determined.

Electric Car Heaters for Cold Weather Concreting.—The Salt Lake and Ogden Railway was able to complete over ½ mile of street track last winter by heating the concrete with car heaters. The concrete was poured through chutes direct from the mixer to the track, and the heaters were then installed at intervals of 10 ft., and connected 10 in series on a 720-volt circuit, keeping the concrete warm until it had set. Canvas was stretched over the green concrete, and current was taken from the trolley wire by means of a fishpole connection.

Train Lighting.—Mr. R. C. Lanphier read a Paper before the American Institute of Electrical Engineers a short time ago on "Recent Improvements in the Electric Lighting of Steam Railroad Cars." The axle system of generating the current is dealt with, and a description given of the most recent improvements in the regulation of the voltage and battery charging current from these dynamos. The methods of control depending upon the voltage of the battery, the author stated, were not so successful as the recent systems which control the charging current by taking account of the actual output and input. One such system was described. In making tests for the development of this method a special graphic-recording ampere-hour meter was used, which gave a complete record of the conditions to which the battery was subjected. In this system the lighting load is put on the generator as much as possible, and the battery works generally between full charge and 75 or 80 per cent. of full charge.

Nobel Prizes.—It is announced that the Swedish Royal Academy of Science has awarded a Nobel Prize for Chemistry for 1915 to Prof. R. Willstätter, of Berlin. A Nobel Prize for Physics for 1915 is to be divided between Prof. W. H. Bragg and his son, Mr. W. L. Bragg, for their researches into the relation of crystals and X-rays.

Oscillating Currents.—At a meeting of the Institute of Radio Engineers on November 3rd, at New York, a Paper on "The Impedances, Angular Velocities and Frequencies of Oscillating Current Circuits" was read by Prof. A. E. Kennelly, in which he developed a new method of finding the true periods and dampings of any system of oscillating circuits.

Military Service and Indispensable Workers.—The Board of Trade announce than an Interdepartmental Advisory Committee is engaged in preparing lists of reserved occupations—*i.e.*, occupations from which enlistments should be restricted—in view of the necessity of maintaining the trade of the country as far as possible. Representations from employers with reference to indispensable and irreplaceable classes of labour should be addressed to the Secretary, Reserved Occupations Committee, Board of Trade, Gwydyr House, Whitehall, London, S.W.

Heating Steel Tyres Electrically.—An ingenious method of heating motor truck wheel tyres is employed by the Pierce Arrow Motor Car Co., Buffalo, N.Y. The tyres, which have to be heated before being pressed on to the wooden wheels, are heated electrically by being laid in a steel tub around a transformer coil. The tyre thus forms the secondary, and is heated in a similar manner to the metal in an induction furnace. In three minutes a tyre about $\frac{1}{2}$ in. thick, 10 in. wide and 36 in. in diameter can be heated to the required temperature, which is just about sufficient to make the ash wheel smoke. The advantages are that there is no danger of fire in the woodworking shop, and that the tyres are heated quickly and uniformly without being sooted or oxidised.

Electrolytic Iron.—According to the "Steamship," a certain French works is now producing tubes and sheets of electrolytic iron by a process in which ordinary cast-iron serves as a basis, and the product consists of iron in a very pure state. The cathode rotates in a solution of ferrous salt so as to have a layer of iron deposited on the surface. The solution is kept neutral by placing iron turnings in the bottom of the tank and by adding oxide of iron as a depolariser. The iron thus produced is very hard at first, and contains some gas, but it is then annealed so as to expel the gas and give a soft and malleable metal. Iron pipe can be made direct by using a rod as a core, but sheet iron manufacture is not yet in the commercial stage, though it is expected to produce, without any rolling, sheets of very soft and pure iron which will be valuable for electrical machinery.

Hard X-Rays.—To the "American Journal of Röntgenology," Prof. W. D. Coolidge has contributed an article on the factors determining the hardness or penetrating power of X-rays, in which is emphasised the fact that for any particular target the penetration is determined entirely by the impressed voltage, increasing with it, and not by the kind of tube or by the vacuum or current passing. The penetrating power so far obtained has been limited because it has been difficult to produce a tube that can be run continuously at very high voltages; but recent experiments seem to show that a hot cathode tube can be designed with a sufficiently high vacuum to operate at any voltage now available. Ordinary commercial tubes can be used on voltages up to that corresponding to a 10 in. spark between points, and experimental tubes have been run at about 200,000 volts (20 in. spark). As Prof. Rutherford has shown, on the quantum theory 180,000 volts should give radiations the penetrations of which would equal that of the hard gamma rays from radium C, which are only half absorbed by 6 cm. of aluminium. These rays would be very valuable for the testing of metals as carried out by Dr. Davey in the Research Laboratory of the General Electric Co. of America.

Hydro-Electric Plant at Lake Margaret, Tasmania.—Some interesting features of this plant have recently been described by Mr. H. D. Cook in the "Commonwealth Engineer." For governing the turbines use is made of a combined deflection and needle-valve control. In order to avoid dangers from water-hammer, the motion of the needle is retarded by a dash-pot so that it would take 30 seconds to close from the fully open position. When the speed rises [illegible], a deflector just above the jet is forced into it, throwing the water down and away from the wheel, so as to give it less power. Then, under the combined action of the water pressure and a spring, the needle is allowed to move gradually forward against the resistance of the dashpot while the deflector returns to its original position. This arrangement gives sensitive control without the shock of suddenly stopping the flow of the water. On testing the mechanism by throwing off full load, the water pressure rise was only 2 per cent., and the momentary speed rise only 7 per cent. Oil at 200 lbs. pressure was used for working the governors. There is also a special compensation device to allow the speed-load characteristic to be adjusted at will. Perfect parallel operation of the generators was obtained with a permanent speed drop of 0·7 per cent.

Manufacture of Aluminium in the United States.—According to Messrs. D. A. Lyon and R. M. Keeney, aluminium manufactured to-day is produced by an electrometallurgical process, either by the Heroult process or by the Hall process, both of which are essentially the same. In the United States the Hall process is used, and in Europe the Heroult process. The production of aluminium in the United States has increased materially since 1912, but exact figures are difficult to obtain (owing to statistics being given for recent years as consumption). The consumption in 1913 amounted to 72,379,090 lb., of which 23,000,000 lb were imported during the calendar year. The actual production in 1913 in the United States has been estimated at 65,000,000 lb., and to-day probably 150,000 H.P. is in use for this purpose. A plant is in course of construction at Whitney, N.C., on the Yadkin River, where a total development in high water of 100,000 H.P. is possible, although the average power will be 45,000 H.P. The capacity of the plant to be erected will be 20,000,000 lb. of aluminium per annum. This company continued its construction work up to the outbreak of the European war, when it became embarrassed by the then existing financial condition, and so was obliged to discontinue its work. Such being the case, the Aluminium Co. of America is the only real producer. Some second quality material is put on the market by concerns which simply re-melt scrap and junk. In Europe the aluminium industry has progressed as rapidly as in the United States. Europe, in 1913, produced about three times as much as the United States, but the latter country leads in individual production, with France second.

Electric Equipment for Ford Cars.—According to the "Electrical World" an electric starting and lighting system to which an electric ignition apparatus may be added if desired has recently been developed for Ford automobiles by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The system consists essentially of a single unit, which acts as starting motor and lighting generator, and a storage battery. When the starting switch is closed, the unit operates as a motor taking energy from the battery and driving the engine at a speed of about 175 revs. per min. When the car reaches a speed of nine miles per hour on high gear, the unit is operated as a generator, and provides energy for the lighting system and for charging the storage battery. Use is made of the frame of the car as the return circuit. At high speed the charging current tapers off so that the battery does not overcharge when touring. The windings of the electrical unit are given a special impregnation treatment, so that they will not be damaged by heat, water, gasoline or oil, and the winding can withstand a temperature of 250°F. without harm. The vertical ignition unit is made up of an interrupter, ignition coil and condenser and flat-surface distributor. Energy is taken from the battery, only one wire

from the dash being required. A circuit-breaker with platinum contacts is provided in the primary circuits for giving a spark in the cylinder at every power stroke. The ignition coil and condenser are enclosed in a tube of "bakelised micarta," which protects them from oil and gasoline, while the core of the coil is of silicon steel.

OBITUARY.

Prof. R. Meldola.—We regret to record the death on Tuesday last of Prof. Raphael Meldola, at the age of 66. He is well known for his work in connection with coal-tar dyes, being one of the few British chemists who had practical experience in their manufacture. For a time he was with Messrs. Williams, Thomas & Domer, and later worked for Messrs. Brooke, Simpson & Spiller. In the interval he was engaged in teaching and research work, first at the Royal College of Science and afterwards at the Solar Physics Laboratory, where he was assisted by Sir Norman Lockyer. In 1885 he became professor of chemistry at Finsbury Technical College, but he continued to take a great interest in the coal-tar colour industry even after leaving it. Even then he pointed out the decay of that industry in this country, and showed it to be due to insufficient attention to pure science and research; and at the beginning of this year he voiced the same opinions when appointed chairman of the Advisory Committee of British Dyes (Ltd.). Besides chemistry, he took a great interest in biology, and was president of the Entomological Society from 1895 to 1897.

Col. John Duncan Bertie Fulton.—We regret to record the sudden death on Thursday, 9th inst., of Col. J. D. B. Fulton, C.B., R.F.A., Assistant Director of Aeronautics. He served throughout the South African War, and was mentioned twice in despatches and received both medals with eight clasps. He was a pioneer in military aviation, being the first military officer on full pay to obtain the Royal Aero Club's certificate. At the time of his death he was Chief Inspector of the Aeronautical Inspection Department, a position he had held from the end of last year.

Prof. H. L. Cripps—We have also to record the death of Mr. Henry L. Cripps, solicitor and Parliamentary agent. Deceased, who joined the firm of Messrs. Dyson & Co., in 1871, acted for the Metropolitan Board of Works from 1877, and for the London County Council from 1890 until his retirement from business. He was subsequently elected an Alderman of the London County Council. He was a sound authority on private bill legislation, and he took a prominent share in the legislation relating to gas and electricity supply. He was a director of the Victoria Falls & Transvaal Power Co.

PERSONAL.

The D.S.O. has been conferred upon Major B. I. Rolling, R.E., for services rendered in Gallipoli. Major Rolling will be known to our readers as the Igranic Electric Co.'s Glasgow manager

Mr. Wm. T. Taylor, electrical engineer, of Burnley, has been gazetted captain in the Royal North Lancashire Regiment. Capt. Taylor has held a Government appointment in Burma, and in 1910 he went to San Luis, Potosi, for the Central Mexico Light & Power Co.

APPOINTMENTS VACANT AND FILLED

A junior assistant is required on the editorial staff of The Electrician. *See advertisement.*

A staff assistant is wanted for electrical office work in a Government department. Salary £200 per annum. Applications to Commanding Officer, H.M.S. "Vernon," Portsmouth. *See advertisement.*

An electrical and mechanical engineer is wanted for an Indian colliery. Must have had experience of the electrical machinery used in large colliery. Commencing salary Rs. 450 rising to Rs. 600 per month at the end of fourth year. *See advertisement.*

There is a vacancy on the professional staff of the Bennett College, Regent-street, Sheffield, for a tutor in the electrical department *See advertisement.*

Wolverhampton Guardians require an assistant in the engineering department, which deals with steam engines, electrical generating plant, &c. Salary £50 with residence, rations, &c. Applications (on forms supplied) to the Clerk by first post Nov. 23.

Mr. W. J Cox, of Euroa (Victoria), has been appointed electrical engineer to the Chelsea, Aspendale & Carrum (Victoria) Electric Co.

Mr. W. R. P. Marmion has been appointed attorney and general manager of the Kalgoorlie (W.A.) Electric Power & Lighting Corpn. in succession to Mr. C. E. Crocker, who has been appointed general manager of the Perth (W.A.) municipal electricity and gas departments. Mr. Crocker will act as consulting engineer to the company.

Mr. Rupert J. Collard has been appointed teacher of electrica engineering at the Central Technical College, Brisbane.

Mr. Horace Priestly has been appointed as municipal electrical engineer at Kaponga (N.Z.).

INSTITUTIONS AND SOCIETIES

Royal Society.—The following have been recommended by the President and Council of the Royal Society for election into the Council for the year 1916 at the anniversary meeting on Nov. 30: *President.*—Sir J. J. Thomson, O.M. *Treasurer.*—Sir A. B. Kempe. *Secretaries.*—Prof. Arthur Schuster and Mr. W. B. Hardy. *Foreign Secretary.*—Dr. D. H. Scott. *Other Members of the Council.*—Prof. J. G. Adami, Sir T. C. Allbutt, K.C.B., Dr. F. F. Blackman, Dr. Dugald Clerk, Sir William Crookes, O.M., Prof. A. Dendy, Mr. J. S. Gardiner, Dr. H. Head, Mr. G. W. Lamplugh, Prof. A. E. H. Love, Major Percy Alexander MacMahon, Prof. R. Meldola, Prof. A. Smithells, Prof. E. H. Starling, Mr. R. Threlfall, Sir Philip Watts, K.C.B.

Institute of Metals.—Prof. W. H. Bragg, F.R.S., is to deliver the 1916 May lecture before the Institute of Metals. He is now devoting attention to the structure of metal crystals as revealed by X-rays, and it is expected that he will have a very important pronouncement to make on this subject before the Institute of Metals on the occasion of the forthcoming lecture.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 19th (to-day).

Institution of Mechanical Engineers.

8 p.m. Meeting at Institution of Civil Engineers, Great George-street, Westminster. Papers on "The Chemical and Mechanical Relations of Iron, Molybdenum and Carbon," by Profs. J. O. Arnold, F.R.S., and A. A. Read; and on "The Cause and Effect of 'Ghost Lines' in Large Steel Forgings," by Prof. J. O. Arnold, F.R.S.

SATURDAY, Nov. 20th.

Birmingham and District Electric Club.

7 p.m. Meeting at Swan Hotel, New-street, Birmingham. General business and Paper on "Organising the Electrical Industry," by Mr. H. Foulds.

TUESDAY, Nov. 23rd.

Illuminating Engineering Society.

8 p.m. Meeting at the House of the Royal Society of Arts, John-street, Adelphi, London. Discussion on "The First Report of the Departmental Committee on Lighting in Factories and Workshops," opened by Mr. Leon Gaster.

WEDNESDAY, Nov. 24th.

Birmingham Section of the Institution of Electrical Engineers.

7 p.m. Meeting at the University, Edmund-street, Birmingham. Paper on "Some Difficulties of Design of High-speed Generators," by Prof. A. B. Field.

THURSDAY, Nov. 25th

Institution of Electrical Engineers.

8 p.m. Meeting at Victoria Embankment, W.C. Paper on "Some Difficulties of Design of High-speed Generators," by Prof. A. B. Field.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing Nov. 22, 1915:

Drills: 5.25 to 7.25, 7.25 to 8.25 p.m.

Saturday, Nov. 20.—Uniform parade 3 p.m.

Monday, Nov. 22.—Sections 1 and 2, technical; sections 3 and 4, squad. Signalling Section and Recruits.

Tuesday, Nov. 23.—School of Arms with Architects Corps, 6 to 8 p.m.

Thursday, Nov. 25.—Sections 1 and 2 and Signalling Section. Shooting.

Friday, Nov. 26.—Sections 3 and 4, technical; Sections 1 and 2, squad. Signalling Section and Recruits.

Sections for technical parade at headquarters, London Electrical Engineers, 46, Regency-street. Sections for shooting parade at the Miniature Range. Unless otherwise ordered, all parades at Chester House. The opening meeting of the new headquarters will be held on Wednesday, Dec. 1st, 6.30 p.m.

THE DEPENDENCE OF THE LIGHT OF THE HEFNER LAMP ON ATMOSPHERIC CONDITIONS—MORE ESPECIALLY ATMOSPHERIC PRESSURE.*

BY DR. E. OTT.

Summary.—There has been some discrepancy in the formulæ proposed for the candle-power of the Hefner Lamp as affected by atmospheric conditions. In order to determine this effect definitely, the author made measurements in a closed receiver, the pressure being varied between wide limits. Three sets of determinations were made.

Dr. E. Liebenthal has proposed the following formula for the illuminating power y of the Hefner lamp, viz :—

$$y=1{\cdot}049-0{\cdot}0055x-0{\cdot}0072(x'-0{\cdot}75)+0{\cdot}00011(b-760)$$

in which

x=the volume, expressed in litres, which the aqueous vapour associated with 1 cubic metre of dry air free from carbon dioxide would have at the same temperature and same pressure.

x'=the carbon dioxide contained in the air expressed in the same manner ; and

b=the atmospheric pressure within the range 735 to 775 mm. of mercury.

On the other hand, Messrs. W. J. A. Butterfield, J. S. Haldane and A. P. Trotter found the formula :—

$$I'=\frac{100-\left(\frac{a-A}{0{\cdot}16}+\frac{c-C}{0{\cdot}035}-\frac{p-P}{12{\cdot}5}\right)}{100}I$$

in which :—

I′=the varying light of the Hefner lamp expressed in terms of its light I in normal conditions ;

a=the varying percentage by volume of aqueous vapour in the air ;

A=the normal percentage of aqueous vapour in the air ;

c=the varying percentage by volume of carbon dioxide in the air ;

C=the normal percentage of carbon dioxide in the air ;

p=the varying atmospheric pressure in millimetres of mercury ;

P=the normal atmospheric pressure at sea level.

Here $y=1$, and I′=I(1 Hefner unit HK) when the Hefner lamp is burning in normal conditions, *i.e.*, with an atmospheric humidity of 8·8 litres of aqueous vapour ; carbon dioxide amounting to 0·75 litre per cubic metre of pure air,† and an atmospheric pressure of 760 mm.

Mr. Butterfield communicated the results obtained in England to the International Photometric Commission at its Third Congress in Zurich in the year 1911. As the English formula contains a correction for the effect of carbon dioxide on the light of the Hefner lamp three times as great, and for the effect of ordinary fluctuations of atmospheric pressure a correction four times as great, as the German formula, that Commission expressed a desire that the researches should be repeated. The president, Prof. Vautier, having suggested that this should be done at very different altitudes in order primarily to ascertain the effect of atmospheric pressure, Mr. A. Weiss, of Zurich (who, unfortunately, has since died), and Hofrat L. Kusminsky, of Vienna, expressed themselves willing to undertake the task.

Owing to various circumstances, our laboratory could not put this special work in hand until the spring of 1914, after a lot of prolonged preparatory work had been carried out. The measurements were made by means of a portable equipment, which is described below, at the Jungfrau Joch station of the Jungfrau Railway (3,450 metres =11,319 ft. above sea level and with a barometer reading of about 500 mm. of mercury) ; at the Wengen Alp Railway stations Kleine Scheidegg (2,067 metres=6,781 ft. above sea level and 590 mm. barometer) and Lauterbrunnen (800 metres=2,625 ft. above sea level and 695 mm. barometer) ; and in the potash mine " Alex " near Bollweiler in Alsace (400 metres=1,312 ft. below sea level and nearly 800 mm. barometer). A more favourable choice of experimental stations with more regular barometric differences could scarcely have been chosen, and the gas works laboratory at Schlieren (about 400 metres=1,312 ft. above sea level and 727 mm. barometer) was in a suitable position to afford an intermediate controlling figure.

Unfortunately, however, these very laborious and tedious measurements showed an improbable course of variation in the light with the differences of height, which was, however, quite readily attributable to the distance in place and time between the experiments. The work had to be carried out in air of very different composition, often (on account of the small size of the room placed at our disposal) in particularly vitiated air, the effect of which on the measurements cannot be determined with sufficient certainty. The results were also liable to be affected unfavourably by the very different temperatures of the rooms, by the fact that the Hefner lamp frequently burnt in an unsettled manner, and by the repeated setting up, taking down, and transporting of the apparatus. To sum up, the results of the experiments undoubtedly demanded confirmation by an investigation made at one and the same spot instead of in different places, in order that the determinations at varying atmospheric pressures should be carried out with air of the same quality as far as possible, and with no change being made in the apparatus in the course of a series of tests.

The recognition of this led naturally to the employment of a compression chamber. This consisted of a new iron vessel which had been ordered for other purposes and in which the desired repetition of the measurements was carried out between January 20th and 31st, 1915. In contradistinction to the earlier work, however, these investigations were made at only three different pressures, viz., at atmospheric pressure and at 100 mm. of mercury above, and 100 mm. of mercury below, atmospheric pressure, since this appeared to be sufficient to cover practical conditions, while the consequent curtailment of the experiments was an advantage from the standpoint of accuracy. The vessel also was thus not subjected to too great a pressure.

The compression vessel had a length of 6·20 metres (=20·3 ft.) and a diameter of 1·80 metres (=5·9 ft.). For practical reasons it was used in the upright position. It was provided with a manhole and three tubulures for the air and electricity supplies, as shown in the accompanying drawing, which also shows the arrangement of the air pump, the air chests and the connections. By suitable setting of the cocks either a reduced or an increased pressure, or atmospheric pressure, could be maintained by the pumps and measured on a water gauge. The pressures were quite readily maintained constant without any special regulator by throttling one or other of the cocks. The air was always passed in from the bottom to the top of the chamber, as in this way rapid removal of the vitiated air could be most easily and completely effected without eddies. The removal in this way is facilitated by the natural upward movement of the air warmed by the observer and the flame. The air particles were given a parallel course through the compression vessel by the perforated plank flooring and the perforated plank ceiling, and consequently with an adequate air supply the flame burned with normal quietness.

The position of the cocks shown in the drawing represents the method of working at a reduced pressure ; in this case in order to compensate for the cooling resulting from expansion, the air was warmed in the electric oven, so that the whole series of experiments could be carried out with fresh air at temperatures between 20°C. to 23°C. (=68°F. to 73°F.).

The pumps were also kept going during the experiments with pure air at atmospheric pressure. Thus the air was practically identical at increased and atmospheric pressure, and little altered in composition at reduced pressure. The contaminated air required for determining the effect of carbon dioxide and aqueous vapour was obtained by stopping the pump and allowing the products of breathing and combustion to accumulate, and by sprinkling hot water or spreading out dry calcium chloride. The maximum temperature thus attained was 24°C. (=75°F.). It must, however, be pointed out in this connection that an effect on the flame varying in degree took place according to the source of the vitiating constituents, viz., carbon dioxide and aqueous vapour, because the light is affected specially by the relative proportion of oxygen, *i.e.*, the ratio of oxygen to nitrogen. The more carbon dioxide and aqueous vapour arise through combustion (and not by mere admixture) the more oxygen disappears relatively to the nitrogen, and the more considerable is the loss of light. Carbon dioxide, moreover, has considerably greater effect than aqueous vapour. This has been proved by Bunte and Burschell 25 years ago (vide " Journal für Gasbeleuchtung," 1891, p. 310, *et seq.*), further reference to whose very interesting experiments will be made later.

The whole apparatus was installed in very favourable temperature conditions in the first condenser room of the No. 2 apparatus house of the gas works. Pure outer air was always supplied to the pump. A small table, which was fastened to the plank floor of the iron vessel, carried a short photometer bench, for comparing the Hefner lamp and the working standard incandescent lamp, by means of a Lummer Brodhun photometer head of the equality and contrast pattern. Carbon filament incandescent lamps with bow-shaped filaments and cylindrical glass bulbs were used, giving a light of about one Hefner unit at about 8 watts (20 volts, 0·4 amperes). These lamps had first been proved to be sufficiently constant on burning for at least 100 hours. They were compared from time to time with similar reference standard lamps which were used but little and merely for control purposes. No considerable change of illuminating power was at any time observed, which tallies entirely with experience of them gained otherwise.

* From the laboratory of the Schlieren Works of the Zurich Gas Undertaking. Communicated by the International Photometric Commission and translated by W. A. J. Butterfield.

† " Pure Air " in the sequel always signifies dry air free from carbon dioxide.

The tests were made with two incandescent lamps, but one and the same lamp was used throughout a complete series of tests at the three different pressures without being disconnected, in order to avoid disturbing the state of equilibrium of the apparatus. Any discrepancies between the readings of the scale on the photometer bench and the true distances between the incandescent filaments, photometer and Hefner lamp, were neutralised by arranging that the photometer settings always fell about the middle of the distance of 80 cm. between the two sources of light and as the latter also had nearly the same colour the errors of measurement were reduced to a minimum.

The current to the incandescent lamps was regulated from outside the compression vessel by means of a portable compensation apparatus which had been standardised at the Imperial Physical Technical Institute af Charlottenburg, and found quite suitable for our purpose by Prof. Dr. Liebenthal. It permitted the current and voltage to be set exactly to 0·01 per cent. and, therefore, the illuminating power are not well adapted for work in conjunction with experiments which have to be carried through quickly with rapid changes of pressure. Moreover, they would not have given results for a particular moment, as was absolutely necessary for tests beginning at any time. The use of the two methods together would have been much too troublesome and tedious. In order to obtain average values which should be as correct as possible, the following order of working was always observed: reading the siphon barometer, determination of the carbon dioxide, determination of the humidity, reading the photometer, determination of the humidity, determination of the carbon dioxide, reading the barometer.

The equipment inside the vessel, which was coated dead black, comprised, in addition to the barometer already referred to, a series of screens, a telephone for intercourse with the exterior, and an incandescent lamp with convenient switch for lighting.

The readings of the photometer were made by the writer of this report personally at such times as were indicated by two other

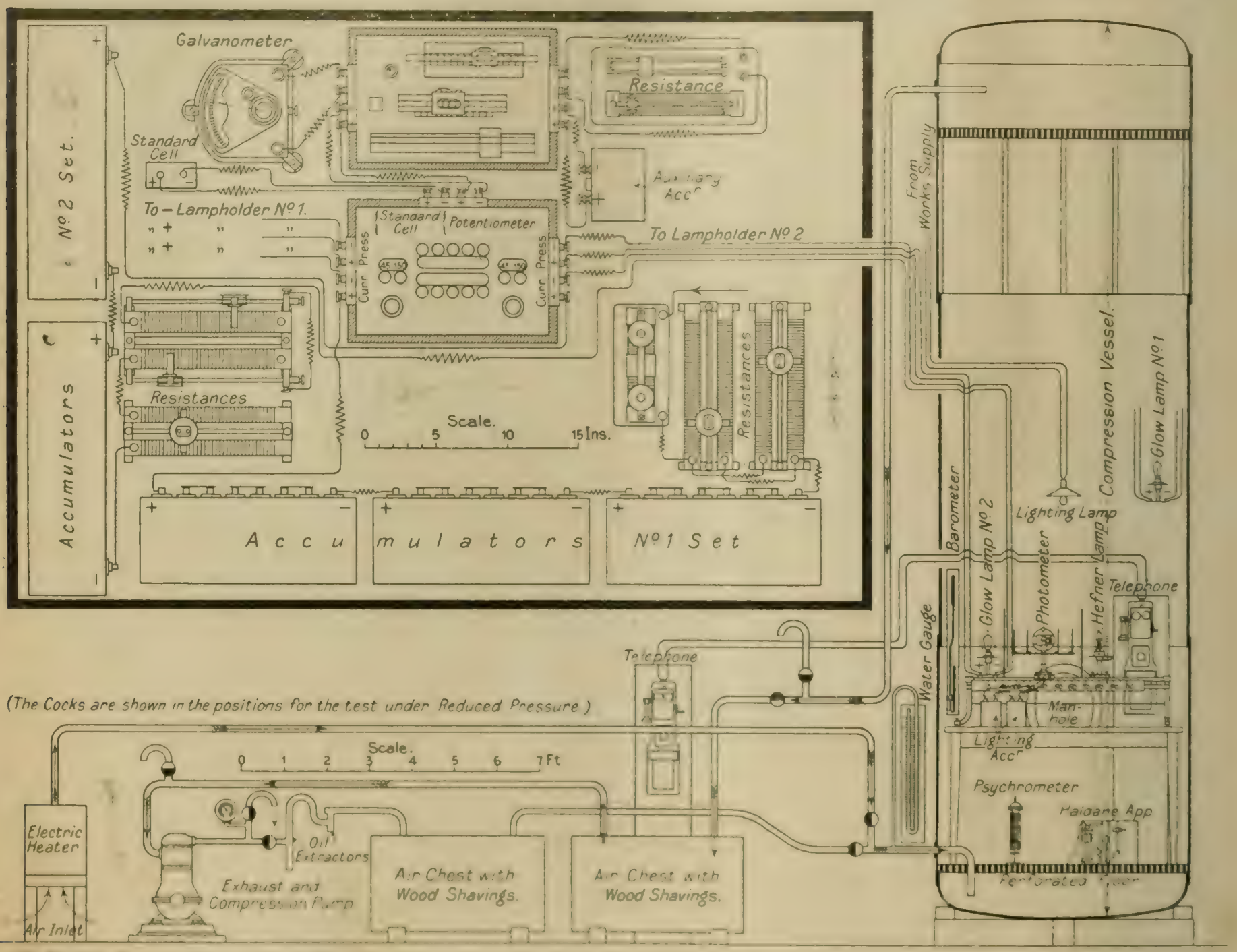


FIG. 1.—ARRANGEMENT EMPLOYED IN DETERMINING THE LIGHT OF THE HEFNER LAMP IN DIFFERENT ATMOSPHERIC CONDITIONS (IN TWO SCALES).

to be fixed to at least 0·1 per cent. The compensation apparatus, supplied by the Land and Marine Cable Works at Nippes, Cologne, was specially arranged so that by means of a positive switch two lamps, viz., the one used in testing and the "reference standard," could be controlled with the required accuracy. A Weston cell saturated at 4°C. and practically independent of temperature was used as the standard cell. The rest of the arrangements can be followed from the accompanying drawing (Fig. 1).

The composition of the air was determined by physical volumetric methods as follows: The proportion of aqueous vapour was ascertained by the Assmann aspiration hygrometer (as recommended in Liebenthal's "Praktischer Photometrie," p. 117), and the proportion of carbon dioxide with the apparatus of J. S. Haldane, as recommended by Butterfield and described *inter alia* in the "Journal für Gasbeleuchtung," 1910, p. 142. Both apparatus gave values in agreement with gravimetric methods. The latter, therefore, could be wholly dispensed with, which was especially advantageous as they observers, who were keeping continuous control of the height of the Hefner flame (which was fed with amyl acetate complying with the prescription) and of the intensity of the current and voltage of the incandescent lamp.* A special device was found unnecessary for mixing the air in the vessel, on account of it being so narrow, and the fresh air being in flow through it. Hence nothing more was necessary in the trials made with fresh air to ensure a sufficient admixture. When the pump was stopped, however, the vitiated air produced was stirred with dusters, while the determinations of carbon dioxide and humidity were always made in the immediate neighbourhood of the flame, but screened from its radiation.

In order to render the solution of the particular question, viz., the determination of the effect of changes of atmospheric pressure on the light of the Hefner lamp, independent of disturbing factors, a transition was first made from atmospheric pressure (717 mm. on the average), through a pressure increased by about 100 mm. of mercury, to a pressure reduced by about 100 mm.; then from the increased

pressure through atmospheric pressure to the reduced pressure; and finally beginning with the reduced pressure. In conclusion, an investigation was made with vitiated air under atmospheric pressure in order to determine the effect of carbon dioxide and aqueous vapour.

The results are summarised in the sequel :—

Effect of Atmospheric Pressure.

(*a*) *816—717 mm. of Mercury.*—On changing the atmospheric pressure from 816 mm. to 717 mm. of mercury with practically unaltered composition of the air (at the high pressure the air contained on the average 10·47 litres of aqueous vapour and 1·27 litres of carbon dioxide, and at atmospheric pressure 10·66 and 1·19 litres respectively, per cubic metre of pure air), the sources of light being at the distance of 80 cm. already mentioned, the photometer had not to be moved approximately 4 mm., which would have corresponded with the change of light of 4 per cent. ascertained in England, but on the average only by 0·95 mm., which corresponds with a decrease of light of 0·95 per cent. Taking into account the effect of carbon dioxide and aqueous vapour, according to the formula given below, the decrease rises to 1·10 per cent., which difference is, however, so small that if falls within the limits of experimental error.

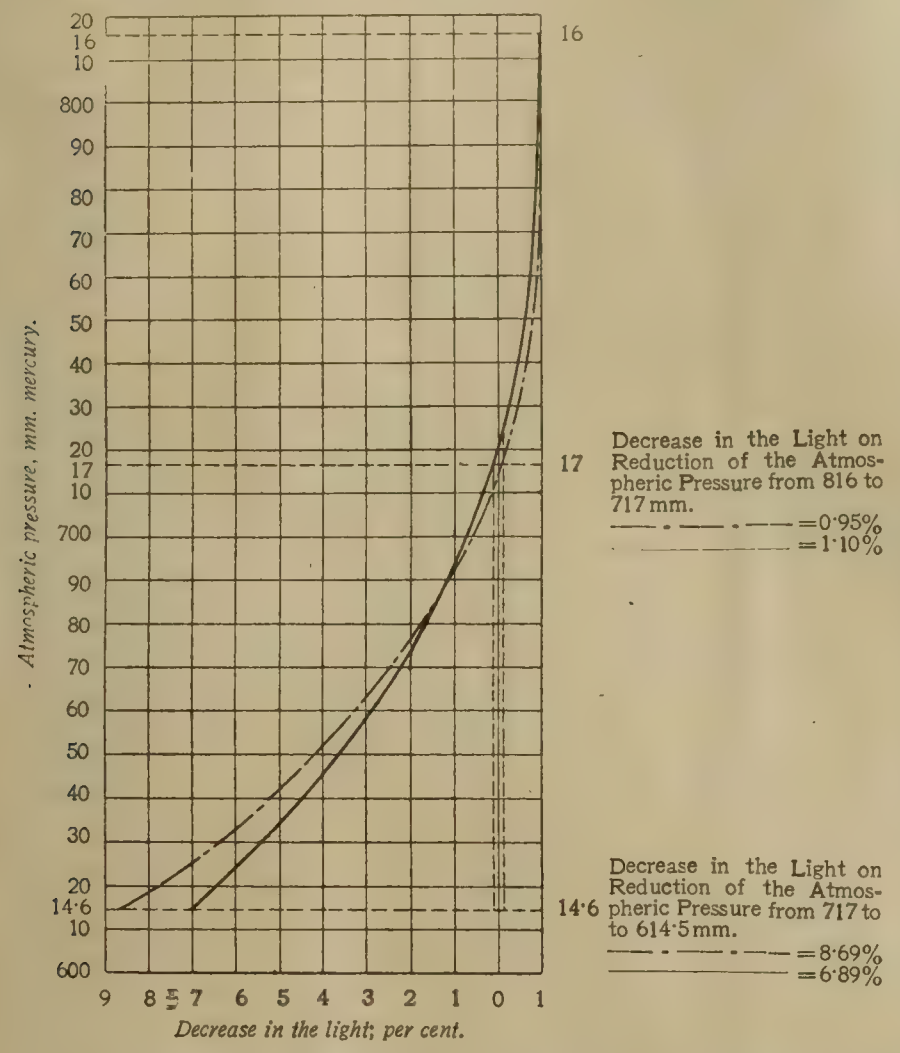


Fig. 2.—Decrease Observed in the Light of the Hefner Lamp on Reduction of the Atmospheric Pressure from 816 to 614·5 mm. of Mercury.

Curve —·—·—·— =Without Correction for Carbondioxide and Aqueous Vapour.
" ———— =With " " " " " "

It can, therefore, be stated with certainty that the decrease of light of the Hefner lamp through a diminution of atmospheric pressure of 99 mm. of mercury in the interval from 816 mm. to 717 mm., which is the most important range from the practical standpoint, amounts to only 1·1 per cent., and that, therefore, the portion of Liebenthal's formula relating to atmospheric pressure corresponds with the fact.

Any other result was hardly to be expected, as the member of the formula in question had been obtained by the method of least squares from a sufficient number of observations made in a well-ventilated large room.

(*b*) *717—614·5 mm. of Mercury.*—At the change of pressure and an average of 12·65 litres of aqueous vapour and 1·34 litres of carbon dioxide in the attenuated air (the composition of the air at the atmospheric pressure of 717 mm. being as already stated above), the photometer had on the average to be moved 9·05 mm. towards the Hefner lamp, which corresponds with a decrease of light of 8·69 per cent. without correction, and of 6·89 per cent. with correction for carbon dioxide and aqueous vapour according to the formula given below.

This decrease is thus considerably greater than that found by Liebenthal in the pneumatic chamber. The difference is readily explicable by the fact that Liebenthal according to his own account, did not secure quite satisfactory measurements because he was using a Weber photometer with a benzine standard.

It is of interest that the average decrease of light thus found over the whole interval from 816 mm. to 614·5 mm. pressure is equal to that found by Butterfield, Haldane and Trotter, viz., about 4 per cent. per 100 mm. decrease of pressure. But our points lie on a curve (Fig. 2) and those of the other observers on a straight line.

It may be mentioned that, further, two mean points at 763 mm. and 663 mm. pressure fit in the curve referred to above. These measurements were obtained from the tests made in the spring of 1914.

Effect of Carbon Dioxide and Aqueous Vapour.

As already explained, this effect depends not merely on the constituents themselves which cause the vitiation, but also on their origin. It could not, therefore, be determined so unequivocally as could the effect of atmospheric pressure. Experiments by Bunte and Burschell with the batswing burner, the Argand burner, and the Hefner lamp, showed in general about the same effect from admixed carbon dioxide and admixed aqueous vapour as Liebenthal found, while these impurities when occurring as products of combustion lowered the illuminating power to a relatively much greater extent. Thus the carbon dioxide lowered it in a ratio which falls between that found by the Englishmen and that found in these experiments.

Since an increase of carbon dioxide and aqueous vapour generally is accompanied by a diminution of oxygen, special experiments with mere admixture of carbon dioxide as carried out by Liebenthal do not represent what actually takes place. On the other hand admixture of aqueous vapour, though of smaller effect, takes account of the change of natrual atmospheric humidity. In any case in a formula applicable to the effect of vitiation of the air of a room the effect of the products of combustion and breathing must not be disregarded. Since, however, the ratio of the quantities of the impurities which thus come into account constantly varies, it is impossible at the outset to give a formula which will be correct for all experimental conditions. The formula expressed below, therefore, strictly speaking, only applies to air of similar composition to that in our experiments, and, therefore, the changes of the light with variations in the atmospheric pressure have been stated above with and without correction for the vitiation of the air.

Our investigations have been mostly made at atmospheric pressure and with the aqueous vapour ranging from 9·93 to 21·19 litres and the carbon dioxide from 1·00 to 3·90 litres per cubic metre of pure air. For our experimental conditions the change of light per litre of aqueous vapour was 0·62 per cent. and per litre of carbon dioxide 3·30 per cent. Liebenthal found 0·55 per cent. and 0·72 per cent.; Butterfield, Haldane and Trotter 0·625 per cent. and 2·20 per cent.; and an investigation made by Paterson at the National Physical Laboratory at Teddington on the effect of aqueous vapour gave the result of 0·60 per cent. These differences, which are inconsiderable for aqueous vapour, are appreciable for carbon dioxide. They arise clearly from the fact that Liebenthal worked in a large room which was always well ventilated, and determined the effect of carbon dioxide only by admixture of carbon dioxide from a cylinder, whereas the other observers carried out their investigations in small rooms with air contaminated by the products of breathing and combustion and, therefore, relatively poorer in oxygen. It may be of interest to point out that the factor for the effect of carbon dioxide given by our formula is smaller than that of Butterfield, Haldane and Trotter, but in any given case may be compensated by the larger factor for the effect of atmospheric pressure. This probably accounts for the difference in the factors for atmospheric pressure.

From the foregoing it undoubtedly follows that the factor relating to carbon dioxide of Liebenthal's formula is considerably too small, as in practice it is not generally a case of admixed carbon dioxide, but of carbon dioxide from breathing and combustion, if work is being carried on in badly ventilated rooms.

The formula based on our researches is as follows :—

$$y=1{\cdot}049-0{\cdot}0062x-0{\cdot}033(x'-0{\cdot}75)+0{\cdot}00011(b-760)$$

in which the symbols have the significance already stated at the beginning of this report, only that b in this applies to the greater range of difference of pressure (816—717 mm. of mercury).

In this connection it must, however, be expressly pointed out that a different ratio of oxygen to nitrogen would also involve a more or less extensive alteration of the factors for aqueous vapour and carbon dioxide. The two members of the formula in question clearly can only be regarded as indicative, especially as the effect of these impurities is probably also to some extent dependent on the atmospheric pressure. For a final settlement of these factors a much longer series

of investigations would still be required as exact measurements with the Hefner lamp in themselves involve very ticklish work, which induces us, even in this connection, to express the hope that a steadier and more readily managed unit of light will soon be found.

The matter is different when the ratio of oxygen to nitrogen remains about the same, as is the case in working in well-ventilated and sufficiently large photometer rooms. Liebenthal's factors for atmospheric humidity and pressure apply especially to this case, and as they emanated from a sufficient number of observations and, moreover, show good or very good agreement with our values, they may be accepted as correct; the factor for carbon dioxide must, however, drop out, and the measurements then apply to the average proportion of carbon dioxide of 0·75 litre per cubic metre of pure air given by Liebenthal for well-ventilated rooms.

In order, therefore, that work may be always carried on in uniform and well-defined conditions and the light of the Hefner lamp be subject to proper corrections, photometer tests with it must always be made only in well-ventilated and sufficiently large rooms; the light is then only dependent on the natural humidity of the outer air and the atmospheric pressure, and may without objection be calculated according to the following abbreviated Liebenthal formula:

$$y = 1{\cdot}049 - 0{\cdot}0055\,r + 0{\cdot}00011(b - 760).$$

In this formula the symbols have the meanings given above, with b ranging from 816 to 717.

The author concludes by expressing his thanks to those concerned in the work.

FOUNDATIONS FOR TRANSMISSION LINE TOWERS AND TOWER ERECTION.

At the recent Annual Convention of the American Institute of Electrical Engineers a series of Papers were read on the practice adopted by various power companies in erecting transmission-line towers and making the foundations for them. We give below a summary of the most interesting facts upon which the authors touched.

Pennsylvania Water and Power Company.

Mr. J. A. Walls gave some notes relating to the transmission lines of the Pennsylvania Water and Power Company, of which he is chief engineer. On the first Holtwood-Baltimore Line (No. 12) the steel tripod stub, Fig. 1 was used with suspension towers and a concrete foundation, Fig. 2, with anchor towers. On the Holtwood-Lancaster line mushroom type concrete foundations were used for both suspension and anchor towers. Lifting tests made on steel tripod stubs, steel single leg stubs, (with fins at top and bottom, Fig. 3) and under-cut mushroom type concrete stubs showed that the tripod type pulled out of fresh ground at about 32,000 lb.; the single leg at about 23,000 lb.; while the mushroom concrete type showed no signs of lifting or cracking of soil up to the limit of capacity of the testing outfit, *i.e.*, 70,000 lb.

Investigations were made on four types of concrete foundations to determine which type of foundation would best suit the conditions. The best type was found to be the mushroom type, without forms, constructed by digging a post hole, approximately 16 in. in diameter, 6 ft. in the ground and under-cut at the bottom of the hole as shown in Fig. 4. It was later found advisable to dig the post holes only 3 ft. to 4 ft. deep and make a bell-shaped expansion in the bottom by the use of dynamite. The mushroom type, in good ground, is cheaper to build, can be built more quickly than the other types experimented with, and is especially satisfactory on account of not disturbing the adjacent ground or necessitating backfill.

The next best type of foundation appeared to be the mushroom type using steel forms. In this type and the following types, excavating by dynamite did not prove successful. Next in order in point of

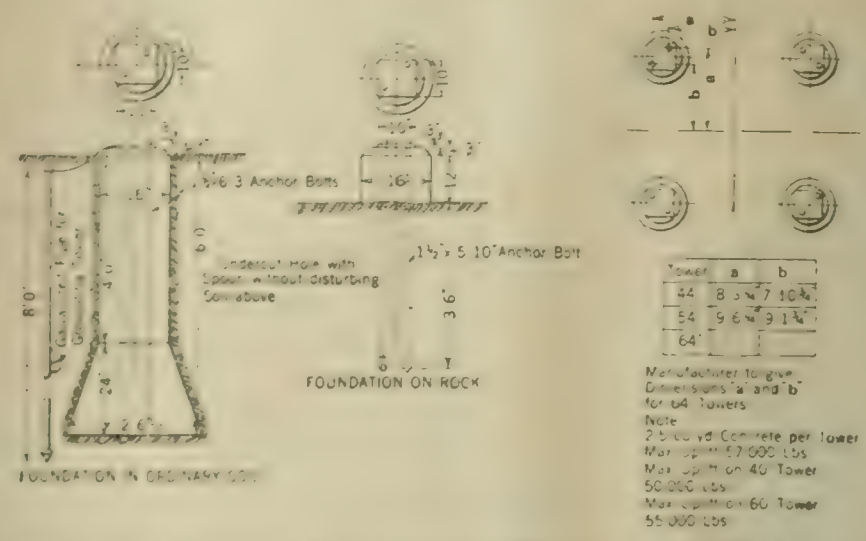


Fig. 4. New Mushroom Type Concrete Foundation: P.W. & P. Co.

cost and rapidity of construction was the mushroom type with wooden forms. Here 24 sets of forms are required, which are heavy and difficult to assemble. The least satisfactory type of base was the truncated pier with wooden forms.

The type adopted on Transmission Line No. 56 was that shown in Fig. 4, and the actual cost of this type on the line averaged per tower, as follows:—

Hauling materials	£2 13 0
Grading	0 10 0
Digging	1 0 0
Materials and concreting	5 14 0
Total	£9 17 0

The hole is dug about 3 ft. deep, using the post hole bars to loosen up the soil, and a long handle shovel to scoop it out. If the soil at this depth is too hard to scoop out with a spoon a hole about 2 ft. is punched in the centre, and the hole shot with about one-half stick of dynamite. Under ordinary conditions one man can dig from two to three holes a day in this manner. In some places rock has been encountered. If this rock is not soft enough to be dug out with a bar, three to four charges of dynamite generally open the hole.

The concrete mixture used for the foundations is made in proportions varying from 1:2:4 to 1:3:5. The cement is good quality Portland cement, which could meet the specifications of the American Society for Testing Materials. 1·5 cubic yd. of stone and 3·4 cubic yd. of sand were dumped at each tower site. This amount was

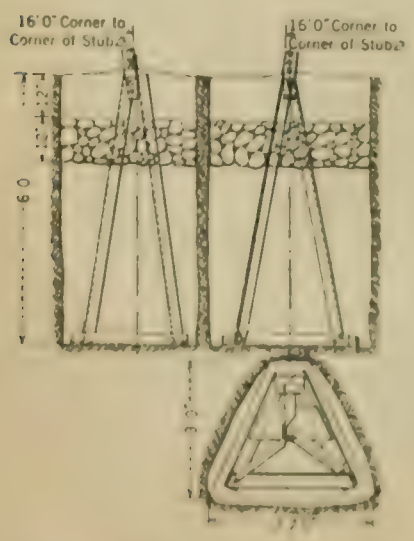


Fig. 1.—Steel Tripod Type Foundation.



Fig. 2.—Mushroom Type Concrete Foundation.

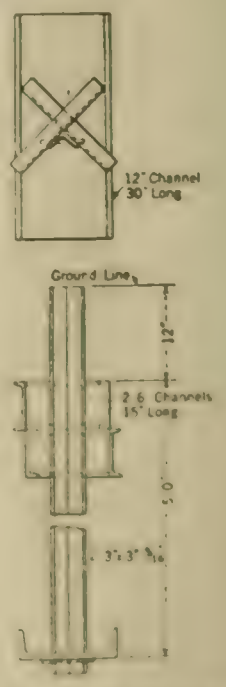


Fig. 3.—Steel Single Leg Stub: P.W. & P. Co.

Old Tower Foundations, P.W. & P. Co.

increased about 50 per cent. at every fifth tower, so as to make up for occasional shortages.

The time required for mixing and pouring the concrete is about three quarters of an hour, while moving and setting up takes about one hour. A 2·5 cubic ft. hand mixer had done excellent work on the Lancaster transmission line and such a mixer was, therefore, purchased for the work on line No. 56. This mixer runs on two wheels and weighs about 1,000 lb. with loading platform. The smallest number of men needed for efficient handling of this work is one foreman with nine men, with from one to three teams depending on the length of haul of water and cement.

Originally buckets were used for removing the concrete from the mixer, but this proved to be inefficient as concrete could be mixed faster than it could be removed. A portable inclined runway was, therefore, made by means of which the mixer could be elevated enough to permit the placing of a wheelbarrow under the chute. Water in the holes was pumped out, but it would be well to carry a short length of 6 in. sheet-iron pipe for cases where the holes filled fast, as the concrete could then be poured through the pipe without draining the holes.

For erecting the towers they are, whenever possible, assembled on the ground in a horizontal position. A rigging gang consisting of a foreman with 11 men and a four-head mule team follows to assemble the towers. The general scheme of erection is to pivot tower legs to the foundations and then lift the head of the tower by means of a tackle running from a point below the cross arms over a shear leg to a dead end at a convenient distance ahead of the tower. The shear leg is made of two 45-ft. spruce timbers, measuring about 6 in. at the top. Back and side guy tackles are also attached to the towers. The light section 40-ft. towers are pivoted on a $\frac{5}{8}$-in. case hardened machine bolt on each side, the bolts running through the leg angle and standard foundation shoe. One tower was dropped and slightly damaged on account of a faulty foundation shoe breaking. This led to the ordering of one pair of shoes made of extra heavy angles, and of such a height that the tower leg cleared the foundation plate by more than $\frac{1}{2}$ in., while the tower was being raised. All extension and heavy towers are bolted to a hinge turning on a 1·25-in. bolt. The hinge and bolt are supported by means of a $\frac{3}{4}$-in. plate bent in channel shape with the web resting on the foundation.

When the shear leg is up and all rigging in place, the mule team is hitched to the main lead line, which is hauled in slowly until the men at the back guy commence to feel the weight of the tower on their tackle, when the team is stopped. The team is moved a step at a time only, at this stage until the weight of the shear leg is sufficient to pull the tower over when the team is unhitched and the tower let down with the back guy alone. When the front leg is about 6 in. from the foundation, the tower is held until the foundation shoe is fitted to each side. If the special erecting shoe is used the tower is rocked ahead by means of the main tackle and these shoes exchanged for standard ones. The side guy is used for emergency only, and is kept taut enough to take out the slack while the tower is going up, but it is not allowed to take any stress.

The Alabama Power Co.

Mr. W. E. Mitchell, operating manager of the Alabama Power Co., in the second Paper of the series, expresses the opinion that concrete foundations for steel transmission line towers in most places are not warranted. Due to the inaccessibility of most lines, and the impossibility of finding proper concrete materials near them, the cost of concrete foundations, including excavation, frequently runs above £20 per tower, and seldom goes below £10.

At the start of the development of the Alabama Power Company it was found the roads were bad and hauls of from four to ten miles from the nearest railway stations were frequent. Also the soil was good clay or disintegrated rock, and there was practically no sand, gravel or hard rock available for concrete. Studies were therefore made of all-steel foundations, and the first 1,000 towers were supplied with footings as shown in Fig. 5.

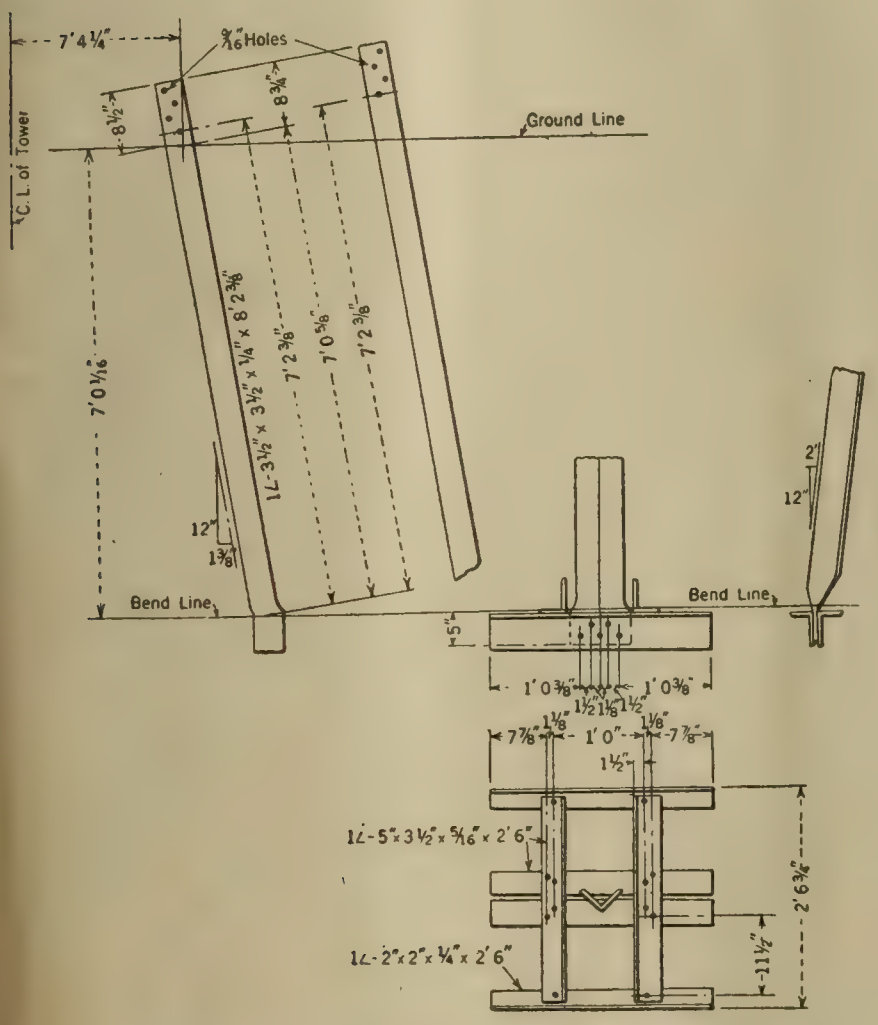


Fig. 5.—First Steel Foundations; Alabama Power Co.

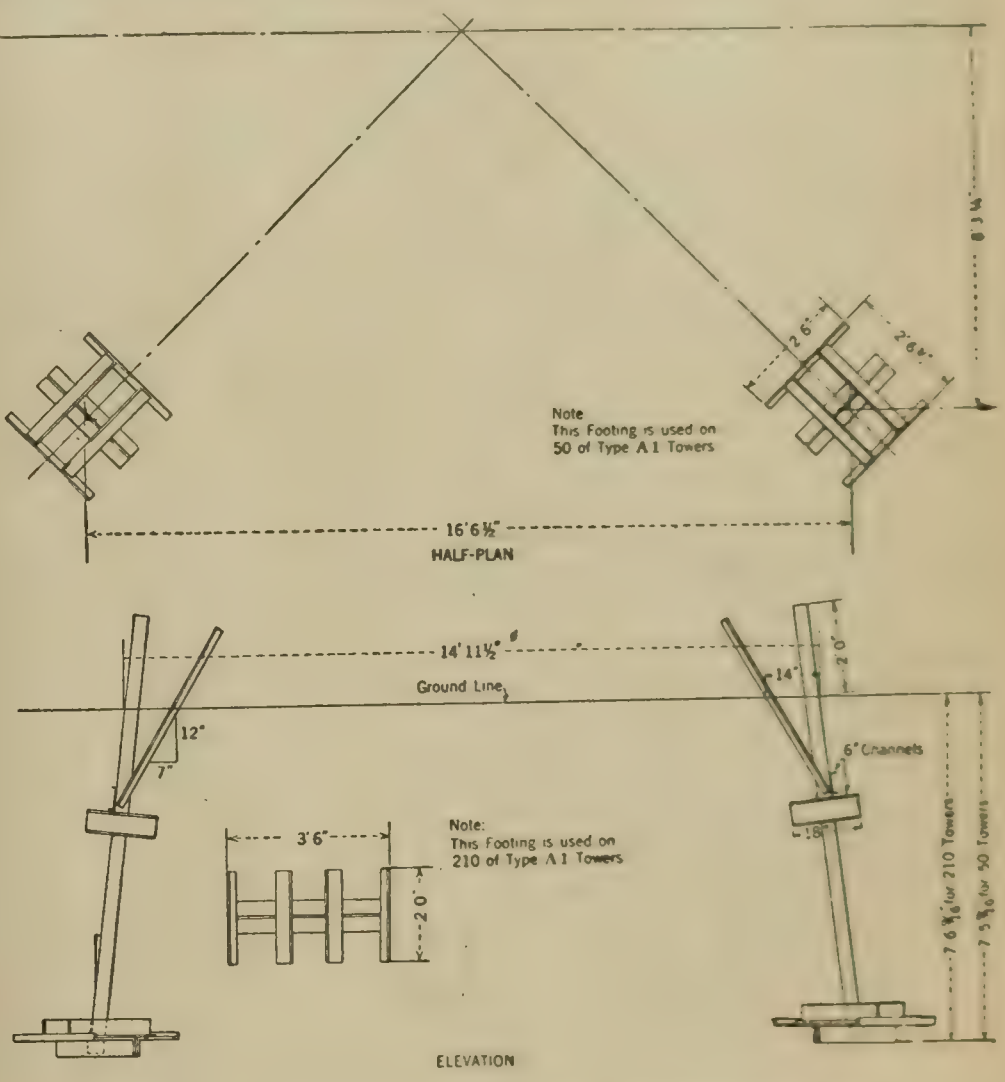


Fig. 6.—Later Steel Foundations; Alabama Power Co.

The towers were designed for two circuits of No. 00 seven-strand medium hard-drawn copper, and two $\frac{3}{8}$-in. Siemen's Martin ground wires. The average span was figured as 750 ft. and maximum span 1,000 ft. Minimum ground clearance for conductors 25 ft. The loadings used were 8 lb. per square foot of projected area of conductors, and 16 lb. per square foot on flat surfaces. Ice loading was taken as $\frac{1}{4}$ in., as in this section sleet is practically unknown, and temperature variation 100°F.

The test loads on the towers were: (1) A horizontal pull in direction of line of 3,000 lb. at any insulator or ground wire support; (2) a vertical load of 1,200 lb. at end of any one or all cross arms; and (3) a horizontal pull, transverse with line, of 5,000 lb. applied at middle conductor cross arm on centre line of tower and at the same time a load of 7,000 lb. parallel with line, applied at the top conductor cross arm on centre line of tower.

Experiments with buried discs and other flat plates show that in pulling them up the soil is removed in the form of a cone, and that the angle of the sides of the cone very closely approximates the adherence angle of the soil. In determining the size and depth of the footing, it was assumed that the maximum force withstanding tension in the tower stub was the weight of an inverted truncated cone of earth which had the area of the tower footing as the smaller

base, and sloped outwardly at an angle of 30 deg. from the vertical. To withstand a thrust on the footing, a fair bearing pressure per square foot was assumed. By these calculations it was found that a base about 6·25 sq. ft. in area, and buried 7·5 ft. in the earth would give a factor of safety of two. The lightest grillage for this given strength therefore was 2·5 ft. square. In the field work it was found that it was necessary to dig a hole at least 2·5 ft. by 3·5 ft. or 4 ft. in order to allow the men sufficient room in which to work. It was evident, therefore, that an anchor of rectangular shape would require less excavation and for that reason the later towers were ordered with anchors 2 ft. by 3·5 ft. in area.

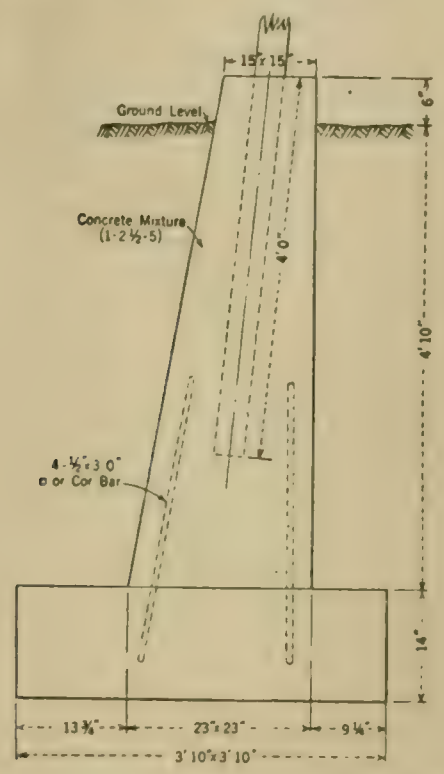


Fig. 7.—Reinforced Concrete Footing; P.G. & E. Co.

In tests and in the field where the erected towers were subjected to heavy overturning strains, it had been noticed that the legs tended to move toward each other at the ground line, even if the earth was well tamped. To resist the horizontal force at this point it was decided to make the junction of the lowest diagonal and the tower leg, about 2·5 ft. below the ground, and two pieces of 6-in. channel 18 in. long were bolted on here at right angles to each other (Fig. 6). A tower with these modifications of the footings and lower diagonals was tested to destruction. The bolts in the upper part of the tower sheared; the legs of the tower, as evidenced by the ground at the base, had not moved.

Where a leg had to be located on a bed of stable rock, a hole 2·25 in. in diameter was drilled, into which was grouted an anchor consisting of a 3 ft. length of steel angle, the same size as the tower leg, forged round for 2 ft. of its length.

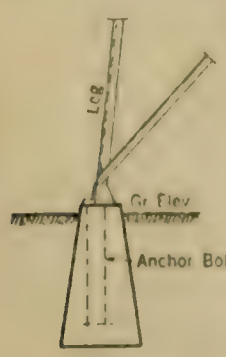


Fig. 8.—Concrete Footing with Anchor Bolts.



Fig. 9.—Concrete Footing with Stub Angle which Extends into the Concrete.

Tower Footings; American Bridge Co.

In excavating, hand drills, coal augers and a portable gasoline-driven air compressor with a jack hammer drill were used. 40 per cent. dynamite was used and practically all holes were shot. Towers were located by the field engineer from the spotting made in the office on a profile of the line. Reference hubs were set and depth of excavation for each footing marked.

Examination of footings after one year show only very slight settlement, and no movement of tower base whatever. Towers were assembled complete on the ground, the insulators hung on the cross-arms, and then raised with a gin pole. The average assembling crew assembled from 12 to 16 towers per day, and the erecting gang raised about the same number. The best record was 20 towers raised in one 10-hour day. The average cost for the footings was about £5. 10s.,; assembling 4,800-lb. towers cost £2 and erection £1.

Pacific Gas and Electric Company.

Mr. P. M. Downing, engineer of Operation and Maintenance of the Pacific Gas and Electric Company, said that the tower designs first constructed called for each structure to be self-supporting under strains due to the breakage of all conductors on one side of the tower together with maximum ice and wind strains. This resulted in a heavy, durable structure of high first cost, and imposed a very much more severe condition than could be met by pole lines. A very safe condition under which to test towers to be used in a country not subject to severe snow and sleet conditions, is to consider a wind pressure of 14¼ lb. per square foot on flat surfaces, combined with a temperature range of 125°F., or a pressure of 21 lb. per square foot on flat surfaces under ordinary temperatures; also two broken wires in any span of a circuit carrying six wires, these breakages to be in such positions on the tower as will give maximum strain.

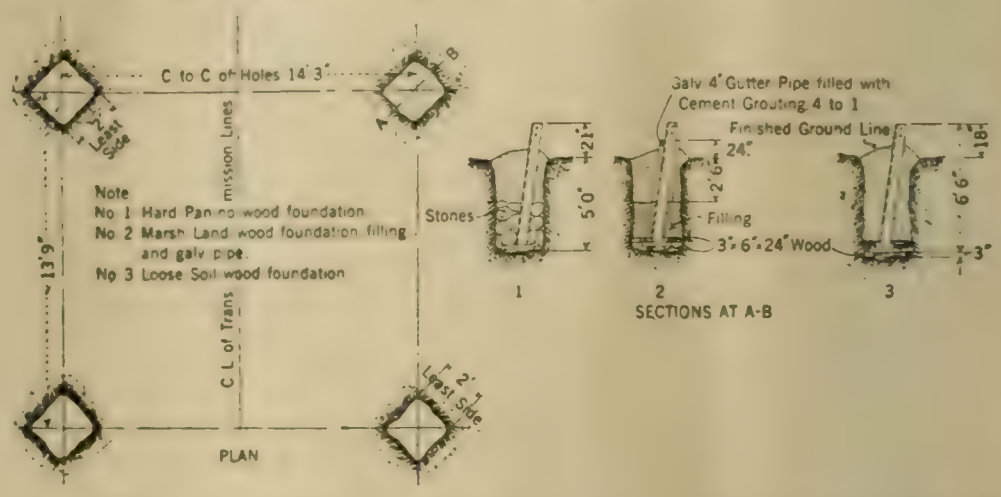
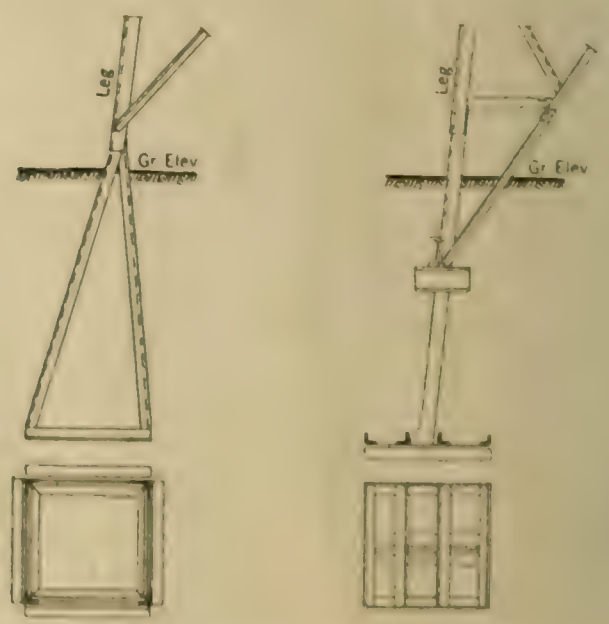


Fig. 12.—Diagrams of Standard 40-ft. Tower—Foundations in Different Soils; Toronto Power Co.

Where the line is subject to heavy snow and sleet conditions, the spans must be short, and very often under such conditions it is inadvisable to place the three conductors in a vertical plane. A safer construction can be had by using single circuit towers with the conductors in a horizontal plane, so that any unequal distribution of the snow load on the different conductors will not cause them to come in contact with each other. On 100,000-volt lines carrying two circuits of three wires each, located in vertical planes on the two sides of the tower, a spacing of 800 ft. to 1,000 ft. will generally be found to give maximum economy.



Figs. 10 and 11.—All-Steel Tower Footings; American Bridge Co.

Mr. Downing did not recommend metal footings. He said that the permissible strains borne by well tamped dry earth do not always obtain under water soaked flood conditions. On a number of different lines originally constructed with all metal footings, tower failures have occurred, and it has since been found necessary to reinforce them with concrete.

On the basis of an 800 ft. spacing between towers, and an allowable stress of 15,500 lb. per square inch for copper conductors, the sag at 60°F. would be approximately 20 ft. On a double-circuit tower line, having conductors strung to this tension and spaced 10 ft. apart, with a required clearance of 30 ft. above the ground, a 75 ft. to 80 ft.

tower would have to be used. The footings of a tower of this height under the assumed load conditions should contain not less than 1¼ cubic yd. of concrete per leg, and be of a form similar to that shown in Fig. 7. A footing of this kind would have a factor of safety of approximately two.

To insure against weakness due to possible poor bonding along the plane of contact between the upper and lower portions of concrete, it is advisable to use short pieces of reinforcing, or let the metal footing extend well down toward the bottom of the foundation. The cost of footings of this kind on a line run through average country is about £18, the amount due to labour being £8, material £3 and hauling material £7.

In a country that is not too steep the most economical way of erecting towers of this size is to assemble them on the ground and end them up into position. One very easy and satisfactory way of doing this is to set a 30 ft. or 35 ft. gin pole just outside of the footings, holding it in position by three guys. Over an open sheave on the top of this gin pole is carried a 0·5 in. flexible steel cable, one end of which is connected to the tower at the lower cross-arm, the other to a set of triple blocks made fast to another anchorage 300 ft. or 400 ft. from the base of the tower. A back guy should also be provided to prevent the tower dropping into place as it comes up to a vertical position. The best motive power for this work is a 3-ton motor truck which can be used not only for raising the towers, but also for transporting tools and equipment between towers. A crew of nine men with a truck will raise and fasten to the footings an average of nine towers per work day of eight to nine hours.

American Bridge Company.

Mr. J. B. Leeper, manager of the Tower Department of the American Bridge Co. considered that the ability of a tower to resist the loads coming on it depended largely on properly designed anchors, for it was these that had to resist the overturning force of the wires. On account of the variability of the character of the earth and the uniformity of the material in the towers, it seems that the anchors should be designed for a greater possible overload than the towers. How much greater is a question of judgment only. In case of an all-steel anchor the weight of an inverted frustum of a pyramid whose sides incline at an angle of 30 deg. with the vertical, is assumed to be the ultimate resistance of the anchor. From the results of some of the company's tests it seems that these assumptions will give no allowable overload with freshly tamped earth. The tests show that the earth in the hole moves up without disturbing the surrounding earth, even when the anchors have been in long enough for the earth to have settled. It has been found that if the uplift is properly cared for there will be practically no movement downward on the compression side.

Most of the failures have occurred on towers with anchors as shown in Fig. 9 with concrete omitted. With this type there is very little resistance to the horizontal component of the stress in the bottom diagonal. The consequent horizontal movement of the main body of the tower causes buckling in the compression leg. A horizontal strut near the ground level preserves the shape of the tower, but tends to cause buckling in the compression stub and also is generally more expensive than the use of anchors as in Figs. 10 and 11. This type may, however, be used if care be taken in the design of the tower to see that there is small stress in the bottom diagonal. There are several effective methods used in constructing anchors to resist this horizontal force, such as illustrated in Figs. 8 to 11 inclusive. Fig. 8 shows an all-concrete anchor to which the tower leg is held by means of anchor bolts. Fig. 9 shows a combination of concrete and steel, the leg extending down into the concrete. Fig. 10 shows an all-steel design, using four spreading angles extending from a point slightly above the ground level to a base at the bottom. The objection to this type is that it must have a perfectly flat bottom on which to rest, or unequal stresses will exist in the different legs of the anchor. This design is in use on the Big Creek Line of the Pacific Light and Power Company.

Fig. 11 shows an all steel anchor which is cheap and yet efficient. In this anchor as shown, the vertical force and part of the horizontal force is communicated through the single stub angle to a steel grillage, the balance of the horizontal force being taken up about 2 ft. below the ground level by extending the bottom diagonal of the tower down to the stub angle at that point, where a channel or plate of sufficient area is placed to resist most of the load. This style of anchor has several advantages: (1) The leg splice to the stub can be kept far enough above ground to be out of the zone of serious corrosion; (2) it can be made practically permanent by splicing the stub about 3 ft. below the ground, making it possible to renew the part of the anchor at the ground level with small expense; (3) ease of setting, back filling and tamping properly; (4) small amount of steel necessary and inexpensive shopwork. In each test that has been made on towers set on these anchors the break has been due to other causes than the movement of anchors.

Mr. Leeper stated that there are very few definite data secured from actual tests which show the effect of the applied loads on the anchors and towers when taken together. He considered this to be due to the fact that engineers when specifying their tests do not state clearly how the tests are to be made, and as a result the towers to be tested have been set on a rigid foundation, which does not show how the tower would act on its foundation in the field.

Toronto Power Company.

Mr. F. C. Connery, superintendent of transmission lines of the Toronto Power Co., contributed some notes relating to the old and new 60,000 volt lines of this company between Niagara Falls and Toronto.

Fig. 12 shows foundations used on standard 40 ft. two-circuit towers. About 100 sets of these footings have been dug up after being in use seven years, and in no instance has the galvanising deteriorated, and the 3 in. by 6 in. by 24 in. impregnated wooden blocks, with a few exceptions, were in a fair state of preservation.

On some 53 ft. two-circuit towers the impregnated blocks were not used, nor were any precautions taken, other than the hot galvanising, to prevent corrosion of the steel. Six of these towers were erected in low marshy black muck, no resistance being encountered with borings at 40 ft. A 2 in. plank sheathing was driven around each tower leg location, the muck dug out and a floating foundation built 6 ft. below the ground surface; this consisted of impregnated 2 in. planking, the footings being set in concrete, with about 1 yd. of cement around and under each stub. These towers have been erected for one year and have neither settled nor got out of alignment.

A number of towers of the same type were erected in rock. This rock was thinly stratified and was easily excavated to a depth of 3 ft. The stubs were cut down to 3 ft. 6 in., and were concreted in with a 1-to-4 mixture. The foundations for one type of narrow-base latticed tower were built in two ways: (*a*) a foundation 6 ft. by 6 ft. by 6 ft. of 1:3:5 concrete with 12 1¼ in. anchor bolts 5 ft. 6 in. long; (*b*) the towers were erected on 12 in. of 1:3:5 concrete and then more concrete was used to fill in the excavation around the pole, the whole foundation being 6 ft. by 6 ft. This method was used on account of the variation in the dimension of the bases of these towers.

Eleven of the above footings were constructed in the waters of Lake Ontario at Burlington Beach, Ontario, the mean depth of water being about 3 ft. A double coffer-dam was built, and the water pumped out and sand and gravel excavated to a depth of 6 ft. below the lake bottom.

The towers were assembled at the locations where they were to be erected, and were erected with a shear-leg outfit. From eight to twelve towers were erected in one day by eight men and one team.

Tower footings are now being designed which include the following points: (1) a modification of an ordinary screw-type guy anchor for light towers; (2) for heavy anchor, long-span, towers, a large footplate supported on a shallow concrete footing and a screw-guy anchor; (3) for extra heavy, or four-circuit towers, a large section screw-pile with top plate to which the tower footplate can be bolted. The question of threading an ordinary wooden pile is also being considered, as where marshy land is encountered it is usually a very expensive operation to use a pile-driving outfit.

SIMPLE THERMAL INSTRUMENTS FOR THE MEASUREMENT OF CURRENT.

BY W. H. ECCLES, D.SC., AND A. J. MAKOWER, M.A.

The instrument in the several forms to be described has the advantage of being very simple to construct and of being suitable for the measurement of high-frequency currents of small magnitude.

If an air-bubble be formed in a horizontal glass tube containing a liquid such as alcohol, the application of a source of heat to the outside of the glass near one end of the bubble will cause the bubble to move towards the point of higher temperature. The heat may be generated (or absorbed) by the passage of a current through thermo-junctions or through a wire of high resistance, and the flow of current will be indicated by a motion of the bubble if the source (or sink) of heat be suitably applied to the tube. When the glass tube is straight and horizontal the instrument is very sensitive, but has no definite zero. In order to make it useful for measuring

currents it is necessary to give the tube a slight upward convexity like a spirit level, so that the bubble may be in a position of stability when at the top of the bend. The slight convexity usually given to the glass in the ordinary spirit-level is not sufficient, and more pronounced convexity was found to be necessary to produce a satisfactory instrument. Of a number of tubes that were tested one that gave satisfactory results was formed of a glass tube of 0·38 cm. bore and 0·038 cm. thickness of wall bent so as to form an angle of about 10 deg. at the centre, which gives a very stable zero with a bubble of air of about 0·5 cm. length in alcohol. Regarding the size of the bubble, it was found that larger bubbles were sluggish, and tended to expand in length rather than move bodily, giving motions of uncertain magnitude.

If thermo-junctions are used they would be applied so that the hot junction is placed at one end of the bubble and the cold junction at the other end. In the instrument sketched in Figs. 1 and 2 the heat was generated in a single bare wire, A,

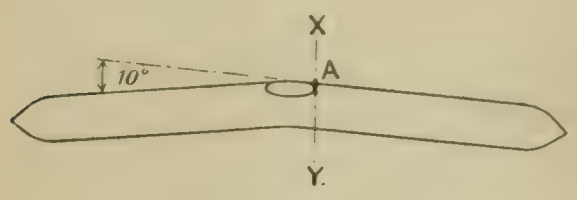


Fig. 1.



Fig. 2.

of No. 47 S.W.G. Eureka laid across the top of the tube close to one end of the bubble. As it was found that the sensitiveness of the instrument was not increased by winding the wire right round the tube, the fine wire was taken of only a few millimetres length, so as to touch the tube only on a short arc, and thus keep the resistance of the instrument as low as possible. In the instrument under test the value of the resistance was 0·75 ohm. The short Eureka heater was connected at both ends to copper leads, and when the current passed the motion produced in the bubble was measured by the eyepiece scale of a microscope focussed on an edge of the bubble. The calibration obtained is shown in Table I. and Fig. 3 :—

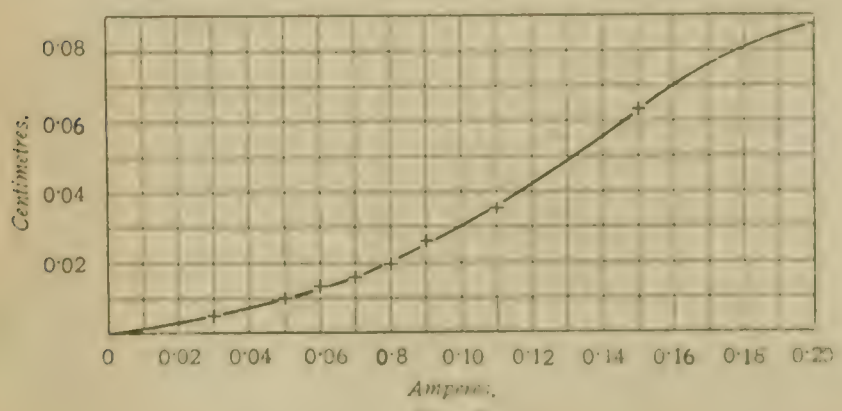


Fig. 3.

Table I.

Amp.	0·03	0·05	0·06	0·07	0·08	0·09	0·11	0·15	0·20
Cm.	0·005	0·010	0·013	0·016	0·019	0·026	0·035	0·063	0·087

For values of the current exceeding the values given the instrument became less sensitive owing to the bubble approaching more nearly to the position symmetrical with regard to the heater; but before the symmetrical position was reached measurements became impossible owing to convection currents being set up in the liquid and agitating the bubble.

With finer wires and heaters formed of several turns smaller currents than those in the table became measurable.

The motion of the bubble appears to be due to change of surface tension being caused by change of temperature. This was borne out by a further experiment made with a vertical capillary tube with its lower end dipping into a reservoir of alcohol and provided with a heater forming a semi-circular arc round the capillary tube at the top of the meniscus.

The tube had a bore of 0·06 cm., and the heater was again made of No. 47 bare Eureka wire. When the current was passed the meniscus fell.

The calibration of this instrument is given in Table II. and Fig. 4.

It will be seen that this instrument had the same order of sensitiveness as the one previously described, but that it could be used over a larger range of current.

In another form of instrument with the heater immersed in the liquid near the bubble, the experiments were not successful owing to the agitation that was produced in the liquid and, sometimes, to the bubble touching the heater and becoming anchored to it.

A form of instrument that suggests itself as having some advantages would consist of a tube as first described mounted on a long support such as a wooden rod horizontally hinged at one end and provided with a screw motion at the other end, so that when the bubble is moved it can be brought back to the original zero by adjusting the screw. The measure of the current that is passing could be taken on a vernier head fitted to the screw, or by a lamp and scale observation of the tilt of a mirror fixed to the bubble tube.

Perhaps the principal advantage of the instrument just described is that it is very easily set up in any laboratory where there is a reading microscope. Even this piece of apparatus is unnecessary when the last described form of instrument is adopted. Another advantage is that the instrument can easily be designed so that the parts carrying current do not

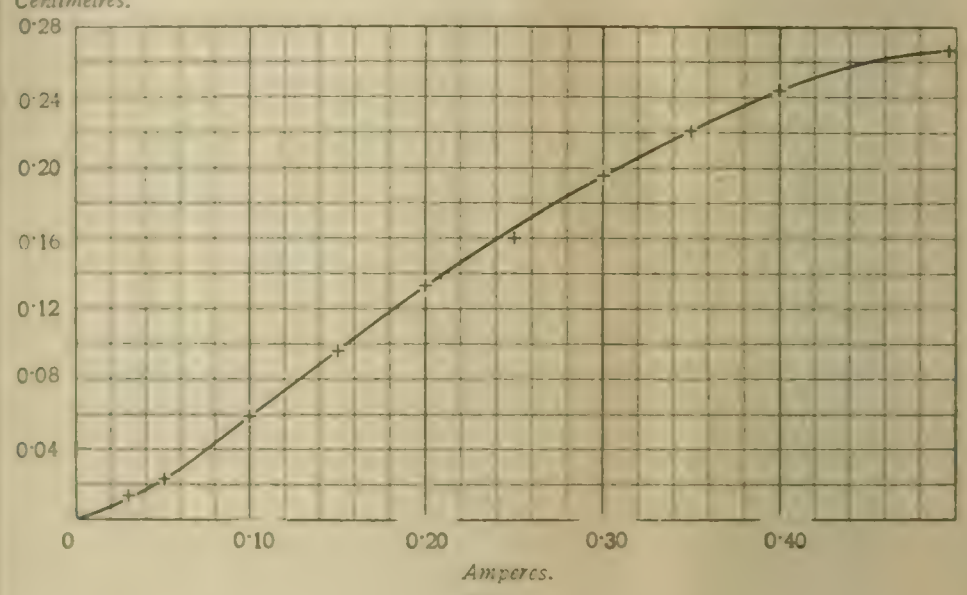


Fig. 4.

Table II.

Amp. ...	0·03	0·05	0·10	0·15	0·20	0·25	0·30	0·35	0·40	0·477
Cm.	0·013	0·022	0·060	0·096	0·133	0·161	0·195	0·221	0·244	0·267

come near any metal masses; and thus the instrument may be made free from electric capacity troubles. It obviously possesses little self-induction, and for these two reasons is specially suitable for the measurement of high-frequency currents.

PHYSICAL SOCIETY.

At a meeting held on Oct. 22, 1915, at the Imperial College of Science, Dr. A. Russell, vice president, in the chair, a Paper entitled

"The Radiation and Convection from a Heated Wire in an Enclosure of Air"

was read by Dr T. Barratt.

The object of the experiments here recorded was to determine the numerical relation between the radiation and the convection losses from a heated metallic wire or rod placed in a gas at constant temperature. The method consisted in (1) measuring the amount of heat required to maintain the temperature of the wire a given amount (about 10° C.) above that of the surrounding gas, the surface of the wire being (*a*) coated with a dead-black varnish, (*b*) uncoated, (2) comparing the radiations from two surfaces exactly similar to (*a*) and (*b*) by means of a thermopile. It is shown that if the total heat lost from unit surface of the wire is "a" times greater from a "black"

wire than from a " bare " one, while the radiation from the black surface is " b " times more that from the unblacked surface, then

$$\frac{r_2}{c}=\frac{a-b}{a-1} \text{ and } \frac{r_1}{c}=\frac{b(a-b)}{a-1},$$

where r_2, r_1, are the radiations from " black " and " bare " surfaces respectively and c is the convection. The experiments indicate that of 100 parts of " total heat " lost from a wire at air temperatures, 2·5 consist of radiation for a bare wire, and 12·6 for a " black " wire. At 100°C. these percentages become 4·4 and 20·7 respectively.

Dr. H. BORNS asked if the author had tested the validity of the assumption that the convection was independent of the nature of the surface of the wire.

Mr. F. E. SMITH asked why the platinum thermometer employed to give the temperature of the enclosure was placed inside it. There would be a temperature gradient between the wire and the enclosure and the thermometer could not give the correct temperature of the latter.

Dr. W. ECCLES asked if the size of the enclosure affected the results. He had once studied the effects of convection in lifting the boom of a small micro-balance. The convection was due to the heating effect of the current in the instrument, and the magnitude of the effect depended on the size of the enclosure.

Dr. A. RUSSELL welcomed the author's work as being the first experimental attempt to determine the proportion of heat lost by radiation and convection. In early discussions on the heating of cables prominence was given to the nature of the surface which they should have to make the radiation as great as possible. It appeared from the author's results that practically all the heat was lost by convection and so the surface was not of much consequence. With different diameters of wire, did the convection loss vary as the square root of the diameter ? It should do so if the currents were uniform. Did the amount of heat radiated per unit depend on the curvature ? From the results it seemed to decrease as the radius was increased.

Mr. J. H. BRINKWORTH (communicated remarks) referred to some results of his experiments by the continuous flow method on the specific heat of steam (" Phil. Trans.," A. 535, pp. 434 and 436). In these measurements the heat loss from the calorimeter was varied by altering the pressure of the air in the sheath surrounding the flow tube. The heat loss per degree per centimetre length of flow tube, when the sheath was evacuated as perfectly as possible—in which case radiation alone occurred —lies between 5 and 10 per cent. of the loss when the pressure in the sheath was about 1 mm. of mercury.

The AUTHOR, in reply, said that he didn't quite see how to verify experimentally that the convection was the same with the two kinds of surface employed. He thought that if the surface was smooth in each case the convection loss was bound to be the same. With regard to the position of the second platinum thermometer he had found that when it was placed about half-way along and below the wire the temperature was always accurately the same as that of the enclosure. He had taken temperatures at various parts of the enclosure from which he had concluded that the convection currents were quite regular. He had not tried different sized enclosures. With wires of different diameters the total heat loss per square centimetre decreased as the diameter of the wire increased, but he had not seen whether or not the square root law mentioned by the Chairman held for the convection loss.

A Paper

" On the Determination, by the Method of Diffusive Convection, of the Coefficient of Diffusion of a Salt Dissolved in Water,"

was read by Dr. A. GRIFFITHS.

In general the diffusion of matter like the diffusion of heat produces convective currents, and there is a diffusive convection which is akin to thermal convection. In the apparatus described in the Paper the convective flow is of the order of one millionth of a cubic centimetre per second from the top of one set of diffusion tubes to the top of another set. The top of each set of diffusion tubes is enclosed in a glass vessel containing water, and the one vessel is connected to the other by means of a long capillary tube. Each set of eight diffusion tubes is of length about 5 cm., and has a total area of cross-section of about 0·5 sq. cm. The capillary tube is about 150 cm. long, and has a diameter of about 1 mm. ; and the linear flow of a coloured index, consisting of a feeble solution of uranine, is of the order of 10 cm. per day. The index is introduced by means of a special four-way glass tap.

Mr. B. W. CLACK said he had repeated his experiments under all possible conditions to try to locate the cause of the 6 per cent. difference between his results and those of the author, but so far without success. In the author's arrangement the water was inside the tube and the solution was in the tank. He had tried that with his apparatus, but gave it up in 1908 in favour of having the water in the tank and the solution inside. He showed some curves taken with the two arrangements. In the case of dilute solutions the results were the same, but with strong solutions there was about 4 per cent. difference. It may be in this direction that the explanation of the discrepancy has to be looked for.

Mr. T. BARRATT asked if the introduction of a salt to prevent the formation of fungoid growths would not be likely to cause some error.

The AUTHOR replied that the amount of copper chloride introduced was exceedingly small, about 1 cubic cm. of 20 per cent. solution being added to the liquid in question, and he did not think it could produce any appreciable error.

A Paper entitled

" The Magnitude of the Thermal Resistance Introduced at the Slightly Conical Junction of Two Solids and its Variation with the Nature of the Surfaces in Contact,"

by Dr. T. BARRATT, was taken as read.

The abrupt fall of temperature caused by the thermal resistance at the slightly conical junction of two solids has been examined, the method consisting in constructing a " double joint," thus doubling also the thermal resistance effect. In the case of wires of small diameter, the fall of temperature was found to be 2½ per cent. ; that is, the temperature of the " hot " end of the wire is 2½ per cent. lower than that of the copper block into which the end of the wire was fitted. This percentage fall of temperature is practically the same at all temperatures of the enclosure (up to 100°C.), and is independent of the excess of temperature of the end of the wire above that of the enclosure (at any rate, up to 10°C. or 12°C.). For wires of greater diameter (6 mm.) the resistance is rather less than for smaller wires.

THE PRODUCTION AND PROPERTIES OF ELECTROLYTIC COPPER.*

BY .B WELBOURN.

As years go on the difficulties of preparing an opening address increase, and so I am venturing to tread new ground to-night by taking a technical subject. In doing so I have borne in mind the fact that the chairman's address is not open for discussion, and I have, therefore, endeavoured to keep it, so far as is possible, on non-contentious lines.

Rolling and Wire-Drawing.—For the transmission of electricity only two varieties of copper are required : (1) Hard-drawn copper, which comprises all conductors in which mechanical strength is required ; and (2) soft or annealed copper, which comprises all conductors which are to be continuously insulated and in which the highest obtainable conductivity is required. The actual manufacture of wire from wire-bars is a straightforward process, and wires can be successfully drawn from 1 mil in diameter of very considerable lengths up to 0·2 sq. in. sectional area in lengths up to 7,000 feet. The number of dies or " holes " through which the wire is drawn down to the required diameter depends on whether the wire is to be used " hard " or " soft," and, if the former, on what tensile strength and other mechanical properties are needed. Generally speaking, the greater the number of holes or dies the higher is the resultant tensile strength.

When hard-drawn wire is needed, it is now ready for use either as a single wire or it can be stranded into a more flexible conductor for use on an overhead transmission line.

Annealing and Jointing.—If soft copper is needed the hard-drawn copper can be treated in a number of ways. The modern process most used for annealing copper and other non-ferrous metals is that known as the " Bates and Peard," or some variation of it. Where long lengths of wire are required, it is frequently necessary to joint wires together during manufacture. In the smaller sizes which are used in the construction of insulated cables this may be done conveniently and economically by the use of electrical butt-welders.

For trolly wires some engineers prefer that copper wire bars of suitable weight should be used to ensure getting the length required without any joints. An alternative to this is to joint the rolled rods (from which the wire is to be drawn), and extensive experience of this method shows that it is entirely successful. Both this and the electrically-welded joint referred to earlier will stand drawing down through the dies.

British Standard for Copper Conductors.—The first attempt to standardise copper conductors was made by an I.E.E. Committee, whose report was published in Vol. XXIX., No. 142, January, 1900, of the " Journal " of the Institution.

The standard at present in use is the one issued by the Engineering Standards Committee (No. 7, revised March, 1910), but it is understood that this is under revision. It is certainly needed in view of the International Electro-Technical Commission's Publication No. 28, " International Standard of Resistance for Copper," March, 1914, which has already been adopted in the new Standardisation Rules of the American Institute of Electrical Engineers

In the interests of uniformity, it is to be hoped that the Engineering Standards Committee will adopt the above standards and will

* Abstract of chairman's address to the Manchester Section of the Inst. E.E.

further provide that (*a*) the resistance of hard-drawn copper shall be considered 2·7 per cent. greater than that of annealed copper of the same size at the same temperature (*i.e.*, 20°C. or 68°F.), and (*b*) the legal standard wire gauge shall be adopted as the standard gauge as in the existing standards.

In the meantime, it should be noted that the Engineering Standards Committee defines hard-drawn copper wire as wire which does not elongate more than 4 per cent. on a gauge length of 10 in. when broken by tension, and that the standard resistance for it is just 2 per cent. higher than that for annealed wire at 60°F. (15·6°C.).

The British engineering standard for trolley wire is contained in Report No. 23, but it needs revision in view of the subsequent experience gained in the manufacture of such wires and of the common use of grooved sections of trolley wires.

Testing and Definition of Hard-drawn Copper.—The testing of annealed copper conductors is very simple, and is confined to gauging the wires with a micrometer gauge and measuring the ohmic resistance and sometimes to the weighing of samples or coils. In the case of hard-drawn copper additional tests are necessary to determine: (1) tensile strength; (2) extension as a test of hardness; (3) elastic limit; and (4) absence of brittleness.

Modern testing machines are arranged so that autographic records of the extension of the wire may be taken. In practice it is found that the actual tensile strength increases proportionally to the diameter and not to the sectional area as one would expect, although the tensile strength in tons per square inch increases with a decrease of diameter.

It is not, however, sufficient to define the strength of the wire. It is also necessary to have some check on its hardness and absence of brittleness by ascertaining that it does not fall below a stated *minimum* extension per cent.

As the result of tests Mr. Pye has suggested * the following as the basis of a satisfactory definition of hard-drawn copper: "Hard-drawn copper, when in the form of circular wires, shall have a tensile strength *not less than* that given by the formula $T=30-20D$, and an extension per cent. on a marked 10 in. length, including point of fracture, of *not less than* that given by the formula $e=5\times D$, wherein T=tensile strength in tons per square inch of original section, e=extension per cent., and D=diameter of the circular rod in inches.

An examination of the standard figures prepared by the Wire Committee of the American Society for Testing Materials (1909) for wires ranging from 0·04 in. to 0·46 in. diameter shows that they agree closely with the above specification for strength, while the minimum extension figures agree closely with the formula, $e=4\sqrt{D}$.

The Engineering Standards Committee might, therefore, consider the adoption of Mr. Pye's specification on the grounds that: (*a*) It calls for a high standard which can easily be obtained by the leading manufacturers throughout the world; (*b*) tables of the minimum tensile strength and extension per cent. can be prepared for use for all the usual sizes of wires; and (*c*) it is easily applied to all intermediate sizes.

Test (4) is almost wholly covered by test (2), and probably could be displaced by it, but the British Post Office and other users specify the following ductility test for wires which range in diameter from 0·0791 in. to 0·2237 in.:—

"The wire shall be capable of being wrapped in six turns round wire of its own diameter, unwrapped, and again wrapped in six turns round wire of its own diameter in the same direction as the first wrapping, without breaking; and shall be capable of bearing the number of twists set down in the table without breaking. The twist test will be made as follows:—

"The wire will be gripped by two vices, one of which will be made to revolve at a speed not exceeding one revolution per second. The twists thus given to the wire will be reckoned by means of an ink mark which forms a spiral on the wire during torsion, the full number of twists to be visible between the vices" (see table at bottom of page).

To show how this works in practice three standard 600 lb. wires were taken at random, and the following results were obtained:—

G.P.O. specification.	Breaking strain, 1,800 lb.	Twists in 6 in. 20 min.	Wraps. 6 on, 6 off, 6 on.	Ohms per mile 1·4645.
Sample I.	1,895 lb.	28	66,663	1·4590
" II.	1,880 "	30	666,662	1·4540
" III.	1,900 "	28	66,664	1·4591

An extraordinary and unexpected result has been that the 600 lb. wire had a breaking strain of 1,850 lb. after 20 twists had been applied, but there was no measurable extension. It would seem that the work done on the wire in twisting had increased its hardness and brittleness until it became useless for any practical purpose.

Elasticity of Copper.—In view of the extensive and increasing use of copper conductors on overhead lines, railways and tramways, and the great importance of the elastic properties of the wire in relieving strains, it seems desirable that any definition of hard-drawn wire should also include a reference to the elastic limit as it does in many foreign specifications, and also, at first sight, to its modulus of elasticity. The Engineering Standards Committee might stipulate for a minimum elastic limit for all hard-drawn wires, and state the conditions under which the test should be carried out. These should include: (1) A statement as to the temperature, although the percentage extension does not appear to be affected by variations within the atmospheric limits in the United Kingdom; (2) the type of apparatus and the conditions under which it should be used; and (3) a statement of the length of the test piece.

An excellent basis for the above is to be found in the Engineering Standards Committee's report No. 55, which contains the results of an investigation carried out by the National Physical Laboratory on some of the standard sizes of wires used by the British Post Office.

I would suggest that this Institution (through the Research Committee) would confer a great boon on the electrical industry if it would carry through an investigation on similar lines for all standard circular wires from No. 5 S.W.G. (0·212 in. diameter) to 7/0 S.W.G. (0·5000 in. diameter). The values could then be interpolated for all other sizes of wire by using a large scale curve which embodied the results of the two investigations.

I would also suggest that the investigation should include work on stranded conductors. From the small amount of work which I have done on this point, there seems reason to believe that the limit of proportionality is higher for a given section of stranded conductor than it is for the corresponding section of solid conductor.

The subject of the elasticity of hard-drawn conductors has not attracted much general attention in this country, but important references to it have been made, notably by Mr. W. B. Woodhouse * and Mr. G. Carr,† and in the Engineering Standards Committee's Report No. 55, already referred to.

In the United Kingdom the regulations of the Board of Trade provide that the conductor shall be erected with such a minimum sag that at 22°F. and with a wind pressure of 25 lb. per square foot of effective area, the stress in it (*excluding its elasticity*) shall be more than one-fifth of the breaking load and that an accumulation of snow may be ignored.

It may be suggested for consideration that the proper procedure would be to decide what would be the worst conditions under which a conductor will have to work and then to erect it, so that under those conditions it will not be stressed beyond the elastic limit. For instance, the engineers of some of the most important Canadian power transmission lines have decided, after long experience, that for the ordinary sizes of conductors used the worst conditions may be taken as ½ in. thickness of sleet collected on the wire at 32 F., and a wind pressure of 11 lb. per square foot of effective area, and that under these conditions a factor of safety of 2 is required, and this is within the limit of proportionality.

Weight per statute mile.			Approximate equivalent diameter.			Minimum breaking stress.	Minimum No. of twists.		Max. resis. per mile at 60 F. when reduced to standard diameter	Weight of each piece of coil.	
Required standard.	Minimum.	Maximum.	Required standard.	Minimum.	Maximum.					Minimum.	Maximum.
Lbs.	Lb.	Lb.	In.	In.	In.	Lb.			Standard ohms.	Lb.	Lb.
800	784	816	0·2237	0·2215	0·2259	2,400	In 6 in.	15	1·0984		
600	588	612	0·1937	0·1918	0·1956	1,800		20	1·4645	100	140
400	392	408	0·1582	0·1566	0·1598	1,250		25	2·1968		
300	294	306	0·1370	0·1356	0·1384	950		30	2·9291		
200	196	204	0·1119	0·1108	0·1130	650	In 3 in.	20	4·3936	75	130
150	147	153	0·0969	0·0959	0·0979	490		25	5·8582	75	120
100	98	102	0·0791	0·0783	0·0799	330		30	8·7873		

* "Journal" of the Institute of Metals, No. 2, 1911, Vol. VI.

* "Journal," Inst. E.E., Vol. XLIV., May, 1910.

† Inst. of Post Office Electrical Engineers, February, 1909.

It is a long and wearisome matter to calculate from the worst sag under windage and low temperature what the erecting sag will be at, say, 60°F. with no wind, but the formulæ given by the author will be found both useful and accurate and they afford a ready means of obtaining the result.

Modulus of Elasticity.—An examination of the stress-strain curve of any hard-drawn copper wire will show that the modulus must be constant for the particular size since the curve is a straight line up to the elastic limit, but the modulus is not necessarily the same for different sizes of wire.

In making measurements for true modulus values it is, in my opinion, necessary to work on long lengths of wire which approximate to the span length employed on a tramway or other overhead line.

The moduli given in the Engineering Standards Committee's report No. 55, Table No. 10, vary between 17,200,000 and 18,200,000 on the second and third applications of the load, and particular attention is drawn to the different values of the readings on the first and subsequent applications of the test load. On the first application of the load the kinks in a coil of wire were pulled straight and the "apparent moduli" varied from 12,300,000 to 15,300,000, while on the subsequent loadings the values were as stated—viz., 17,200,000 to 18,200,000.

In the report referred to the following statement is made: "It is thought, however, that the values of the apparent moduli will be of interest and use, since it is these which must be taken into account in the erection of long lengths of wire."

I venture, with all respect, to express strong disagreement with this statement because on all well-constructed overhead lines the wires should first be strained to a tension higher than that at which they will be permanently bound in. The object of this is to get rid of the kinks referred to in the report and to allow the wires, especially stranded conductors, to "settle down." This procedure makes it permissible to take advantage of the real modulus value.

In view of the figures and considerations quoted, I consider that it is permissible to adopt an all-round value of 18,000,000 in future, instead of the usual test-book figure of 16,000,000.

Tensile Strength.—An interesting point arises out of the widely-held belief that the strength of hard-drawn wire lies in its skin being hardened during the drawing process. An examination does not disclose any conclusive evidence in support of this theory. I have investigated the matter and obtained the following results, starting with a length of 0·400 in. diameter hard-drawn circular trolley wire Six pieces were turned down to different diameters with great care in order to avoid undue heating of the specimens.

Test No.	Diam. In.	Area. Sq. in.	Breaking load.	Breaking stress, tons per sq. in.	Percentage elongation on 10 in.
1. Original wire	0·400	0·1257	6,950 lb.	24·70	2·50 p.c.
2. Turned down	0·376	0·1110	6,190 ,,	24·85	...
3. ,,	0·351	0·0967	5,520 ,,	25·42	...
4. ,,	0·326	0·0834	4,745 ,,	25·40	...
5. ,,	0·301	0·0711	4,100 ,,	25·70	...
6. ,,	0·276	0·0598	3,425 ,,	25·60	1·66 p.c.
7. ,,	0·250	0·0491	2,840 ,,	25·80	...

This result is not, of course, absolutely conclusive because the work done on the wire in the lathe will have some effect in hardening the skin at each stage.

The question of whether the strength of copper wire is uniform throughout its cross-section is of great importance in connection with contact wires on railways and with trolley wires on tramways, because they are subject to wear from pantographs, slider bars and trolley wheels. An investigation was made on this point recently on a 0·25 sq. in. grooved contact wire in connection with a railway electrification scheme which is now under construction. The wear on the wire was reproduced by gently filing away the face and the cross-sectional area was accurately determined by weighing the specimens. The tensile strength of the original section of this wire was 21·8 tons per square inch, and the extension was 6 per cent. on a 10 in. length.

Effect of Temperature on the Strength of Hard-drawn Copper.—The current which any bare overhead conductor will carry for a specified temperature rise under still air conditions can be pre-determined by the use of Prof. George Forbes' well-known formula. The question of the maximum permissible temperature of hard-drawn copper is of importance on overhead power lines because of the effect of heat in reducing its tensile strength.

The National Physical Laboratory found that on wires up to 0·194 in. diameter "the reduction in breaking load due to temperature appears to be approximately one-tenth of 1 per cent. of the breaking load at normal temperature per degree centigrade rise of temperature."

I have carried out a series of tests on specimens of 4/0 copper trolly wire, diameter 0·400 in., using apparatus which did not admit of any such refinements as those at the disposal of the National Physical Laboratory, and have obtained the following results:—

Samples.	Temp. °C.	Breaking load in lb.	Average. lb.	Reading in breaking load per °C.
1.	15·5	6,937		
2.	15·5	7,080	7,043	
3.	15·5	7,112		
4.	63·0	6,800		
5.	63·0	6,700	6,770	0·0831
6.	63·0	6,810		
7.	82·0	6,700	6,700	0·0730
8.	88·0	6,640	6,640	0·0792
9.	88·0	6,640		
10.	15·5	6,900		
11.	15·5	7,000	7,000	...
12.	15·5	7,100		
13.	110·0	6,350		
14.	110·0	6,400	6,383	0·0933
15.	110·0	6,400		
16.	132·0	6,160		
17.	132·0	6,135	6,148	0·1045
18.	132·0	6,150		

(Samples 1 to 9 were from a different batch of copper to samples 10 to 18.)

I regard the results on samples 13 to 18 inclusive as being more reliable than those on 4 to 9 inclusive, because the samples were heated in oil instead of water and this gave, as will be seen, an appreciable lagging effect. The results so far as they go, seem to confirm that the National Physical Laboratory's determination, quoted above, will hold good for all sizes of circular copper wire.

A number of experiments have been carried out by Dr. F. J. Brislee to determine the permanent effects of prolonged heating on the strength of wire, and he has very kindly given me the following unpublished results of experiments on trolley wires. All the figures given are the mean of three determinations, and the test after heating was made when the copper had cooled to atmospheric temperature:

Diam. of wire.	Duration of heating.	Temp. in °C.	Breaking load before heating.	Breaking load after heating and cooling.	Extension p.c. after heating.
0·324 in.	2 hours.	150 to 152	4,766	4,740	2·2
0·324 in.	4 ,,	190 to 195	4 766	4 609	2·2
0·324 in.	1 ,,	190 to 192	4,766	4,701	2·2
0·324 in.	60 ,,	320	4,766	2,852	44·0
0·372 in.	6 ,,	195	5,856	5,745	2·5
0·372 in.	60 ,,	190	5,856	5,793	2·5
0·400 in.	4 ,,	151	6,761	6,756	2·5
0·400 in.	4 ,,	150	6,761	6,757	2·5
0·400 in.	2 ,,	200	6,754	6,684	2·5
0·400 in.	6 ,,	200	6,754	6,691	2·5

From these results it will be seen that with 1/0 S.W.G. trolley wire the permanent decrease in strength after two hours heating at 150°C. (302°F.) is only 0·5 per cent., while a 4/0 S.W.G. wire was not affected after four hours.

Among tramway engineers, it is generally understood that the temperature of trolley wires never exceeds 220°F. (say, 105°C.), and it is a fair deduction from the above tests that the limiting temperature is not reached. In view, however, of the fact that the temperature rise occurs on wires while under strain, it would not appear to be advisable to exceed a temperature of 250°F. in practice. At this temperature the tensile strength of the wire would be about 10 per cent. less than at normal temperature, but the strain would be relieved by the expansion due to heating.

In this connection it may be noted that the Engineering Standards Committee's Report No. 55 gives the co-efficient of expansion of copper per 1°C. as varying between 0·0000163 and 0·0000167. The average of these is equal to 0·0000093 per 1°F. The voltage drop due to resistance would appear to be the limiting feature in overhead wires rather than the question of temperature. In case it should be necesasry to know the resistance of copper resulting from change of temperature this formula may be used:—

$$R_t = R_0(1+0{\cdot}0042t),$$

where R_0=the resistance at 0°C, and R_t=the resistance at t°C.

CHAIRMAN'S ADDRESS TO THE YORKSHIRE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

The one outstanding fact that this world war has taught us, is that success cannot be won without the aid of the engineer and mechanic. The rapid production of guns, rifles, shells, bombs, not to mention wireless apparatus, telephones and the thousand and one other pieces of complicated apparatus, which are necessary for the equipment of our navy and army, has resulted in a state of activity in our workshops and arsenals never before approached. The war is also proving a great spur to invention in every branch of engineering. Science has been organised; its units have been registered and the best brains of the professors and students of science throughout the Empire are being made use of.

Thus our universities are devoting a large part of their attention to national needs. Scientific advisory committees have been formed to meet manufacturers and lay before them the results of their researches.

Twelve months ago the admirable inaugural address of the past Chairman indicated the duties devolving upon those of our profession remaining in civil life. Three of these duties are interdependent and inseparable.

The first is, "To do all possible to support the sentiment 'Business as usual' with regard to the electrical industry in particular and all other British industries in general." This sentiment must not have the effect of weakening our determination to put the last ounce of energy into the production of munitions. So at the present time the sentiment "Nothing as usual" would be more appropriate. Twelve months ago only our largest engineering works were organised for the production of munitions. Now nearly all, irrespective of size, are "controlled" by the Government.

Secondly, "To assist in every way possible the efforts which are being made by British manufacturers to capture and retain foreign and colonial trade which until recently has been in the hands of alien enemies." Once hostilities are ended, the ability and organisation of Germany will be directed to underselling us everywhere, though a restricted world market is, for her, in any case, certain. Nor shall we ourselves be free from severe competition by our allies and by neutrals, particularly America. In Germany economic causes will force a reduction of wages, and a flood of cheap German goods will result. No great wage reductions are probable in this country. To meet these conditions we must cheapen production, by better organisation, improved machinery, designs and co-operative sale methods.

We need a higher and more general standard of specialised technical education for our engineers. Germany was the first country to bring a scientific and methodical spirit to bear on the organisation of technical and commercial education, and she has reaped the benefits of that education in the organisation of her factories.

A much closer study of foreign markets is needed: for that purpose a thorough technical and commercial education is as necessary for our salesmen as for our engineers. Our expert salesmen should have passed through every shop and should have held positions in the estimating and designing departments, and should be capable of advising customers on highly technical questions. To meet the expense of this costs may be reduced by co-operative sale methods. Electrical manufacturers could also extend their foreign markets by combining to charter an electrical exhibition ship fitted up with those goods which are most in demand.

Far too little attention has been given by our sales engineers to the study of foreign languages. Yet however perfect we may be individually, as salesmen, there will still be wanting for complete success that organised State assistance, which Germany has so lavishly extended to her foreign industry. The Board of Trade, as at present constituted, and the Diplomatic and Consular Services, as carried on by the Foreign Office, are not adequately equipped for the encouragement and protection of our foreign trade. A permanent and non-party Board of Industry is required, presided over by one of our most experienced business men and advised by a permanent staff of experts. In the year 1913-14 the amount of our foreign trade was over 1,400 millions, yet the cost of running the whole of the Board of Trade, including the Home departments, was only £213,000.

Apart from the Consular Services, the Foreign Office Staff, interested in trade in foreign countries usually consists of commercial attachés, having little or no special knowledge or commercial training, and their number is very limited. China, with a yearly import trade of £80,000,000, has one commercial attaché.

It would be the business of the Board of Industry to appoint qualified trade commissioners in our Colonies, dependencies and all foreign countries, whose duty it would be to collect and report to headquarters all useful information as to trade openings and the activities of our foreign competitors, to negotiate for improved trade relations, and to counteract the dissemination of false and injurious information by enemy competitors. And thirdly, "To consider carefully the methods of educating and training young electrical engineers with a view to re-organising and improving such methods in order that in future the designing as well as the manufacture of all electrical apparatus required for the naval and military services, shall be carried out by British born subjects." We are still to-day behind other great nations in making public provisions for the higher branches of education. In the case of France and Germany, external political forces, coupled with the need of unity for defence, have brought about the consolidation of their education systems. With us the force was an internal one, namely, the establishment of democracy, which demanded a certain minimum of enlightenment on the part of those who have a share in the Government.

One of the first duties of our legislators after the war should be to provide the country with an organised system of compulsory primary and secondary education forming a co-ordinated step to our technical high schools and universities. The leaving age for primary schools should be raised, and the continuation schools made compulsory. The last period at the primary school should be devoted to a pre-apprenticeship training, during which the youth's aptitude, or otherwise, for engineering would be proved.

At present lads are put into trades for which they have no natural ability, often because the financial position of the parents demands that the boy be put to the trade which pays the highest wages. It should be the special duty of the teachers during the pre-apprenticeship period to note the boys likely to be suited to skilled handicrafts. A much closer collaboration between the education authorities and the engineering employers is necessary.

In 1905 the Leeds Education Authority started as an experiment a day preparatory trades school for boys between 12 and 15 years of age. It has proved a decided success. The same idea has been further developed by superimposing a similar practical course upon the education now given. It is thus gradually becoming recognised that the only effective way to train the rising generation of skilled workman after leaving the elementary schools is to have half-time in the workshop and half-time in the technical school between the ages of 14 and 18.

A number of our principal technical schools give a two or three years' day course of instruction for student apprentices during the winter months. These are steps in the right direction and I should like to see the scope of the classes widened to form part, or an extension of, our elementary education system with the grant of a leaving certificate. This certificate would gradually become a qualification required by the engineering employers for trade apprentices.

Usually in engineering works the apprentice has to pick up such experience as he can in a more or less haphazard fashion. In a few British and certain German and American works, special schools and training shops are provided. One at least of our foremost electrical manufacturing concerns has an admirable apprentice school.

The instruction is divided into two classes, "General" and "Trade," the first being a continuation of the apprentice's regular education, while the second, devoted purely to trade teaching, consists of youths selected from the general class.

The teaching of both classes is undertaken by the firm's engineering staff, assisted by leading foremen and shop engineers, and is carried out in working hours and at the firm's expense. The quality of the workman is thus raised and with it the standard of the foremen.

This, however, is only possible for large firms, and it is to be hoped that ultimately the need of such schools will be met by the half-time trade classes provided by the education authorities in all large industrial centres. These improved educational facilities will gradually result in increased numbers rising from the ranks of labour to fill the commissions of the engineering industry.

Turning to the consideration of the technical engineer, we may divide his specialised training into that of "Design," "Works Management" and "Commercial Engineering." His education is built up on the secondary or public schools forming an intermediate step to the higher technical school. Germany's system of higher technical education is only one cause of her commercial advance. Her system of highly efficient non-technical secondary schools has contributed quite as much to that advance, for without them, higher technical education would have been impossible.

In this country we make the mistake of allowing technical instruction to be given too early instead of postponing it till after the completion of a thorough secondary education. This should be under public control and primary, secondary and technical education

* Abstract of an address delivered at Leeds, by Mr H. H. Wright.

should be inseparable and co-related. There must also be a closer association between our universities and technical high schools and the engineering industry.

I am convinced that great advantages would result to the electrical and engineering trades if they would submit those problems to the universities for solution, which they have neither the staff nor the time to solve. Immediately the war is over Germany will endeavour, at all costs, to recapture her lost foreign trade, and we may be certain she will flood the world with low-priced German goods. The strongest weapon we can forge to meet that competition is without doubt to look carefully to the better training of our artisans and engineers. The Institution is one of the channels through which we can make our influence felt on questions within its legitimate scope, and there can be no doubt that technical training is one of them.

DIELECTRIC LOSSES IN VARIOUS INSULATORS.*

A large number of experiments have been made in the Imperial Telegraph Experimental Station to determine the losses due to what is known as "dielectric hysteresis" in various insulating materials. The loss N was calculated from the formula $N=\omega CV^2 \tan\delta$, where δ is the amount (angle) that the advance in phase of the charging current relatively to the pressure is less than 90 deg., when a sine-wave alternating pressure is applied to the electrodes of the condenser; δ may be termed the angle of dielectric loss, the power-factor of the condenser being sin δ. In regard to the other symbols, $\omega=2\pi f$, as usual, C is the capacity of the condenser and V the effective pressure at the condenser. Experiments were made with frequencies from 350 to 4,800 per second (corresponding to ω=2,200 to 30,000), and for a number of temperatures. With pure gutta percha the losses are considerable at ordinary temperatures—*i.e.*, between 0°C. and 15°C.—and for the frequencies of telephonic currents (ω=2,200 to 10,000) are a maximum between 0°C. and 10°C. As the temperature rises, the dielectric losses first decrease rapidly and then more slowly, reaching a minimum value at a temperature just above 40°C As the material begins to soften at this temperature, the minimum cannot be reached. The addition of green gutta percha (obtained from the leaves of the plant) displaces the whole system of losses downwards on the temperature scale, and thus improves the efficiency of the gutta percha at working temperatures. As green gutta percha contains only a small percentage of resin (about 8 per cent.), it may be assumed that this result is due to the reduction in the amount of resin. This result was confirmed by experiments on balata. The results are given in the following table:—

Material.	Dielectric constant. at 15°C. and ω=5,000.	tanδ. at 15°C. and ω=5,000.
Gutta percha I.	3·16	0·0234
,, ,, II.	2·99	0·0244
,, ,, III.	3·07	0·0240
60 p.c. gutta percha, III., 40 p.c. green gutta percha	3·18	0·0160
Balata I. (with its resin)	3·39	0·0048
,, II.	2·93	0·0042
,, I. (with part of resin removed)	2·99	0·0038
,, I. (with large proportion of resin removed)	3·14	0·0026
50 p.c. gutta percha III., 50 p.c. balata I.	3·13	0·0104
67 p.c. balata I. with part of resin removed, 33 p.c. green gutta percha	3·24	0·0035
Gutta-Gentzsch, dark	2·53	0·0065

In each of the above cases, the dielectric constant decreased as the frequency increased, whilst tan δ increased with the frequency at all temperatures between 6°C. and 40°C., except in the case of gutta-Gentzsch, where tan δ decreases as the frequency increases, and increases with the temperature.

Other dielectrics gave results as shown in the following table.

With the above insulators (the porcelain excepted, no results being given for this material), the dielectric constant decreased as the frequency increased, and increased with the temperature. For soft rubber and condenser paper, tan δ decreases as the frequency increases, and increases with the temperature. For hard rubber, tanδ, between 0°C. and about 28°C., decreases with the frequency;

Material.	Dielectric constant.	tanδ.
Soft india-rubber for insulating conductors, normal mixture (V.D.E.) with 33 p.c. Para rubber	2·79	0·014
Hard rubber, good quality	2·72	0·0[illegible]
Ceresin (M.P. 72°C.) prepared from ozokerit	2·18	0·[illegible]
Condenser paper, undried	1·80	0·10
,, ,, dried	...	0·0[illegible]
Porcelain insulators	...	0·0[illegible]

but between 28°C. and 50°C., it decreases as the frequency increases; at 28°C. it is the same at all frequencies; at each frequency, however, it increases with the temperature. For ceresin, tanδ increases with the frequency, there bring for each frequency a minimum value occurring at about 55°C.

Some experiments were also made with undried condenser paper saturated with molten paraffin at different temperatures, viz:—

Temperature.	ω.	Saturated at 53°C. Dielectric constant.	Saturated at 53°C. tanδ.	Saturated at 145°C. Dielectric constant.	Saturated at 145°C. tanδ.
16°C.	3,000	1·970	0·0417	2·128	0·0[illegible]
	5,000	1·944	0·0359	2·117	0·0[illegible]
	10,000	1·916	0·0291	2·106	0·0[illegible]
	40,000	...	...	2·089	0·0[illegible]
25°C.	3,000	1·957	0·0505	2·107	0·0[illegible]
	5,000	1·924	0·0451	2·092	0·0[illegible]
	10,000	1·887	0·0377	2·076	0·0[illegible]
	40,000	...	...	2·054	0·0109

In order to obtain the best results it will thus be seen that the paper must be dried before being soaked in paraffin. By effecting the drying and soaking under a vacuum, tan δ can be easily reduced to 0·005.

A number of paper-air insulation telephone cables gave values of tan δ, varying from 0·0026 to 0·0037.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., pp. 111-113, 121-123, 135-137, 163-165.

5,000 H.P. Chain Drive for a Hydro-Electric Plant.—The Ox-Bow hydro-electric plant on the Snake River in Oregon, U.S.A., possesses the most powerful chain-drive gear in the world. An account of the circumstances deciding its installation has been given in "Engineering News." The location is at the down-stream end of a sharp bend or loop in the river. The original project provided for a tunnel across the neck of land, about 1,160 ft. long and 26 ft. diameter, which gave a natural head of from 20 ft. to 22 ft. In addition, a diversion dam was to be constructed about 1,000 ft. below the tunnel intake, raising the head-water level 30 ft., and thus affording about 50 ft. to 52 ft. head. There were to be six units, each consisting of two pairs of 48 in. waterwheels operating in open flume through centre-discharge shaft tubes and direct-connected by flange couplings to a 3,600 kw. alternating-current three-phase 60-cycle generator running at 225 revs. per min. Financial difficulties necessitated the stopping of construction when the tunnel had been finished, except for the openings from the headgates in the river. The power house was partly constructed, and machinery had been purchased, but the dam had not been built. With only a 20 ft. head, instead of 50 ft., the turbines could not be run at the speed required for the generators, so the engineers recommended the installation of a single unit composed of two water wheels and one generator with a chain-drive transmission. Each of the two water-wheel shafts carries a 71-tooth sprocket wheel 45·49 in. diameter, while the generator shaft carries two corresponding 47-tooth sprockets, 30·31 in. diameter. Each pair of sprockets carries four Morse silent driving chains 31·67 ft. long and 21 in. wide, weighing about 2,800 lb. each. The pitch is 2 in. throughout. The sprockets are made in halves and bolted on the shafts, which are 129 in. centre to centre. The speeds are 149 revs. per min. for the water-wheel shafts and 225 revs. per min. for the generator shaft.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Displayed Advertisements not for proof before first insertion can be taken until NOON ON WEDNESDAY, and Official Announcements, Auctions and "Smalls" of all kinds of which no proofs are required before insertion can be accepted up to FIRST POST THURSDAY MORNING.

THE B.E.A.M.A. AND THE STRUGGLE AFTER THE WAR.

We have so often insisted upon the importance of the electrical industry in this country being prepared for keen competition as soon as the war comes to an end, that we were particularly pleased to be present at an informal dinner of the British Electrical and Allied Manufacturers' Association last week, when an informal discussion took place upon German methods of doing business and kindred topics. There are some people, we are well aware, who think they are sufficiently engaged at the present moment in putting every effort forward to bring the struggle to a successful issue, and that time cannot be spared to look into the future. This attitude will prove altogether fatal if it persists; the more so because in Germany it is most improbable that any such attitude is being adopted. Evidence in support of this view is already forthcoming. Quite recently a meeting was held by the Central Union of German Merchants and by the Federation of Merchants, in order to discuss questions of foreign trade. The necessity was pointed out for the careful cultivation of German foreign trade, and that even during the war steps to this end should be taken. For this purpose, in the opinion of the meeting, a systematic investigation of the world's commercial conditions was necessary, and the committees of the two Associations had come to the conclusion that after the war an intelligently organised expansion of German exports would be required in order to remove the injuries brought about by the war. The important point about such deliberations is that they are being undertaken at a time when Germany must be straining every nerve in prosecuting the war. There is no voluntary system over there, and the drain on commercial organisations must be enormous, far greater than over here; yet time is found to look into these matters.

Are we in this country, therefore, to take up the attitude that we are too much occupied at the moment, and that we must wait to consider peaceful matters until peace comes? We trust that this will not be the policy.

Undoubtedly when the time comes much will have to be done to set our house properly in order. There may be questions of labour and capital, matters of education, of greater efficiency in management and in production. For the moment, however, these questions, interesting and important as they are, are not what we have to consider. What is required is careful organisation from the point of view of meeting the inevitable competition when it comes, by taking advantage of our position in foreign markets as soon as the war comes to an end. There must be greater mutual support between one industry and another, and more combined action in order to advance British trade as a whole; this is and can be the only successful method of restoring our financial position to a normal one after all the vast expenditure on war.

We were glad to hear the announcement made at the dinner last week that the B.E.A.M.A. is taking active steps to consider the whole situation. As is well known, before the war the Association was engaged in the organisation of the industry at home and in the avoidance of excessive competition. For this purpose the industry was divided into sections. The commercial managers of the various departments and of the manufacturing firms concerned met and discussed matters, and thus obtained a greater confidence in each other, while that suspiciousness which is fatal to combined action was eliminated. Since the outbreak of war this part of the work has necessarily come somewhat to a standstill, but efforts are now being made in other directions, and serious attention is being paid to export trade, first within the British Empire, and then to countries outside the Empire. Committees have been appointed abroad which work with agents of British firms and collect reports. In less important countries and districts, where committees could not be formed, correspondents have been appointed. The reports so obtained deal with local conditions, opportunities for business, criticisms of our methods and those of our competitors, and the information so obtained is handed over to the sections more particularly concerned. The Association is also giving assistance in the preparation of catalogues in the metric system and in foreign languages for circulation abroad, and an attempt is being made to obtain uniformity in export conditions.

The Association has in view the sending out of commissioners from time to time to make special reports upon trade in various parts of the world, and there is a likelihood of greater use being made of publicity in the press both here and abroad when the time is ripe for a movement of this kind Apart from the technical journals, advantage is likely to be taken of the daily press for affording publicity in regard to popular developments, but before this can be done it is essential that a Bill dealing with the contentious subject of wiring and hiring should be passed through Parliament, such Bill being acceptable to both the Incorporated Municipal Electrical Association and to the Contractors' Association. We hope that this desired end may be soon accomplished.

Returning to home affairs, the Association has been playing an active part in the drawing up of general conditions of contract, and in the work of the Engineering Standards Committee. It is hoped that the specifications of this body will in the near future be available in foreign languages, and become recognised standards on which British plant is sold.

Apart from the electrical industry there is, of course, the much wider question of the engineering industry as a whole and the various other industries upon which this country so much depends, such as textiles, coal, shipbuilding, &c., and it is satisfactory to know that a movement is on foot for a combination of all these industries, so that they may work together for the common good, and so that they may be able to point out to the Government from time to time what steps on behalf of industry are desirable.

We are glad to be able to say that the Association is working in close co-operation with Government Departments. It is supplying information to the Board of Trade, and it has also supplied the Board of Education with a schedule of researches which are desirable from the point of view of electrical manufacturers.

It will be a matter of gratification to many of our readers to know that such steps are being taken. For ourselves, we feel that all these developments are of the utmost importance, and that if and when the B.E.A.M.A. is able to carry through a programme on the lines here indicated, it will deserve well not merely of the electrical industry but of the country as a whole.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s Add 10 per cent. for abroad or for foreign books.]

Continuous Current Electrical Engineering. By W. T. MACCALL. (London: University Tutorial Press.) Pp. vi.+466. 10s. 6d.

In the preface it is stated that this book is intended for general use in technical colleges and schools, and that it covers all the continuous current work that is required in the usual three years' course in electrical engineering. An examination of the index shows that this ground is indeed covered in the headings, but the text would hardly suffice for the needs of a third year course without the aid of further special text books. It may, however, be said that the first two years' work are well dealt with, and it is no mean feat to have succeeded in including within the covers of a single book so much of the general principles of such a wide subject. As far as examinations are concerned, the student will find all that he requires for the City and Guilds of London Institute Grade II. examination in continuous-current work, and for those who are preparing for the Final B.Sc. (Eng.) Examination of the University of London the book will serve as a useful guide to the avenues into which he should direct his specialised studies. The chapters are 18 in number with a scope almost exactly defined by the continuous-current portions of the London B.Sc. syllabuses of the examinations in Electrical Technology and Electrical Design.

One feature is likely to be disturbing to the teacher. Many books make use of the sign $\backsim$ for frequency, with the obvious drawback that when reading out the text aloud it is necessary to say the word "frequency" every time that the symbol appears. This somewhat irritating feature has been extended in this book by the introduction of two quite new symbols to denote "ampere-turns" and the "number of turns in a coil." The author has evidently appreciated the difficulty referred to, and gives the ugly name "atts" to the one symbol, although no name is suggested for the other one. The choice of the one name suggests the invention of the name "freqs" for the symbol $\sim$, and this designation has the advantage that with a slightly different spelling it may be applied to all symbols of the nature in question.

The care that has been taken in the writing and editing of the book is shown by the almost complete absence of the usual inaccuracies and misprints that one expects to find in first editions. Among the few that appear to have been overlooked are the expressions on p. 253 for eddy current losses in sheet iron, in which the constants do not agree with one another nor

with the values given in other places, and the following misprints: On p. 25 lines 8 and 26, read 10^{-4}; in Fig. 3·18, coil A, referred to in the text, is not marked in the diagram; on p. 245, on the right-hand side of the equation read T_f for T. A. J. M.

Arithmetic of Alternating Currents. By Ellis H. Crapper. Pp. vii.+208. (London: Whittaker & Co.) 2s. 6d. net.

It is becoming less and less difficult for a student of average ability to acquire a thorough knowledge of alternating-current phenomena. In our early student days there were many elementary matters that we failed to understand, and, student-like, we were inclined to doubt whether our instructors really understood them. Now we know that they could not have done so. In those days laboratory work was meagre, and the purchase of a wheezy second-hand machine for the laboratory was a sufficiently important event to be noted by the principal in his annual report. We are referring to the time when there were few alternating current machines in the country, and when an arc lamp was an attraction sufficient to compel us to forego our lunch in order to see the lamp trimmed and to get a view of the mechanism. On red-letter days the "engineer-in-charge" permitted us to see the dynamo.

Nowadays we have 30,000 kw. alternators and half-penny units. Although the joys and deprivations described above are unknown to the electrical engineering student of to-day, he has the boundless satisfaction of knowing that with a little industry and perseverance he can become highly proficient in the theory and practice of at least one branch of his profession. Book reading and attending lectures are of themselves of little real service to the elementary student. To become skilled he must solve as many numerical exercises as possible, not one or two in haphazard fashion, but half-a-dozen or more per week, and every one reasoned out from first principles.

The book under review will give the elementary student all the practice necessary to begin with. It is divided into 10 chapters, and contains 232 examples, of which 50 are fully worked out. Answers to all the examples are given. For the examples in the first six chapters we have nothing but praise. They deal with periodic and alternating quantities, generation of alternating E.M.F.s, inductances, inductive circuits, capacity and condensers, and resistance, inductance and capacity in parallel. A few of the items in the text call for comment. In our opinion the diagram, Fig. 20, in the chapter on inductive circuits, would be much improved by adding a vector diagram. The power diagrams, Figs. 28 to 30, are incorrectly drawn, and here again vector diagrams are indispensable. The use of the letter K for capacity is weak, and in many of his worked-out examples the author gives the answers to too many places of decimals. As a rule the end figures are without meaning. Thus, it is generally unnecessary to give the angle of lag in degrees, minutes and seconds, and a charging current of 3·1416 amperes with equal accuracy would be written 3·14 amperes. Similarly in measuring polyphase power by the two-wattmeter method, the author surely cannot be serious when he determines a power factor of 82·78 per cent. from two wattmeter readings? But these are minor blemishes on work otherwise entirely satisfactory.

In Chapters VIII., IX. and X., on static transformers, induction motors and transformation of currents, the choice of examples is less happy. Beyond question vector diagrams ought to have been given, as well as examples showing the application of such diagrams. These chapters, perhaps wrongly, give one the idea of being hurriedly written, or that the author's perspective is altogether wrong. Probably the author has a second volume in view, in which case the criticism falls to the ground. If such a volume is contemplated we should like to see a chapter on the impure wave, together with examples showing the effect of such waves. Such examples are for the most part of an elementary character, and they tend to keep a student interested in his work.

Recherches sur la Commutation. By J. Rezelman. (Brussels: Etablissements Emile Bruylant.) Pp. 36. 1 fr.

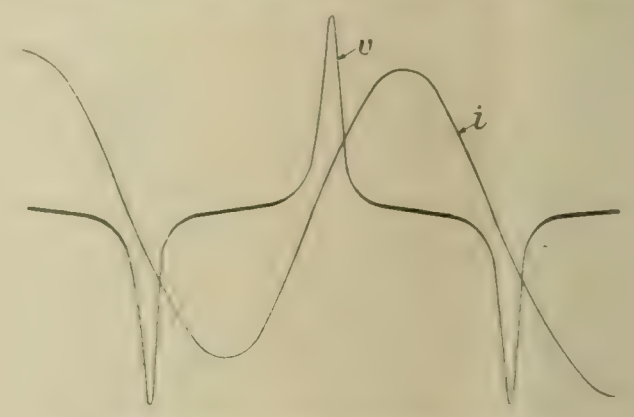
In this pamphlet, which is extracted from the "Bulletin" mensuel de la Société belge des Electriciens, the author continues his experimental and analytical investigation of the phenomena of commutation. A review of the author's previous work on this subject has already appeared in these columns.

In the work under notice, the treatment followed is on the same lines as in the previous Paper, and does not call for much further comment. The cases of a 35 H.P. 650 revs. per min. series motor, and an 85 kw. 750 revs. per min. dynamo are dealt with in great detail. In addition, a comparison is given between straight line commutation and that giving most satisfactory working.

THE MATHEMATICAL INVESTIGATION OF VOLTAGE WAVES OBTAINED IN TESTING IRON.

BY N. W. McLachlan, B.Sc., Eng.

In carrying out permeability * tests on Lohys, using sinusoidal magnetising currents, oscillograms of the type shown in the accompanying figure were obtained. When the maximum flux density ($B_{max.}$) is greater than 10,000 lines per square centimetre, the most important portions of the voltage waves are the steep parts on each side of the maximum, for the other parts are inclined to the axis of time at a small angle, and include only a relatively small area with this axis. Now, the magnitude of the current corresponding to the steep parts of a voltage wave is small, but its time rate of change large. Moreover, to determine the shape of a voltage wave by a mathematical equation requires that the relationship between B and



Oscillogram obtained with Lohys.
Frequency 50. Form factor 1·94. Current a sine wave, and $B_{max.}$=12,300.

H for small values of B, and, therefore, of H, must be known to a fair degree of accuracy. Neglecting for the moment the effect of hysteresis and assuming the B-H curve is always convex upwards, the shape being similar above and below the origin, suppose an equation can be found. This would by no means meet the case, for if the B-H curve was plotted from the equation, the slope for small values of B would differ materially from the actual slope on account of hysteresis altering the shape of the curve and preventing it passing through the origin. When B=0 there is a point of inflexion on the hysteresis loop, and from this point to that where H =0 (going clockwise round the loop), the curvature is concave upwards. Granted that for a certain value of $B_{max.}$ two equations were found, one for each of the two quarters of a loop, it by no means follows that these two equations are connected with those for another value of $B_{max.}$. The fact that the hysteresis loop obtained for static fields cannot be identical with that obtained for alternating fields, on account of the different conditions in the two cases, must not be overlooked. In a recent Paper published in the "Journal" of the Institution of Electrical Engineers,† it was shown that at high flux densities the relationship between B and H for stalloy was $B = kH^{0\cdot1}$. The case of a sine wave of current in the electric circuit is considered on the assumption that the above equation holds good down to the origin. This assumption is allowable when looked at from the point of view

* When the magnetising current is sinusoidal the permeability is greater than that obtained ballistically, the maximum value of the alternating current being equal to the value of the steady current.

† A. L. Tackley, "Mathematical Relationship between Flux and Magnetising Current Waves at High Flux Densities." "Journal" I.E.E., Vol. LIII., p. 521, 1915. Abstracted in The Electrician, Vol. LXXV., p. 511.

that the width of the hysteresis loop is small compared with the large values of H when the flux density is high. But it cannot hold when due consideration is given to the slope of the B-H curve, when the flux density is small, which is the most important point. This may be demonstrated in the following manner :—

$$B=kH^{0\cdot1}.$$

Since the current is sinusoidal $H=k_1 \sin\theta$, where $\theta=2\pi ft$.

Thus the equation to the flux wave is $B=A \sin^{0\cdot1}\theta$, where $A=k_1{}^{0\cdot1}$.

The voltage being proportional to the time rate of change of B we have

$$v \propto \frac{dB}{d\theta}=0\cdot1A \sin^{-0\cdot9}\theta \cos\theta.$$

Let $\theta=0$, and we get $V=\infty$, which is impossible in practice. This leads to a consideration of the slope of the flux wave.

We may write $B=\varphi(H)$, *i.e.*, a function of H, $H=\chi(\theta)$, *i.e.*, a function of θ, where $\theta=2\pi ft$.

Moreover, the equation to the flux wave is :—

$$B=\varphi\{\chi(\theta)\}.$$

Now, $dB/dH=d\{\varphi(H)\}/dH=\varphi'(H)$;
and $dH/d\theta=d\{\chi(\theta)\}/d\theta=\chi'(\theta)$;
also $dB/d\theta=(dB/dH)\times(dH/d\theta)$;

$$\therefore\ dB/d\theta=\varphi'(H)\times\chi'(\theta),$$

i.e., V= a constant × slope of B-H curve × slope of current curve. When B is small neither $\varphi'(H)$ nor $\chi'(\theta)$ are zero, and if one of them is infinite, the product is infinite, and hence the voltage is infinite. Thus, it may be inferred that no portion of the hysteresis loop is perpendicular to the axis of H, and that when B=O (where the point of inflexion occurs), the tangent to the curve makes an acute angle with the same axis. Obviously the maximum voltage occurs when the product of the slopes of the B-H and current curves is a maximum.

In the Paper cited above, the current wave corresponding to a sine wave of voltage is also treated. The equation to the current wave in this instance is $i=k \sin^{10}\theta$.

Differentiating, we obtain $di/d\theta=10\ k \cos\theta \sin^{9}\theta$.

When $\theta=0, \pi \ldots n\pi$, $di/d\theta=0$; hence the current has no rate of change where the wave crosses the time axis, and, therefore, it is parallel to this axis. Since H is proportional to the current i, we may write

$$v \propto dB/d\theta=c(dB/dH)\times(di/d\theta), \quad \ldots\ (1)$$

where c is a constant.

But when $\theta=0, \pi \ldots n\pi$, the voltage is never zero ; hence, from (1) it is obvious that in practice $di/d\theta$ can never be zero in the neighbourhood of $\theta=0, \pi \ldots n\pi$. Thus, in both the above cases the relationship between B and H for small values of H cannot be assumed as $B=kH^{0\cdot1}$.

THE STARTING OF ROTARY CONVERTERS.*

BY W LINKE.

The following notes are abstracted from two articles on the starting of rotaries ; the question of the practical working of the machines is the point of view from which the matter is approached, and this necessarily involves the consideration of the design and arrangement of much auxiliary apparatus. Those who are interested in the matter from the standpoint of the working engineer or of the designer would do well to consult the articles in the original, as our abstract deals cursorily with some parts in which the author gives a good deal of detail.

A rotary can be started from the direct-current side and synchronised in the usual manner. The synchronising apparatus is generally on the primary side of the transformer, as it then has to deal with smaller currents. On this plan there is no great risk of surges in connecting the transformer to the network, and its secondary can be permanently connected to the sliprings without the need of a switch. This arrangement requires a larger starting current on the direct-current side, but in any case it amounts to considerably less than half the normal current. There is some trouble in synchronising with a very varying voltage on the direct-current side, as in traction work ; the operation may last more than 10 minutes before the switch can be closed. This can, to some extent, be avoided by putting a resistance between the mains and the direct-current side for starting purposes ; cases have been known where it was impossible to synchronise with certainty without this device.

Another method of starting is to provide a small motor, which has two poles less than the rotary, and a correspondingly higher synchronous speed. By proper adjustments the rotary can be synchronised and brought to the proper voltage as a self-excited machine. A further plan is to provide a starting motor which has the same number of poles as the rotary ; the slip-rings of the rotary are then connected to the network through protective resistances at the moment when the rotor of the motor is short-circuited. If the resistances are suitably calculated, about two-thirds of the normal current should flow into the rotary, and with this the rotary falls automatically into step. It is, perhaps, an advantage at the critical moment to connect the armature up for self-excitation, inserting a fairly big resistance in the field circuit. But it is not advisable to make the rotary excite itself before connecting the slip-rings to the network. As soon as it falls into step, it is well to increase the self-excitation till the current becomes a minimum ; this may be done in one or two stages ; the resistance is then short-circuited. This is best done as quickly as possible, as it is known that a synchronous machine with much ohmic resistance in series with the stator is liable to hunt, but this is to some extent prevented by the short-circuited starting motor. There may be a slight surge of current at the moment when the resistance is short-circuited, but there is very little visible sparking. Oscillographic records are given for a three-phase 100-kw. rotary for 500 volts, the slip-rings being connected to the network through resistances of 1·7 ohms on each phase ; a diagram of connections is also given for carrying out the operations through one controlling switch. The resistances can be replaced by choking coils, and this is an advantage with large machines. Full particulars are given of this plan with a rotary of 1,000 kw., giving 500 volts on the direct current side ; when the slip-rings were connected through the choking coil to the network, 20 per cent. of the normal current passed, the voltage on the slip-rings being about 15 per cent. of the full secondary voltage. The choking coil carried about 20 kw. for a very short time, probably about one minute, and was therefore quite small, having regard to the size of the machine. This plan requires caution, if the rotary itself has any tendency to hunt, or if there are vibrations on the network, in such a case as that in which gas engines are the motive power ; choking coils increase the tendency to hunt, and there may be a difficulty in getting the rotary into step. On this plan it may happen that the polarity on the direct-current side is wrong, and in order to avoid this a voltmeter must be used, giving deflections on both sides of the neutral point. It is possible with a main controlling switch to test this ; one or two tests suffice to pick out the right instant, and the whole process of switching the rotary into circuit ought in any case to be done in less than 30 seconds.

Another method of starting consists in using a starting motor with the same number of poles as the rotary, and synchronising the motor. When the slip-rings of the motor are short-circuited, and the slip thus reduced to a minimum, the rotor circuit is opened by means of a change-over switch, and direct current is at this moment applied to the slip-rings. The rotor thus has a direct-current excitation, which causes the asynchronous motor at once to become a synchronous one. Thus it automatically falls into step. If the armatures of the motor and the rotary are mounted on the same spindle, the rotary consequently also falls into step ; the rotary can be regarded as a self-excited shunt machine, it can be brought to the voltage of the network, and then the switch can be closed between the slip-rings and the network without further preliminary. If this method is to succeed perfectly, it is necessary that the slip of the starting motor should be small. There must, therefore, be a good deal of copper in the secondary armature. Under these circumstances it is a good plan to interchange, as it were, the stator and rotor, *i.e.*, to connect the rotor to the network, and to make the stator into a secondary winding. This is because it is possible to put more copper into the stator ; besides this, we lose the effect due to the resistance at the brush contacts, which might tend to increase the slip. There is an advantage in slightly increasing the air-gap in the motor, which makes it possible to carry a greater overload. With machines, having many poles, the connection of the two armatures to the same spindle is not without difficulties, because the phase-displacements cannot be calculated exactly. This can be got over by mounting the two armatures on the same spindle, and for direct-current excitation two phases of the three-phase secondary winding are put in parallel with one another, and in series with the third. If suitable resistances are put in series with one of the two parallel phases, the phase of the

* Abstract of articles in the "Elektrotechnische Zeitschrift," Heft 12 and 13, 1915.

rotary can be exactly determined. In the original a diagram of connections is given showing this method, a small auxiliary direct-current machine being supposed to be necessary in the absence of any other source of direct current. Thus the series of operations would be to start the starting motor; to excite the auxiliary direct-current machine by closing its regulating switch, to change over the switch connections to the stator, and to excite the direct-current windings of the starting motor's stator by connecting to the auxiliary machine, the rotary now falls into step, and is then excited so as to produce the required voltage; it is then connected to the network. The only thing on this plan is to remember the proper order in which the switches have to be closed; the experience and care of the switch-board attendant does not matter at all. There is no question of any surges in the network, the starting motor takes scarcely more than 10 per cent. of the normal current. The whole process can be carried out in less than a minute; so that if the thing is to be done quickly, and safely, and no specially skilled attendants are to be employed, this plan is to be recommended.

The British Westinghouse Company have patented a plan by which the stator winding of the starting motor is put in series with the rotor winding. Connections are shown in the original article. An asynchronous motor is used for starting purposes; the simplest case is to have a short-circuited armature and the same number of poles as the rotary, or to have a pair of poles less. By closing a switch the stator of the starting motor is joined through the slip-rings to the full secondary voltage. The electrical quantities must, therefore, be so chosen that the stator winding takes about 30 per cent. of the normal full-load current. The starting motor then brings the rotary up to speed. When the synchronous speed is nearly reached, the field circuit of the rotary is joined to the armature; the voltmeter, joined to the armature, begins then to vibrate to and fro. The rotary then drags itself into step, it becomes normally excited, and takes nearly the whole voltage. The stator of the starting motor can now be short-circuited, and the rotary is thus connected directly to the network. There is here no question of the polarity being wrong. There is no sparking at the slip-rings. When, however, the stator of the starting motor is short-circuited, there is apt to be considerable sparking. When the rotary is synchronised and excited, the stator winding of the starting motor behaves like an impedance, so that the phases of the voltage on the slip-rings and in the network are different. When the stator winding is short-circuited, the speed of the rotary must be considerably increased; this sometimes causes a rush of current and much sparking. This sparking can be moderated by short-circuiting through a resistance which can be gradually cut out.

An asynchronous method of starting can be used. Then a low-voltage alternate current is applied to the slip-rings. The field system and a damper winding, if there is one, act as a short-circuiting winding. The voltage, which is necessary for starting, is between 20 and 40 per cent. of the normal voltage. This is conveniently obtained by taking a corresponding tapping from the secondary of the transformer. On the asynchronous method a rotating field is produced in the armature moving with a speed corresponding to the periodicity and the number of the poles. The rotating field produces short-circuited currents in the armature windings, closed by the brushes, which cause sparking at the brushes; on the other hand, it produces under circumstances considerable voltages in the field winding of the rotary, and precautions must be taken to render these pressures harmless. The sparking is largely determined by the impressed voltage and by the width of the brushes, *i.e.*, by the construction of the rotary. It remains nearly constant till the period of synchronism is approached. A radical method of dealing with it is to raise the brushes at starting and this plan has been largely employed in America. But it requires a rather complicated form of construction and more carefulness on the part of the attendants. Two extra brushes are also needed, the one positive and the other negative, *i.e.*, two brushes are needed to determine the polarity at synchronism, and to furnish the current for excitation. The German plan is to do away with these complications and to apply the lowest voltage which is sufficient for starting purposes. But this is not easily determined by calculations, and one is therefore reduced to the plan of testing the completed rotary and finding out the lowest voltage sufficient to start it. The transformer is provided with several tappings, and the terminal supplying the necessary voltage is noted and is used thereafter for starting. If there is a polyphase transformer for regulating the direct current voltage of the rotary, this can be used for regulating the starting voltage within certain limits. By using the minimum voltage for starting, it is possible with rotaries of modern construction, in sizes up to 1,000 kw. and 600 volts, to keep the sparking on the commutator within such limits that no damage is done. In larger sizes and for voltages above 600, the asynchronous method means almost necessarily a considerable amount of sparking; this means that in such cases the method is hardly suitable. In sizes up to 2,000 kw. with voltages not exceeding 200 or 300 on the direct current side, the sparking can be sufficiently controlled, so that if the network is not affected by the rushes of current, the asynchronous method can be applied. It may be further noted that the sparking is generally worse in those rotaries which have commutating poles than in those without them. This depends on the fact that the polyphase field is strongly marked in the neutral zone on account of the nearly closed iron path. Still the sparking can be somewhat brought under control by slightly displacing the brushes; it matters not whether the displacement is backwards or forwards, so long as the windings, short-circuited by the brushes, lie midway between the main pole and the commutating pole. After the starting has taken place, the brushes are brought back into their proper position. A second method of subduing the sparking is a strong damping winding on the commutating pole; this is best done by short circuiting the winding on the commutating pole, since a permanent damping winding would be a nuisance if there were sudden changes of load.

The voltage which is induced by the polyphase field in the exciter winding at the moment of starting depends essentially on the method of construction of the rotary. Particularly it depends on whether the poles are solid or laminated, and on the nature of the damper winding. Take the case of a four-pole rotary with laminated poles, giving 500 volts direct current; when the asynchronous method of starting is used, voltages above 6,000 may be noted in the exciter winding. An old method of protection consisted in dividing up the field circuits by separating switches; lately the plan has been employed of short-circuiting the field on itself or connecting it up to the armature, in the normal way for self-excitation. It is a good plan at starting to place the handle of the field-regulating switch in the usual running position. It is very necessary to take care, if there is another field-switch in the circuit, to see that this is closed; otherwise a breakdown of the insulation of the field is almost certain. One generally finds that on this plan the rotary is rather more difficult to start; but this is of no great importance. The current necessary to start a rotary on the asynchronous method varies between 80 per cent. of the full-load current for large rotaries up to 300 per cent. for small ones. The transformer is usually so tapped that it gives about 30 per cent. of its normal voltage. Therefore the starting current, reckoned on the primary side, varies from 30 to 120 per cent. of the normal full-load current. Generally speaking it may be said that rotaries, varying in size from 200 kw. to 600 kw. require from 70 to 100 per cent. of the full-load current, reckoned on the size of the primary network. A very important point with the asynchronous method is to get the right polarity on the direct-current side. Generally speaking, the polarity is a matter of chance; so that either we may have to correct the wrong polarity, or by means of a throw-over switch we can connect the rotary to the network so as to produce the right polarity, or some plan must be adopted which is certain to make no mistake about the polarity we get. We must have, of course, a voltmeter giving deflections on both sides of a zero, which must be in the middle of the scale. In order to avoid any possible mistake on the part of the attendant, the voltmeter scale should only be graduated on the one side of the zero mark, *i.e.*, on the side which gives the right polarity; the other part of the scale on the other side of the neutral point should be left blank. The author then proceeds to give four different methods, commonly employed, by which the right polarity can be obtained, but we cannot find room for the reproduction of these details, for which the original Paper should be consulted. The author concludes with some observations as to the final process of switching the rotary on to the working voltage, to which the above remark also applies. Suffice it to say that this operation must be carried out with great speed, if current-rushes are to be avoided. The throw-over switch must be so constructed that the travel is very short. It may be mechanically operated; if it is worked by hand, some form of bell-crank switch with the contacts on either side of the fulcrum should be used; an illustration is given showing a switch of this type.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from THE ELECTRICIAN Offices [illegible] free [illegible] on receipt of publishers' price, adding 3d. for books published at 1s. net, 6d. for books published at 2s. 6d. net, and 10 per cent. for books published at 5s. net. Add 10 per cent. for postage of foreign books.)

"How to Make a Transformer for Low Pressures," by Prof. F. E. Austin. (Hanover, N.H.: F. E. Austin.) Pp. 17. 40 cents.

"Directions for Designing, Making and Operating High-pressure Transformers," by Prof. F. E. Austin. (Hanover, N.H.: F. E. Austin.) Pp. 46. [illegible] cents.

GERMAN BUSINESS METHODS.

On Thursday, the 11th inst., an informal dinner was held by the British Electrical and Allied Manufacturers' Association when the chair was taken by Mr. F. R. DAVENPORT, the Chairman of the Association. A discussion took place on German business methods. The subject was introduced by Mr. F. W. WILE, the late Berlin correspondent of the "Daily Mail," in an address entitled "German Business Methods as I knew them." Unfortunately, Mr. WILE was indisposed and was, therefore, unable to be present, but his Paper was read by Mr. D. N. DUNLOP, the Secretary of the Association.

In his address Mr. WILE mentioned that owing to early business training he was able to appreciate business matters although professionally he was a journalist. It was impossible for a foreign correspondent, even though bound to specialise in high politics, to live in Berlin for so long as he (Mr. Wile) had lived without acquiring at least a knowledge of German business methods in broad outline. The effect left on his mind on looking back was a strange combination of scientific efficiency and a great unreliability. The statement of the Chancellor on August 4th, 1914, that "Necessity knows no law" was the basic principle of German business methods; the end always justified the means. The average German business man had a total disregard for the elementary principles of honour, propriety and generosity. Thus there was a great tendency to break agreements with foreigners. The sacredness of a verbal promise was an utterly unknown quantity in Germany. In regard to contracts the following might be taken as an example: A German would give A exclusive agency rights in England for a German speciality for a fixed period of years, but at the end of six months, finding that A's sales were not up to expectations, he would not have the slightest compunction in entering into a surreptitious bargain with B for competitive rights with A, assuring B convincingly that he was in no way infringing A's rights. If trouble resulted he would let A and B fight it out. Similarly, finding that some foreign product was a good thing German adventurers would register the trade mark in Germany and would proceed to supply the article. Being in possession of the trade mark they were inviolable possessors under German law. There was much business trickery of that kind. There was an immense traffic in Germany in illicit business information, and it was not an uncommon thing for banks to finance the employee of a concern in starting a competitive works on the information that he had gained in his employment. Similarly, it was probable that much commercial information had been transmitted from this country to Germany by the numerous German clerks that had been employed. Probably the cheap German clerk who had infested British offices was the costliest investment British business men had ever made.

On the other hand, the groundwork of organisation on which the German commercial structure rested was splendid, yet there was not much doubt that shop management in many works of the British electrical industry was in every respect on a par with any system which had sprung from the brain of a Rathenau. Perhaps only in one department German works gave better results than those achieved in this country, namely, in specialisation. It was on account of this that the German firm employed a large number of engineers who were content to devote their skill and energies indefinitely to a specific and more or less minor speciality instead of generalising. Thus a staff so obtained with joint efforts the maximum of general efficiency.

The German always looked up to Great Britain as the master business mind and came over here to study business. Thus it was that the A.E.G. decided about 10 years ago to put their export trade in the hands of an English engineer. But although Germany had looked upon Britain as the mother of commerce and trade, the Germans had undoubtedly outstripped this country in respect of organisation. The success of the German was due to tremendous zeal and application. He examined all the conditions in detail. He was willing to give long credit. In order to take business from an English, American or French firm he gave some advantage either in price or quality. Further, he received the systematic sleepless support of the German Government throughout the world. German embassies and legations were always at the service of the business man. Moreover, there was a sagacious legislation at home which provided tariffs and commercial treaties; there was an intimate partnership between the great shipping companies and the Government. There was a practice of preferential rates to German merchants and manufacturers. There was a continual interest in the welfare of German industry.

With regard to the capture of German trade he (Mr. Wile) wondered if the subject was being approached with that far-sighted comprehensive thought and energy which alone would pave the way to the desired goal. From the German papers he gathered that German exporters were waiting for peace suddenly to break out in order that the markets of the world might be the scene of the dumping of vast quantities of goods on a scale hitherto unwitnessed. From a meeting of the leading German industrial associations in Dresden the other day a telegram was sent to the Kaiser assuring him that the manufacturers of the country were only waiting for the moment to arrive when the German commercial army could once again clear for action throughout the globe. This was one of the most significant warnings from business Germany to reach the outer universe and it ought to be taken seriously to heart by England. In the United States defensive measures were already in prospect. Congress was to be asked at the forthcoming session to pass legislation making it unlawful for foreign manufacturers to sell their products in the United States at less than the cost of production there. War work in this country had, of course, seriously interfered with the prosecution of export trade, but unless a beginning were made to look far ahead and think of things after the war, the people of this country would find themselves out-generalled by the Germans. The Germans too were pre-occupied with war work, but we might be quite sure that with their marvellous faculty for leaving no contingency uncomtemplated they were at this hour busily planning and plotting for a new raid on the world's markets of even a more determined character than any effort they had ever put forth in the past. With our increasing indebtedness the need for inexpensive exploitation of export trade would be far more urgent than at any previous time in British history. It was necessary to set Germany the pace instead of following supinely in the lead she would be all too ready to assume. Waiting to see would be as fatal to British industry as it had proved to certain politicians.

Above all the Government should understand that we could not meet German competition on equal terms until there was that offensive and defensive alliance between the Government and industry which had contributed so largely to the development of the enemy's commerce both at home and abroad. The Government should be made to understand that one of its vital functions was to facilitate and not to hamper business. They should make the British business man welcome at British embassies, legations and consulates. There should be a Minister for Foreign Commerce who was an eminent practical business man and not a meritorious politician. The banks also should realise the role they have to play in promoting British export trade. Our great shipping and railway companies should realise that along with the banks they were the natural allies of British business men to send goods to foreign markets. Considering the emergency in which the export trade would find itself at the close of the war it would require extraordinary co-operation with all interested agencies.

The value of foreign languages should be better appreciated, so that agents could be sent forth knowing the language of the country in which they were to work. The lecturer concluded by advocating a tariff war sufficiently high to keep out any German manufacturer After the crimes of which the "Lusitania" would for ever be the symbol, he would decree that a German vessel of commerce should never again pollute the waters of a British port. He would cause it to be looked upon as a disgrace to any British merchant to offer German goods across the counter and he would withhold the right of naturalisation from German subjects. German ruthlessness called for retribution of no ordinary calibre. What Germany hoped for more than anything else was that England would return to the state of "business as usual" with her when the guns were no longer barking.

DISCUSSION.

Mr. W. L. MADGEN thought that many of the complaints against the British manufacturer, such as lack of appreciation of foreign languages and unwillingness to vary his manufactures, no longer held. It was often forgotten that our population is small, so that we cannot produce more than a certain amount. We, therefore, found it necessary to select what we desired to manufacture. The important thing was that we should improve our efficiency, but there were many difficulties in doing so. The lawyer politician had a way of always increasing the difficulties of manufacture, and we must break through shackles of this kind by bringing pressure upon the Government.

Mr. R. W. PAUL felt that we ought to increase our power of productivity. Here trade union rules were a great difficulty. There ought to be some sort of organisation for introducing better brains and skill to manufacturers, and he thought that it should be possible for manufacturers to assist each other if the result of so doing was for the good of the industry.

Mr. DAVENPORT, having asked the representatives of the press if they would be willing to express any opinions upon the subject,

Mr. W. R. COOPER called attention to a recent meeting of the Central Union of German Merchants and of the Federation of Merchants in Germany with a view to taking steps to promote German foreign trade at the conclusion of the war. It was evident that if the Germans had

enough time to attend to such matters we ought not to be behindhand in taking corresponding steps. He was afraid there was a tendency to be apathetic in the matter and to follow a policy of "wait and see," which would be absolutely fatal. The present gave a very fine opportunity for the B.E.A.M.A. to take up the whole subject.

Mr. S. RENTELL expressed the view that the trade union rules were fatal to industrial expansion in this country.

Mr. A. H. BRIDGE was of opinion that we ought not to adopt the idea that we were sufficiently productive in this country or producing as much as we could. This would be a mistaken idea to go upon.

Mr. D. N. DUNLOP gave a brief outline of what the B.E.A.M.A. was doing and what he hoped that it would do in the organisation of industry and in the encouragement of export trade. We refer to this in detail in our Leading Article.

Mr. C. COLTON did not believe that Great Britain was working up to her full capacity. In his opinion we could do much more, as well as handling the trade which we at present possess. It was necessary to have the assistance of the Government and the railway and shipping companies.

Mr. DAVENPORT, in bringing the meeting to a close, expressed pleasure at its successful character, and stated it was hoped to hold meetings of the same kind at intervals, at which similar subjects would be informally discussed.

PROTECTION OF LIFE AND PROPERTY AGAINST LIGHTNING.*

BY O. S. PETERS.

This Paper is a report of a survey of statistical data relating to life and property hazards from lightning, and also of existing methods of protection against lightning. The field covered does not include electrical power and signal systems. In the course of preparation of the Paper an examination was made of the available literature on the subjects of lightning phenomena and protection against lightning and of the reports of fire superintendents and insurance companies. In addition to this, a considerable amount of data was obtained from the reports of the Census Bureau, and manufacturers of lightning rods were asked to submit their opinions, and the results of their experiences, as to how a system of lightning rods should be installed. Appendixes are included in the Paper, giving rules concerning the installation and maintenance of lightning rods which have in some cases been followed in Germany, England and the United States, and also rules for first-aid treatment in cases of persons injured by lightning.

The chief facts disclosed by the information obtained in the course of the inquiry may be summarised briefly as follows :—

1. The property loss by lightning for the entire United States is approximately £1,600,000 per year, of which by far the greater part occurs in rural districts.

2. During each year there are approximately 1,500 persons affected by lightning stroke in the United States, one-third of this number being killed and the rest subjected to injuries which in many cases are permanent. About nine-tenths of these accidents occur in rural districts.

3. Such evidence as is available on the effectiveness of lightning rods indicates that, taking rods as they come in the general run of installations, they reduce the fire hazard from lightning by 80 to 90 per cent. in the case of houses, and by as much as 99 per cent. in the case of barns. The same is undoubtedly true of other buildings having characteristics similar to those of barns and houses.

4. With regard to the proper metal for lightning rods, it may be said that the differences of resistivity of the metals ordinarily available for lightning rods are not great enough to make one metal preferable to another. Resistance to atmospheric and soil corrosion is the chief essential to be considered.

5. Extended metallic masses on or within a building must be made a part of the lightning rod system, with a possible exception, however, in the case of metallic masses within the building which do not come near the roof and are at a distance of 10 ft. or so from the rods. Gas pipes should be avoided, if possible, in erecting lightning conductors, but if they are so located that it is impossible to keep at a distance of 10 ft. or more, they should be electrically connected to the rods at several points, connected to earth within the building and well bonded around the gas meter.

6. The maximum current in a lightning flash may, in some cases, be more than 20,000 amperes.

7. Each flash of lightning consists, in most cases at least, of a number of consecutive discharges along the same path, with short time intervals between them. The duration of each of the consecutive discharges is of the order of 0·00005 second. The best obtainable evidence points to the fact that these consecutive discharges are unidirectional and of steep wave-front.

8. The heating effects of a lightning stroke on a rod of ordinary size—*i.e.*, a rod weighing about 0·5 kg. per metre—are not likely to be appreciable except at the place where the stroke enters the rod, or at high-resistance joints.

9. Good mechanical construction in a lightning rod system is a prime essential to permanency. Rods are subject to severe strains from wind, snow and ice, thermal expansion and contraction; and, in the event of a stroke of lightning, to electromagnetic stresses, so joints must be strong and the rod securely fastened to the building.

10. The resistance of the earth connection should be made as low as practicable. In practice there is no chance of getting too low a resistance. On the other hand, a resistance which rises above 15 or 20 ohms at any time should be considered as excessively large on account of the potential drop which may possibly be set up in the event of a stroke.

11. When a system of lightning rods is installed, aerial terminals with points should be placed at all chimneys, gables, points or other projections toward which a stroke of lightning might be directed. This is because a point cannot be relied upon to protect objects other than that upon which it is placed.

12. Down conductors should be run in such a way that a stroke on any aerial terminal on a structure will have two or more widely-separated paths from the foot of the aerial terminal to earth. One path to earth has been found to be unsafe, and more than two are preferable.

13. It has been shown photographically that the path of a lightning discharge may be shifted by the wind as much as 10 metres or more during the period between the initial and final discharge. For this reason it is advisable not to allow too great an expanse of flat roof to be exposed without aerial terminals.

14. The return on an investment in lightning rods may be expected in two ways: In a sense of personal security from lightning, and in actual security to life and property. The property loss from lightning is not sufficient to cause universal protection against lightning to be a paying investment. Protection against lightning is justified as an investment only where risk to human life is involved, or where the property risk is great enough to make protection against lightning more economical than insurance.

15. With regard to personal safety from lightning, it may be said that no place to which a person may ordinarily retire can be considered as absolutely safe. The only places which can be considered as closely approximating absolute safety are in a building completely surrounded by a metal network, in a steel frame building, or in an underground chamber. A high degree of safety, however, may be found in a well-rodded building; the next degree of safety is undoubtedly to be found in an unprotected house, which may be considered as far preferable to the open or unprotected outbuildings

* Communicated by the U.S. Bureau of Standards to the "Journal" of the Franklin Institute.

RESISTANCE OF RADIOTELEGRAPHIC ANTENNÆ.*

BY L. W. AUSTIN.

The resistance of a radiotelegraphic antenna may be divided into three parts: First, the ohmic resistance of the wires; second, the so-called radiation resistance; and third, the so-called earth resistances. The first is generally negligible where a sufficient number of wires in parallel is used. The second is derived from the expression for the radiated energy of an antenna, which is

$$E = 160\pi^2 \frac{h^2}{\lambda^2} I_s^2,$$

where h represents the height to the centre of capacity of the antenna, λ the wave-length and I_s the current measured at the base of the antenna. The expression $160\pi^2 \frac{h^2}{\lambda^2}$ is called the radiation resistance, as it takes the same position in the energy equation as that occupied by R in the case of ohmic losses. The expression shows that the radiation resistance falls rapidly as the wave-length is increased.

Up to the present no satisfactory theory of ground resistance has been developed. The experimental curves of antenna resistance, on account of the decreasing radiation resistance, fall rapidly at first as the wave-length is increased, and then, as the wave-length is further increased, remain nearly constant if the ground conditions are good, as in the case of a ship's antenna, or again rise nearly in a straight line if the ground conditions are poor. This rise may be very rapid in the case of peculiarly poor grounds. For instance, the resistance of the Bureau of Standards antenna rises from 13 ohms

* From the "Journal" of the Washington Academy of Sciences.

at 800 metres wave-length to 28 ohms at 2,000 metres. Great difficulty has been found in explaining this increase of resistance with increasing wave-length, but it is believed that the following explanation is the true one :—

The antenna system must be looked upon as a condenser, the antenna itself being the upper plate and the ground water the lower plate. Between the ground water and the surface there is usually a layer of semi-conducting material which would correspond to a poor dielectric in the case of an ordinary condenser. It is well known that the dielectric losses in imperfect condensers generally increase in proportion to the wave-length of the current employed in the measurement. It is found that by covering the surface of the ground under and around the antenna with a wire net, thus making the net the lower plate of the condenser, the ground losses nearly disappear.

CORRESPONDENCE.

THE PASSING OF THE SMALL TURBINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Your interesting editorial remarks in the issue of THE ELECTRICIAN of October 29th last are worthy of a few remarks. You particularly refer to the development of the "Parsons" type of turbine, and it is gratifying to learn of the enormous extension of the steam turbine generally, not only in capacity but also its increase in thermo-dynamic efficiency.

The particular characteristic of any make of steam turbine is the fact that it must have relative high blade velocity, and because it is so inefficient at high pressures, it must have a well-maintained vacuum, it is also essential to utilise a high temperature steam in order to extract the maximum of mechanical work from the heat energy. Consequently, in order to obtain a high relative blade velocity it is essential either to construct the machines for high revolution speed or to build them of large diameter for low-revolution speed. The advantage is very much in favour of the high-speed turbine in all possible directions, owing to cheapness, less clearance, smaller heat loss, &c. It is perfectly true that a still greater thermal efficiency and consequently lower steam consumption will always result by increasing the size and capacity of machine, by increase in heat volume in given unit of time, but this characteristic is not only evident in the steam turbine, it is to be found in all types of heat prime-movers. There are yet to be made great developments in the design and construction of steam turbines for transforming "heat energy" into "mechanical energy," and one of the most encouraging developments in this art, is that embodied in the invention of Mr. Ljungström. No doubt the old fashion type of reaction turbine is doomed in small units, but, in my opinion, the coming of the "Ljungström" high-blade speed, high temperature, turbine offers great possibilities for the immediate future.

As to the passing of the "small turbine," I am convinced that this type of turbine will still hold its own, especially in the type of small power generating plants found in this country. You refer to the large generating plants in operation in America. Conditions over here are entirely different, and even there the generating costs and consequently the selling price is not so low as the art of heat engineering science warrants to-day. What is wanted before a scheme can be entertained for the centralisation of generating power for London is the development of a steam turbine which can safely carry steam at a temperature of 800°F. or 900°F.

The talk of raising the pressure to 500 lb. per square inch is not indicative of much knowledge of the thermal conditions of turbine transformation of heat energy into mechanical energy. It is perhaps true that is a line of thought for those engineers who may be still thinking of retaining the old-fashioned "fuel-heat" transformer, in the shape of "steam boilers and superheaters"; it is the only way, inefficient as it is, from a steam generation, or utilisation, point of view, but I would strongly recommend those authorities who may be thinking of the adoption of "higher pressures" to "wait and see" a bit. Experiments have proved to me that it is highly probable that the provision of really high-temperature steam is possible on a large scale by means of a revolutionary method of "heat-transformation," which is capable of the full utilisation of the higher range of temperatures obtained by the fuel, of whatsoever kind. Taking a survey of the present state of steam engineering I am convinced that the "commercially" efficient steam turbine is at hand, not because of any particular improvement in the turbine system itself, but because of the much more efficient utilisation of fuel in the production of high-temperature steam, and this accomplished by neither the use of steam boilers or superheaters.—I am, &c.,

WILLIAM P. DURTNALL, M.I.Mar.E., M.I.Auto.E.

London, Nov. 10.

[We have taken the liberty of abbreviating our correspondent's letter.—ED. *E.*]

THE CORONA IN AIR AT CONTINUOUS POTENTIALS AND PRESSURES LOWER THAN ATMOSPHERIC.*

BY DONALD MACKENZIE.

Summary.—The author describes experiments revealing the difference between the formation of positive and negative corona round wires at low pressures. He also shows the possibility of using the apparatus employed as a rectifier.

The general agreement among observers of corona discharge is that the corona-forming voltage is independent of the material of the discharging conductor and of the humidity of the air; that the critical surface-intensity is greater for smaller wires; that increased temperature or decreased gas pressure decreases the critical voltage; and finally, that the onset of the phenomenon is not affected by the antecedent ionisation near the wire.

It was with a view to examining the continuous potential corona at low pressures and so to test the extension of the empirical laws found for the alternating corona that the work here reported was begun. In this laboratory at the present time the only available source of direct current at high potential is a battery of 500-volt 0·1 kw. generators driven by a direct-current motor. These generators are separately excited from a lighting circuit, which also furnishes power to the motor; this makes the control of voltage very difficult, the fluctuations in the line voltage amounting at times to 3 or 4 per cent. Most of the irregularities of the points plotted for some of the curves are attributable to this condition. The speed control of the motor enables the generated voltage to be raised to more than 900 volts on each machine; at the beginning of the work five such generators were at hand, furnishing a potential of 4,000 volts and more, but two machines broke down before much progress had been made. This limited the total voltage to 2,700 volts, and so placed a regrettable restriction on the dimensions of the corona apparatus and the pressure range.

DESCRIPTION OF APPARATUS.

A diagram of the apparatus used is shown in Fig. 1. A is a large glass tube 10 cm. in diameter and 75 cm. long, inside of which is supported by hard rubber rings the brass cylinder B, 4·9 cm. in internal diameter and 61 cm. long. These rings are pierced with a number of holes to permit free flow of air through all parts of the apparatus. The glass cylinder is closed at each end by brass plates, cemented on with a mixture of beeswax and resin. In the centre of each of these plates a hole is drilled, permitting the passage of the wire C, which is soldered at each end into bushings held by the nuts DD. In all cases it was easy to apply sufficient tension to hold the wire straight unless a large current was allowed to pass in the discharge.

The glass tube A is provided with three side tubes, two of which serve for the ground connection to the brass cylinder and for the pump connection respectively. The third side tube, the uppermost in the figure, supported another glass tube, sealed into it with sealing wax and drawn down at each end to hold a small brass rod screwing into a brass plate about 2 cm. in diameter. Connection to ground and to the brass rod just mentioned was by small platinum wires sealed directly into the glass tubes. The disc carried on the end of the brass rod E is curved parallel to the surface of the brass cylinder, and stands about a millimetre above it. Directly under the disc are a dozen or more small holes in the cylinder, through which charged particles may pass on their way out from the central wire, charging or discharging the electroscope to which the disc is connected.

* Abstract of an article in the "Physical Review."

The voltage of the three generators is applied to the apparatus over leads including the water resistance W, about 3 cm. in diameter and 75 cm. long, variable by varying the separation of platinum electrodes. One end of the generators is connected thus to the brass plate closing the glass tube; the other end is earthed, as is the brass cylinder through a milliammeter or galvanometer. Reversal of wire polarity is effected by reversing the excitation of the generators. Measurement of voltage is by means of a Weston direct-current voltmeter V with a multiplier M, reading 150 volts when the wire potential is 3,000. In the upper brass plate are cut holes covered with glass windows. Above these is fixed a mirror permitting visual exploration of the space within the cylinder.

It was expected that a charged electroscope connected with the disc E would be affected by a discharge passing between the wire and the cylinder; a positive corona on the wire should discharge a negatively charged electroscope and vice versa. This expectation was justified; when the corona starts the gold-leaf drops instantaneously and there is no possibility of confusing this effect with a loss of charge due to atmospheric leak. As the voltage is raised, electrostatic induction brings about a partial fall of the gold-leaf; a negatively charged gold-leaf receives an induced positive charge in the presence of the positively charged wire, the corresponding negative charge appearing at the disc E. As long as the potential of the wire is constant the magnitude of the induced charge on the electroscope does not vary, and the definiteness of the observation is not diminished by this action.

The electroscope is charged statically, and the voltage gradually raised until the gold-leaf suddenly falls. The voltmeter is then read and the pressure recorded.

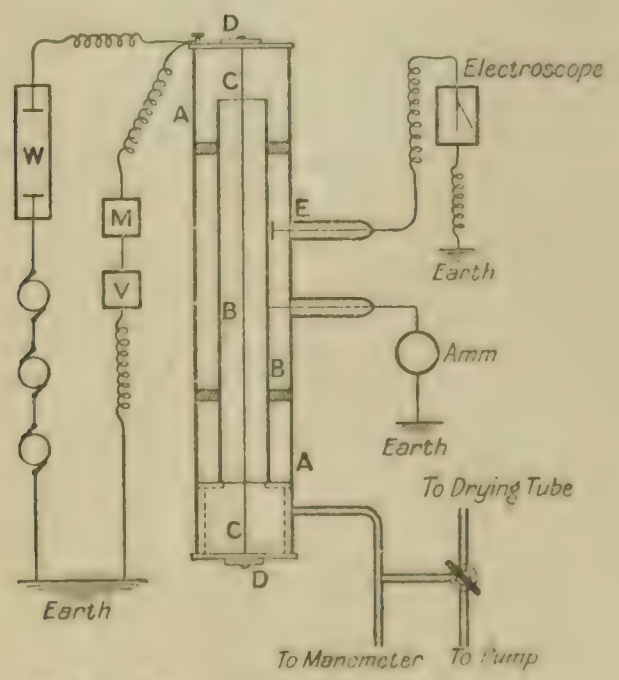


Fig. 1.—Diagram of Corona Apparatus.

The wires used were carefully straightened by the electric current, except in the case of the larger wires, which were brass rods free from kinks. All were polished with fine emery and crocus cloth, and when put into the tube showed no sign of surface irregularity. Dust particles from the air settling on the wire are of no importance, since unless the wire is sticky they are driven off by electrostatic repulsion. This fact has been overlooked by most observers, who attribute irregular behaviour of the corona to dirt which they suppose to have settled on the wire.

The most important step in setting up the apparatus is the centering of the wire in the brass cylinder. The end bushings pass through ¼ in. holes in the end plates which allow sidewise displacement of the whole wire. It was found a simple matter to set the wire to [illegible] in.

When the tube has been set in place the air is exhausted by means of a Gaede pump, and the space refilled with air drawn through a column of sulphuric acid to exclude moisture. This is repeated a number of times, and the apparatus left exhausted to allow leaks to manifest themselves. Leaks could usually be kept so slight that no alteration in the reading of the manometer could be detected in the time spent in making observations at any one point. In one case when the leakage was faster than this, it was possible to estimate its magnitude and correct the pressures recorded.

Preliminary Experiments.

The first experiments were made with large wires, [illegible] in diameter. The voltage then available was 4,000, and corona formed on such wires at a pressure of about 4 cm. or 5 cm. At once a difference was noted in the positive and negative discharges. With the wire positive, the corona formed at a definite voltage and pressure, disappearing as soon as the voltage was lowered or the pressure raised by the smallest step that could be made. With the wire negative, however, the discharge was of quite different form. At a given impressed voltage, no visible discharge passed until the pressure was lowered well below the value corresponding to the positive corona at the same potential. Finally, however, came on a discharge carrying a large current sufficient to burn out two 16 c.p. incandescent lamps in series in the ground connection. This discharge persisted after the voltage was lowered far below the initial value, and was not extinguished by a moderate increase in pressure. In fact, a discharge setting in, say, at 3,500 volts and 4 cm. pressure, persisted up to a pressure of more than 26 cm. Increase in pressure was accompanied by an increase in the current flowing; even at low pressure sufficient heat-energy was liberated to make the glass tube uncomfortably warm.

The water resistance had not been used. It was then inserted in the high potential side in order to keep the current down to a value safe for the generators. On examining the discharge from the negative wire, it was seen to show the characteristic structure of the discharge in high vacua. Instead of a uniform glow along the whole wire as in the positive effect, the luminosity is confined to a small length of the negative wire.

With the large wires it was possible to obtain the positive corona at the lowest pressures attainable (from 1 mm. to 2 mm.), but the negative corona never appeared; the discharge from the negative wire was always of the vacuum tube type. On removing the wire from the tube it was found deeply oxidised at the points where the vacuum tube discharge had existed. This singularity is intimately associated with the size of the wire, as will appear from the experiments about to be described.

Final Results.

1. *The Positive Effect.*—All of the wires when positive to the tube form coronas at the lowest pressures to which the apparatus was evacuated. The discharge is a perfectly uniform and stable violet or bluish glow extending the whole length of the wire within the brass cylinder. Using the electroscope charged negatively, the gold-leaf is seen to fall sharply at a definite voltage, and keeping the pressure constant this value of voltage may be read any desired number of times.

It was invariably found for the larger wires that the onset of the visible corona accompanied the discharge of the electroscope. Having once verified this expected result I relied thereafter upon the electroscope. With each wire the verification was repeated.

As the voltage is raised above that necessary to start the corona, the luminous sheath expands progressively, accompanied by an increase in the current, making the latter readable on the milliammeter. With further increase in voltage a point is reached where the corona is unstable. A slight increase in voltage causes the corona, previously uniform over the whole length of the wire, to collapse to a vacuum tube discharge confined to a few millimetres. The instability of the corona at this transition point is shown by the fact that if the generator excitation and motor speed are kept at the appropriate value and the potential suddenly applied to the wire, corona forms for an instant and then collapses to the vacuum tube discharge. Refilling the tube with cool air and then exhausting anew lengthens the time taken for the change to four or five seconds. On the establishment of the vacuum tube discharge, the voltage drops 50 or 60 per cent. and simultaneously the current rises to many times its former value.

This form of discharge shows all the structure recognised in the vacuum tube discharge. The negative glow is a thin blue layer against the inner wall of the brass tube, separated from it by a narrow Crookes dark space. The positive column is a pink sheath enveloping (usually, but not always, completely) a centimetre or two of the wire, directly opposite the negative glow, which does not go completely around the inner surface of the cylinder, but covers an increasing circular extent of it with increasing voltage. Between the positive column and the negative glow is the Faraday dark space: at low currents (total voltage over corona tube and ballast resistance lowered) this space is invaded by the positive column, which becomes striated. Further lowering of the voltage causes the striations to become more distinct, and the positive column extends almost to the point of meeting the negative glow: the latter is greatly diminished in extent and brilliancy. At last, just as the Faraday dark space seems to be completely eliminated, the discharge ceases. The same sequence of phenomena is seen when the pressure is allowed to increase. After cessation of the discharge the voltage between the wire and tube rises to the value appropriate to an inactive field. Increasing the total voltage increases the current carried: the voltage on the tube and wire slowly decreases. Decreasing total

voltage decreases the current at the same time that the tube-wire voltage gradually increases.

2. The Negative Effect.—For the larger wires used in my experiments the negative corona is not obtainable; the first detectable discharge is the vacuum tube discharge. For the smaller wires the case is different. At the lowest pressures the vacuum tube discharge is the only one obtainable. At higher pressures the negative corona appears, expands with increase of voltage above the critical value, and gives place to the negative vacuum tube discharge at a transition point determined, as in the positive effect, by the pressure and the wire diameter. After the vacuum tube discharge has been established the current and tube-wire voltage vary as in the positive effect. The cessation of the discharge is after the same sequence of changes in the two cases.

The negative corona is never a uniform sheath like the positive. It is grouped about bright blue points set at intervals along the wire; these blue points are surrounded by reddish streamers, and increase in number as the voltage increases. With decreasing voltage the blue points are the last to disappear; they persist at a voltage lower than that at which they form.* After transition the structure of the discharge is the same as the positive vacuum-tube discharge, but reversed; next to the wire is the Crookes dark space surrounded by the negative glow, cylindrical in form; then comes the Faraday dark space, and after it the positive column flat against the surface of the tube.

The negative glow may appear outside the uniform field, at the very end of the wire—the positive column collecting in a restricted

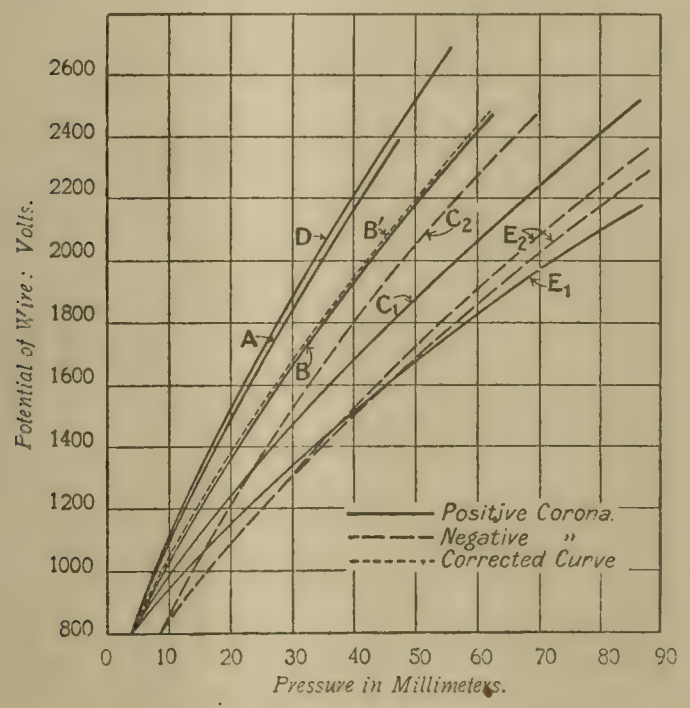


FIG. 2.—CORONA-FORMING VOLTAGE.

Diameters: A, 0·157 cm.+; B, 0·107 cm.+; B1 is B corrected or leak; C_1, 0·063 cm.+; C_2, 0·063 cm.−; D, 0·165 cm.+; E_1, 0·042 cm.+; E_2, 0·042 cm.−.

area at the edge of the brass tube. The discharge may start in the interior and climb up more or less rapidly to the end of the wire. This is probably due to convection currents, set up even in rarefied air by the very hot discharge. This explanation is suggested by the fact that if the voltage is suddenly removed and reapplied, the renewed discharge prefers points which have just previously been discharging.

The energy of the discharge is sufficient to heat the wire to redness and partially to oxidise the wall of the tube; after prolonged discharge a green colour is seen in the field.

DESCRIPTION OF OBSERVATIONS.

The observations at each point were considered satisfactory if no readings of the voltmeter differed from the mean by more than one-half a volt; this variation was unavoidable because of fluctuations. The multiplier ratio being 20 to 1, this means that a disagreement of 10 volts was considered tolerable.

Wires of diameter 0·165 cm., 0·157 cm., 0·107 cm. and 0·063 cm. were all investigated, using the electroscope as a detector of the onset of the corona. For the negative effect when no corona can be formed, visual observations were relied on; but the behaviour of the electroscope is irregular when the tube is sustaining a vacuum tube discharge unless the region involved lies directly under the disc E; in this event the positively charged electroscope is immediately discharged and then receives a negative charge.

When associated with the smallest wire, 0·042 cm. in diameter, the electroscope gave evidence of an ionisation current unaccompanied by luminosity.

Accordingly, the attempt to detect corona formation by the electroscope was given up for this size of wire, and in place of the milliammeter there was substituted a galvanometer, giving a deflection of one scale division for 7×10^{-6} amperes. The suitability of the galvanometer for this work (at least under these conditions) is shown by a comparison of curves A and E_1, Fig. 2.

Curve B, Fig. 2, is plotted from observations on a steel wire of diameter 0·107 cm. During these observations the leak of air into the apparatus was quite rapid, and efforts to overcome it failed. Accordingly it was decided to let the apparatus leak and make corrections. The electroscope was charged, the voltage raised until the gold-leaf fell, then the pressure read immediately and the voltmeter last. Five series of such observations were made as the pressure increased, due to the leak and through them a smooth curve, B, was drawn. It was calculated that in the time taken to note the discharge of the electroscope and read the manometer the pressure rises

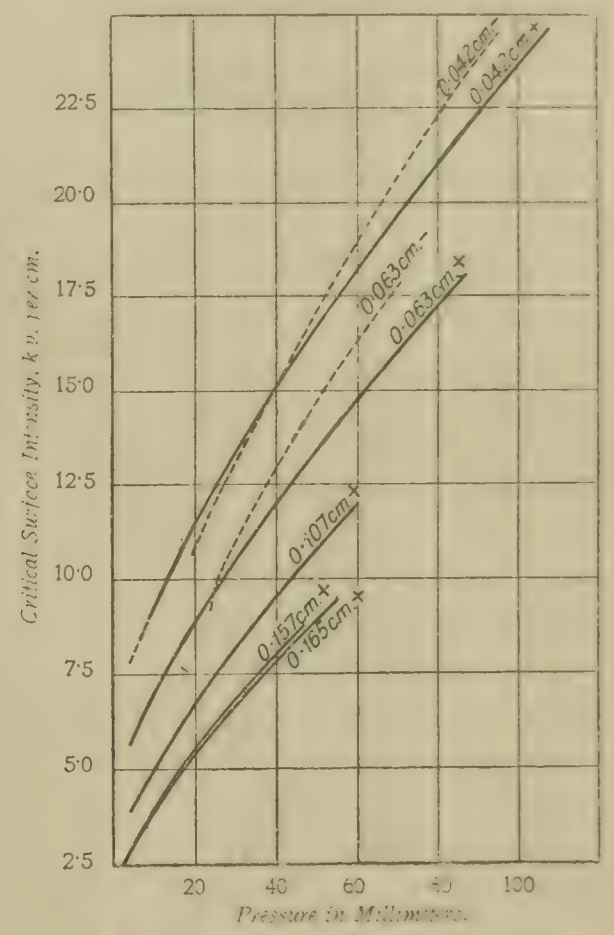


FIG. 3.—CRITICAL SURFACE INTENSITY.

Solid curves indicate Positive Corona, and dotted curves Negative.

0·5 mm. The correction, then, is to shift the plotted curve to the left on the sheet through a distance corresponding to 0·5 mm. in pressure. Curve B′, Fig. 2, results.

Fig. 3 shows the influence of pressure on critical surface intensity. It was found that within the limits of variation of room temperature during observations (19°C. to 21°C.), the influence of temperature is not appreciable.

COMMENT ON CURVES.

The intersection of the positive corona curves by the negative curves for the same wires is of the greatest interest. It has been suspected for some time that under certain circumstances the positive and negative coronas begin at different voltages. The difference varies with the size of wire and the pressure. In the case of each of the two wires for which observations of the negative corona were possible, there is a pressure below which the positive critical voltage is higher than the negative, while above this pressure the negative starts at the higher voltage.

The intimate relationship of the negative corona to the pressure and the size of wire is well shown in the curves. The 0·063 cm. wire forms a stable negative corona only at pressures above 25 mm. The 0·042 cm. wire gives a stable negative corona as low as 19 mm. This peculiarity of the negative corona has not, it is believed, been heretofore recorded.

The lower curve E_2 of Fig. 2 represents the observation that as the voltage is gradually lowered below that corresponding to the first deflection of the galvanometer needle, the negative corona persists

* Since these observations were made, experiments by Farwell have shown that the negative corona is invariably that described above, and that the number of the blue points on the wire is characteristic of the voltage.

for a time. The interval of voltage during which it continues to be observable on the galvanometer is indicated by the vertical lines.

Mr. E. A. Watson,* who has worked with the corona in cylindrical fields, describes the same difference in the appearance of the two coronas as that observed here, and finds that the negative corona starts at a higher voltage than the positive on the same wire.

V. Schaffers has studied the continuous potential corona at atmospheric pressure, using extraordinarily small wires, 0·0003 cm. to 0·35 cm. He concludes that the ratio of the potentials critical for the positive and negative coronas varies regularly with the radius of the wire; for $r=0·01$ cm. the two potentials are equal; for r less than this, the negative is lower than the positive; for r greater than 0·01 cm. the positive is the lower. These results refer, however, to atmospheric pressure only.

Investigators of the alternating corona have usually thought that the corona forms on the two half waves at the same value of instantaneous voltage. This conclusion is rendered doubtful by the experiments of Bennett,† who made an oscillographic study of the corona-current and voltage. The sine curve of the charging current is broken by humps; a smooth hump for the positive corona, an oscillatory disturbance for the negative. Also the negative hump is more pronounced. This is in accord with the observations made here when using the galvanometer to detect the corona.

If it is true that one corona forms at a lower voltage than the other, then if the pressure and voltage are appropriate the corona tube should rectify the current due to an alternating potential. An experiment to test this was carried out with a 20 : 1 transformer, excited by 110 volts 60 cycles. The pressure was adjusted to 85 mm. around the wire of 0·042 cm. diameter. This pressure corresponds for this wire to a positive critical potential lower than the negative. On closing the secondary circuit of the transformer and raising the voltage to the critical value, a steady deflection of the galvanometer needle occurs, corresponding to a positive current—*i.e.*, from wire to grounded cylinder. With increase in voltage the deflection is reversed; the negative current is larger than the positive. Thus, the corona tube acts as a rectifier, the sign of the rectification depending on the value of the impressed voltage.

This was almost anticipated by an experiment of Dr. J. B. Whitehead,‡ but he did not go so far as to use alternate currents.

The theory of secondary ionisation has been applied to the corona by Mr. Townsend.§ His formula is verified by Watson's results. According to Townsend,

$$kv=P\left(30+\frac{9}{\sqrt{aP}}\right),$$

where P is the pressure in atmospheres and a the wire diameter.

An empirical law has been proposed by Peek ‖ to comprehend the results of work on pressure and temperature. His equation is

$$b=31\delta\left(1+\frac{0·3}{\sqrt{r\delta}}\right),$$

where g = critical surface intensity in kilovolts per centimetre, r = radius of wire, δ = "density factor" $=3·92p/(273+t)$; p is the pressure in centimetres, t is the temperature Centigrade.

If curves of diameter and critical surface intensity are drawn from this equation and also from the observed results the curves differ numerically but not in form—the difference being a function of the pressure, but independent of the diameter of wire.

It seems unprofitable to speculate on the nature of the corona until it has been more thoroughly studied. Observations at atmospheric pressure and at pressures considerably below the atmosphere have yielded empirical equations which require modification to enable them to include the results reported in this Paper.

The principal results of the work described in this Paper may be briefly enumerated as follows:—

1. The formation of the stable negative corona has been shown to be dependent upon the pressure and the size of conductor. Of the wires used, with those of larger diameter such a corona is never formed, while around the smaller wires the negative corona can exist only at pressures greater than a critical value which varies with the diameter of the wire.

2. The transition has been observed from the stable corona to the vacuum-tube discharge. The vacuum-tube discharge is the only luminous discharge with negative wires below the critical pressure.

3. Curves have been plotted of critical surface intensity for the positive corona and wire diameter at various pressures. These curves are similar in form to those of Peek's equation.

4. The ratio of the critical voltages for the positive and negative coronas on a given wire varies with the pressure. A pressure exists at which the two critical voltages are equal; below this pressure the negative critical voltage is lower than the positive, at higher pressures the positive corona-forming voltage is the lower.

5. The corona rectifies an alternating current, the direction of the rectified current depending on the voltage and the pressure.

6. In the case of the smallest wire evidence has been found of the existence of an ionisation current flowing before the appearance of the luminous discharge.

* The Electrician, Vol. LXIII., p. 828; Vol. LXIV., p. 707.
† "Proceedings" A.I.E.E., XXXII., 1473-1494, 1913.
‡ Ibid., XXX., 1857-1887, 1911.
§ The Electrician, Vol. LXXI., p. 348.
‖ "Proceedings" A.I.E.E., XXX., 1889-1963, 1911; XXXI., 1051-1092, 1912; XXXII., 1337-1355, 1913.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 Specifications.

21,145 Mellersh-Jackson. (Commonwealth Electric Tool Co.) Electrically-actuated tools.

21,266 Godfree. Telephone systems.

21,383 B.T.-H. Co. (G.E. Co.) Wireless signalling systems.

Consists in connecting to suitable points in the antenna circuit an electron discharge relay adapted to absorb more or less energy from the antenna in accordance with the signals to be transmitted, so that by connecting such energy consuming device in parallel with the antenna circuit between two points between which there is a large difference of potential, and by suitably varying the amount of energy consumed by such device it is possible to vary the amount of energy which will be radiated by the antenna; the larger the amount of energy consumed by this device the smaller will be the amount radiated.

21,593 Miller. Electric switches. (28/10/13.)

21,998 Leitner. Electric switches.

23,238 Beaumont. Electric batteries.

23,314 Neiman. Electric heat radiators.

23,653 Blake. Simplified method for localistaion of bullets and other foreign bodies by means of "X" rays.

Obviates the necessity of taking any preliminary measurements, as both the horizontal and vertical measurements from the surface of the patient to the foreign body or bodies can be found from the one photograph taken from two directions.

23,921 Chalmers, Black & Black. Signalling apparatus for use in mines.

1915 Specifications.

180 Maschinenfabrik Oerlikon. Electric starting devices for motor-driven vehicles. (29/1/14.)

459 Back. Brushholders for dynamo-electric machines.

1,694 Western Electric Co. (Western Electric Co.) Ionisation devices for amplifying electric currents.

An amplifying device of the thermionic type for amplifying electrical energy, in which is provided a source of ionisation and input and output electrodes connected respectively with the incoming and outgoing circuits with which the device is adapted to operate, in which the input electrode is located in immediate proximity to said source of ionisation, being separated therefrom by an amount just sufficient to electrically insulate it from such source of ionisation.

4,076 Willard. Storage battery separators and process of making same.

5,104 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electric motor controllers.

8,047 Robert Bosch (Firm of). Electric switches for lighting installations. (9/6/14.)

8,903 Tedeschi & Rossi. Electrical relays.

Consists, broadly, of two stationary coil systems, one the inductor and the other the armature, perfectly identical and symmetrical, so that either may be used indifferently as the primary or secondary element; also comprises a rotary element constituted by a metallic member having a high conductivity, of homogeneous and continuous character, which is rotated in any manner at a constant speed by means of an external force.

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

October 25, 1915.

15,057 Greville. X-ray apparatus. (Addition to 21,609/14.)

15,081 Forrester. (James Whiteford Dunham, U.S.) Joint for electric-light fittings. (Divided application on 2,489/15. Feb. 16.)*

15,082, 15,083 Forrester. (James Whiteford Dunham, U.S.) Portable lamps or other portable devices. (Divided application on 2,489/15. Feb. 16.)*

October 26, 1915.

15,094 Thomas. Attachment for miners' electric safety lamps for detecting firedamp and [illegible]

15,104 Price. Electric lock and lighting appliance for miners' safety lamps.

15,106 Kennedy. Electric clocks and electric time-indicators.

15,113 [illegible] Dynamo-electric machines adapted for synchronous working. (A[illegible] 24,839/14.)

15,128 Lincoln. Electric indicators. (12/11/14, U.S.)*

15,142 [illegible] (13/11/14, Denmark.)*

15,143 [illegible] (17/11/14, Denmark.)*

15,149 [illegible] Protection of electric installations against excess voltage. (26/10/14, Switzerland.)*

October 27, 1915.

15,185 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.

15,196 [illegible] Devices for the protection of electric installations against excess voltage. (27/11/14, Switzerland.)*

October 28, 1915.

15,209 [illegible] Electromagnetic [illegible] signal-transmitting apparatus.

15,211 William Briggs & Co. & Duncan. Steam-metal arc installation.

15,222 Day. Combined electric lamp holder and detachable shade support.

15,237 B.T.-H. Co. (G.E. Co., U.S.) Wireless signalling systems.

15,240 [illegible] Electrical rotary converters.

15,247 Kitsee. Electrical rotary converters.

October 29, 1915.

15,261 Carter & Dow. Automatic [illegible] for extinguishing or diminishing the light from [illegible] lamps in certain predetermined directions.

15,267 Relay Automatic Telephone Co. & Aitken. Automatic and semi-automatic telephone systems.*

15,303 Tissier. System of distribution for electrically-operated railway trains.

October 30, 1915.

15,330 Bamford. [illegible] for the low-tension induction circuit of automobile engines.*

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	251	Industrial Trucks in Operation	1*
Imports and Exports of Electrical Manufactures	252	A "Co-Operative" Motor Lorry. Illustrated	2*
LEGAL INTELLIGENCE	252	New Battery Charging Rates in Birmingham	2*
PARLIAMENTARY INTELLIGENCE	254	An Electric Milk Float. Illustrated	3*
Bankruptcies, Liquidations, &c.	254	Operating Cost Data of Electrics v. Horses	4*
Electricity Supply	254	Ward Electric Vehicles. Illustrated	6*
Lighting and Power Notes	256	A Mazda Lamp Vehicle. Illus.	6*
Traction Notes	256	Electric Vans Record Run	4*
Telegraph & Telephone Notes	256		
The Round Table	45	Empire Notes	257
Light and Munition Work. Illustrated	46	Foreign Notes	257
Lifting Magnets. Illustrated	47	Miscellaneous Notes	258
A Temporary Travelling Cable Way. Illustrated	50	Tenders Invited	259
An Attractive Fire Poster. Illustrated	50	Tenders Received & Accepted	259
The "Veriott" Electric Fire. Illustrated	50	Municipal Accounts	260
Electric Vehicle Progress Supplement—No. 22.		Companies' Meetings and Reports	260
Battery Vehicles with Searchlights. Illustrated	1*	New Companies, &c.	261
		City Notes	251
		Electrical Companies' Share List	261

COMMERCIAL TOPICS.

Agencies at Home and Abroad. It is satisfactory to chronicle the recurring notifications that agencies are being sought in the capitals and principal cities of the countries of our allies for goods of British manufacture, the object, of course, being to substitute these manufactures for those formerly supplied by the manufacturers of enemy countries. In addition to the case of the British Consul-General in Paris notifying that an electrical engineering firm in that city is anxious to secure agency representations of United Kingdom manufacturers of electrical supplies, the Society for Electrical Enterprises (Ltd.), of Petrograd, is desirous of entering the field, as set out in our last issue, page 211. All these are the proverbial straw which show the way the wind is blowing, and there are other evidences of a keen desire to organise various schemes of the kind, all of which will serve to facilitate working arrangements so soon as the necessary engagements can be entered into and the effective interchange of orders and goods can be made.

* * * *

The Submarine Telegraph Service. At the meeting of the Western Telegraph Co. last week it was shown that over a complete year of the war the whole of this company's submarine telegraph cable service has been practically immune from material disturbance from any cause whatsoever. For a considerable period during the early months of the war quite a large number of enemy cruisers were at large over the oceans capable of interfering for a time at least with the regular conduct of the submarine cable service. Not a single sea-laid cable suffered damage. The incidents at Cocos and the Fanning Islands may, for this argument, be ignored. Commerce and enterprise suffered nothing from this danger, and investors in ocean telegraph securities have found their investments as secure as anything connected with *terra firma*. The Western Telegraph Co. has wide ramifications, and the effect of the war upon its general revenue has not been unfavourable. Working expenses have risen only proportionately to increase of revenue, just as in pre-war days, and the company's shareholders will receive for the past year, as for many previous years, a dividend and bonus amounting to 7 per cent. In periods of stress such as we are passing through the experience of investors in submarine telegraph securities appears at least as favourable as for any class of investment, despite the dangers of the seas and the alleged liability of such enterprise to attacks from the enemy. Amongst electrical investments, the oldest of all submarine telegraph enterprises maintains its old premier position, besides taking its place as one of the greatest factors in the successful conduct of the war. In this respect it shares honours with the Navy, whose possession is the nation's grandest asset.

* * * *

Aviation Engines. The annual meeting of the Sunbeam Motor Car Co.'s shareholders was held at Wolverhampton last week, and Mr. John Marston, who presided, was able to give his shareholders an excellent account of the company's operations for the past financial year. Besides cars and ambulances, said Mr. Marston, the company was able, within one month of the declaration of war, to supply a high type of aviation engine (the Sunbeam-Coatalen) to the Admiralty. This engine was, Mr. Marston continued, the result of many months' experimenting by their general manager and designer, Mr. Coatalen, and he believed they had succeeded in producing an engine which, in view of the work it was asked to accomplish, could not be excelled. The company's new engine works up to 300 H.P., and is the outcome of the Sunbeam Co.'s long experience in producing engines for racing motor-cars. As an indication of what this country is doing in the way of developing different branches of trade that were formerly almost exclusively in the hands of foreigners this progress by the Sunbeam Co. is exceedingly promising. In this connection the Sunbeam Co. are to be congratulated upon their enterprise, which is certain to lead to healthy, competitive emulation on the part of other makers of this type of machine, which ultimately will make us free of foreign assistance and possible intrigue.

* * * *

Minimum Rates for Battery Vehicle Charging. Mr. R. A. Chattock, city electrical engineer, Birmingham, and also chairman of the Electric Vehicle Committee, is to be congratulated upon the step which he has recently taken in reducing the minimum charge to electric battery vehicle users who require to purchase energy from the sub-stations in the Birmingham area of supply. The missionary work which the electric battery vehicles makers had been doing in the Birmingham area is now bearing fruit, and anything up to a dozen vehicles are in daily service doing transport duty for both industrial and trade organisations. The larger establishments which charge the batteries of the vehicles from their private plants are not affected by the new rates, but the trade and commercial undertakings, which as a rule purchase energy for lighting and power purposes from the Corporation, find it necessary to take the vehicle either to a generating or sub-station for charging purposes. Hitherto a minimum charge of 2s. has been made irrespective of the amount of energy taken to recharge the battery. In the case of the lighter vehicles this charge proved excessive, having regard to the printed tariff of 1d. per unit for energy for electric battery vehicle charging. On Mr. Chattock's recommendation this charge has now been reduced to a figure of 6s. per week, the assumption, of course, being that the vehicles are in daily operation. On this basis the lighter types of vehicle users will be purchasing energy round and about the advertised figure of 1d. per unit, and the electric vehicle movement in the district will unquestionably benefit. It is to be expected that this example will be followed by a similar reduction in other towns where the minimum charge has operated to the disadvantage of the small vehicle user. Incidentally, we are pleased to note that electrics are making substantial progress in the Birmingham area, and now that a number of vehicles are in daily service the task of persuading users of mechanical transport to adopt this method where it is proved to be more economical than petrol or horses, will not be so difficult as it has proved to be in the past.

* * * *

Electric Vehicles v. Horses. We publish in the "Electric Vehicle Progress" Supplement this month a number of figures, which have recently been made public in the American press, comparing the operating costs of electric battery vehicles and horse traction, more particularly for brewers' transport work. It is interesting to note that the field of transport in the United States is able to furnish cost figures which are based upon actual operating conditions and which are in the main drawn from the books of users of horse, petrol and electric transport. It is true that these figures are, as a rule, applicable to a specific branch of transport, and it is not wise to regard them as sufficiently

accurate to represent the average conditions obtaining. On the other hand, they are better than no data at all, and in this respect we think that the Electric Vehicle Committee in this country may advantageously devote some of its efforts to the collection of data of this character. The British motor transport user, even the large haulage and contracting firms, are exceedingly apathetic in the matter of operating costs. They do not appear to have any reliable system whereby figures can be arrived at readily which would enable even a rough comparison to be drawn between their particular method of transport and others which they are recommended to adopt on grounds of economy and efficiency. There are undeniable difficulties in the way of obtaining these figures, particularly as they are treasured by individual firms as representing what they regard as exceptionally economical and efficient results. They are unwilling to relinquish them even for the uses of an Association and not necessarily for publication purposes, because they feel that their release will give their competitors an opportunity of introducing newer machinery or better methods. If something could be done to break down this commercial reticence, a great amount of good would be done to the business of mechanical transport in general and that for which the electric vehicle is pre-eminently suited in particular.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Nov. 8, 1915, *to* Nov. 13, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

LONDON.—*U.S.A.:* Elec. machinery, £5,131; carbon candles, £488; elec. lamps, £234; telephone materials, £291; lamp parts, £773; wire and cable, £180; unenumerated, £1,929—14 pkgs. *Holland:* Elec. lamps, £1,561—712 pkgs.; unenumerated, £127. *France:* Elec. machinery, £262—53 pkgs.; carbon candles, £707. Unenumerated, £310. *Denmark:* Elec. machinery, £112. *Italy:* Elec machinery, £1,030; elec. wire, 37 pkgs.
SWEDEN.—Lamp parts, £159.
CANADA.—Unenumerated, £837.
SWITZERLAND.—Elec. machinery, £1,785; carbon candles, [illegible]; unenumerated, £17.
MACHESTER—*Holland:* Elec. lamps, 4 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £87; elec. machinery, £226; unenumerated, £71. *Melbourne:* [illegible]. *Sydney:* Elec. machinery, £373; wire and [illegible]. *Wellington:* Elec. [illegible] £379 [illegible]; £41 [illegible]. *Dunedin:* Unenumerated, £10 [illegible]. Unenumerated £179. *Freemantle.* Wire and cable, £177. *Gisborne:* Unenumerated, £23. *New Plymouth:* Elec. machinery, £22. *Hobart:* Wire and Cable, £150; unenumerated, £125.
AFRICA.—*Durban:* Unenumerated, £234. *Port Elizabeth:* Unenumerated, £65. *Zanzibar:* Unenumerated, £39.
EGYPT.—*Port Said:* Elec. machinery £368; wire and cable, £21. *Alexandria:* Unenumerated, £37.
[illegible] Unenumerated, £22.
U.S.A. [illegible]: Unenumerated, £49
CANADA.—*Toronto:* Unenumerated, £23.
H[illegible]. £39.
S[illegible]. Unenumerated [illegible].
N[illegible]. Wire and [illegible].
[illegible]
ITALY.—*Genoa:* Elec [illegible].
INDIA, CEYLON, [illegible] £238; unenumerated, £39. [illegible]. *Madras:* Unenumerated £47. [illegible]. *Singapore:* Elec. machinery, £254; telegraph material, £620; unenumerated, £319. *Penang:* Unenumerated, £19. *Port* [illegible] material, £94; [illegible]. Unenumerated, £70. *Kilindini:* Wire and cable, £31; unenumerated, £13. *Karachi:* Telegraph material, £1,51[illegible]
CHINA.—*Shanghai:* Unenumerated, £38. [illegible]: Wire and cable, £[illegible] machinery, £14; unenumerated, £29 [illegible]
JAPAN. *Yokohama:* Unenumerated, £[illegible]
WEST INDIES. *Jamaica:* Unenumerated, £[illegible]
CYPRUS.—Unenumerated, £21.
MAURITIUS. Unenumerated, £134. *Zanzibar.* Unenumerated £43
FIJI. Unenumerated 73
MALTA. Unenumerated £62
GIBRALTAR—Unenumerated £[illegible]
SPAIN. *Cadiz:* Unenumerated, £7
FRANCE. *Bayonne:* Wire and [illegible], £[illegible] machinery, £202; unenumerated, £773. *Boulogne:* Unenumerated, £2,010. *Calais.* Wire and cable, £3,944; unenumerated, £891.

FOREIGN GOODS (duty paid and free).

Belgium: Unenumerated, £3[illegible] £171. [illegible]. *Netherlands:* Unenumerated, £30. [illegible]. Unenumerated, £[illegible]. *Norway:* Unenumerated, £9.

IN TRANSIT.

From: Elec. lamps, £102. *Factories:* Elec [illegible] £1,[illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Osram Lamp Works Ltd. v. Pope's Electric Lamp Co. (Ltd.)

On the 11th inst. the Court of Appeal (the Master of the Rolls and Lords Justices Bankes and Warrington) commenced the hearing of the appeal of plaintiffs from a judgment of Mr. Justice Joyce in favour of defendants in an action by plaintiffs to restrain the alleged infringements of Letters Patent No.23,899 of 1904, granted to Dr. A. Just and Franz Hanaman for "Improvements relating to the manufacture of incandescent electric lamps." The proceedings were reported in THE ELECTRICIAN for June 25, and July 2, 9, 16 and 23. Mr. Justice Joyce decided that plaintiffs' patent was not for making filaments of tungsten but only for making them by the particular process specified; that defendants did not use an atmosphere of steam and hydrogen in the sense in which it was used in plaintiffs' specification, and that defendants had not been guilty of infringement. He further held that if it had been necessary to decide the question of validity of plaintiffs' patent it was doubtful if the subject matter and the directions were sufficient. Upon those grounds he dismissed the action and from that decision plaintiffs now appealed.

Mr. A. J. Walter, K.C., Mr. Colefax, K.C., Mr. J. H. Gray and Mr. Lunge appeared in support of the appeal; and Mr. T. Terrell, K.C., Mr. Hughes, K.C., and Mr. Russell Clarke for respondents.

Mr. WALTER, in opening the case for appellants, said questions of validity were raised but not decided by the learned Judge. Various issues were raised some of which were the same as in an action tried before Mr. Justice (now Lord Justice) Warrington. That action was brought by the present plaintiffs against the "Z" Electric Co.

Lord Justice WARRINGTON: I suppose the issue of validity may be raised here?

Mr. WALTER: Oh, clearly. Continuing, the learned Counsel said the invention related to incandescent electric lamps. It related to the filaments which were in the incandescent electric lamps which most of them used. The first idea was to use platinum filaments, but there was a difficulty, for if a strong current passed the platinum melted. Other forms of filaments were suggested made up of putty and finely powdered coal and other matter, such as woody fibre which was formed into a small carbonised thread. For about 30 years carbon filaments held the field, but at present all filaments were made of tungsten. Dr. Welsbach, the inventor of the incandescent gas mantle, turned his attention to incandescent electric lighting; he went to the metals of the platinum group, which included osmium, and in 1898 he invented the osmium filament, but it was never made practicable for electric lighting. In 1898 the demand for a metallic filament was a pressing one. Osmium was a very expensive thing, costing about £100 per pound. In 1904 the present invention came along and it was the first time that anybody had produced a coherent tungsten filament. Since the date of plaintiffs' patent other patents had been taken out. Before 1904 no method was known by which one could so use tungsten. Defendants had raised several defences. They said that they had not infringed; then they alleged want of novelty and want of subject matter, insufficiency of directions and want of utility.

The MASTER OF THE ROLLS: You have opened a very large field, Mr. Walter. Would it be possible for us to deal with the question of infringement or non-infringement first?

Mr. WALTER replied that he thought that course would be convenient, but he thought it desirable that the Court should have a full statement as to the nature of plaintiffs' invention.

Continuing, Counsel said that what Welsbach did was to teach the world that certain defined metals could be used for the manufacture of coherent filaments, these metals being osmium and the metals of the platinum group. Welsbach went back to platinum which was the original idea for the metallic filament. He taught the world nothing except what would happen with regard to the metals of the platinum group. He thought the evidence of plaintiffs went to that effect and no questions were asked of any witness by defendants at all that that specification had taught the world anything more. Tungsten was a well-known metal, worth only some shillings per pound, whereas osmium cost several silverlings. At the time of Welsbach's specification tungsten was a well-known metal and was a thing which was largely used for hardening steel. Notwithstanding that Welsbach knew about tungsten in 1898 it occurred to nobody for six years afterwards to experiment and try to make a coherent tungsten filament by a process which was one of the three processes indicated by Welsbach. Tungsten for the purpose of [illegible] had been suggested long before Welsbach for electric lighting. It had been suggested as long back as 1889 by Bottom, but all that he said then was to produce an incandescent filament composed of metallic tungsten and carbon in varying proportions. Counsel referred to the specifications of Sawyer & Hobson of 1904, and to Gulcher's specification, and pointed out that Welsbach's experiments did not lead him to suggest that tungsten could be used advantageously for making filaments. Defendant's process consisted in taking a mixture of finely divided tungsten and an [illegible] of it, mixing it with a carbonaceous binding material, and then squirting the mixture. The filaments so produced were put into an [illegible] furnace, heated electrically and filled with hydrogen, and passed down from the cool, lower part of the furnace to the hot upper part, and then back to the lower part. Steam was formed in the furnace, and the process was thus in effect plaintiff's. Electricity as used by plaintiff had no function other than heating. Counsel also explained defendants' alternative process before the final heating. By that process it appeared that defendants put the filaments

on holders in a quartz tube heated in an electric furnace to 950 deg., and exhausted by an air pump. Chemical action successively took place, and hydrogen, steam and carbonic oxide were formed. The filaments were then cooled, heated in air to 220 deg. to oxidise the tungsten, heated again in the quartz tube at 950 deg., cooled and finally heated to 850 deg. in hydrogen. He contended that there had been clear infringement by defendants, and that there was subject matter in plaintiffs' invention. He proceeded to read the evidence given in the Court below.

Mr. Cozens, K.C., followed on the same side, and the case was proceeding when we went to press.

Plymouth Tramways Arbitration.

On the 11th inst. Mr. B. Hall Blyth, the arbitrator appointed to determine the price to be paid by Plymouth Corporation for the tramway undertaking of the Devonport & District Tramways Co., commenced to hear evidence. The company were represented by Mr. Macmillan, K.C., and Mr. Eustice Hills, and the Corporation by Mr. E. H Lloyd, K.C., and Mr. W. E. Tyldesley Jones.

Mr. Macmillan said that whilst the system had had its ups and downs, it was fair to say the difficulties of its earlier period had now been surmounted, and it might be regarded as a prosperous undertaking. He thought that on the general principles of valuation there was no dispute at all, and a certain measure of agreement so far as figures were concerned had been arrived at between the parties. The price to be paid for the rolling stock had not been agreed upon, but there was no difficulty as to the number of cars, because the Corporation had decided to take over the entire rolling stock. The cost of the various works and improvements carried out to enable the tramways to be completed, and which were imposed upon the company by statute at the instance of Devonport Corporation and the Admiralty, ought to be taken into account in computing the value. An item they would claim for would be interest on capital during construction. All tramway companies were authorised to pay interest during construction, and therefore they must provide for that. There was also the cost of raising capital, which was a necessary item in the account. The principle of that claim was founded upon the National Telephone Co.'s case. With regard to the light railway, the purpose of which was to link up the railway systems of Devonport and Plymouth, the problem was to value that light railway on the basis of its fair market value as a going concern. It would be unfair to value the undertaking as it stood that day; they must take into account its potentialities. Parliament authorised his clients to be the persons to make the link, and the undertaking which they had to sell was an undertaking which was essential to through running. No complete system could be inaugurated without dealing with them, and he thought it was not an unfair way to look at it that that concern was undoubtedly about to become a going concern. His submission would be that, through running being the potentiality of that undertaking, a potentiality on the eve of realisation, the value of it was that at which it stood whenever it was put into operation, the immediate result being very largely increased drawings both on the Plymouth and on the Devonport side.

Mr. Stephen Sellon, M.Inst.C.E., stated that he had valued the tramways. He estimated the value of the rails on Oct. 2 at £13.14s.per ton. The excavation work was permanent, and did not depreciate in value. It remained for all time. The concrete used was of a very high quality, and that also had a perpetual life. He estimated the value of the permanent way at £60,161. Other values he gave as follow: Overhead equipment £4,939, cables £4,729, ducts £2,784, manholes £436, Milehouse depot buildings and overhead equipment in approach road, yard and sheds £8,827. He was of opinion that the trolly wire would have to be renewed during the next year or two. The value of the land at the Milehouse depot was £2,571. There were 33 cars and there was also certain other rolling stock, the price of which had been agreed. All the cars were in good condition, and he estimated their total present value at £21,545. The company had spent £10,337 on road improvement works. Under the head of "Alterations to pipes, wires, &c.," witness pointed out that in laying a permanent way a number of sewers, pipes and wires were encountered, and had frequently to be re-laid and readjusted. In respect of work of that kind the following payments were made by the company: Devonport Gas & Coke Co. £743, Devonport Water Co. £932, Postmaster-General £71, National Telephone Co. £18, and Great Western Railway Co. £65. The company also made payments to the Corporation in respect of the Corporation's inspection of the company's work. It was the practice in obtaining powers for the construction of a tramway to take power to pay interest during construction. The claim in respect of that item was £8,000, and he considered that claim for interest during construction proper. The new value of the undertaking was £165,875. A fair figure for legal and Parliamentary expenses by the promoters of the system would be £5,000. The actual sum paid to the Parliamentary solicitor was roughly £1,858. Under the agreement which set up the present arbitration the third article gave the company the right to such a sum as would be equal to the aggregate amount they might be expected to earn between Oct. 2, 1915, and Aug. 12, 1919. The principle upon which he had proceeded had been to go as far back in realisation as he had to go forward in anticipation. During the first year or two after the tramway was opened it did reasonably well. In later times there had been a continual upward tendency in receipts. He put in a table showing profits from 1912 to Oct. 1, 1915, and estimated progress from Oct. 2, 1915, to Aug. 12, 1919. For 1912 the car-mileage was 687,791 and profit £5,500, for 1913 the car-mileage was 703,061 and profit £6,079, for 1914 the car-mileage was 749,900 and profit £5,966, for 1915 (to Oct. 1) the car-mileage was 581,730 and profit £8,624. From Oct. 2 to Dec. 31, 1915, the car-mileage was 197,072 and profit £2,718, for 1916 the car-mileage was 812,994 and profit £14,901, for 1917 the car-mileage was 848,586 and profit £18,361, for 1918 the car-mileage was 884,178 and profit £21,164, and for 1919 (to Aug. 12) the car-mileage was 564,461 and profit £14,832. The total profits from Oct. 2, 1915, to Aug. 12, 1919, was £74,002; deducting £5,000 for loss on resale of three additional cars, £300, and depreciation Oct. 2, 1915, to Aug. 12, 1919, £5,126, leaving £68,576. In Devonport there had been a considerable increase in activity in recent times. This year there had been a large increase in population. During the continuance of a state of war the activity in Devonport would be maintained, and that activity might perhaps last after the cessation of hostilities. They could look forward to a large increase in tramway traffic consequent upon war conditions continuing.

At this point a consultation took place between the parties with a view to arriving at a settlement of some of the items in dispute. Mr. Macmillan then informed the arbitrator that for the Milehouse depot buildings and land the Corporation had ageed to pay £9,500. The amount claimed by the company was £11,211. The claim by the company for road improvements was £10,337, and they had agreed on £10,000. As to the alterations to pipes, wires, &c., payments to a series of companies and to the Postmaster-General, £1,830 had been agreed on, as had also the sum of £1,334 in regard to the payments to Devonport Corporation. It was possible that they might be able later on to eliminate other smaller items.

In cross-examination by Mr. Lloyd, K.C., Mr. Sellon admitted that in its early years the company had been subject to considerable ups and downs. From 1904 to 1910 the net result was a drop of a very considerable number of passengers, partly attributable to the stoppage of the leased line. The tramways depended very largely upon the activity of Devonport Dockyard. In 1911 there was an increase of 700,000, in 1913 there was an increase of 150,000, and in 1914 an increase of 600,000 passengers. In 1914 the company was just recovering from a condition of management which was not satisfactory. The fact that the profits jumped from about £6,000 to £12,338 in 1915 was not an extraordinary thing in the history of a tramway; the profits were due to the war, and their whole claim was based upon that, and they assumed that it was not only going to continue, but to increase. In regard to the price paid for electrical energy, witness thought that the Corporation of Plymouth, now that they were going to supply their own undertaking, would supply electricity much cheaper than they did at present. As to the light railway, he based his claim on the assumption that there would be through running immediately. He agreed that from a mileage basis the value of the light railway was practically nil. He had assigned for 1916 £5,081 to be added as additional earnings in consequence of through running; that sum was arrived at by taking 1½d. per car-mile run. He assumed that every car from Devonport would run into Plymouth. The 1½d. was a figure he had arrived at after having considerable experience of the same conditions that accrued here. He would not be surprised to hear that the 1½d. fares were only 14·6 per cent. of the whole. He had valued the light railway at £20,000. He thought the owners of the Devonport tramways would be only too glad as a business proposition to give him £20,000.

The hearing had not concluded when we went to press.

Wireless Apparatus in Territorial Waters.

At East Ham Police Court on Saturday, Jakob Veenhoven, a Dutch subject, captain of the s.s. "Roepat," was charged on a warrant with using on board wireless telegraphy in territorial waters.

Mr. A. F. Rowe (for the Director of Public Prosecutions) said defendant was liable to a penalty of £10 and to have his wireless apparatus confiscated. Defendant was proceeding from the Dutch East Indies with a general cargo to London. The ship had called at Deal and was going round the North Foreland, up the mouth of the Thames, on the morning of Nov. 5. On that morning a naval officer at the Navy office at Ramsgate heard the s.s. "Roepat" calling on her wireless Scheveningen. She was heard calling up the town from 8 o'clock until 8:35, when a message was sent in Dutch, which when translated into English meant: "Arrived safely at Deal. At London to-night. Hearty greetings.—Kees." There was no evidence that it was anything but a perfectly innocent message, but it was well-known that dangerous communications might be wrapped up in seemingly innocent messages. The calls were very loud and were interfering with Admiralty wireless communications.

Mr. O. H. Clarkson (for defendant) tendered his full apologies to the Court and to the Admiralty. It was customary when the "Roepat" was in territorial waters before for the Admiralty to advise the master when it was necessary to disconnect his wireless. On this occasion he had no instructions, and he thought that until he received those instructions he was entitled to make use of his wireless telegraphy.

The Court imposed the maximum penalty of £10 with £2. 2s. costs.

Brown v. Lambeth (London) Borough Council.

A Divisional Court (Avory and Lush, J.J.) recently heard an appeal by plaintiff against a judgment of the Lambeth County Court dismissing an action for damages to his taxicab alleged to be due to defendants' negligence. It appeared that at about 11 p.m. on Jan. 6 last plaintiff was driving his cab along a street in Lambeth when it came into collision with a refuge in the middle of the road and was damaged. Plaintiff alleged that the accident happened owing to the negligence of defendants in not lighting the refuge. Evidence was given that the refuge was generally lighted by an arc light, but owing to the police regulations the light had

been darkened, but plaintiff alleged that it was out altogether and a constable said it was out after the accident. The lamp was supplied with electric current and maintained by a company for defendants, and there was no evidence that it was defective. The County Court Judge held there was no evidence of negligence either by the company or by defendants in the management of the lamp; he also found that the general lighting of the place was adequate and reasonable having regard to the police regulations, and that the general darkening of the street, the speed of the cab, and the fact that this particular lamp was out, all contributed to the accident. On these facts he gave judgment for defendants.

Plaintiff appealed on the ground that the County Court Judge was wrong in holding that there was no evidence of negligence and in holding that the onus of proving negligence was on plaintiff. It was also contended that the judge had been wrong in law in refusing to let him give evidence that the lamp was defective. It was argued that when once it was proved that the lamp was usually lit and was out at the time of the accident it was a case of "res ipsa loquitur." Evidence of this was not allowed.

The appeal was dismissed, as the Court held it was not necessary to decide whether the fact that any particular lamp was out after dark was of itself evidence of negligence by the local authority. On the facts the County Court Judge had had evidence to justify him in saying that the fact that that lamp was out at that time was not due to any negligence on the part of defendants or of the lighting company.

Light Electric Motor Co. v. M. Rosen.

At the City of London Court last week, before his Honour Judge Atherley Jones, K.C., plaintiffs sued defendant for £10, or the delivery up of an electric motor brush and bracket stand let on hire to one Sigmund Hockman. For plaintiffs it was said that Hockman entered into an arrangement for the hire of an electrically-driven brush. It was afterwards found that defendant had taken possession of the business and was using the machine.

Defendant pleaded that he bought the business and the brush from Hockman.

Judgment was entered for plaintiffs for £4. 10s., with costs; or for the return of the brush.

Workmen's Compensation.

In the City of London Court recently, Arthur Motley, electrician, sought to obtain from the Ocean Accident & Guarantee Corpn. damages for the loss of a portion of one of his legs. Motley had been employed by a firm who had gone bankrupt, and therefore proceedings were brought against the insurance company. The accident occurred on Feb. 27, 1911, and plaintiff was given £1 a week. In October, 1914, the insurance company provided him with a wooden leg, and they now asked that the £1 might be reduced to 10s. a week. Eventually the parties agreed to the payment of £340, with £60 for costs.

Pembroke Urban Council v. Diesel Engine Co.

In the King's Bench Division (Dublin) on Friday Mr. Justice Kenny granted the application of plaintiffs for liberty to issue and serve a writ of summons out of the jurisdiction upon defendants, whose registered offices are at Aldwych, London. Defendants had contracted to supply plaintiffs with a 180 kw. Diesel d.c. (220-250 volts) tandem generator set, together with all accessories, including cable connections and switchboard alterations, &c. The contract was made in January, 1913, for an inclusive price of £2,977. The engine was erected, but plaintiffs found that it was defective in construction and design, that it had failed to comply with the warranty, and had completely broken down. The defendant company was now in voluntary liquidation and Sir William B. Peat had been appointed liquidator. No steps had been taken by defendants to remedy the defects in the engine, which in its present condition was utterly useless to plaintiff. Plaintiffs claimed damages for breach of contract.

Re County of Durham Electrical Power Distribution Co. (Ltd.)

On Tuesday Mr. Justice Sargant heard a petition for the sanction of the Court to confirm a reduction of the capital of this company.

It was stated by counsel in support of the petition that the scheme was to reduce the capital from £500,000, divided into 100,000 shares of £5 each, to £300,000 in £1 shares, the reduction to be effected by cancelling capital lost or unrepresented by available assets to the extent of £3 per share, and by sub-dividing each £3 share in three £1 shares. The loss of assets amounted to £207,000, of which it was proposed to write off £200,000. There had been a depreciation of £98,000 in the value of the company's investments, which were of the value of £282,000. The principal reason for the loss of assets was a change in the method of generating and distributing power since the company was incorporated in 1899. At that time it was the practice to use a number of small power stations, but now it was considered the better way to use one large central station. The company had recognised this, and had entered into an arrangement with the Newcastle on Tyne Company, the result of which was to render a large proportion of their stations commercially useless. No dividend had been paid on the ordinary shares since 1907.

In the result his lordship sanctioned the reduction.

Re "Z" Electric Lamp Mfg. Co. (Ltd.)—On Tuesday Mr. Justice Astbury sanctioned a petition for confirming the reduction of the capital from £150,000 to £15,000. It was stated that the chief loss of the company was in relation to the value of the patent which the company owned.

PARLIAMENTARY INTELLIGENCE.

ELECTRICITY SUPPLY CHARGES.

In the House of Commons recently the President of the Board of Trade was asked whether he was aware that the Metropolitan Electric Supply Co. had circulated a notice to its customers that in future an entirely new minimum quarterly charge of 13s. 4d. for the supply of electricity would be imposed: and, inasmuch as its customers do not always consume 13s. 4d. worth of electricity in the quarter, would he take steps to prevent that encouragement of extravagance in the consumption of electricity for the benefit of dividends at a time of national crisis, when economy was essential.

In reply, Mr. RUNCIMAN said he had seen a copy of the notice referred to. The company were within their rights in issuing the notice, as the Orders under which they supplied electricity, and which were confirmed by Parliament, authorised the company to make a minimum charge of 13s. 4d. per quarter. The provision was one which was quite commonly inserted in Orders. Electric supply bodies, whether local authorities or companies, were under the obligation to maintain a general supply sufficient for the use of all consumers, and the object of the provision was to ensure to them a reasonable return for the expenditure involved.

Military Inventions.—In reply to a question in the House of Com- last week, Dr. Macnamara stated that the Board of Inventions had received proposals from some 8,000 inventors, many of whom had sent in several different proposals. The proportion of possibly useful inventions was small.

Patents and Designs Act (Partial Suspension) Bill.—On the 10th inst. this Bill, for the suspension of the operation of sec. 27 of the Patents and Designs Act, 1907, during the continuance of the present war and for six months thereafter, was presented by Mr. Pretyman, and read a first time.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of J. W. Dewhurst, electrical engineer, 52, North End-road, West Kensington, London, W., will take place on Dec. 8, at Bankruptcy-buildings, London, W.C.

Claims against Geo. J. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, are to be sent by Nov. 23 to Mr. C. H. King, 26, Baldwin-street, Bristol.

A first dividend of 2s. 6d. will be payable on Nov. 22 at 30, Mosley-street, Newcastle-on-Tyne, to creditors of Arthur F. Hawdon, electrical engineer, Yetholm, Elmfield-gardens, Gosforth.

A first and final dividend of 4s. 6d. will be payable on Nov. 24 at 24, Bond-street, Leeds, to creditors of Tom Arthur Flather, electrical engineer, lately trading at Park Electrical Works, Speedwell-street, Leeds.

A meeting to receive an account of the winding-up of the "Dac" Accumulator Synd. (Ltd.) will be held at the offices of Messrs. Chantrey, Chantrey & Co., 61 and 62, Lincoln's Inn-fields, London, W.C., on Dec. 6.

A meeting to receive an account of the winding-up of the Central Wireless Co. (Ltd.) will be held at 45, Newhall-street, Birmingham, on Dec. 13.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Electricity Committee is considering the question of extensions of the generating plant rendered necessary by the increasing demand for electric current.

Alloa.—The Council propose to raise a loan of £950 for extensions of the electric supply department.

Bacup.—It is proposed to extend the electric supply cables so as to give a supply of current to New Hey Mill for power and lighting.

Applications for a power supply to Albion Mills, and on behalf of a proposed manufactures factory, for a free cable connection to supply upto 60 h.p. have been referred to a sub committee.

Barnsley.—At the meeting of the Corporation last week tenders amounting to £1,110 for extensions of the electricity works were accepted.

Bradford.—The Electricity Committee recently decided to give supplies of electrical energy to Messrs. Croft & Perkins and Thwaites Bros., and negotiations are proceeding for a temporary supply of electricity to the Yorkshire Electric Power Co.

Darlington.—The Council recently decided to apply to the L.G. Board for sanction to borrow £10,800 for new generating plant.

Ald. STARMER moved the adoption of the minutes of the Electricity Committee, which included a recommendation that application be made to the L.G. Board for sanction to borrow £2,800 for coal-handling plant. The capital and maintenance charges would be about £300 per annum, and it was estimated there would be a saving on labour of about £420, leaving a net saving of about £120. It was recommended that, subject to the engineer's report and the receipt of a certificate from the Ministry of Munitions, one of the two tenders submitted for the supply of a 3,000 kw. turbo-alternator, and also that under the same conditions a tender for condensing plant, be accepted. Ald. Starmer explained that, in addition to the above loans, there was one of £2,000 for cables and switchgear, which would make the total £15,600. The 3,000 kw. generating set ordered last year, which they expected would have been ready in September, would probably not be working until the end of the year. They had entered into an agreement to supply the North-Eastern Railway Co. with 1,100 kw., plus 600 kw. for the shell factory, and the Government were also asking for additional work to be done in Darlington, which meant another 800 kw. A further 200 kw. would be required for small increases and 400 kw. for Messrs. Summerson's works. They had, therefore, no other alternative to the suggestion of the Committee; if they had the slightest breakdown they would be in difficulties, and it was essential that the new set should be ordered at once.

Dunfermline.—The District Committee has authorised the Fife Electric Power Co. to extend their electric supply cables to the village of Halbeath.

Edinburgh.—The Electric Light Committee recommend the Council to approve estimates of £24,000 to £25,000 for the sea water plant for the Portobello power station.

Gravesend.—The electrical engineer (Mr. C. F. McInnes) reports that it will be necessary to apply to the L.G. Board for sanction to a further loan of £1,500 for main extensions and £1,000 for house services for the next two years. The matter has, however, been postponed.

Hackney (London).—The application to the L.C.C. for sanction to borrow £2,950 for house services to March 31 last has been amended, as the actual expenditure for the period was £3,031.

The Establishment Committee recommends the Council to pay a bonus of 2s. per week to the ordinary pay of all workmen on the weekly pay roll of the electricity and refuse destructor undertakings.

Mr. H. G. Barraclough, generating engineer, has resigned his appointment.

Manchester.—The L.G. Board, in their reply to the objections of the Manchester Ratepayers' Association to the Electricity Committee's scheme for the erection of new electricity works at Barton, state that they are satisfied the Council have proper grounds for proceeding with the full scheme at the present time, and they are not prepared to intervene further in the matter.

Walsall.—Mains are to be extended at a cost of £150 to give a supply of electric current to some manufacturers

Terms have been agreed with the South Staffordshire Tramways (lessee) Co. as to the price to be paid for electrical energy supplied to them by the Corporation for traction purposes as from Jan. 1 last.

GENERAL.

Ballater.—Aberdeenshire County Council have authorised Duncan Electricity Supply Co. to erect overhead mains for supplying electricity to the Darroch Learg, Ballater.

Barnes.—The statement of the electricity department for the quarter ended Sept. 30 shows that 1,105 private lamps had been connected, and that the total costs per unit was 1·41d., compared with 1·10d. for the corresponding period last year. The receipts were £3,144. 13s. 3d., against £3,265. 1s. 5d., and the expenditure was £3,097. 16s. 1d., against £2,771. 7s. 8d.

Blackburn.—The Corporation have decided it must retain the services of men in the and gas electricity works. These number 100, and there are 29 other employés of military age considered indispensable.

Farnham.—As the Farnham Gas & Electricity Co. has failed to give a supply of electrical energy within Hale Ward, the Hale Lighting Committee has been authorised to expend a sum not exceeding £50 in obtaining technical and legal advice as to the advisability of powers being sought by the Council to enable them to supply electricity within the district.

Ilford.—At last week's meeting of the Council it was reported that the L.G. Board had refused to sanction the borrowing of £870 for the erection of an engine room at the refuse destructor.

The Electricity Committee reported that they had instructed the Clerk to ask the Board to receive a deputation upon the subject, and as the result of a discussion the Council decided to defray the cost out of the electricity reserve for the present, and the Committee was requested to bring up the question of equipment at the earliest possible moment.

The electrical engineer (Mr. A. H. Shaw) has been instructed to report upon the cost of fitting producer gas to one of the boilers at the works and the estimated saving and advantage (if any) to be obtained therefrom.

The recently delivered electric coal wagon has been found to be short of the specified capacity, and was returned to the makers for rectification.

Manchester.—Councillor Dagnall has been re-elected chairman and Alderman Walker vice-chairman of the Electricity Committee. Alderman Bowes and Alderman Chapman are respectively chairman and vice-chairman of the Tramways Committee.

Otley.—The Urban Council have unanimously decided to support the proposed application of the Electrical Distribution of Yorkshire (Ltd.) for a provisional electric lighting order for Otley.

The Council are to have power to purchase the concern at the end of 21 years, and thenceforward at recurring periods of seven years up to 42 years, at which date the Council's powers of purchase under the Electric Lighting Acts should take effect.

Portrush.—The Board of Trade have approved the site selected by the Council for an electricity generating station.

Provisional Order Transfers.—The Board of Trade have extended for one year from Jan. 30, 1916, the time for making the transfers authorised by sec. 5 of the Bradford-on-Avon Electric Lighting Order, 1914, and by sec. 5 of the Warminster Electric Lighting Order, 1914.

Rhyl.—The Council are now supplying electrical energy to Kinmel camp.

At the last meeting reference was made to the failure of the wood troughing in certain streets, and the chairman of the Electricity Committee (Mr. T. D. Jones) said that, to be quite on the safe side so far as cable faults were concerned, they would have to replace all wooden troughing with earthenware troughing, and money would have to be provided next year for that purpose.

Sheffield.—The new Lord Mayor (Councillor Warlow) is an engineer and at the meeting of the Corporation last week, in returning thanks for his election, he referred to the huge dimensions of the work of the Council, which in normal times employed nearly 9,000 persons.

He said his experience as an engineer had caused him to take a special interest in the electric supply department, which had made very rapid progress during the past three or four years, and in the present crisis was of untold value to manufacturers of war material. The amount of current supplied had increased from 16,902,360 units in 1912 to 44,874,342 units in the past year, and the gross revenue had gone up from £96,868 to £184,658. He looked forward to a considerable further increase in the business of the department.

Shoreditch (London).—The Borough Council has received the L.C.C.'s sanction to borrow £1,500 for the electricity undertaking.

Shrewsbury.—Ald. T. P. Deakin, chairman of the Electric Lighting Committee, has been elected Mayor for the current year.

Stoke-upon-Trent.—At the last meeting of the Council a report was presented on the question of the proposed agreement with the Potteries Electric Traction Co. for the extension of the company's lease from 1932 to 1940 and for other purposes.

The Special Committee had suggested certain amendments, including the insertion of clauses reserving to the Council power to require the company to put into operation ½d. stages over the whole or part of the system, and that if it became necessary to provide additional generating plant the company should, instead of installing fresh plant, take the additional energy from the Corporation upon terms to be agreed.

The proposed amendments had been submitted to the company, who had intimated that the terms were so many and so serious that the directors were of opinion that it was impossible for the company to carry out the original proposals and suggesting a conference between the parties.

The Committee, therefore, recommended that the question of entering into the agreement be deferred for the present, the Town Clerk to inform the company that in the event of the Council considering a conference desirable, notice would be given later.

The recommendation was adopted.

Swinton and Pendlebury.—At the last meeting of the Council it was reported that the agreement with the Lancashire Electric Power Co. for a bulk supply of electricity was for five years from Sept. 1, 1912, with a proviso that the period could be extended to 10 years by agreement.

If such an extension were made, there would be a reduction in the scale of maximum demand charges from the date of the extension of the agreement. At the present rate of consumption the amount of the reduction would be about £80 per annum. It was, therefore, resolved that steps be taken to extend the agreement.

Turton.—The residents of Harwood, near Bolton, are pleased at the prospect of electric supply being introduced.

At the recent meeting of the Council it was reported that there had been several applications for current from residents at Harwood, and it was decided to approve the erection of an overhead cable, which was estimated to cost about £220.

LIGHTING & POWER NOTES.

Asylum Lighting.—Southampton Council has applied for sanction to borrow their share (£6,346) of the cost of providing the electrical plant at Park Prewett Asylum.

Aylesbury.—At the last meeting of the Council it was agreed that the charge for electric current to the Street Lighting Committee should be the capital charges of the undertaking so far as they could be apportioned to street lighting, plus the actual cost of production at the works.

Coniston.—Ulverston Rural Council has confirmed a recommendation from the High Furness Committee that the electric lighting of Coniston should not proceed until the Rural Council had approved the places in which the poles should be erected in that village.

Hospital Lighting.—The Metropolitan Asylums Board have approved an extra expenditure of £96. 9s. 5d. incurred on the work of altering the wiring, &c., at the Park and Brook Hospitals, making the otal cost £1,646. 9s. 5d.

In Messrs. R. Elliott & Co.'s tender for the extension of East Cliff House £650 was provided for the electric lighting, but owing to the increase in the cost of labour and material the architect (in submitting tenders from sundry selected firms) stated that he would have to increase his estimate to £1,050. The Works Committee reports that the increased estimate has been justified by the tenders received, the amount of the lowest satisfactory tender being £1,075, and an order has been placed through the main contractor for the execution of the works at this amount.

Lowestoft.—The Electric Supply Committee recently submitted terms to Messrs. Maconochie for the supply of electric current to their factory, but the firm are unable to accept them.

Nuneaton.—The Electricity Committee is considering a scheme for introducing electric lighting into some new small property.

The electrical engineer has been authorised to carry out installations in six or eight houses through a local contractor. The charge to consumers through prepayment meters will be 5½d. per unit, the ordinary rate to come into force when the cost of the installation has been repaid.

Tamworth.—The retiring mayor (Mr. F. G. Allton), in the course of an address on the work of the Council during his two years of office, said he did not think anything would make the town progress more than the adoption of electric lighting.

TRACTION NOTES.

Birmingham.—An accident occurred on Friday morning to a tramcar on the Lozells-Gravelly Hill route.

The car was proceeding to Gravelly Hill, and while descending the Victoria-road incline it could not be pulled up at the regular halt. It passed the curve at too rapid a speed, and left the rails. It proceeded across the roadway and then struck a lamp standard. So violent was the impact that the upper deck was wrenched off and the passengers were thrown to the ground. The body of the car ran a few yards further along the road and then toppled over on to the footpath. One man, named Fredk. Smith, was killed and 25 were injured. Of the latter, one has since died.

The inquest on the two persons who were killed as the result of the accident was opened on Tuesday, and after hearing some evidence it was adjourned until the 25th inst.

Mr. R. H. Dickinson, chief engineer of the tramways department, said that he had examined the car as it lay on its side, and tested all the cables that led from the motor to the magnets and the connections of the hand brakes. They were all perfectly sound. After the body of the car had been replaced on its wheels he tested both hand brakes, and found them in order. It was towed to the Witton depot, and on the way they passed down a gradient much more severe than that at Victoria-road. The hand brake of the overturned car was tested and it not only held up the chain between the two cars, but helped to steady the following car. The magnetic brake was also applied and it pulled up the car and the car in front. At the depot the car was fully examined, and all the working parts were found to be sound. Both the sand-box pedals were down in such a position they could not be operated by the driver. When witness first examined the car the magnetic brake was on to the full. The car was re-wheeled on Sept. 2 last. It was in use the day previous to the accident, and was booked off "O.K." There were no "flats" on the wheels of the car. If the wheels skidded and sand was applied a "flat" was caused, but the wheels might skid on a wet surface and no "flat" be caused, provided no sand was employed.

The Board of Trade inquiry was held on Wednesday.

At the meeting of the Tramways Committee on Tuesday Councillor Harrison Barrow was re-elected chairman for the ensuing year.

The total number of persons who volunteered to become motormen to take the places of those who have left to join the Forces was 625, and over 100 suitable men have been interviewed. The majority of these are now attending the school of instruction at Moseley-road depot. The experiment of appointing women to clean the cars at the depots has proved very successful. There are 61 women thus employed in the day time, and about 600 women have been engaged as conductors.

Croydon.—Ald. G. J. Allen, J.P., has been re-elected chairman, and Councillor A. A. Thompson has been elected vice-chairman of the Tramways Committee for the current year.

Dundee.—The Tramways Committee have decided to reorganise the service on account of the depletion of staff through enlistment.

It was reported last week that 29 men had enlisted during the previous week, and it was stated that if there were further losses the department would begin to feel them severely in working the system.

The Convener (Mr. G. A. Johnston) said a scheme had been worked out to meet the men's demand for a rise of 3s. per week on the ground that cost of living had gone up. The idea was that the working week should be increased from 54 to 60 hours, and that men now earning 27s. and over should get 5s. extra and men earning under 27s. should get 3s. extra, with the war bonus of 1s. The proposal was agreed to on the understanding that it should remain in force during war conditions, and that the former hours should be reverted to on the return of a sufficient number of the employees from military duty. It was also agreed to curtail the evening car service on the principle that no car should leave the centre of the city on service later than 10:30.

Light Railways.—The Board of Trade have confirmed the Derwent Valley Light Railway (additional capital) Order, 1915, and the Dearne Valley Light Railway Order, 1915.

Metropolitan Railway.—The Board of Trade have extended for one year the time limited for the completion of works authorised by sec. 5 of the Metropolitan Railway Act, 1911, and for the compulsory purchase of lands authorised by the Metropolitan Railway Act, 1913.

Municipal Motor Lorries.—Shoreditch (London) Council are unable to purchase horses for their municipal work under £110 each, and are, therefore, considering the advisability of purchasing motor lorries.

Women Tramcar Conductors.—About 600 women conductors have been engaged by Birmingham tramways department, and it is stated that they are performing their duties satisfactorily.

Women conductors are now also employed by Burton-on-Trent, Colchester, Lowestoft and York Corporations.

TELEGRAPH & TELEPHONE NOTES.

Municipal Telephony.—At a meeting of Hull Telephone Committee on Saturday permission to enlist under Lord Derby's scheme was given to the manager (Mr. T. Holme) and 70 employés of military age.

The manager stated that at the outbreak of war he intimated to the employés that, owing to the nature of their work, they would not be allowed to enlist. The position now was that it rested with the Appeal Committee, and not with the Corporation, whether or not the men were indispensable, but if all men of military age were enlisted only 27 would remain.

On Tuesday morning all the telephone employés of military age left the Central Exchange, Mytongate, for the City Hall. At the head of the procession of 63 young men were Mr. T. Holme, the manager, and Lieut. Douglas Boyd, the recruiting officer. Mr. Holme was the first to sign the paper, and his colleagues gave him a cheer in the Hall as he passed into the examination room.

Telephone Rates.—The special committee on telephones of Glasgow Corporation has been considering the question of the increased telephone rates which are to come into force in March next.

The Committee resolved that in their opinion the new tariff is exceedingly unfair, especially to those whose requirements are limited, and that to impose it would almost be prohibitive, and that in view of the experience shown that on the Glasgow area a flat rate of £6 would meet every charge. They recommended the Corporation to associate themselves with the Corporation of Brighton and other towns in making representations to the Postmaster-General against the proposed increase in telephone charges, and especially to urge a house installation at, say, £3 per annum, the messages from dwellings being mainly earlier or much later than those during the press of business hours.

EMPIRE NOTES.

Australasia.—The "Commonwealth Engineer" says Mr. J. Rist has arrived in Melbourne from London to train the motor staff in connection with the electrification of the Melbourne suburban railways.

The estimated cost of the new Government electric power house at Perth is £295,000. Perth City Council is to be supplied with 4,000,000 units per annum, and the Perth tramways will require 3,300,000 units.

The agreement between the Tasmanian Government, the owners of the Great Lake hydro-electric scheme, and Hobart City Council, for the supply of power for the tramways and for other purposes, provides for power to be taken at the d.c. end of the Government switchboard at 0·8d. per unit up to 1,500,000 units per annum, and 0·5d. per unit for all further units. The Council to pay a minimum of £4,750 per annum, and to guarantee to meet the demand and to push the sale of electricity within the scheduled area. The Council are to establish and maintain a showroom for motors, and to draw up a scale of charges for power, to be approved by the Government. The Council will retain all its present consumers, but it must not take any more consumers outside the area, while the Government undertakes not to supply power direct in the said area (except as hereinafter mentioned), and hands over to the Council all contracts which it may have within that area at the date of commencement of supply. If the peak load of the Council exceeds 750 kw. for half an hour at a time on more than 30 days per annum the Council must pay an extra £1 per kilowatt of maximum demand. The Government have the right to supply power for Government departments and to supply current direct to all consumers of 500 H.P. and over. The Government will pay the Council £750 for rental of the Council's existing steam plant as a stand-by (the tramway to have first call thereon in the case of a breakdown) and to maintain same in proper order at its own expense. An agreement has been completed between the Commissioner of Railways and the West Guildford (Western Australia) Roads Board for the supply of electric current to the latter body. Arrangements are being made to raise £2,000 for extensions to the distribution system.

An electric supply undertaking for Aspendale, Carrum and Chelsea (Victoria) has been put into operation. Lamps of 200 c.p. have been installed on the main road, and the branch streets and avenues are also to be lighted. Many house connections are also being made. The power plant consists of a 94 H.P. Hornsby suction gas plant and twin cylinder engines driving a 50 kw. three-wire generator made by the Electric Construction Co. Supply is given at 460 and 230 volts d.c.

The erection of the Government's power house at Canberra (N.S.W.) is completed. The plant comprises four Babcock & Wilcox boilers, with chain grates, feed heaters, feed pumps, economisers and induced draught fans, coal crushing and elevating plant, one 150 kw. Robey-Hall and two 600 kw. Belliss & Morcom-Brush sets, with circulating pumps, air pumps and condensers, water softening and oil eliminating plants. The erection of the dam at the Cotter river is proceeding satisfactorily. The concrete is now some 40 ft. above the bed of the stream. The concrete lining of the roof and sides of the tunnel is completed.

The official starting of Geraldton (W. Australia) electric light plant took place recently. The capacity of the plant is three times that of the original installation. It consists of a 200 H.P. Commonwealth gas producer, 180 H.P. National gas engine, 50 kw. dynamo and Little's water coolers. Mr. J. R. W. Gardam, of Perth, is the Council's consulting engineer. The contract was carried out by Hoskins & Co., of Perth (W.A.).

The Shire of Dimboola (Victoria) is raising £5,500 for the construction of electricity supply and other works.

The report of the manager (Mr. W. H. Morton) of Wellington municipal tramways and electric lighting departments for the year ended March 31, 1915, has been issued. Tramway revenue was £167,331 (against £160,347 in previous year), working expenses were £111,138 (£105,613); total operating expenses, including interest, sinking fund and depreciation £151,962 (£144,917); net surplus £15,369 (£15,430). Power supply revenue was £11,638 (£11,439), working expenses were £5,909 (£5,402), and capital charges £5,415 (£5,044); total £11,324 (£10,446). Net surplus £314 (£993). Net surplus from tramways and power supply was £15,683, out of which expenditure on special works and amount written off preliminary expenses accounted for £7,818, leaving net credit balance £7,865. The net increase in the capital account was £26,263, making total capital expenditure £716,839. Revenue per car-mile was 15·92d. (16·52d.), working expenses were 10·57d. (10·88d.), and capital charges 3·89d. (4·05d.); total 14·46d. (14·93d.). Passengers carried were 25,517,515 (24,565,376). There are 260 power consumers. A reduced scale of charges came into force in August, 1914. There is practically no margin of boiler plant, and provision has been made in the year's estimates for a large water-tube boiler. Provision will also be made for an additional generating unit in the near future. In view of the increase in demand for the tramways and lighting departments, consideration must shortly be given to the best and most economical means of generating and transmitting power to outlying districts, more particularly South Wellington and the adjacent suburbs. Reports on the matter are being prepared and on the advisability of installing such additional generators as may be required. Great economies could be made if a suitably equipped power station for both undertakings were available. A [illegible] could be made by discarding with the present [illegible] substituting more economical [illegible] more favourably situated. Mr. Morton [illegible] should also be given to the possibility of a hydro-electric [illegible]. A further £1,000 per annum could be saved if the [illegible] available in the original portion of the lighting station could be [illegible] with. After the death of Mr. Richardson, city electrical engineer, the Council appointed the chairman of the board of management (Mr. Morton) to the position of general manager, and dissolved the board from Dec. 31, 1914. Mr. Cable, who had previously been traffic superintendent, was appointed electrical engineer and assistant manager, and Mr. D. McGillivray, senior traffic inspector, became traffic manager.

Electric Lighting Department. Revenue was £32,875 (£31,063) and working expenses were £28,259 (£28,484). Interest on loans £7,133 (£7,133), sinking fund £3,169 (£3,169), and depreciation £7,014 (£7,171), leaving net surplus £16,315 (£15,809), out of which £10,500 has been written off goodwill, station plant, &c. Capital expenditure was £18,626, though net increase was £8,317, and total capital expenditure now stands at £236,633. Total consumers are 10,453 (increase 1,396). Reductions in charges for current were made during the year, the concessions amounting to over £1,000 per annum to power consumers, £2,000 for cooking and heating (resulting in a considerable increase in consumption for these purposes), and nearly £1,000 for Government and Harbour Board Lighting. Deferred payment installations carried out during the year were 119, making a total of 659. A new 1,500 kw. Parsons turbine set has been installed. In consequence of the death of Mr. Richardson, Mr. Geo. Lauchlan, formerly lighting superintendent, was appointed electrical engineer and assistant manager.

FOREIGN NOTES.

China.—A memorandum on trade expansion in China, prepared by the Assistant British Commercial Attaché in China (Mr. C. A. W. Rose), expresses similar views agreeing to a large extent with those indicated in consular reports from China which have appeared in some of our recent issues. The following extracts may be of interest to our readers :—

On the subject of the capture of German trade in China there exists a good deal of confusion of thought. There are (1) Great financial groups representing most of the treaty powers, which combine extensive banking operations with their businesses and which obtain political support in various spheres in China for the exploitation of railway, mining and similar enterprises; (2) manufacturing firms who are able to finance their own businesses, and to establish a virtual monopoly for their products wherever they choose to compete with the large selling organisations which have established foreign agencies in the interior, with an elaborate organisation for distribution purposes throughout China; and (3) merchant houses and firms (large and small) who import goods, metals, sundries, &c., and export China produce, and who are ready to handle any business promising fair profits and quick returns. There is a slight overlapping, but, broadly speaking, the different classes represent distinct divisions of activity. Under the first two, British interests are holding their own, and the memorandum is devoted to an examination of the British position under the third head.

In the German firms large salaries are not paid, but every head of a department has a generous share of the profits which he brings to the firm, and similar treatment has been accorded to the chief Chinese staffs, their energies having been stimulated by profit sharing. The heads of departments keep closely in touch with the Chinese; they cultivate personal relations with them; they learn their customs, habits of thought and often their language. Several of the most successful British firms are encouraging the study of the language, and they find that it pays them to do so. The German firms go to the headquarters of industrial activity and suggest business to the men they know. In most cases the demand must be created, especially in such matters as installations of machinery and industrial undertakings. The Chinese have been taught to need electric light and power stations, waterworks, pumps, &c. There has been a tendency of late years for British manufacturers to combine to capture the machinery market of China, and large quantities of British machinery have been introduced, but this machinery is largely sold by German firms. It may be known in Shanghai that a cotton mill is likely to be erected in the interior. The German firms send up a representative (in the case of textile machinery usually a British representative) with pictures, sometimes with a magic lantern, and a Chinese assistant, who gives a real idea of the costs and the profits of such things to untrained but practical minds. The contract will be closed if a profit of any sort is in sight, the contract being regarded merely as an advertisement. Whilst the main contract is in progress the business man knows that many subsidiary contracts will arise, and on these individual purchases he is certain of a good profit, which will cover a small margin for the contract as a whole. The small business is the backbone and staff of the Chinese trade; industrial enterprises and Government contracts are the plums—but they are within the reach of every enterprising firm with a reasonable capital. Anyone with experience in the Chinese will know that an agreement is generally concluded at the most unexpected moment. There will be long discussions and elaborate arguments: then suddenly the revelation of some new and unexpected element and the necessity for quick decision. There is no time for reference to headquarters, and the

man on the spot must close at once. Though the Shanghai dealers and guilds were strong and formed a "ring," German firms have got behind the first line of defence with piece goods. Agents are travelling in every Province of the interior, carrying samples and booking orders by telegraph. Where German firms have succeeded surely British firms can also succeed. China's credit is good, her economic and industrial development is proceeding on steady lines, and her producing and absorbing capacities grow greater each year. The real commercial struggle is only just beginning, and, although British firms still hold the first line, foreign competitors are getting behind it, penetrating to the very centres of supply and demand. German firms have used their technical bureaux with success. These are groups of non-competitive manufacturers in Germany, unwilling to incur the expense of individual representation in China, but determined to find an opening in the market. They send out a joint representative, with expert knowledge of their products, to join an established and well-connected merchant firm in China. That firm supplies the representative with special knowledge of the Chinese and their ways of business, and he does the work of advising and suggesting. When orders are forthcoming, they go direct to the manufacturers of the group. These bureaux are useful in establishing connections, but they are very elastic and are run on economical lines. If a member of the group receives no orders he drops out; if, on the other hand, he establishes a connection, he is able to stand alone. In this way many German manufacturers have been enabled to secure openings at a minimum of expense. British organisations on these lines have generally failed through the schemes being too ambitious and through the firms not realising that business is very close-cut and that practical knowledge of the market is indispensable to success. German firms have practically created the business in Chinese export produce during the last 10 years. They have established foreign buying agents, and appliances for storing, &c. They have also created a demand in Germany for Chinese produce, and it has the great advantage of maintaining men in central positions all over the interior and helping to open the interior to foreign trade. In regard to the assertion frequently made that Germans obtain their advantage by allowing long credits and large commissions, Mr. Rose says he has had unusual opportunities of watching German firms at work with their normal trade, and he is convinced that the more successful do not encourage long credits, that their business is generally conducted on sound lines, and their success largely due to the fact that they do not lose money by giving credit without suitable security. They certainly cut profits and offer exceptional facilities to customers when breaking new ground. They also pay commissions on machinery and Government contracts. On the question of Government support, experience of a large number of German business men in different parts of China has not proved them to be more anxious to enlist the sympathy or to court the interference of their officials than are British firms. There is just as much comment among Germans as among Britons as to the support afforded to its nationals by the Government of their rivals.

MISCELLANEOUS NOTES.

Enlistment of Commercial Men.—The Home Office Committee to consider the conditions of clerical and commercial employment with a view to advise what steps should be taken, by the employment of women or otherwise, to replace men withdrawn for service in the military forces has issued its report.

The committee invited representatives of a number of important technical and commercial associations, including the Institutions of Electrical, Civil, Mechanical, Mining and Gas Engineers, the Municipal Corporations' Association, the Association of Chambers of Commerce, the Institute of Actuaries and Bankers, &c., to attend a conference which was held at the Home Office on Oct. 28. The committee also had interviews with representatives of business organisations and large employers of clerical labour, with the result that many valuable suggestions were received. It is calculated that the number of men of military age in clerical and commercial employment in England and Wales is over 300,000, and substitutes will be required for a very large proportion of this number. The members of the committee are satisfied that the bulk of the substitutes must be drawn from the ranks of women not at present employed, and they propose that in all commercial centres a local body, representative of higher education, and of the commerce of the district should be formed to organise the supply and training of women clerks. The committee have addressed a communication to the secondary education authorities, asking them to take steps to set on foot a scheme for the purpose without delay. The committee also express a strong hope that it will be made clear that the employment of women substitutes will be temporary and for the period of the war only, and also that, as far as conditions and other circumstances permit, the scale of wages will be based on the rate paid to men engaged in similar duties.

Inquest.—An inquest was held at South Shields last week on an electric welder named H. Smith, who was killed on Oct. 25.

Deceased, who was employed by the North-East Coast Electric Arc Welding Co., was engaged on work at Messrs. Brigham & Cowan's dock. As he was going towards an electric generator he slipped off the crane lines into a pool of water, and then fell against the machine. The man who was working with him pulled him off by his clothing. It was then found that he had received a severe shock, and although artificial respiration was applied for over an hour the man never recovered.

Wm. E. Groves, electrician, employed by the company, said that after the accident he found a small flaw in the cable connecting the generator with the crane trolley. There had been a heavy shower of rain, and he thought that the pool of water and the scrap metal over which the cable passed had become charged. The man had received a shock when he got into the pool, and when he fell against the machine the circuit was completed.

The jury found that death was due to syncope, caused by an electric shock.

Local Authorities and Excess Profits Tax.—At the last meeting of Sheffield Corporation the following resolution was adopted on the motion of Ald. Styring:—

That the Council respectfully draws the attention of the Chancellor of the Exchequer to the following facts:—

With the view of furthering the wishes of the War Department, the Council, to facilitate the enlistment of members of its official staff and workmen in its employment, have entered into obligations with such persons, involving an annual payment of over £46,000, and the Council is at present considering similar applications from many more of its employés. If excess profits of the Corporation, are to be separately treated and taxed, the result will be to inflict a great hardship on the Corporation. To deal with the matter in this way would be to treat this and other municipal corporations similarly placed in an altogether different manner from that of manufacturing and trading undertakings. If excess profits are to be taxed in the case of municipal corporations, the Council respectfully but strongly submits that the affairs of the Corporation should be treated as a whole in the same way as would be done in the case of a manufacturing concern. Provision should be made in the Finance Act to give effect to this by making it clear that, in ascertaining excess profits in the case of a municipal corporation the additional costs incurred by the corporation in any department (trading or otherwise) in respect of the war may be brought into account. The Council further draw attention to the fact that they have, in connection with the provision of base hospitals and in many other ways, rendered assistance to the Government in connection with the war in a manner that manufacturing concerns could not possibly do, and, in the view of the Council, this entitles municipal corporations to fair and considerate treatment. That the Town Clerk be directed to transmit the above resolution to the Chancellor of the Exchequer, and to take all necessary steps to give effect to the wishes of the Council in the matter.

Naval Wiremen.—The new ratings in the Navy of wireman first class and wireman second class, with pay of 3s. and 2s. 6d. a day respectively, are established for the duration of the war.

Parcels for the Troops.—In consequence of the difficulties attending the transmission of parcels to troops in the Dardanelles, and in view of the anticipated desire of relatives at home to send presents for Christmas, special directions have been issued, amongst which are the following:—

The weight limit is 7 lb.; perishable articles (fruit, &c.), bottles or pudding basins must not be sent. Articles sent must be well padded, and the packages made as nearly round as possible, the outer covering being of linen, canvas, or similar material and closed by sewing; the address to be written on the covering, and not on a label. Articles (such as chocolate) which are likely to become soft or sticky, must be in tins well fastened down, but wood or metal boxes with square corners must be well padded, so as not to damage other parcels. Parcels should be posted at once, and letters by Dec. 1. If the address is known to be in hospital, "Hospital" must be written on the parcel.

Plant for Sale.—Mr. John F. Wake, Darlington, advertises for sale a 500 h.p. gas engine and 350 kw. three-phase generator.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during October, 1915, and (*b*) the aggregate figures from Jan. 1 to Oct. 31, with the increases or decreases compared with the corresponding periods of 1914:—

Electrical machinery, (*a*) £69,152 (including generators and motors other than for aeroplanes, motor cars and cycles, £14,295, and electrical machinery unenumerated, £45,857) (decrease £48,224), (*b*) £1,284,752 (including generators and motors other than for aeroplanes, motor cars and cycles, £223,048, and electrical machinery unenumerated, £1,061,704) (increase £69,633); telegraph and telephone cables (*a*) nil (decrease £422), (*b*) £131 (decrease £864); other than submarine, (*a*) £530 (decrease £10), (*b*) £26,145 (decrease £19,389); telegraph and telephone apparatus, (*a*) £17,383 (increase £6,258), (*b*) £79,098 (decrease £99,759); other electrical wires and cables, rubber insulated (*a*) £79,64 (increase £4,101), (*b*) £82,779 (decrease £146,267); with other insulations, (*a*) £2,372 (increase £2,350), (*b*) £43,336 (decrease £15,958); carbons, (*a*) £11,805 (increase £6,885), (*b*) £118,900 (increase £11,161); glow lamps, (*a*) £16,671 (increase £10,104), (*b*) £123,468 (increase £14,849); arc lamps and electric searchlights, (*a*) £1,038 (increase £765), (*b*) £2,664 (decrease £495); parts of arc lamps and searchlights (other than carbons), (*a*) £4,098 (decrease £5,117), (*b*) £72,515 (decrease £4,814); primary and secondary batteries, (*a*) £9,055 (increase £2,745), (*b*) £108,119 (increase £37,319); meters and measuring instruments,* (*a*) £3,573, (*b*) £24,245; switchboards,* (*a*) nil, (*b*) £5,264; electrical goods and apparatus unenumerated, (*a*) £12,280, (*b*) £166,233. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £86,769 (increase £26,889), (*b*) £852,897 (decrease £236,295).

Exports.—The exports of electrical machinery, material, &c., (*a*) during October, 1915, and (*b*) from Jan. 1 to Oct. 31, with the increase or decreases compared with the corresponding periods of 1914, were as follows :—

Electrical machinery, (*a*) £157,152 (including railway and tramway motors, £2,315, generators and motors other than aeroplanes, motor cars and cycles £80,630, and electrical machinery unenumerated £74,204) (decrease £31,299) (*b*) £1,185,656 (including railway and tramway motors £99,233, generators and motors other than for aeroplanes, motor cars and cycles, £563,752, and electrical machinery unenumerated, £522,671) (decrease £741,232); telegraph and telephone cables, submarine (*a*) £15,549 (increase £8,458), (*b*) £171,476 (decrease £45,920); other than submarine, (*a*) £23,052 (decrease £1,970), (*b*) £344,733 (increase £82,263); telegraph and telephone apparatus, (*a*) £18,426 (decrease £3,374), (*b*) £171,476 (decrease £45,920); other electrical wires and cables, rubber insulated, (*a*) £25,849 (decrease £4,073) (*b*) £250,086 (decrease £31,409); with other insulation, (*a*) £58,781 (increase £29,810), (*b*) £408,418 (increase £57,609); carbons, (*a*) £891 (increase £611), (*b*) £7,145 (increase £285); glow lamps, (*a*) £17,676 (increase £2,315), (*b*) £131,216 (increase £20,852); arc lamps and searchlights, (*a*) £293 (decrease £30), (*b*) £4,135 (decrease £8,508); parts of arc lamps and searchlights (other than carbons), (*a*) £946 (increase £681), (*b*) £10,976 (decrease £2,386); primary and secondary batteries, (*a*) £17,299 (increase £4,702), (*b*) £164,680 (increase £20,483); meters and measuring implements * (*a*) £13,075, (*b*) £125,469; transformers * (*a*) £3,320 (*b*) £54,024 switchboards * (*a*) £3,560, (*b*) £51,181; electrical goods and apparatus unenumerated (*a*) £47,123 (decrease £24,242), (*b*) £481,474 (decrease £260,026). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £245,840 (increase £32,843), (*b*) £2,516,107 (decrease £81,280).

* Not enumerated separately in previous years.

TENDERS INVITED.

Telegraph Material, Instruments, &c.

Tenders are invited for the supply of g.i. Wire (specification No. 301; schedule No. 402), Measuring Instruments, &c. (stores schedule No. 347), Jointing Sleeves (schedule No. 356) and c.b. Multiple Switchboard for Adelaide telegraph exchange (specification No. 552; schedule No. 405) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *The times and places for the receipt of tenders are given in an advertisement.*

Power Plant and Machine Tools.

Extension of Time.—The time for the receipt of tenders by the AUSTRALIAN COMMONWEALTH Department of Defence (Navy Office) for Power Plant and Equipment, and for Machine Tools for the Naval Dockyard, Cockatoo Island, Sydney, N.S.W., is extended to Nov. 30. Specifications from the Director of Navy Contracts, Navy Office, Melbourne.

Wiring, Fittings, Lamps, &c.

ATHY (co. Kildare) Urban Council require tenders before 11 a.m. Dec. 6 for the electric lighting of the town on a three years' contract. About 50 Lamps of 50 c.p. each will be required for public lighting, and it is estimated that 300 private consumers can be obtained.

CHATHAM Corporation require tenders by 10 a.m. Nov. 24 for one year's supply of Stores and Materials, including incandescent Electric Lamps, &c. Specifications from Borough Surveyor.

The TYNE IMPROVEMENT COMMISSIONERS require tenders by Nov. 22 for three, six, or 12 months' supply of Incandescent Lamps, Arc Lamp Carbons, Metals, Ironmongery, Oils, &c. Forms of tender from the Manager and Secretary, Berwick-street, Newcastle-on-Tyne.

Cable Testing Outfit.

SYDNEY Municipal Council require tenders by 3 p.m. Nov. 22 for the supply of a High-tension Cable Testing Outfit, consisting of 350 k.v.a., s.p. Transformer, 175 k.v.a. s.p. Potential Regulator and 1,600 k.v.a. s.p. Inductance, and Control Switchboard (Contract No. 423). Specification from City Electrical Engineer.

Electric Cable, Trolley Wire, &c.

Tenders are invired by the Deputy Minister of the Dominion Government Department of Naval Service, OTTAWA, for the supply and delivery at H.M. Canadian Dockyards at Halifax (N.S.) and Victoria (B.C.) of Electric Cable and Wire, Acids, &c. Specifications and conditions of contract from the Deputy Minister of the Department, to whom tenders by noon Nov. 23.

MANCHESTER Tramways Committee require tenders by 10 a.m. Nov. 23 for h.d. Copper Trolley Wire. Specifications from Mr. J. M. McElroy, 55, Piccadilly, Manchester.

ILFORD Council invite tenders for supply of Triple Concentric Cable and Boxes. Specifications, &c., from the Electrical Engineer, and tenders to the Clerk by noon Nov. 23.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections (contract No. 29,491), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fishplates (contract No. 28,685). Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

Telegraph and Telephone Material, &c.

The CHESHIRE LINES COMMITTEE require tenders by 10 a.m. Nov. 24 for one year's supply of Telegraph Materials, Carbons, Metals, Wire, Oils, Paints, &c. Specifications, &c., from the Stores Superintendent, Cheshire Lines, Warrington.

The SLIGO, LEITRIM & NORTHERN COUNTIES RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Stores, including Telegraph Materials, Rubber Goods, Lead, Oils, &c. Forms of tender from the Secretary, Enniskillen.

THE GREAT NORTH OF SCOTLAND RAILWAY Co. require tenders by 10 a.m. Nov. 25 for six or 12 months' supply of Stores, including Telegraph Material, Ironmongery, Rubber Goods, Belting, Packing, Waste, Oils, &c. Forms of tender from the Stores Superintendent, 80, Guild-street, Aberdeen.

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department: Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273). Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. Dec. 7 for supply of Electric Motors, Polarised Relays, Morse Sounders, Telephonometers and Voltmeters (schedule 1,272), and by 3 p.m. Dec. 14 for 18,670 c.b. Wall-pattern Telephones (schedule 1,264) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from the High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Tenders are invited for the supply of 294 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. Tenders to DeputyPostmaster-General, Perth(W.Australia),by 3 p.m. Dec. 8.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Transformers and Switchgear.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED.

DERBY.—The Corporation have accepted the tender of Newton Bros. for a motor-generator at £845.

SYDNEY (N.S.W.).—At a recent meeting of the Council the Electric Lighting Committee recommended that the Council place the following orders :—

Gibson, Battle & Co. (for Chloride Electrical Storage Co.), 3,000 wood board separators, 6,000 wood board centre rods, and 6,000 wood board

side rods for the battery at the town hall sub-station, £264; R. W. Cameron & Co., 18 "Blonck" boiler efficiency meters, £337. 10s.; W. G. Watson & Co., 35 200-ampere three-pole 500-volt switches, £145. 5s.; British Insulated & Helsby Cables, copper 'bus bars, £222 and £115 (estimated); Lawrence & Hanson, service fuses, £2,644. 15s. 10d.

SCHOOL LIGHTING.—London Education Committee received three tenders for wiring the Thornfield-road school, Hammersmith, and the lowest, that of James Whitaker & Sons, at £420. 11s., has been accepted. The other tenders were at £429 and £483 1s.

MELBOURNE (VICTORIA).—The Council have decided to order from Bullers (Ltd.) 400 h.t. insulators f.o.b.-£47, and from Noyes Bros. h.d. cables. £1,045.

METROPOLITAN WATER BOARD.—The tender of Simplex Conduits Ltd. (at £58. 17s. 1d.) has been accepted for the supply of electric fittings required for the Central Buildings (Battersea); and that of the New Phonopore Telephone Co. (at £108. 6s. 8d.) for brass receivers cases with diaphragms, spacing rings and ebonite ear pieces.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Middleton.—The report of the borough electrical engineer, Mr. S. Pauls, on the work of the electricity department for the year to March 31 last states that the net loss for the year was £429.

Total capital expenditure is £50,157 (increase £665). Revenue was £8,187 (increase £379) and expenditure was £8,617, including insurances £125, interest £1,246, sinking fund £1,913. The expenditure included £337 towards cost of new switchboard and £183 for economisers. Coal cost £1,939, decrease £136, although more units were generated and price of coal was higher. Units sold were 1,223,938 (increase 67,229). The profit and loss account shows a debit balance of £2,244, including debit balance from previous year. Coal cost 0·380d. per unit sold (against 0·451d. in previous year), working costs were 0·868d. (0·957d.) or, with rents, rates, management, &c., 1·069d. (1·154d.). An agreement was entered into in February, 1914, with Manchester Corporation for a bulk supply of electricity for large consumers and also to act as an auxiliary to the present station which will soon be fully loaded. One consumer is taking 600 H.P. from this supply and another has agreed to take 2,500 H.P. Application was made to the L.G. Board for powers to borrow £7,433 in connection with the supply from Manchester. An inquiry was held into the application in August, 1914, but a notification was received from the Treasury that borrowing powers, unless necessary for purposes of the war, would not be granted.

York.—The accounts of the electricity department for the year ended March 31 show total capital expenditure £206,102 (increase £22,705), of which £67,504 has been repaid.

Revenue was £33,798 (against £29,343 in previous year), and expenses (including £462 allowed to men on military service) were £18,702 (£16,290) the gross profit being £15,096 (£13,053). Interest required £5,314 (£5,299) sinking fund £7,235 (£6,790) and tax on profits £281 (£132), leaving £2,265 (£831) to transfer to reserve and renewals fund.

Units generated were 8,651,478 (against 7,542,131 in previous year) and sold 7,417,089 (6,447,118). Total maximum supply demanded was 3,316 kw. (2,750 kw.).

COMPANIES' MEETINGS AND REPORTS.

Amazon Telegraph Co. (Ltd.)

The twenty-first ordinary general meeting was held on Tuesday under the presidency of Mr. GEORGE KEMP.

The SECRETARY (Mr. M. S. Munns) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, I regret to say the revenue of our business falls very short of what it was last year, and notwithstanding the very substantial reduction made in the maintenance and working expenditure, we are unable to pay any dividend. The Amazon rubber trade, upon which, as you know, our business mainly depends, continued during the year very dull and depressed. The low price of rubber further restricted its collection, and there was a decrease in the year's crop of about 12 per cent., which, coming after the falling off of the year before, seriously crippled trade generally on the Amazon. The traffic receipts show a decrease of £24,771, due to the falling off of the traffic transmitted over our cables and to the lower exchange. Interest brings in £296 less and the total revenue, including subsidy and transfer fees, comes out at £57,933, or £24,818 less than it did last year. On the other hand, the expenditure shows a large decrease, which reflects great credit on Mr. Nosworthy, our general manager, and his staff, who exercised every possible economy in the working and maintenance of the cables. The stations' expenses have been reduced £3,738, due to lower exchange and other reductions in the various charges. Expenses attending maintenance of cables show a large reduction of £11,233, due to less cable having been used during the year and to the small vessel "Ramos" having done the cable repairs in place of the larger vessel "Viking," which was laid up practically during the whole year. The other charges are also less, and altogether the year's working expenses amount to £34,939, or £17,521 less than they were last year. After meeting the working expenses and providing £22 888 for the year's debenture interest and sinking fund, there remains a balance of £107, making the amount carried forward £5,947, as compared with £5,840, brought forward from last year's account. As regards the balance-sheet, considering the crisis through which Brazil is passing and the immense difficulty in getting accounts collected, I think the figures are not unsatisfactory.

As regards the present year, business generally on the Amazon still continues anything but bright, and there is little prospect of improvement while the war lasts. The lower exchange value of the currency has lately been helping matters somewhat by increasing the currency value of rubber, while, owing to the lack of employment, currency wages have so far not risen, but rather fallen, and this gain in the currency price over the cost of production is acting in some measure as compensation for excessive export duties, which continue to handicap the Amazon rubber industry. This over-taxation should evidently be largely reduced, if not abolished, for surely it cannot be in the interests of Brazil to paralyse its rubber industry by overtaxation. The economic conditions of the Amazonas appear to be gradually improving. A good deal of cereal planting has already been done up-river in many places and the people are becoming more and more self-supporting and less dependent on imported supplies, which is making for cheaper and increased production. I now move the adoption of the report and accounts.

Mr. E. B. ELLICE-CLARK seconded the resolution, which was unanimously carried.

The retiring director (Mr. Eustace C. Quilter) and the retiring auditors were re-elected, and a vote of thanks to the chairman, directors and staff brought the proceedings to a close.

DRAKE & GORHAM (LTD.)—Mr. B. M. Drake, who presided at the meeting last week, said that £810. 16s. 5d. had been paid out of profits to the 62 members who were serving their country. In addition, fees had been paid in full to two directors, one of whom (Lieut. Carver) was at the Dardanelles. They had also provided out of profits £1,194 to cover depreciation on investments and £555 for income tax, against £67 for the previous year. The increase this year was partly due to the average system of assessment and partly to the increased rate. Economies had been effected in several directions, without which a loss for the year would have been inevitable, especially in view of the disappointing results of the Manchester office, where the installation profits were less than a third of those for the previous year. The amount of work in hand at the close of the year was largely in excess of the previous year's record, and included some important installations. Among these may be mentioned a complete generating station for the United Alkali Co., which would contain three turbo generating sets each of 1 000 kw. and one of 250 kw., or a total of 4,700 H.P. The plant would include Babcock & Wilcox boilers, Parsons geared turbines, condensers, superheaters and all modern improvements, and would, it was hoped, lead to further work of the same class. It was to be used for electrolytic work in connection with urgent war requirements. They had also large contracts for the Cotton Powder and other powder companies—in connection with which they had made a special study of the requirements—for the Lord Wandsworth Institution, and the new buildings of the Horticultural Society at Wisley. Ten camps and military hospitals, as well as an aeroplane factory, had been or were being fitted with light and power. The Queen's Hotel, Birmingham, was being lit for the L. & N.W. Railway, and lighting contracts included those for Messrs. Sir W. G. Armstrong, Whitworth & Co., Lever Bros., Joseph Crosfield & Sons, and Topham Jones and Railton. Their list for the year also included the King Edward VII. Sanatorium, some banks, churches, several private houses, &c. The wholesale department had sustained a severe loss in the death of its capable assistant manager (Mr. F. H. Gooch), who was killed at Vermelle after serving for eight months at the Front with the Cameron Highlanders. The restriction of lighting and absence of new building work had naturally affected the results; but, in spite of that, the net profit was slightly above that of the previous year. Attention was being paid to the lighting requirements of aviation and other factories engaged in Government work. Owing to the shortage of carbons there had been a large demand for half-watt lamps with specially designed fittings to replace arc lamps. They

had manufactured complete switchboards for H.M. Office of Works for Windsor Castle, the Houses of Parliament and elsewhere), also for Corporations, power companies and others. The shortage of capable labour had caused considerable inconvenience in the works. The use of commercial lorries and delivery vans propelled by electric accumulators had been extended during the year, and vehicles had been supplied to Liverpool and Bury Corporations and some business houses. Subject to our acceptance of deferred payment, they had the offer of several Corporation orders. Considering the fact that one of their principal departments—namely, that connected with country house lighting—had been so seriously affected by the war, it was a cause for congratulation that they had been able to adjust themselves to the altered conditions and to show a small profit. That had been largely due to the ungrudging loyalty of the office staff, who had willingly undertaken the work of absentees by working long hours.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The annual general meeting of this company was held at Winchester House, Old Broad-street, London, E.C., yesterday (Thursday), under the presidency of Mr. C. J. Ford. A full report of the proceedings will appear in our next issue.

INTERNATIONAL LIGHT & POWER CO. (LTD.)—For the year ended June 30 the net profit, after payment of debenture interest and London and Canadian administration charges, was £10,273, and with £3,886 brought forward the total was £14,160. The preference dividend at rate of 6 per cent. per annum for the year has been paid, leaving £1,831 to be carried forward. The subsidiary companies, before declaring their dividends, placed to reserves for renewal and general purposes sums amounting to £8,260, making the total of those reserves £26,731. The progress of the subsidiary companies in Venezuela and the Argentine has been retarded by the effects of the war, and the Merida undertaking has been seriously affected by the Mexican troubles.

SOUTHERN BRAZILIAN ELECTRIC CO. (LTD.).—For the report for the year ended June 30 the net earnings of the company's Brazilian undertakings show an increase in currency of about 8 per cent. on the year. After deduction of all charges in Brazil and London, and of interest on debentures to July 1, 1915, there remains a balance to credit of profit and loss of £2,127, which the directors propose to carry forward.

STIRLING AND BRIDGE-OF-ALLAN TRAMWAYS CO. (LTD.)—The report for the year ended Aug. 31 states that the directors had decided to obtain a provisional order to authorise the substitution of mechanical traction for horse haulage. Meetings were held with the local authorities interested in order that the necessary consents might be got, but at the urgent request of the authorities the directors reluctantly agreed to postpone the matter.

UNITED RAILWAYS OF HAVANA AND REGLA WAREHOUSES (LTD.)—The report for the past year states that the total increase in receipts was £10,000, of which £6,600 had been on the electric services, a striking reproduction abroad of home experience. The ordinary dividend is 5 per cent., which will be paid in cash instead of in debenture stock as in 1914.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

L. ADAMS (LTD.) (142,058).—Reg. Nov. 6, capital £1,000 in £1 shares, to carry on the business of mechanical and electrical engineers and contractors, founders, manufacturers of machinery, tool and boiler makers, &c., and to adopt an agreement with Alfred Emil Voss. Private company. Reg. Office: Heath Works, South Hill-park, Hampstead, N.W.

ALBERT A. BALL & CO. (LTD.) (142,084)—Reg. Nov. 10, capital £1,000 in £1 shares, to acquire business carried on as Albert A. Ball & Co., of business and financial and commission agents, &c., and of manufacturers of refills for electric batteries and pocket lamps and torches as the K. Mfg. Co. Private company. First directors are A. A. Ball, F. Osbaldeston and O. D. Leslie. Reg. office: 2 and 3, Eldon-street, E.C.

T. W. GLAZE & CO. (LTD.) (142,113)—Reg. Nov. 11, capital £6,000 in £1 shares, to take over the Maritime Works at Foxoak-street, Cradley Heath (Staffs), and the business carried on there as T. W. Glaze & Co., and to carry on the same and the business of furnishing ironmongers, electrical engineers, &c. Private company. First directors are T. W. Glaze, W. Jackson and J. Priest.

W. SANDERS & CO. (1915) (LTD.) (142,057.)—Reg. Nov. 5, capital £2,000 in £1 shares, to take over the business of an electrician, metal worker, mechanical engineer and manufacturer carried on by L. G. Russell. Private company. First directors are L. G. Russell (permanent director and chairman), Lucy Russell and W. Sanders. Secretary, Lucy Russell. Reg. office, 7, Oxford-street, Digbeth, Birmingham.

MORTGAGES AND CHARGES.

LONDON ELECTRICAL TRADING CO (LTD.)—Issue on Nov. 8, 1915, of £600 debentures, part of series of which particulars have already been filed.

RECEIVERSHIP.

CENTRAL WIRELESS CO. (LTD.)—R. B. Earle, 45, Newhall-street, Birmingham, ceased to act as receiver or manager on Nov. 4, 1915.

CITY NOTES.

MEMORANDA (Nov. 17).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 65. Consols Pay Day Dec. 1. Stocks and Shares Pay Days Nov. 25 and Dec. 14. Pay Days Nov. 26 and Dec. 15. Price of silver, 24¾d.

BUENOS AIRES PORT & CITY TRAMWAYS CO. (LTD.).—The accounts for the period from Dec. 31 to June 18, when a [illegible] was liquidated, show profits of £6,191, and debenture and rents [illegible], sinking fund £2,592, and interest £2,340.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the four weeks ended Aug. 27 amounted to 2,151,304, compared with 1,501,589 in the corresponding period of 1914. The number of units sold during the five weeks ended Oct. 1 was 2,[illegible] against 1,811,098 in 1914.

CASTNER-KELLNER ALKALI CO. (LTD.)—The net profit for year to Sept. 30 was £260,805, and amount brought forward was £18,302. It is proposed to place £50,000 to depreciation reserve and £10,000 to general reserve, and to pay a final dividend of 12 per cent. (making 20 per cent. for year) payable on the 30th inst., leaving £61,152 to be carried forward. Last year the net profit was £174,150, and the distribution was 15 per cent.

METALLIC SEAMLESS TUBE CO. (LTD.)—The net profit for the past year was £3,415, and with £4,349 brought forward, the total was £7,764. A dividend of 20 per cent. (tax free) is proposed, adding £3,000 to reserve and carrying forward £1,612.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 16. The greatest care is taken in compiling these figures but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Nov. 16.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	7¼	7 2 8	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅛	4 15 8	Feb Aug
10	6%	Do. 6% Cum 2nd Pref.	9¼	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	3⅝	5 16 9	Mar Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 9 9	..
5	5%	Do. Ord.	4	6 5 0	Aug. Feb
5	4½%	Do. City Pref.	3⅛	5 13 5	Jan Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4¼	5 8 1	Mar. Sept
St.	4½%	Do. do. Deb.	88½	5 1 2	Jan. July
10	9%	City of London Elec. Lt. Ord.	12½	7 8 5	Feb Aug
10	6/0	Do 6% Pref.	12¾	4 17 0	Mar. July
St	5%	Do. 5% Deb. St.	99½	5 0 0	Jun. Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9½	7 7 4	Mar Sept
10	6%	Do. 6% Pref.	10⅝	5 18 6	Feb, Aug
St.	4½%	Do. 1st Deb.	91	4 18 11	Jan. July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	76½	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	9⅛	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4⅛	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	86½	4 11 11	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2⅞	7 3 7	Mar, Aug
St	4½%	Do. 1st Mort. Deb.	98	4 11 10	Jan. July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan. July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 7	Mar. Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar. Sept
..	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 16 4	Apl. Oct
4	5%	South London E.S Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7⅛	6 19 9	Feb Aug
5	7%	Do do. Pref.	6⅞	5 13 1	Feb Aug
St.	3½%	Do do. Debs.	80	4 7 6	Jan Oct
St.	½%	Urban Elec. Supp 4½% Db. St	34	5 6 10	Apl. Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	⅛	7 2 3	Mar Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar. Sept
5	4½%	Do. 4½% Cum. Pref.	4⅛	5 7 5	Jan. July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl. Oct
St.	6%	Do. 6% Cum Pref.	98	6 10 6	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	67¼	5 .. 3	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 6	..
St	4½%	Do. 4½% Pref.	100	4 10 0	Jan. July
St	4%	Do 4% Deb. St.	86½	4 5 9	Jan. July
St.	4%	City & S. London Deb.	71¼	5 11 4	Mar. Nov
St.	5%	Do. Pref. 1890	80	6 5 0	Feb. Aug
10	⅝%	London Electric Ry. Ord.	1¼	5 11 1	Jan. July
St.	4%	Do. 4% Pref.	56½	7 1 0	Mar. Sept
St	4%	Do. 4% Debs.	85	4 14 4	Jan. July
St	1%	Metropolitan Ry. Con. Ord.	25	4 0 0	Feb. Aug
St	3½%	Do 3½% Pref.	77½	4 10 4	Feb. Aug
St	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb. Aug
St	3½%	Do. 3½% A Debs	82¼	4 4 6	Jan. July
St	3½%	Do. 3½% Debs	83¼	4 4 1	Jan, July
St	..	Metropolitan Dist. Ry. Ord.	15¼	..	Feb. Aug
St	4%	Do 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	73	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	115	5 4 4	Jan. July
St	4%	Do. 4% Debs.	72½	5 10 4	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	67⅞	5 18 0	Jan. July
St.	4%	Do. 4% Guar. Stock	78½	5 6 0	Mar. Sept
10	..	Underground E. Rys. of London Shares.	1⅝	..	..
1/0	..	Do. A Ord.	⅜	..	..
St.	6%	Do. 6% Inc. Debs.	104	5 14 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Tues., Nov. 16	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	75½	7 18 10	Mar, Sept
..	4½%	Do. 4½% Bds.	98¼	4 11 10	Jan, July
5	..	Yorkshire W. Riding Ord.	¼	..	March
5	6%	Do. Pref.	4 7/16	6 15 3	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2 5/16	6 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1 3/16	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	92½	5 8 5	Jan, July
1	6%	Do. 6% Pref.	⅝	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10	7 10 0	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5¼	5 14 3	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1 3/32	8 8 5	April
100	6%	Do. 6% Prior Lien Debs.	101⅛	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70½	5 10 4	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10½	7 2 10	Jan, July
5	2/6	Do. 5% Pref	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	15%	Castner Kellner	3⅛	4 16 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	3⅛	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	1/32	..	Feb, Aug
St.	4%	Do. 4% Deb.	62	6 9 0	Jun, Dec
1	6%	Elec. Construction Ord.	1/16	8 14 7	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10 7/16	9 11 7	July
10	6%	Do, 6% Pref.	9 7/16	6 7 2	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅛	7 14 4	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4¼	4 14 9	..
St.	4½%	Do. 4½% Db.	91⅛	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7 13/16	6 4 10	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	33½	7 3 3	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅝	4 12 4	May, Aug
1	6d.	Do. 5% Pref.	5/16	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	82½	4 17 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	100⅛	4 9 2	Jun, Dec
		Telegraphs.			
..	15/0	Anglo American 6% Pref. Ord.	100¾	5 17 11	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23	6 19 5	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	68½	5 16 9	Ja.Ap, Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6 1/16	6 11 11	Ja,Ap, Jly,O
St.	7%	Eastern Tel. Co. Ord.	123½	5 13 4	Ja,My, Jly,O
St.	17/6	Do. 3½% Pref.	65	5 7 8	Ja,My, Jly,O
St.	4%	Do. 4% Debs.	80½	4 19 8	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11⅞	5 17 11	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8.	33¼	7 3 1	Ja, My, Jly
25	13%	Indo-European	45	7 4 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅞	5 6 8	April
1	7%	Do. 7% Pref.	1 5/16	3 19 0	July
10	1%	West India & Panama Ord.	1 1/16	9 2 10	May, Nov
10	6%	Do. 1st Pref.	8	7 10 0	May, Nov
10	7%	Western Telegh. Co. x d & bonus	12 7/16†	5 12 7	Mr, Jly,O,Dec
St	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135½	5 7 10	Ja,Ap, Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	76	6 11 7	Jan, Jly
..	7½d.	Monte Video Telephn. Ord	⅝	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101 3/16	4 5 9	May, Nov
..	10%	*Oriental Telephone Ord.	1 3/16	5 4 11	Apl, Oct
St.	4%	Do. Db. St.	81	4 18 9	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
..	8%	United River Plate Ord.	5 7/16	7 4 8	Apl, Oct
..	5%	Do. 5% Cum. Pref.	4 13/16	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10⅜	5 17 9	Sp.Dc,Mr, Jn
10	6%	Do. 6% Pf.	10⅛	5 17 1	Sp.Dc,Mr, Jn
100	5%	Mackay Companies' Common	86½	5 15 7	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68¼	5 16 4	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	81	6 3 5	Jun, Dec
St.	4½%	Do. 4½% Debs	75⅛	5 18 7	Jan, July
St.	4%	Do. 4% Debs.	76	5 5 3	Jan, July
5	2/9	Do. 5½% 1st Pref.	3 1/16	7 0 0	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅛	7 10 6	Jan, July
100	20%	Brazilian Traction Ord.	57⅛	6 18 3	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	92	6 10 5	Ja,Apl, Jly,O
5	8%	Brisbane Trams Ord.	6⅛	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4 1/16	5 5 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62	6 17 1	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅛	7 16 11	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	89	5 12 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4 1/16	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	41	..	Fb,M,Aug,N,
..	5%	Do. 5% Bds	50	10 0 0	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	95	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	78	6 8 2	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	3⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	97	5 3 1	Jun, Dec
10	6/-	Bombay E S & T 6% Pref.	10⅛	5 15 8	..
St	4½%	Do. 4½% Debs.	87⅛	5 2 10	Jan, Jly
5	9%	Calcutta E. S. Corp. Ord	6 3/16	7 4 9	May, Nov
5	5%	Do. 5% Pref	4⅛	5 11 3	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	124½	5 12 5	Ja,Apl, Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	98	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29	..	Ja,Apl, Jly,O
..	..	Do. Pref.	42	..	May, Nov
..	5%	Do. 5% Bds	42⅛	10 4 2	Jan, Jly
..	5%	Shawinigan Water & Power 5% Bds	101⅛	4 18 6	Jan, July
..	6%	Do. Cap Stock	143½	4 3 2	Ja,Apl, Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	84⅛	5 6 6	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	1⅛	..	Jan, July
—	5½%	Do. 5½% 2nd Mort. Debs.	95⅛	5 9 9	Jan, July

* And 13⅓% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 17, the following as the present basis prices of

New Metals.	per lb.		per ton
Solid Drawn Brass Tubes	14½d.	English Lead	£28 0 0
Solid Drawn Copper Tubes	14d.	Antimony	Nominal.
Brazed Copper Tubes	14d.		
Brazed Brass Tubes	16½d.		
Brass Wire	13½d.		
Copper Wire	13d.		
Rolled Brass	13½d.		
Brass Sheets	14½d.		

	per ton.	Old Metals.	per ton.
Copper Sheets	£110 0 0	Clean Scrap Copper	£71 0 0
Spelter	£90 0 0	Brazlery Copper Scrap	£64 0 0
		Clean Scrap Brass	£55 10 0
		Old Lead	£22 0 0
		Old Zinc	£45 0 0
		Hollow Pewter	£120 0 0
		Black Pewter	£80 0 0
		Gun Metal	£62 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 16, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£100 0 0	Old Lead	£22 10 0
Clean Mixed Brass	£58 0 0	Tea Lead	£20 10 0
Clean Copper	£73 0 0	Old Zinc	£53 0 0
Brazlery Copper	£67 0 0	Hollow Pewter	£115 0 0
Gun Metal	£68 0 0	Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £74; Commercial Tinman's Solder, £95; Blowpipe Solder, £106.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 10	1,861	+ 132	23	48,814	+ 2,239
Anglo-Argentine	,, 11	53,091	+ 207	23	2,293,384	— 134,896
Ashton-under-Lyne	,, 13	439	+ 49	33	16,086	+ 1,151
Ayr Corporation	,, 13	251	+ 20	26	11,374	+ 611
Birkenhead Corporation	,, 14	1,362	+ 163	33	45,224	+ 3,588
Birmingham Corporation. Trams	,, 6	15,218	+ 2,810	32	444,429	+ 57,650
Birmingham Corporation. Buses &c.	,, 6	806	+ 100	32	27,238	+ 17,376
Blackburn Corporation	,, 10	1,079	+ 57	33	43,315	— 418
Blackpool Corporation	,, 11	662	+ 104	33	64,315	+ 1,356
Blackpool and Fleetwood	,, 13	292	+ 9	45	37,011	— 248
Bolton Corporation	,, 14	2 582	+ 148	33§	88,798	— 2,057
Bournemouth Trams	,, 10	1,722	+ 66	32	70,643	— 3,767
Bournemouth Buses	,, 10	6	— 1	32	870	— 103
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	,, 14	918	+ 72	33§	38,738	+ 139
Bristol Trams Trams	,, 12	4,837	+ 501	45	211,871	+ 2,267
Bristol Trams Buses, &c.	,, 12	4,831	+ 1,291	45	220,072	+ 39,478
Burmah E. Trams & Ltg.	,, 13	R4,235	+ R 902	..	..	+ R240
Burnley Corporation	,, 13	1,488	+ 183	6	9,273	+ 1,329
Burton Corporation	,, 14	282	— 6	33	9,563	— 412
Bury Corporation	,, 14	1,237	+ 86	33§	45,417	— 611
Calcutta Tramways Co.	,, 11	R62,550	+ R2,471	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 11	473	— 2	45	22,773	+ 27
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	,, 9	979	+ 36	31‖	33,584	+ 881
Dover Corporation	,, 13	277	+ 57	32	10,551	+ 1,896
Dublin & Lucan Railway	,, 12	115	— 5	19	3 072	+ 104
Dublin United	,, 12	5,874	+ 234	45	276,535	+ 10,579
Dundee Corporation	,, 10	1,388	+ 123	26§	35,484	+ 1 938
East Ham Council	,, 13	1,247	+ 43	32‖	43,026	+ 5,678
Exeter Corporation	,, 12	347	+ 29	32	12,708	+ 744
Glasgow Corporation	,, 13	21,795	+ 1,558	24‡	520,305	+ 38,931
Glossop Trams	,, 13	123	+ 24	46	5,780	+ 170
Gloucester Corpn.	,, 10	285	— 5	32	10,975	+ 105
Halifax Corpn. Trams	,, 9	2,060	— 43	32	73,790	+ 899
Halifax Corpn. Buses	,, 9	41	— 2	32	1,636	+ 7
Hastings Elec. Trams Co.	,, 11	790	— 62	45	44,585	— 163
Huddersfield Corpn.	,, 13	2.512	+ 159	32	88.717	+ 12.767
Hull Corporation	,, 13	3,104	+ 120	32	99,402	— 3.368
Ilford District Council	,, 13	585	+ 7	32	21,421	+ 2,897
Ilkeston Corporation	,, 10	125	+ 4	32	4,363	+ 116
Ipswich Corporation	,, 13	479	+ 92	31	18.494	+ 2,928
Isle of Thanet Co.	,, 13	248	— 57	6¶	1,817	— 711
Kilmarnock Corporation	..	..	..	..	..	..
Lanarkshire Trams Co.	..	..	..	..	..	..
Lancashire United	,, 10	1.595	+ 109	45	78.786	+ 4.871
Leeds Corporation	,, 13	8,748	+ 732	33	294.986	+ 23.099
Leicester Corporation	,, 13	3.195	+ 459	46	138.002	+ 7.858
Leith Corporation	,, 13	728	+ 52	26	20,469	+ 1,231
Lincoln Corporation	,, 13	130	+ 14	33	4,640	— 510
Liverpool Corporation	,, 13	13,052	+ 397	45¶	605,306	+ 7,891
Llandudno & Colwyn Bay R	..	..	..	..	..	..
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	,, 11	192	+ 11	32	7.358	+ 164
Manchester Corporation	,, 13	17,455	+ 782	32	587,915	+ 19,146
Nelson Corporation	,, 13	187	+ 39	32‖	6.455	+ 137
Newcastle-on-Tyne Corpn	,, 13	5.799	..	..	207,527	..
Newport (Mon.) Corpn.	..	..	..	..	..	..
Northampton Corporation	,, 12	664	+ 90	32¶	24,142	+ 4,580
Nottingham Corporation	,, 11	3.635	+ 310	32	121,541	+ 8,179
Oldham Corporation	,, 4	12,123	+ 232	34	78,852	+ 3,267
Portsmouth Corporation	..	..	..	..	..	..
Preston Corporation	,, 10	934	+ 48	32••	31,244	+ 772
Ramsgate	..	..	..	..	..	..
Rotherham Corporation	,, 10	1.196	+ 246	32	37.538	+ 3,985
Salford Corporation	,, 15	4,919	+ 392	33‡	172,531	+ 6,665
†Sheffield Corporation	,, 14	9,310	+ 1,775	32‖	299,548	+ 40,103
Southampton Corpn.	,, 10	1,438	+ 252	32	49,244	+ 5,067
Southend Corporation	..	..	..	..	..	..
South Shields	,, 6	751	+ 3	31‖	25,675	+ 908
Stalybridge, Hyde, &c. Jt. B	..	..	..	..	..	..
Sunderland Corporation	,, 14	1,424	+ 154	33	49,493	+ 148
Sunderland District	,, 10	535	+ 6	32	1.079	+ 3
Swindon Corporation	,, 10	170	— 2	32	6,482	+ 609
Tynemouth Trams Co.	,, 3	540	— 10	18	11,490	— 513
Wallasey Corporation	,, 13	1,123	+ 56	32‖	43,095	+ 335
Walsall Corporation	,, 13	782	+ 139	46	33.834	+ 5.044
Walthamstow	,, 13	718	— 13	33	30,476	+ 3,267
Warrington Corporation	,, 11	462	+ 30	32	14,765	+ 681
West Ham Corporation	,, 11	2.870	+ 36	32	101.194	+ 9.266
Widnes Corporation	,, 11	1,545	+ 178	32	49,804	+ 2,252
Wolverhampton Corpn.	,, 11	1,087	+ 75	6	6,473	+ 384
Yorkshire W.R. Trams	,, 14	1.503	+ 13	46	72,921	+ 5.980

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses &c. ‡ Minus 2 days. ‖ Minus 3 days ¶ Plus 1 day. § Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 263
Arrangements for the Week .. 266
Experimental Data Concerning the Safe Operating Temperature for Mica Armature Coil Insulation. By F. D. Newbury. Illustrated 267
Economics of Electric Power Station Design. By H. F. Parshall, D.Sc. Illustrated 269
Some Difficulties of Design of High-Speed Generators. By Prof. A. B. Field. Illustrated 272
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated. *Continued* 276
Organising British Engineering Industry 278
PRO PATRIA 280
REVIEWS 281
Alternating Current Work [Maycock].
REVIEWS—*Continued.*
Grinding Machinery[Guest].
Micrometers, Slide Gauges and Calipers: Their Construction and Use [Marshall and Gentry].
Mr. C. P. Sparks' Presidential Address to the Institution of Electrical Engineers 282
CORRESPONDENCE 285
"Some Problems of Electromagnetic Induction" (J. C. Wilson).
Transformer Core Loss as Affected by Triple Harmonics (H. M. Lacey and C. H. Stubbings).
Frequency, Freq., or Curl? (W. Perren Maycock).
Physical Society 286
Manchester Corporation Electricity Supply Accounts. Illustrated 287
Educational Notes 288
The "Electrician" Commercial and Industrial Section .. 289–300

NOTES.

The Necessity for Manufacturing Profit.

IN his presidential address to the Institution of Electrical Engineers last week, Mr. C. P. SPARKS touched upon a point the importance of which is often forgotten. It is not infrequently assumed that it does not much matter whether the manufacturer makes a profit so long as the purchaser obtains his plant at the lowest possible price. This, however, is a very short-sighted policy, and much of the mischief that has been done is no doubt due to the acceptance of the lowest tender, irrespective of the quality of the plant that is offered. Mr. SPARKS rightly points out that if a reasonable margin of profit is not secured, the contractor cannot, in the long run, do his duty by the purchasers. He cannot provide for developments, because new capital cannot be attracted without a prospect of reasonable profit. Under these conditions everything is cut down to a minimum; provision cannot be made for improvements, and the last thing that can be encouraged is research. Thus it becomes impossible to keep pace with our competitors in other parts of the world. Unfortunately, at the present time, there is a great deal of capital in the electrical industry which is not productive, or which at least does not earn a reasonable dividend. So long as this is the case it cannot be considered that the electrical industry is in a satisfactory position.

Scheduled Trades.

ON Saturday last the Local Government Board issued a circular for the guidance of the tribunals to be set up under the Derby recruiting scheme. After a careful perusal of the circular we are moved to express the wish that such tribunals will show sound common sense in the interpretation of the circular, and will be composed of business men as distinct from political organisers. The occupations scheduled as being vitally important at the present time for war work, or for other essential requirements, have manifestly been selected by someone without expert knowledge of the trades to which reference is made. Men of military age engaged in any of the occupations set out in the schedule who present themselves for attestation are to be placed in the Army Reserve, but will not be called up for military service unless it has been decided that it is no longer necessary to retain them in civil employment. It is common knowledge that eligible men, in no sense indispensable, have been taken into munition works without either training or experience and have been starred. In many trades the omissions are serious, and unless the Schedule is amplified without delay our soldiers will find themselves without shirts to their backs, without clothing for their bodies, and without food for their bellies. In the engineering trades, and particularly in electrical engineering, the omissions are equally serious. For the moment the wiremen are "safe," as also are the armature winders, ship electricians, and electrical instrument makers, and it has been officially recognised that those engaged in electric light and power supply are doing work of cardinal importance for the maintenance of some other branches of trade and industry. Designers and trained engineers, experts, testers, inspectors and assessors do not figure in the lists, neither do engineering and technical students. Unless steps are taken quickly to stop these men sacrificing their careers, we shall be unable to make headway in the struggle for industrial supremacy that will unquestionably begin with the termination of the war. We warn the Government that in this, at least, they must take thought for the morrow.

Mica Insulated Armature Coils.

THE advantages of mica as an insulating material are well known. The mica used for armature coil insulation has a greater factor of safety at 150°C. than impregnated tape at 105°C., and it shows no distress under conditions which quickly puncture treated tape, causing the latter to break down under severe operation. Moreover, mica shows a continuously increasing insulation resistance at temperatures above 200°C., whereas treated tape breaks down structurally at temperatures higher than 100°C., and the insulation resistance rapidly decreases. It has been found that this characteristic alone prevents the safe use of treated tapes and fabrics for the insulation of the armatures of high-tension alternators, and for temperatures above 100°C. In the latest standardisation rules of the American Institute of Electrical Engineers, the ability of manufacturers to employ mica insulation successfully at maximum temperatures of 150°C., and even higher, is recognised, but in the rules it is stated that as sufficient data covering experience over an extended period at such temperatures is at present unavailable, a temperature of 125°C. has been adopted as a conservative limit for this class of insulation, and any increase above this figure should be the subject of special

guarantee by the manufacturer. In the British Standardisation Rules for Electrical Machinery a maximum observable temperature of 115°C. is allowed for mica insulation for rotating machines wound for pressures not exceeding 5,000 volts. For a machine, other than a transformer, wound for a pressure exceeding 5,000 volts, the limits of observable temperature allowed are reduced by 1·5°C. for each 1,000 volts or part thereof by which the rated pressure exceeds 5,000 volts.

FURTHER data on the safe operating temperatures of built-up mica-and-cambric insulation were given recently by Mr. F. D. NEWBURY in an informative Paper read before the American Institute of Electrical Engineers. The tests were made on the first alternator installed at Niagara Falls 20 years ago by the Westinghouse Co. It is interesting to note that this generator has operated for approximately 110,000 hours, which is equivalent to 5,800 hours per year, or to 16 hours' operation every day, and has delivered 280-million kilowatt-hours. From the abstract given elsewhere it will be noticed that in one series of tests the operating temperatures were measured by installing special conductor bars having thermo-couples in actual contact with the copper at its hottest part. Temperatures considerably in excess of those set out above were observed, and an examination made in 1914 showed the insulation to be in good condition, with the mica unchanged and with the conductors tight in the slots. Before removing the insulation from some of the bars Mr. NEWBURY made a puncture test, and 22,000 volts was reached before the poorest sample broke down. The operating voltage is 2,300. The growing practice of building into electrical machinery suitably placed thermo-couples or temperature detectors should place at the disposal of the designer a good deal of valuable information on the question of maximum temperatures. This will in all likelihood lead to further progress in the ventilation of electrical machinery, and will probably necessitate a revision of the maximum allowable temperatures. It is evident that by using suitable materials manufacturers need have no fear in giving the special guarantee called for when the maximum observable temperature exceeds that laid down by the several institutions.

Economics in Power Stations.

ELSEWHERE we give in abstract a Paper by Dr. H. F. PARSHALL, who has a knack of compressing a vast amount of useful information into a small space by means of curves. Some time ago Dr. PARSHALL gave curves relating to the design of traction systems. In the present Paper, which was read before the International Engineering Congress in San Francisco, he gives curves showing the way in which certain items of cost vary with the size of the plant, load factor, &c. Such curves serve to bring out prominently many points that arise in power station design. For example, the coal cost falls only slowly with increasing total capacity of plant installed after, say, 10,000 kw., and is much more affected by load factor than by total capacity. This is largely true also of the total works costs. Capital charges, on the other hand, still show a marked tendency to fall with larger capacities, and this is still more true of total costs, including capital costs. In regard to the possible saving due to transmission from a generating station at a distance, a diagram is given showing that with a 20 per cent. load factor it does not pay to transmit further than about 5½ miles, and with a 10 per cent. load factor beyond about 2 miles. This is on the assumption of the price of coal being reduced from 15s. to 11s. by the change in locality, and it is also assumed that transmission is by underground cables. Obviously, no very general conclusion can be drawn, and every case must be considered on its merits, otherwise the many examples of transmission over longer distances would not show to commercial advantage. Other curves given by Dr. PARSHALL refer to the gain by using economisers and artificial draught. In every case it is a question of the balance of capital charges against increased efficiency, and it is often found that it is commercially better to have a less efficient station in order to make a gain in capital charges.

The Audion Amplifier.—*Erratum.*—Mr. E. H. Armstrong has asked us to state that with reference to his letter which appeared in our issue of Oct. 15th, on p. 61, the date on which the Paper concerning the regenerative system of amplification was presented before the Institute of Radio Engineers was March, 1915, and not as stated March, 1914.

Electricity in Wool.—This is a subject of very considerable importance to wool-spinners, as the presence of static electricity in the fibrous material results in difficult manipulation as well as in bad and uneven work. This defect is found also in cotton, silk and other materials. According to "Engineering," various methods have been adopted for discharging the electricity, one of the most novel being the employment of radio-active salts, arranged on an earthed plate below the fibres. This method, it is stated, has proved fairly successful.

Electric Oven for Testing Shrapnel.—In the testing of shrapnel shells it is necessary that a temperature of 120°F. be maintained continuously for a period of 24 hours. In one of the United States Government Arsenals in Pennsylvania this is done in an electric furnace in which the control of temperature is secured by means of a thermostat. Arcing has been reduced to a minimum by means of a condenser shunted across the contacts. It is claimed that the temperature of the oven in a continuous test of 24 hours did not vary more than 1 deg.

Remote Control of Marine Engines.—According to the "Shipping Gazette," successful trials have been made at Nagasaki, Japan, with an invention of Dr. K. Ito, for manœuvring a ship entirely from the bridge. The device replaces the usual telegraph to the engine room by a complete remote control of the engines from the bridge, the starting, stopping and reversing being carried out by electrical means. Such an apparatus would have the advantage of quick response in emergency, and it is even claimed that the navigator could prevent "racing" in rough weather by suitably lowering the engine speed as the stern of the boat was lifted by a wave.

Turbo-Electric Dredger.—The "Steamship" states that in a dredger now under construction by the New York Engineering Co. all the machinery will be electrically driven, the current being provided from a steam turbo-dynamo set. There is to be a 12 in. high-pressure pump coupled to a 125 H.P. motor, and a 14 in. low-pressure pump directly driven by a 75 H.P. electric motor. The other machinery includes the usual fire pump and accessories, and there is also a travelling crane and several auxiliary pumps and machines. The buckets of the dredger, which is to be used for gold dredging, are to be made of manganese steel, and will dig 55 ft. below the waterline, rising to 35 ft. above it.

Mechanical Coal-Loading Plant.—In a new type of coal-handling plant built for the Southern Railway at Charleston, S.C., by the Wellman Seaver-Morgan Co., Cleveland, Ohio, the coal is mechanically loaded into the ship instead of being allowed to flow by gravity. This type has the advantage of little breakage of coal, while the plant need not be so large as the gravity type. A movable car dumper of standard type is used to empty the trucks into the hopper of the movable loading tower, which is of 100 tons capacity. Thence the coal is taken by a conveyor through a curved arm extending over the boat, at the extremity of which it falls through a telescope chute into the hold. The arm can be adjusted as to vertical height and horizontal extension for boats of different size. There is also a trimmer of the Blake rotating type operated by a motor at the side of the chute. The conveyor, of the scraper type, has a capacity of 3,600 tons

per hour. The plant can handle 30 100-ton trucks per hour. It is entirely electrically-driven and requires three men to operate it.

Electric Percussion Rock Drills.—The Fort Wayne Electric Works (U.S.A.) have standardised a rotary-hammer type of electric drill, recently described in "Engineering News." A rotating helve carries two hammers and is belt driven at 850 revs. per min. by the driving motor, using a tightening idler pulley to give speed variation. The round-headed hammers strike a round-headed cap or tappet block, against which the drill steel is set. On the recoil the hammers are cushioned by the air trapped in the hammer chambers. Normally the drill gets 1,700 blows per minute. The steel is also rotated by a worm gear. Special drills are used with a helical rib, or wing, going around from point to grip and serving to convey the rock punchings out of the drill hole. The motors, which are fully enclosed, are furnished for 115, 230 and 550 volts direct current, and 110 and 220 volts single or two-phase alternating current, and absorb from 1·5 H.P. to 2·5 H.P.

Molecular Physics.—A Paper was read before the Royal Society on 4th inst., by Mr. W. B. Hardy, F.R.S., on "An Application of the Principle of Dynamical Similitude to Molecular Physics." Applying the principle of dynamical similitude to the case of the internal latent heat of evaporation, it is found that if temperature be proportional to the mean energy of progressive motion of the molecules, the internal latent heats of dynamically corresponding states should be given by the equation $LM=a\tau$, where L is the latent heat, M the gramme-molecular weight, a a constant, and τ the temperature. The assumption made is that the critical states are dynamically corresponding states, and that corresponding temperatures are equal fractions of the critical temperature. The equation for internal latent heats is then found to have the form $LM+b=a\tau$ for normal paraffins and for certain halogen derivatives of benzene. The conclusion is drawn that, subject to the assumption being correct, the potential energy of repulsive forces acting between the molecules contributes to the process of evaporation.

Trams and 'Buses in London.—At the International Engineering Conference in San Francisco Sir Albert Stanley contributed a Paper on "London Traffic in 1913." In speaking of the competition between the London County Council trams and the motor omnibuses, he showed the situation by the following table :—

L.C.C. Tramways.

	Number of passengers.	Per cent.	Average receipt.	Proportionate share of whole.
1911 ...	516,092,489 ...	— ...	1·04d. ...	60·2
1912 ...	501,102,149 ...	2·9 (dec.)*	1·03d. ...	50·4
1913 ...	522,952,600 ...	1·3 (inc.)* ...	1·01d. ...	41·8

L.G.O. and Associated Motor 'buses.

1911 ...	340,669,411 ...	— ...	1·32d. ...	38·8
1912 ...	492,858,934 ...	44·7 (inc.) ...	1·32d. ...	49·6
1913 ...	705,156,724 ...	107 (inc.)* ...	1·33d. ...	58·2

* On 1911.

Reviewing the growth of the Underground Electric Railways Co. of London the author said that to-day it is responsible for the operation of 61½ route miles of electrically-worked urban railway, 123 route miles of tramway and practically all the motor-omnibuses of London.

Trailer Cars on the L.C.C. Tramways.—Some interesting features of the trailer trams employed on the lines of the London County Council have been described in the "Tramway and Railway World." These are four-wheeled cars, drawn by ordinary bogie trams which have been fitted with a special draw bar and automatic coupling gear. A spring shock-absorber is fitted in the trailer draw bar, and a universal joint allows for horizontal and vertical deviation due to curves and to the oscillation of the cars. In addition to an ordinary hand-brake equipment with brake blocks on the outer sides of the wheels, there are automatic brakes, the blocks of which are on transverse beams between the pairs of wheels, and are pressed outwards upon them by strong springs forcing the beams apart. The action of these springs in holding the brakes "on" is counteracted by the pull of a chain mechanism connected to the draw bar. Thus, when the tractor car is drawing the trailer at an even speed, or accelerating, the brakes are pulled "off," but as soon as power is shut off the springs put them into operation. "Skefko" ball bearings are fitted to the trailers, as it is found that by their use the pull required to start the car is reduced by more than half as compared with ordinary bearings.

OBITUARY.

DR. H. C. BASTIAN.—We regret to record the death at Bourg-la-Reine, Bois on Wednesday last of Dr. Henry Charlton Bastian, F.R.S. He will be remembered in connection with his claim to have conclusively proved by experiment that life could arise of itself from inorganic matter.

KILLED IN ACTION.—Lieut. Frank Stevenson Long, 11th Essex Regiment, was killed about Sept. 26. At East London College he obtained the B.Sc. in 1909. He then became demonstrator, and took up research work. In 1911 he went to Cambridge, first as a member of the Day Training College, and afterwards as secretary to the Censor and Librarian at Fitzwilliam Hall. He also took the Mathematical Tripos in the first class.

PERSONAL.

Among the members of the U.S.A. Naval Advisory Board, of which Mr. T. A. Edison was appointed chairman, is Dr. WILLIS R. WHITNEY, Ph.D., Director of the research laboratory of the General Electric Co., of Schenectady, N.Y. Dr. Whitney graduated in 1890 from the Massachusetts Institute of Technology, and served as an assistant professor of chemistry in that institution. He was subsequently appointed by the General Electric Co. as director of their research laboratory at Schenectady, and among the many important developments and inventions made in this laboratory under Dr. Whitney's direction have been the drawn-wire tungsten filament and the gas-filled (half-watt) lamp. Another member is Dr. W. L. R. EMMET, chief engineer of the lighting department of the General Electric Co. Dr. Emmet is a graduate of the United States Naval Academy, and served as an officer in the United States Navy, which position he resigned to take up engineering work with the General Electric Co. (U.S.A.) at their Schenectady works. He was responsible for the development of the Curtis steam turbine as applied to the driving of electric generating machinery, and was specially engaged on this work for a number of years. His most recent development is the mercury vapour turbine, a Paper on which was presented before the American Institute of Electrical Engineers during the past year.

The numerous friends of Mr. A. V. Gifkins, electrical contractor, who was seriously injured in the recent Zeppelin raid, will be pleased to hear that he is making excellent progress, and hopes to leave the hospital within the next fortnight. In the meantime he tenders his sincere thanks to the large number of those who have written to him expressing their sympathy, and hopes to deal more fully with their letters at a later date.

Among those present at the funeral of Prof. Raphael Meldola, at the Spanish-Portuguese Cemetery at Golder's Green, were Mr. H. F. Heath, C.B. (Advisory Council for Scientific and Industrial Research), Dr. A. S. Woodward (Geological Society), Mr. A. C. Chapman (Society of Public Analysts), Mr. E. B. Knobel (Royal Astronomical Society), Dr. Sylvanus P. Thompson, Prof. I. Gollancz, and representatives of the Board of British Dyes (Ltd.), the Society of Chemical Research and other bodies.

ROYAL ENGINEERS (T.F.)—The following appointments and changes have been made :—

Tyne Electrical Engineers : A. J. L. Planket and Richd. G. Ellis to be Second Lieutenants. Lieut. G. J. N. Deane is seconded.

Southern Signal Companies (Army Troops) : Lieut. Harold Dickinson has been appointed temporary Captain.

INSTITUTIONS AND SOCIETIES

Institution of Electrical Engineers.—At the meeting held last week Mr. D. J. Blaikley presented in trust to the Institution a valuable collection of books and manuscripts belonging to Faraday. Mr. Blaikley remarked that he was happy to be able to make the presentation personally. Miss Barnard and Mrs. Blaikley (the wife of

Mr. D. J. Blaikley) were nieces of Faraday, and Miss Barnard had lived with him in his later years; thus the present books and manuscripts had been left in her hands. In her will she had left them in trust to Mr. Blaikley to dispose of them in the way in which he thought best. She had also wished that Mr. W. M. Mordey should be consulted in the matter, and this has been done. The books included Faraday's Journal of his tour with Sir Humphry Davy, various laboratory notebooks, autograph letters, letters to Faraday from scientists abroad and from Kelvin, Clerk-Maxwell, Morse and many other well-known workers in this country. At the same time he presented an iron filings diagram of lines of force which had been made by Faraday, and a plate showing prismatic colourings, presented to Faraday by the late Mr. Gassiot. In his concluding remarks Mr. Blaikley expressed his thanks to Mr. W. M Mordey and to Prof. Silvanus Thompson for the assistance he had received from them in the examination of the papers.

Prof. S. P. Thompson, in proposing a vote of thanks, stated that the Institution were fortunate in having such a legacy, and it was a great advantage to have them presented by one who had known Faraday personally, and to whom he was personally connected. One of the most interesting volumes in the collection was the journal of the tour with Davy in 1813, when, at the age of 23, he was learning foreign languages by contact with foreign peoples and enlarging his grasp of physical phenomena by coming into contact with foreign scientists. He was interested to find that the collection included a pamphlet on "Dry Rot in Timber," which he (the speaker) had only been able to find after a search of 10 years.

Mr. W. M. Mordey formally seconded the vote of thanks. He expressed the hope that the Institution would at some later date publish a fourth volume of Faraday's "Experimental Researches," in which the most interesting parts of this collection would find a place.

Mr. Blaikley, in acknowledging the vote of thanks, stated that he left the rights of publication entirely in the hands of the Council, making no reservations.

Mr. Mordey then made a presentation of two gifts which had been presented to him by Miss Barnard, one being a manuscript book of extracts which Faraday had made from various works in 1809-10, when he was apprenticed to a bookbinder. This, he felt, was an exceedingly interesting volume, in that it showed the tendency of Faraday's mind at an early age. The second was a piece of the "heavy glass" with which Faraday in 1845 made his magneto-optic experiments, demonstrating the connection between light and magnetism by obtaining a rotation of the plane of polarisation in a magnetic field, and with which he also discovered diamagnetism.

Sir John Snell expressed the thanks of the Institution to Mr. Mordey for his generous gift. Sir John then presented the premiums which had been awarded in connection with the past session, and introduced Mr. C. P. Sparks as the new President. A vote of thanks to the retiring President was proposed by Mr. W. Duddell, and seconded by Mr. J. S. Highfield.

Mr. Sparks then delivered his presidential address, of which an account will be found on another page. At the conclusion of the address a vote of thanks to Mr. Sparks for his address was proposed by Mr. C. H. Wordingham, and seconded by Dr. Russell.

Manchester Association of Engineers.—On Saturday last Mr. S. L Pearce, chief engineer of the Manchester electricity department, gave a lecture on "Manchester Electricity Supply: some Recent and Projected Extensions." He reviewed the past history of the undertaking, describing its rapid growth and comparing it with other large undertakings. He also spoke of the projected new generating station at Barton, and gave a general description of the scheme.

Faraday Society.—At the annual general meeting held on Tuesday Oct. 19, at the Institution of Electrical Engineers, the following officers and members of council were elected to serve for the year 1915-16: *President*, Sir Robert Hadfield, F.R.S.; *Vice Presidents*, Prof. K. Birkeland, Bertram Blount, W. R. Bousfield, K.C., Prof. F. G. Donnan, F.R.S., Dr. Eugene Haanel, Prof. A. K. Huntington, Dr. T. Martin Lowry, F.R.S.; *Treasurer*, F. Mollwo Perkin, Ph.D.; *Council*, W. R. Cooper, Dr. C. H. Desch, Dr. J. A. Harker, F.R.S., Emil Hatschek, Cosmo Johns, Prof. Alfred W. Porter, F.R.S., E. H. Rayner, A. Gordon Salamon, Dr. George Senter, Capt. Magg. F. Stassano. The report of the Council for the past year states that the two general discussions on "Optical Rotatory Actions," and "The Hardening of Metals," resulted in no less than 90 and 88 pages of contributions respectively from most of the leading authorities on these subjects.

Royal Society of Arts.—On Wednesday, 17th inst., Sir Dugald Clerk, the new chairman of the Council, delivered his inaugural address, in which he gave his views on British and German methods. He reviewed Germany's recent industrial progress, emphasising the enormous growth of the production of pig-iron in that country. While admitting the German genius for organisation, Dr. Clerk held that the British were the more practical nation, and had to their credit far more pioneer work in invention and discovery. He agreed with Buckle that the German brain was deductive, while the English was inductive.

The British Electrical and Allied Manufacturers' Association.—The Association will not hold an annual dinner during the present session.

APPOINTMENTS VACANT AND FILLED.

A junior assistant is required on the editorial staff of The Electrician. *See advertisement.*

Mexborough Urban District Council invite applications for the appointment of electrical engineer, at a salary of £200 per annum. Applicants should be competent mechanical and electrical engineers, and have had commercial experience. Applications to the clerk of the Council, Mr. J. W. Hattersley, Hope-street, Mexborough, by Monday, Dec. 6. *See an advertisement.*

A staff assistant is wanted for electrical office work in a Government department. Salary £200 per annum. Applications to Commanding Officer, H.M.S. "Vernon," Portsmouth. *See an advertisement.*

There is a vacancy for an inspector of the private telephone system of the electric supply department of the City of Birmingham. Applications to the city electrical engineer and manager, Mr. R. A. Chattock, 14, Dale End, Birmingham. *See also an advertisement.*

Walthamstow Council require a station superintendent in their electricity department. Salary £150, rising to £200 per annum. Applications to the Clerk of the Council by 5 p.m. Nov. 30.

There is a vacancy on the professional staff of the Bennett College, Regent-street, Sheffield, for a tutor in the electrical department.

Swindon Corporation require temporarily for their electricity and tramways department a chief clerk (wages 50s. a week) and a clerk (wages 30s.). Applications to the Town Clerk by Dec. 1.

Middlesbrough Gas and Electricity Committee recommend the appointment of Mr. R. H. Scotson (mains engineer) to the position of chief electrical engineer, in succession to Mr. H. M. Taylor, resigned.

Mr. A. C. Bott, of Llangefni, has been appointed resident electrical engineer at Holmfirth.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Nov. 26th (to-day).

Physical Society.

5 p.m. Meeting at the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. Agenda: Papers on "Obtaining and Maintaining a Bright Hydrogen Spectrum, with Special Reference to the 4,341 Line," by Mr. J. Guild: and on "Determination of the Coefficient of Diffusion of Potassium Chloride by an Analytical Method," by Dr. A. Griffiths; and an "Exhibition of Apparatus for Evaluating Elliptic Integrals," by Mr. A. F. Ravenshear.

MONDAY, Nov. 29th.

Royal Society of Arts.

4:30 p.m. Meeting at John-street, Adelphi, London, W.C. "Cantor Lecture," by Dr. W. Rosenhain, F.R.S., on "Optical Glass."

TUESDAY, Nov. 30th.

Manchester Section of the Institution of Electrical Engineers.

7.30 p.m. Meeting at the Engineers' Club, Albert-square, Manchester. Paper on "Some Difficulties of Design of High-speed Generators," by Prof. A. B. Field.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding: Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the week commencing November 29, 1915:—

Drills: 6.25 to 7.25, 7.25 to 8.25 p.m.

Monday, November 29th.—Sections 1 and 2, technical; sections 3 and 4, signalling. Signalling Section and Recruits.

Tuesday, November 30th.—School of Arms with Architects Corps, 6.0 to 8.0 p.m.

Wednesday, December 1st.—Opening of new Headquarters, 6.25 p.m.

Thursday, December 2nd.—Sections 3 and 4, shooting.

Friday, December 3rd.—Sections 3 and 4, technical; sections 1 and 2, signalling. Signalling Section and Recruits.

Sections for technical drill parade at Headquarters, London Electrical Engineers, 16, Regency street, S.W. Sections for shooting parade at the Miniature Range. Unless otherwise ordered, all parades at Chester House. At the opening of the new Headquarters on Wednesday, members are requested to bring as many recruits as possible.

EXPERIMENTAL DATA CONCERNING THE SAFE OPERATING TEMPERATURE FOR MICA ARMATURE COIL INSULATION.*

BY F. D. NEWBURY.

Summary.—The Paper gives the results of tests, made on the first 3,750 k.v.a. generator installed at Niagara Falls, to determine internal copper temperatures. Temperatures of the copper conductors were obtained by means of thermo-couples in actual contact with the copper at its hottest part.

During the past two years a number of unusual temperature tests have been made on one of the original Niagara generators through the courtesy of the Niagara Falls Power Co. These tests give valuable data on the question of the maximum safe temperature for mica insulation as applied to the armature coils of large generators. The early Niagara generators have been in operation for a longer time than any other generators of corresponding capacity, and at an unusually high load-factor. It has also been recognised for some years that the internal temperatures have been high in this type of generator. The tests were made on the first generator installed by the power company. This generator was selected because it had been longest in service, and the major part of the original winding with its insulation was still intact. The tests were made to determine the actual internal temperatures of the generator winding at loads representing the usual operating loads of the unit.

The armature conductors consist of solid bars 43/32 in. by 7/16 in. in section, with half-round edges, and there are two bars in each slot, as shown in Fig. 1. The straight copper bars are insulated by a wrapper built up of mica splittings on a cambric base. The mica in each wrapper is approximately three times as thick as the cambric, so that about 75 per cent. of the complete wrapper is mica. This sheet of mica and cambric is wrapped around the bar by hand, and held in position by an outside layer of linen tape. This insulation falls within the Institute definition of Class B insulation, inasmuch as the total dielectric strength is supplied by the high-temperature material—mica—and the low-temperature material—cambric—is used as a structural material only.

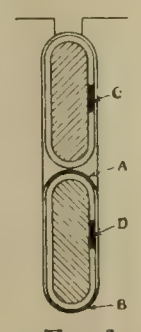


FIG. 1.
A, B Location of thermocouples in second series of tests, Oct.,'14. A, C, D Location of thermocouples in third series of tests, Feb., 1915.

TEMPERATURE TEST RESULTS.

Small resistance thermometer coils were installed in the generator. They were placed between the two bars in a slot, but the leads were relatively short, so that the thermometer coils could be located only 5 in. from the end of the core, while the total length of the core is 36 in. A typical run then showed that after four hours with an average load of 859 amperes per phase there was a temperature rise of 100·5°C., the final temperature being 130°C. It was felt that still higher temperatures existed in the centre of the core and with the higher loads that the generator frequently carried. With the indicating instrument used in this test temperatures at higher loads could not be measured.

Accordingly, a second series of tests was arranged, in which the temperature measuring device could be located in the hottest accessible part of the winding and temperatures up to 200°C. could be measured. For these tests thermo-couples (of copper-constantin metals) were installed in three pairs of slots equally spaced around the armature. In one slot of each pair, couples were located in the middle of the core and 5 in. from the top surface; in the other slot of each pair, couples were located in the middle of the core and 5 in. from the bottom surface. In each of these four locations, couples were placed between bars (registering the average copper temperature) and between the bottom bar and the bottom of the slot (registering the core temperature at these points). There were, in all, 24 couples. These locations, for one pair of slots, are shown diagrammatically in Fig. 2. All couples were in the same phase, and were encased in micarta-paper cells shaped to fit the curvature of the slot and bottom bar.

Two temperature runs were made after the thermo-couples had been installed. In the first run made October 2, 1914, the generator was operated at normal voltage and open circuit for 1½ hours, and then for four hours at approximately 800 amperes and normal voltage (approximately duplicating the first test made with resistance thermometer coils) and then for one hour at approximately 1,000 amperes per phase. This increased current was obtained by a reduction in power-factor as the water-wheel was somewhat clogged. The temperatures reached by the various couples at the ends of the two periods are given in Table I.

* Abstract of a Paper read before the American Institute of Electrical Engineers, Nov. 12, 1915.

Table I.—*Final Temperatures (degrees Centigrade)—Test of October 2, 1914.*

Load Amps. per phase.	Armature slot No.	Top of core. Between bars.	Top of core. Between core and bar.	Centre of core. Between bars.	Centre of core. Between core and bar.	Bottom of core. Between bars.	Bottom of core. Between core and bar.	Air temp.
800	135	...	...	126	108	110	86	28
	136	117	77	125	82	...	...	
1,000	11	...	...	161·6	112·2	138·2	104·1	27
	12	152·2	100·3	160·2	113·2	...	...	
	73	...	...	161·6	115·0	141·7	109·0	
	74	155·0	95·5	161·6	114·0	...	...	
	135	...	...	158·2	119·7	139·5	101·4	
	136	150·2	91·7	161·6	98·0	...	...	

The second run was made on the following day—October 3, 1914—after the turbine had been cleaned, and a load of 1,000 amperes per phase at the load-power factor could be carried, and the maximum temperatures of all the couples are shown in Table II.

Table II.—*Final Temperatures (degrees Centigrade)—Test of October 3, 1914.*

Load Amps. per phase.	Armature slot No.	Top of core. Between bars.	Top of core. Between core and bar.	Centre of core. Between bars.	Centre of core. Between core and bar.	Bottom of core. Between bars.	Bottom of core. Between core and bar.	Air temp.
990	11	...	...	164·8	112·8	140·0	103·3	33
	12	154·4	101·3	162·2	113·8	...	...	
	73	...	...	166·5	117·2	145·0	111·0	
	74	158·3	96·5	164·8	115·7	...	...	
	135	...	...	160·7	122·5	144·7	102·7	
	136	153·2	94·1	165·0	99·5	...	...	

It will be noted that at the maximum operating load averaging 990 amperes, a total temperature of 166·5°C. was measured on the external surfaces of the insulation between the two bars in the slot. With the air temperature existing during the test, this is equivalent to a *temperature rise* of 133°C. This is by no means the highest temperature to which the insulation has been subjected for long periods of time.

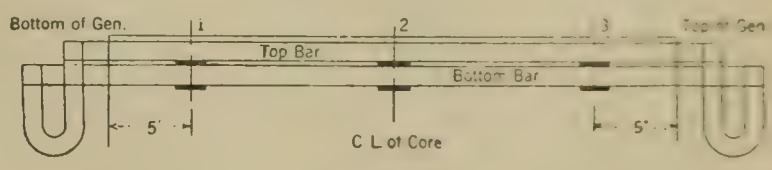


FIG. 2.
Three slots spaced 120 deg. had thermocouples in Locations 2 and 3. Three slots adjacent to the above had thermocouples in Locations 1 and 2.

It was felt that this second series of tests gave the highest existing temperatures at any point *on the outside surface of the insulation.* In comparing the observed temperatures at different parts of the slot with the estimated losses existing in the copper and in the armature teeth, it was found that the difference in temperature found at the bottom of the slot and between the bars, amounting to nearly 50°C. (*see* Table I.), could only be explained on the assumption that the bar nearest the air-gap was at much higher temperature than the other bar. This assumption is also in accordance with the known fact that the eddy current losses in the bars are large and exist mainly in the bar nearest the air-gap. Mr. A. B. Field has calculated these losses in this Niagara generator to be as large as 6·6 and 1·7 times the loss due to the load current in the top and bottom conductors, respectively. If the two bars are at different temperatures, then there will be a flow of heat between the two bars and a corresponding drop in temperature along the path between the two heat producing bodies. Under these conditions, the temperature measured at the outside surface of the insulation between the two bars in the same slot no longer represents the true copper temperature.

These considerations pointed to the desirability of making a third series of tests in which actual copper temperatures could be measured. Accordingly, special bars were made with the same kind and thickness of insulation as used originally and in which thermo-couples with the copper element in actual contact with the copper bar were included. Four bars, for two slots, were provided. Each bar had one thermo-couple located on the side of the bar and in the centre of its length. Two thermo-couples were provided for insertion between

the two bars in the same slot in the centre of the core to correspond with similarly located couples in the second series of tests.

Two temperature tests were made; the first at a load of 680 amperes, was made February 12, 1915, and the second, at 870 amperes, which after constant temperatures were reached, was increased to 980 amperes, was made February 13, 1915. The maximum temperatures of all couples for the two tests are shown in Table III. A graphical log of the first test is shown in Fig. 3 and of the latter part of the second test in Fig. 4.

Table III.—*Final Temperatures (degrees Centigrade)—Tests of February 12 and 13, 1915.*

Date.	Load, amp. per phase.	Armature slot No.	Bottom bar.	Between bars.	Top bar.	Final air temp.
Feb. 12 .	680	157	111	120	138	31
	,,	173	115	124	142	,,
Feb. 13 .	870	157	147	161	190	,,
	,,	173	152	166	199	,,
Feb. 13 .	980	157	164	179	214	30
	,,	173	168	185	224	,,

The results of this third series of tests confirmed the assumption that the upper and lower bars operate at considerably different

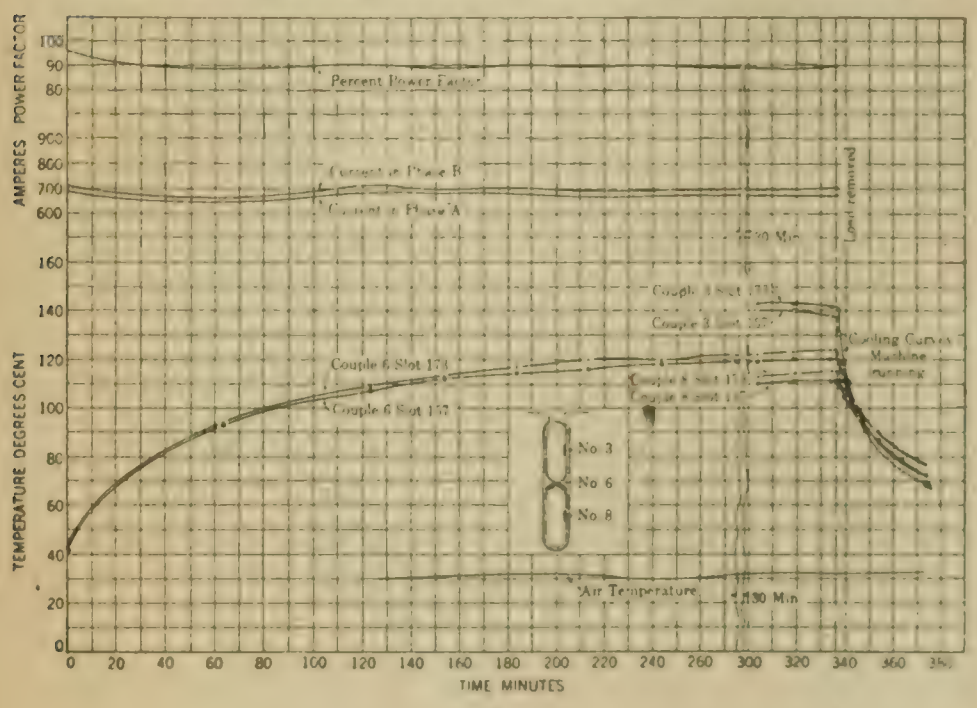


Fig. 3.

temperatures and that, consequently, the temperature indicated by a thermo-couple placed between them is not even approximately the true copper temperature. From Fig. 4 and Table III it will be noted

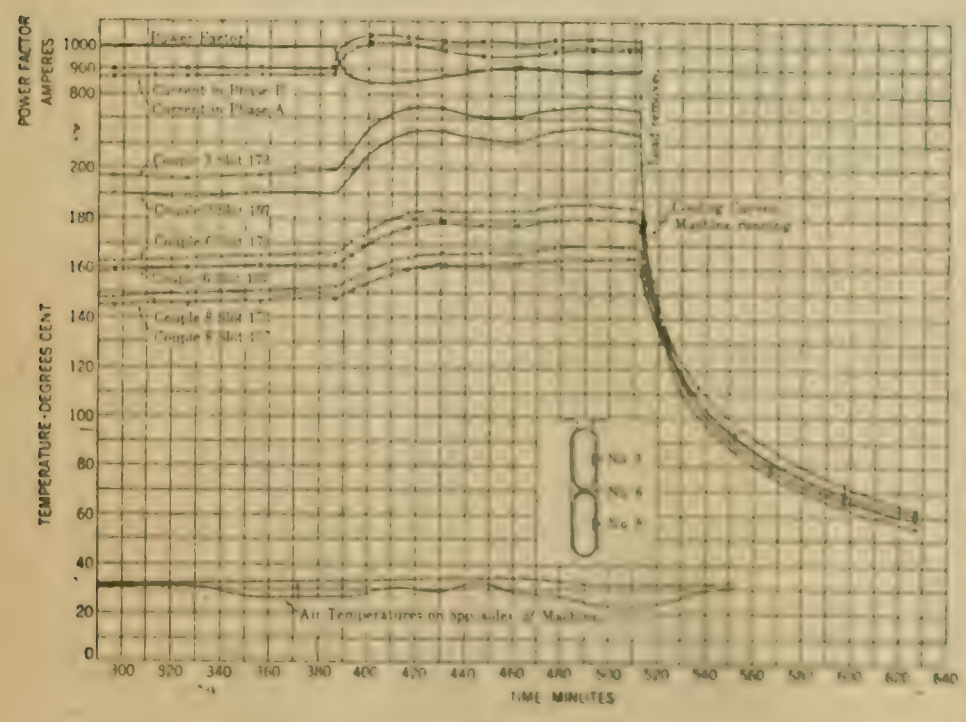


Fig. 4.

that the maximum temperature of the upper bar at 980 amperes is 224° C., the maximum temperature of the lower bar is 168° C. and the maximum temperature between bars is 185° C. That the temperature indicated by the thermo couple located between the two bars is much nearer the temperature of the lower bar than of the upper bar may be explained by the fact that the thermo-couple fitted the curvature of the lower bar and so was in much better contact with it than with the upper bar.

Table IV.—*Summary of Maximum Temperature Rises.*

Date of test.	Volts.	Amp. Ph.A.	Temperature rises. Between bottom bars and slot (centre of core).	Bottom bar actual copper.	Between bars (5 in. from end).	Between bars (centre of core).	Top bar actual copper.
8/14/13	2,340	859	...	...	100·5	...	...
10/2/14	2,300	790	72	...	89	98	...
10/3/14	2,300	990	89	...	125	133	...
2/12/15	2,300	680	...	84	...	93	111
2/13/15	2,300	870	...	120	...	134	167
2/13/15	2,300	980	...	138	...	155	194

The temperature rises from the three series of tests are collected together in Table IV., and in Fig. 5 these are shown graphically; these curves show very clearly the very large temperature drops that

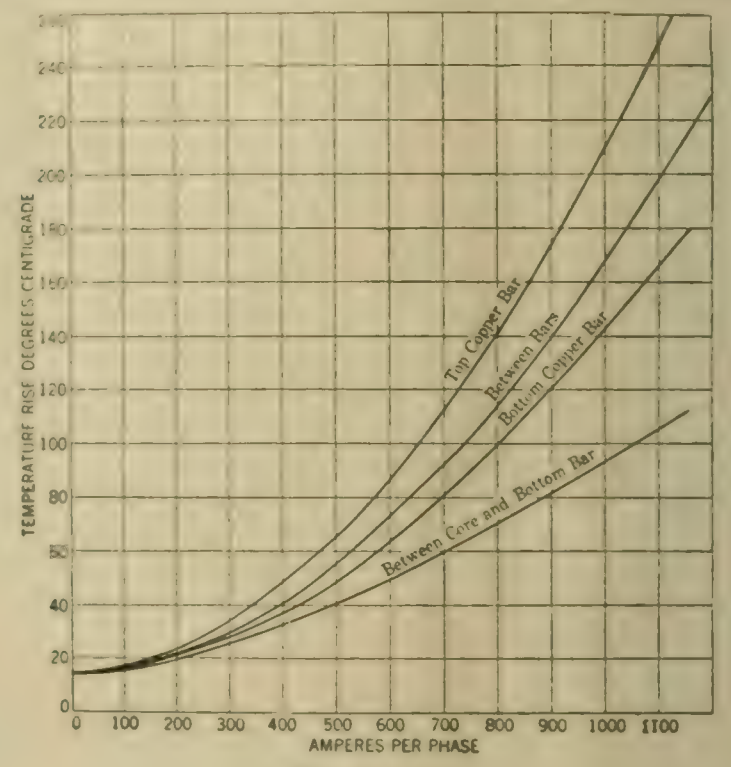


Fig. 5.

occur through the insulation in this generator, the large difference between the temperatures of the top and bottom bars, and that, while the temperature measured between bars is between the tem-

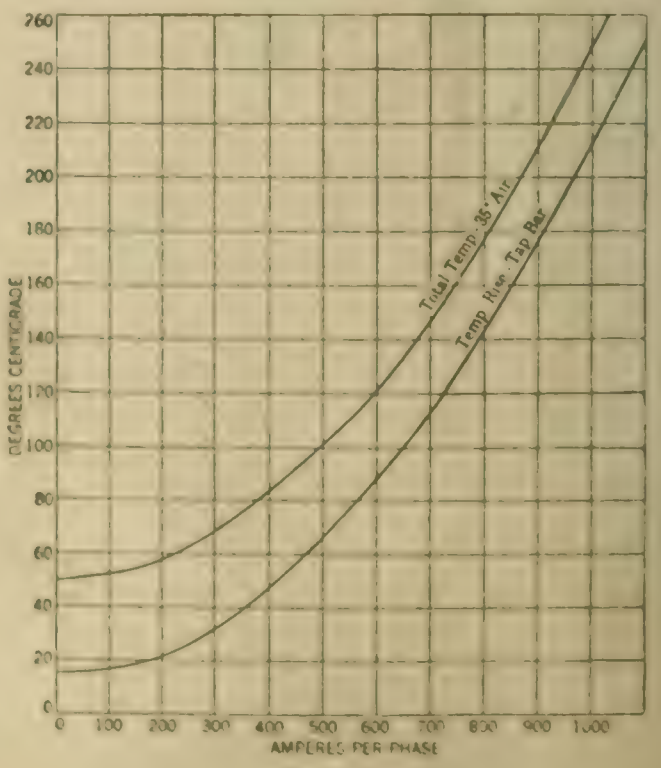


Fig. 6.

peratures of the two bars, it is much nearer that of the lower bar for the reason already suggested.

In Fig. 6 the maximum temperature rise occurring in the generator—that is, the temperature rise of the centre of the top bar—is

shown together with the total temperature of this same part on the basis of 35°C. air temperature.

In this generator the magnetic density in the core teeth, at no load, is only 11,000 c.g.s. lines per square centimetre, and the current density at rated current is only 1,400 amperes per square inch (215 amperes per square centimetre). But, as has been pointed out, the greater part of the copper loss is that due to eddy currents, so that the actual current density in the copper, and particularly in the top bars, is very high.

It is now possible to explain several unusual results of these tests The low temperatures obtained when operating the generator on open circuit, are, of course, due to the low core densities. The very rapid rate of heating and cooling of the winding is due to the concentration of large losses in a small volume of material and to the relatively low core temperature. The large difference between the temperature measured between bars and that measured between the bottom bar and the bottom of the slot is due to the extreme difference in loss in the two bars in the same slot arising from the large eddy current loss. This is also the reason for the large differences between the temperatures of the two bars in the same slot and the temperature measured between them. The large difference between the actual copper temperature and the measured temperature between bars in the present case is due to conditions that do not exist in well-designed modern generators.

Operating History.

This generator has been in service for 20 years. There have been only two interruptions in any way due to the armature winding, and in neither instance was the breakdown due to the effects of the operating temperature upon the insulation. The generator has operated for approximately 110,000 hours up to August, 1915, and has delivered 280,000,000 kw.-hour of energy during the above operating time. This is equivalent to an average load of 2,550 kw., or of 600 amperes per phase. The generator has operated for approximately 65,000 hours (approximately 60 per cent. of the time) at loads in excess of its average load of 600 amperes per phase. From the records of the time run at various loads the operating times at various temperatures can be found from Fig. 6. In this way it is found that this generator has been operating for over 60,000 hours at temperatures varying from 120 °C. to 285°C., and for 24,700 hours at temperatures varying from 145°C. to 285°C.

Condition of the Insulation.

During the summer of 1914, a number of bars, removed from the winding, while still in good operating condition as far as the insulation was concerned, were stripped, and the insulation was carefully examined. The mica was found to be in as good condition as when new—there was no observable change in structure, in mechanical strength or in elasticity. The cambric, as would be expected, had lost its mechanical strength in all places, was entirely gone in some, and in many other places only a fine powder remained. Before removing the insulation from some of the bars, an insulation puncture test was made, and 22,000 volts was reached before the poorest sample broke down. The operating voltage is 2,300.

In spite of the fact that the cambric was practically destroyed, and that it made up 25 per cent. of the material of the insulation, the old insulated bars were tight in the armature slots. This point deserves emphasis because the only reason for questioning the ability of this class of insulation safely to withstand very high temperatures, say, 200°C. to 300°C., is the problematical effect of the loss of the binding structural material on the mechanical support of the insulated coil in the slot.

This circumstance (confirmed by other tests)—that an appreciable part of the insulation can be destroyed without sensibly changing the total thickness of the remaining insulation, paradoxical as it may seem—is, in fact, readily explained by the elasticity of the remaining mica. The mica wrapper is, in effect, a spiral spring so that the thickness of the insulation depends chiefly in the resiliency of the mica instead of on the compactness of the insulation as a whole. If this explanation is accepted, it must follow that the temperature limit of mica-and-paper-wrapped insulation is determined almost entirely by the properties of the mica. From this standpoint a high temperature limit for this kind of insulation is entirely reasonable, since mica does not begin to break up under the action of heat until temperatures of 700 or 800°C .are reached.

Mica insulation in use at the present time differs very little from the mica insulation applied to the first Niagara generators 20 years ago. Paper is used to carry the mica splittings instead of cambric and machine wrapping is largely employed instead of hand wrapping. Machine wrapping not only brings to the task a much stronger wrapping pressure, but enables the wrapping to be done while the insulation is heated. Both of these conditions are favourable to the production of a very tight wrapping with the result that with a machine wrapped insulation, the carbonisation of the paper has still less effect in loosening the coil in the slot. The old Niagara insulation has a somewhat greater proportion of mica than the modern insulation—in the ratio of 75 to 60 per cent., but comparative tests made with samples having 60 per cent. mica and 80 per cent. mica have not shown any observable difference in this respect with temperatures up to 300°C .

Very high temperatures have existed in this generator for long periods of time without impairing the usefulness of the insulation. This seems to indicate that with mica insulation of proper design and fabrication, the temperature limit will be determined by other factors—*e.g.*, the melting temperature of solder or the linear expansion of the copper conductors.

ECONOMICS OF ELECTRIC POWER STATION DESIGN.*

BY H. F. PARSHALL, D.SC.

Summary.—While there may not be any great choice as to the type of plant to be used in a power house, there are many questions as to the economies to be gained by increasing the size of plant and by centralisation. The present Paper deals with the constants involved in this general problem and, as illustrative of the nature of the problem, particulars are given of the electric supply of London.

The design of a power station may be considered from two points of view, one, which may be termed the mechanical, relating to type and arrangement of plant, and the other, the economical, involving the

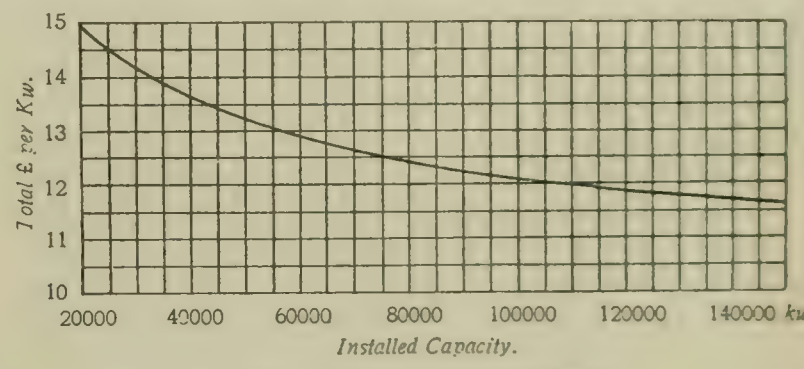


Fig. 1.—Total Capital Cost.

balancing of capital against the economies effected by the use of various amounts or types of plant upon which the consumption of fuel depends either directly or indirectly.

It is the purpose of this Paper to discuss power station design from the economical point of view, and the various aspects will be considered from the general principle that the amount of capital that can be used in effecting any economy in generation is proportional to the number of hours in the year during which such economy can be realised. In order to establish a basis from which the effect of varying conditions may be determined, the operating and capital costs are given for modern power stations designed to give the most

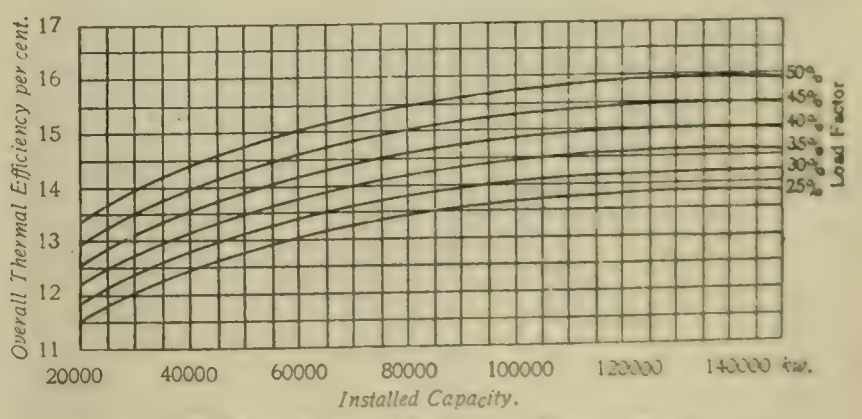


Fig. 2.—Overall Thermal Efficiency.

economical results under certain assumed conditions, but such examples must be taken as only generally illustrative and not what the author might consider applicable to every case.

Fig. 1 shows the total capital cost of such modern power stations per kilowatt installed. Although these figures will vary with the locality and market conditions generally, and may be considered on the high side, they are consistent throughout the range of sizes and load factors considered, and therefore do not affect the resulting conclusions when viewed as a comparison between varying conditions

Fig. 2 shows the overall thermal efficiencies which may be expected

* Abstract of a Paper read before the International Engineering Congress, 1915, in San Francisco.

from modern stations of various sizes and load factors. The steam conditions assumed are pressure 175 lb. gauge, vacuum 28½in. (bar. 30 in.) and superheat 100°F. and it is assumed that the station is equipped with five generating units.

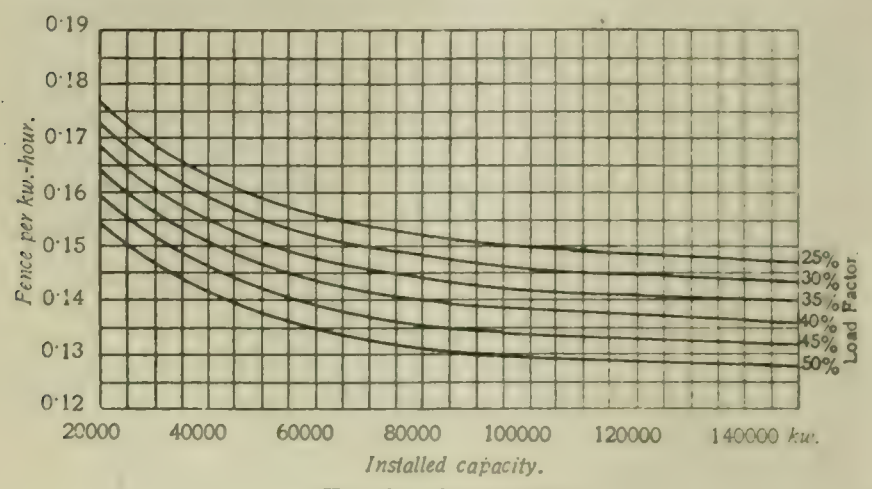


FIG. 3.—COAL COSTS.

Fig. 3 shows the coal costs derived from the thermal efficiencies given in Fig. 2 with coal at 14s. per ton, the calorific value assumed being 12,500 B.Th.U. per pound. The total costs (Fig. 4) are based

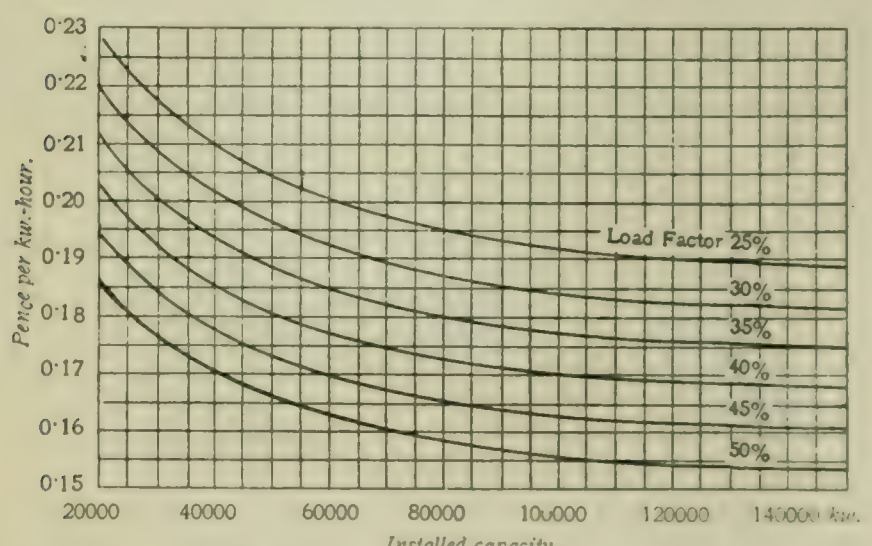


FIG. 4.—TOTAL COSTS PER KILOWATT-HOUR.

upon a ratio of coal to total costs taken from the actual results of modern stations. The capital charges per unit shown in Fig. 5 are calculated from Fig. 1 on a 10 per cent. basis, the maximum load

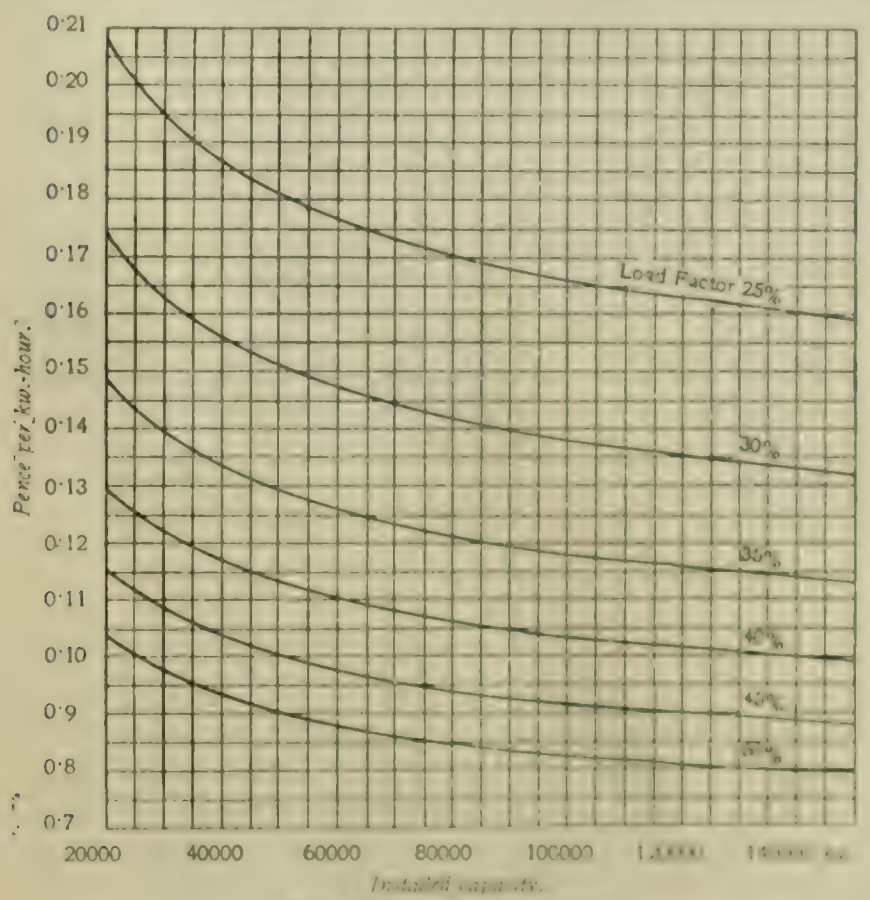


FIG. 5.—CAPITAL CHARGES.

being taken as 80 per cent. of the installed capacity for all sizes of stations. Fig. 6 shows the sum of operating (Fig. 4) and capital costs (Fig. 5) and the result may be taken as indicative of the improvement to be expected from the centralisation of generation and increase of load factor.

These results are shown in Fig. 7, expressed as comparative costs, the ordinate scale being purely arbitrary and indicating the relative total cost under varying conditions. Expressed in this manner only two curves are necessary, since the relative costs with varying sizes of station are constant for any load factor and the relative costs with varying load factors are constant for any size of station.

An important consideration in the design of a modern generating station is the selection of the site, the chief consideration in this

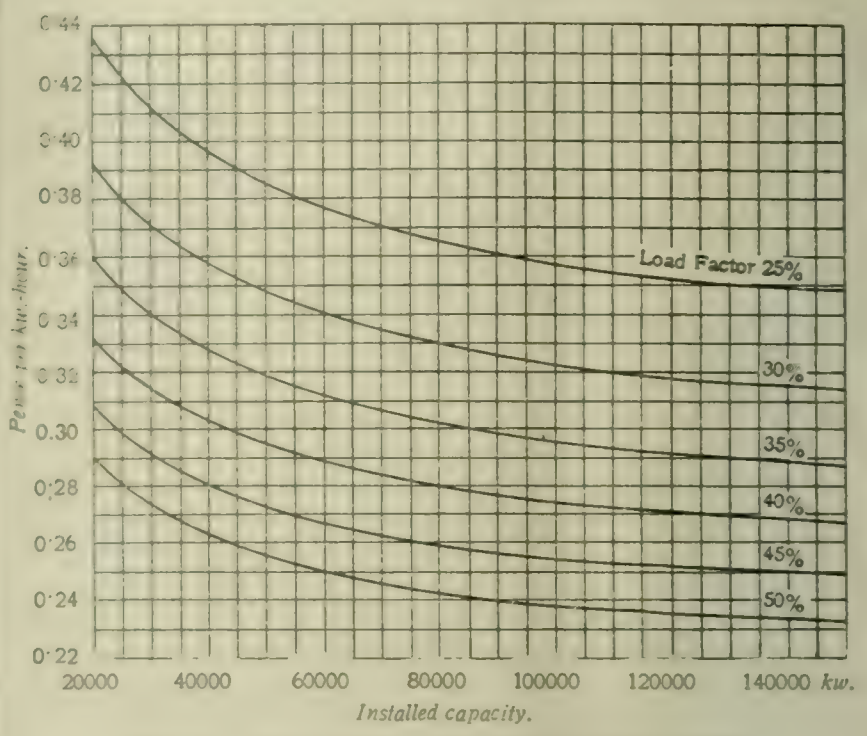


FIG. 6.—TOTAL COSTS (INCLUDING CAPITAL COSTS).

respect being coaling and condensing facilities. It will usually be found that a site with good condensing facilities will also be most convenient for coaling, but such a site is generally difficult to obtain near to the area of supply, and so the question arises as to how far it is expedient to go from the area of supply in order to secure the most efficient generation. This involves the balancing of the cost of transmission against the saving to be effected and the distance will be determined chiefly by the load factor. Many other considerations enter into the question, but as these vary but little, and as the effect

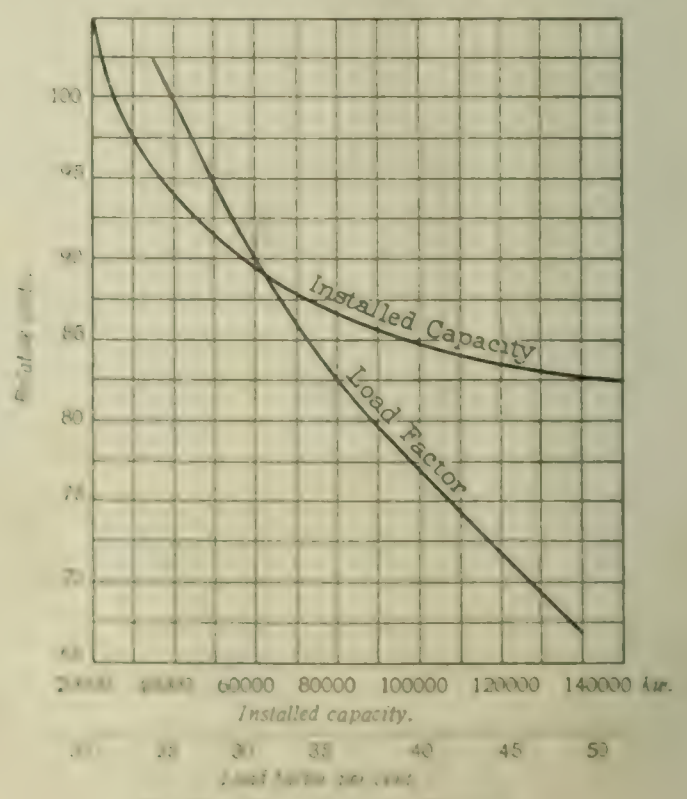


FIG. 7.—COMPARATIVE COSTS.

of such variation upon the economical distance is so slight, values have been assigned which in the author's experience are most likely to obtain. The cost of transmission includes maintenance, energy loss and 10 per cent. on the cost of mains. The cost of cables per mile laid under average conditions is taken uniformly at 12s. per kilowatt of maximum load, and the energy loss is calculated upon the assumption of 20,000 volt transmission and 500 amperes per square inch maximum working current density at 0·8 power factor.

Upon these values the total annual cost of transmission works out

at 16·5d. per kilowatt of maximum load and is practically constant for any load factor or maximum load. The saving to be effected includes the saving in generation, price of coal, water lost in cooling towers, and 10 per cent. upon the cost of cooling plant. For this purpose it is assumed that the vacuum is increased from 27 to 28½ and that the price of coal is reduced from 15s. to 14s. per ton. The efficiency of the Rankine steam cycle will be thus increased. The saving in cooling plant is taken at 10 per cent. on £1 per kilowatt = 24d. per kilowatt of maximum load. The cost of the water evaporated by the cooling towers and saved by a riverside station is based upon an evaporation of 15 lb. of water per kilowatt-hour at 6d. per 1,000 gallons. Assuming a station efficiency of 12 per cent. and the total annual cost of transmission being 16·5d. per kilowatt-mile, the

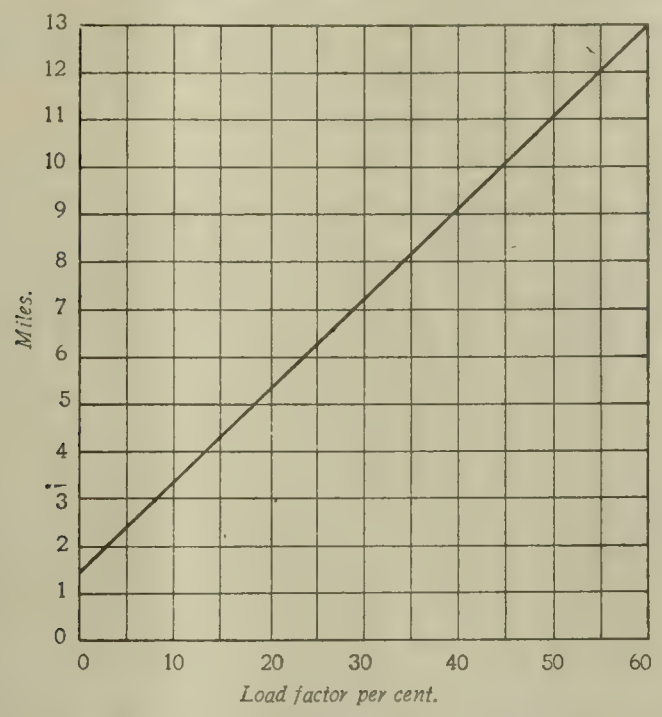


Fig. 8.—Curve showing the Distance at which the Cost of Transmission balances the Saving due to Transmission.

distance at which the saving balances the cost of transmission depends on the load factor according to the curve in Fig. 8. No account has been taken of rates and taxes or site values.

The determination of the steam and exhaust conditions under which a station should operate, is also, although more complicated, a matter of balancing the saving in fuel cost against the cost of effecting such saving. While the effect of any variation in the steam conditions upon the operating costs may be determined with a fair degree of accuracy, the variation in the capital cost is a matter which must be determined according to the conditions prevailing in each individual case.

The effect of variation of either pressure, vacuum or superheat upon the efficiency of the Rankine steam cycle is to increase or de-

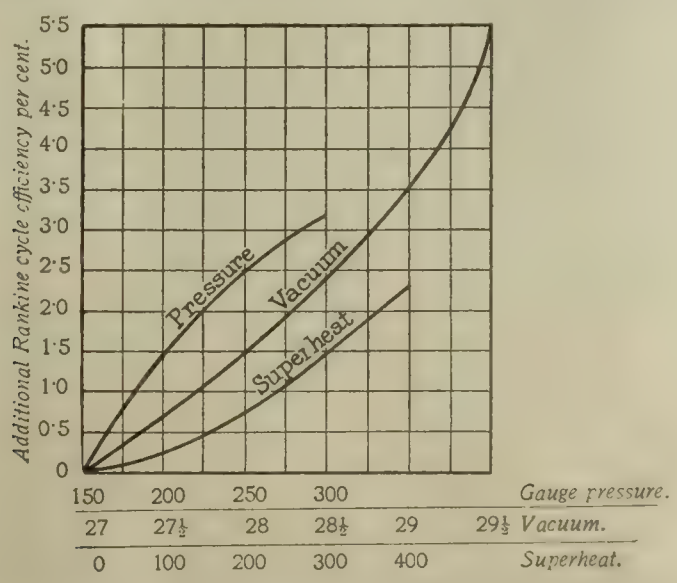


Fig. 9.—Curves showing the Increase in Efficiency by Varying the Steam Pressure, Vacuum or Superheat.

crease such efficiency by a definite amount whatever the value of the other two conditions may be. The improvement is expressed in Fig. 9, which gives the additional efficiency due to variation of any one of the three conditions. The author also gives curves showing the effect of similar variations on the running costs for various load factors.

Capital expenditure will increase considerably with increase of vacuum, and depends upon the cooling water temperature, but in the case of pressure and superheat the increase in capital expenditure is practically confined to the increased size of pipes and valves up to the point where increased pressure involves a departure from standard boiler designs or increased superheat calls for a separately fired superheater. These values are in the neighbourhood of 250 lb. pressure and 200 deg. superheat. The cost may be ascertained for any individual case, but in the author's opinion the economic benefit is, in the majority of cases, at a maximum at these values.

With regard to increased size of piping and valves, it is convenient to note that any increase of either pressure, vacuum or superheat results in a variation in the volume of steam per kilowatt-hour, and that when considering any one condition variation in volume can be expressed as a definite proportion of the original volume either at the pressure or exhaust end of the turbine, whatever the values of the other two conditions may be. Curves are given showing these percentage variations.

Another feature of power station design which may be determined by balancing capital charges against the saving is the economiser installation. A considerable number of variables enter into this investigation. The author develops formulæ showing the annual saving to be effected. For any given value of the station efficiency the saving varies with the load factor and chimney temperature, and the surface upon which the capital charge depends varies with the chimney temperature and inlet water temperature.

When considering annual saving it must be noted that, with a given economiser installation any reduction in load will result in a drop in chimney temperature if the whole of the feed water is passed through the economiser. The chimney temperature, however, may be kept constant by bye-passing a portion of the feed water to an extent where the decreased difference of temperature balances the increased surface per kilowatt of load. Curves are given showing

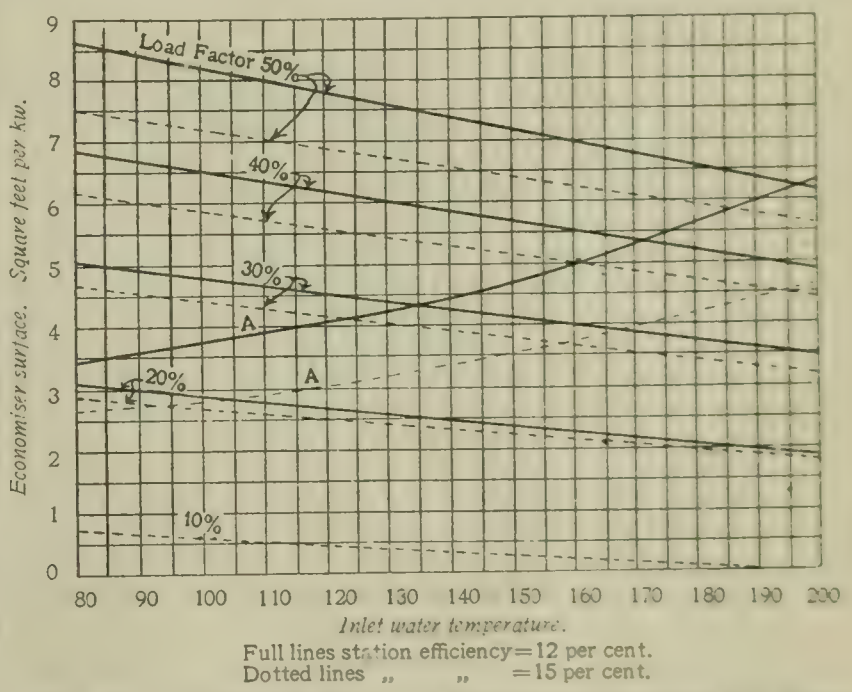


Fig. 10.—Curves showing the Economical Surface for Economisers at Various Station Load Factors.

the relation of cost to chimney temperature and economiser surface, and from these Fig. 10 has been plotted, which shows at a glance the economical surface for any given load factor and inlet water temperature and the manner in which the same varies with the station efficiency. On this sheet also curves marked A have been drawn corresponding to a chimney temperature of 300°F., and above these lines artificial draught is necessary. These show that the installation of an economiser becomes a doubtful improvement at 10 per cent. load factor, and that artificial draught is of doubtful value unless the load factor is above 40 per cent., as the increased expense would reduce the economical surface. It should be noted that the curves are based on a fuel price of 167,000 B.Th. U. per 1d., and that while the saving would vary directly and the loss inversely as the price of fuel, the economical point would be unaffected, and Fig. 10 is, therefore, independent of the coal cost.

The inlet temperature of the feed water considerably affects the economiser installation, and consequently has an important bearing upon the commercial result, due to the prevailing practice of heating feed water by means of exhaust from auxiliary plant. It is often urged that turbine-driven auxiliaries when exhausting to a feed heater are most efficient, since the latent heat is returned to the system in the feed water. Such efficiency is more apparent than real, as with increased feed water temperature the saving due to the economiser must be considerably less, capital cost considered. The exhaust from turbine auxiliaries would raise the temperature of the feed water by approximately 100°F., and, supposing the original

temperature at the economiser inlet to be 100°F., the annual saving by economiser will be reduced by about 18d. per annum for every kilowatt of maximum load at 40 per cent. load factor. This must be set against the apparent thermal efficiency of the auxiliary steam cycle.

Another method is to exhaust the auxiliaries into the main turbine at atmospheric pressure, thus increasing the available heat by expanding to condenser pressure. Considering the inefficiency of the high-pressure stage of expansion, it is doubtful whether this arrangement has any advantage over electrically-driven auxiliaries when the latter are properly arranged.

It is now common practice to drive the exciter direct from the main turbine shaft, and the author is of opinion that in the majority of cases it would be advantageous if such a machine could be designed with sufficient output to drive the auxiliaries in addition to excitation. With a common direct-current bus bar and a small independent direct-current set as stand-by, this arrangement would be convenient to operate, would obviate the necessity for steam piping and the attendant fittings, and the necessary current being generated direct by the main turbine would compare favourably in efficiency with any arrangement of turbine-driven auxiliaries in the case of stations with units above 5,000 kw. rating.

From the foregoing it will be seen that, to secure the highest economy in generation, centralisation on a large scale is an economic necessity. The figures given as regards the cost of mains will show that, under present-day working conditions, the cost of electric transmission does not affect the general principle of centralisation—that is to say, the gains that can be effected by diversity factor and increased output more than offset the cost due to transmission mains over wide distances. As an example of what can be effected by centralisation and what is to be avoided in the economic development of electric supply for a great city, I quote the instance of London, with which I am specially familiar.

Politically there are two kinds of supply, one by the local authorities parcelled out according to the boundaries of the different parishes, the other what may be termed the companies' area, which was parcelled out by Parliament in the belief that it would be injudicious to entrust the electrical supply of more than a certain portion to a given private undertaking. As a result, the generation is at present carried out by some 45 separate undertakings at a great variety of voltages and frequencies, so that general interconnection is impracticable. Excluding railway supply, which is not here considered, the energy consumption amounts to 400 million kilowatt-hours per annum. Generally speaking, none of the stations possess proper facilities for generation on a large scale. Very many of the stations are located on costly sites, so that the site value of the existing undertakings would go a long way towards creating a general bulk supply. The sum of the individual maximum loads amounts to 217,500 kw. per annum, or an average load factor taken over the whole of 21 per cent. The generating cost amounts to £1,080,000 per annum. This could be replaced by a bulk supply undertaking properly located as regards coal, condensing and all other conditions favourable to a bulk supply with an average distance of transmission of 10 miles. Allowing for such losses as would have to occur provided the present kinds of supply were continued in each place, the average efficiency of distribution would be 75 per cent. If standardised so that the distribution be done generally at 50 cycles, which is the most economical way of attending to a general supply, the efficiency would be 85 per cent. The general diversity amongst these various undertakings, if concentrated, would approximate to 1·35, which would, of course, improve with the increased power load that would follow upon concentration and a cheap supply. This diversity would bring the general load factor up to 28·5, equivalent to a maximum station load of 214,000 kw. Assuming two stations each of 125,000 kw. installed capacity, the cost of generation would be 0·185d. per kilowatt hour (see Fig. 4). The total cost of generating 535 million units, corresponding to 75 per cent. efficiency, or 472 million units, corresponding to 85 per cent. efficiency, would not exceed £412,000 per annum at 75 per cent. or £364,000 at 85 per cent., representing a saving of over £625,000 or £675,000 respectively, after allowing for maintenance of the mains. The cost of the generating stations would be £3,000,000 and the cost of the transmission system £1,284,000, making a total of £4,284,000, so that the economy effected by centralising the supply would amount to 14·6 per cent. on the capital cost in the first case and 15·7 per cent. in the second.

The cost of this bulk supply installation, including mains, would be £17 per kilowatt, whereas the cost of the existing stations exceeds £50 per kilowatt.

The existing installations consume about 1,000,000 tons of coal per annum, whereas the bulk supply station would not consume more than 450,000 tons of the same class of fuel. It will thus be seen that, independent of those economies that can be effected by concentrating the 45 undertakings into one, the capital required for generation in a proper bulk supply would be 35 per cent., and the fuel cost 45 per cent. of the amount obtaining under the existing arrangement.

The case of London is best known on account of its magnitude, and shows the extent of the economic waste that may arise from decentralisation of electric generation. By comparing the actual results obtained on such a large scale with the results that would be reached by applying the data set down in the Paper a somewhat startling conclusion is reached as to the extent of the waste.

SOME DIFFICULTIES OF DESIGN OF HIGH-SPEED GENERATORS.*

BY PROF. A. B. FIELD.

In early days the limitations of speed imposed by the generator design acted somewhat as a handicap in the rapid development of the turbine, but recent years have witnessed a concurrent development of both turbine and generator, with the raising of the speeds of the combined sets to the limits corresponding to two-pole and four-pole designs. Simultaneously, the output per machine has been greatly raised, until many sets are now running capable of giving continuously up to 6,250 k.v.a. at 3,600 revs. per min., 20,000 k.v.a. at 1,800 revs. per min., and higher ratings at 1,500 revs. per min. (60, 50 and 25 periods).

In attaining these results many difficulties have been overcome in as many different ways, and it has been thought that a general discussion of a few of them would be of great interest. By way of introduction, the author thinks it desirable to mention some of the difficulties encountered, and to describe the means of overcoming them adopted.

In order to put the matter upon a practical basis, it may be best to take a specific example; and reference will chiefly be made to a 20,000 kw. three-phase machine having the following characteristics:

Speed	1,800 revs. per min.
Poles	4
Cycles	60
Kilovolt amperes	20,000 at power factors from 1·0 to 0·8
Voltage	13,200
Rotor dimensions	51 in. 75 in.

The design of such a machine represents to a greater degree than is usually the case a compromise between many conflicting mechanical and electrical requirements. Viewed in a general way, there is, first, the problem of constructing a rotor which must necessarily weigh something like 60,000 lb., and which will be running with a peripheral speed in the neighbourhood of 24,000 ft. per minute. The centrifugal force acting upon a 1 lb. mass at the periphery will be about 1 ton.

Rotor Material. In the first place, it is impracticable to use a through shaft with a hollow body or with discs threaded upon it—a construction which, however, is permissible and satisfactory in some smaller examples of this class of work. The rotor body could be made as a solid steel casting or forging in one piece with the shaft ends, and it would be quite possible to obtain such a piece with a fair amount of forging work done upon it; for example, an ingot diameter of about 6½ ft. would allow of a 2 : 1 reduction of area on the mean section.

The construction initiated by the Westinghouse Company (U.S.A.) for the large rotors under consideration was adopted after investigations upon the regular market productions obtainable in the United States, and in consequence of realising that one must be prepared to build turbo-generators at all times, irrespective of market conditions (i.e., when the steel mills are busy, and therefore not anxious to devote extra and special care to the production of material of unusual properties to satisfy the requirements of critical inspectors), and that it is of great manufacturing importance to have designs such that the material may, as far as possible, be obtained from any one of many sources in the country. These are some of the more important reasons which influenced a decision in favour of the material and construction described below. It will surely be unnecessary for the author to disavow any intentions of maintaining that such is the only safe or sound engineering procedure.

Now a difficulty had previously arisen in connection with large forgings for high-speed waterwheel-driven generators, and it had been overcome by the use of open-hearth rolled plates consolidated

* Abstract of a Paper read before the Institution of Electrical Engineers last night.

and mounted on a shaft. Compared with rolled plates, there is probably no other form in which such large masses of steel can be produced at a low cost having such good physical properties in directions of two dimensions. It remained open, in the case of the water-wheel-driven rotors, to use either comparatively thin boiler plate or thicker plates machined on both sides.

In the case of a number of important machines the latter alternative had been used by Behrend, who, for evident reasons, used the thickest rolled plate that was commercially available. This would limit us generally to plate about 2¼ in. thick in the rough. One batch of about 100 tons of such steel, about 2¼ in. thick, produced under unusually favourable conditions and containing a small percentage of nickel, gave the following tests :—

Ultimate tensile strength	80,000 lb. per square inch.
Yield point	53,000 lb. per square inch.
Elongation	26 per cent. in 2 in.
Reduction of area	60 per cent.
Bending test	Strips the full thickness of the plate bent through 180 deg. and closed down without fracture.

The results that can be expected generally on commercial material will be given later.

Plate-built Rotors.—In the case of the steam-driven turbo-generators under consideration, this plate material appeared very attractive, combining, as it did, a very low cost per pound with entirely reliable properties from the periphery to the centre and from end to end of the rotor. Its use would result in the production of a rotor in which practically the only internal stresses would be intentional ones ; there would be nothing corresponding to the huge initial stresses to which solid forgings and castings are liable. With the plate construction every cubic inch of material would be within an inch or two of a forged surface (or the equivalent). The impossibility of using a central shaft, however, at first discouraged the idea of a built-up plate rotor. It was due to the suggestion of Behrend, again, that the feasibility was demonstrated of constructing such a rotor with the plates slightly rabbeted into one another, and into a flanged shaft at each end. A rabbet about ⅛ in. deep is ample, and by means of a group of four or six chrome-nickel steel bolts, each about 4 in. in diameter, a 50 in. to 56 in. diameter rotor can be constructed with practically the solidity of a single piece. These bolts can be tightened up until they have a stress of about 40,000 lb. per square inch, and in the actual construction of the rotors special means are adopted to ensure obtaining a tension in the bolts roughly corresponding to the desired amount. This has been done by tightening the nuts until a specified elongation of the bolts has been attained, the elongation being a distinctly measurable amount—viz., over 0·1in. in many cases.

It may be contended that the plate construction here described only partially overcomes the difficulties indicated above, inasmuch as it is still necessary to have heavy forged shafts with large flanges forged on them of the full diameter of the rotor. However, the difficulty of securing a satisfactory forging has not only been reduced as the consequence of the much smaller weight of each single-piece forging, but the axial length of the large diameter part can be kept down to such dimensions that, in addition to the usual radially-directed forging process, the material can be worked in an end-wise (*i.e.*, axial) direction. This method of working the material ensures good properties in a radial direction. Radial test bars taken out of the flanges of such pieces, even at a depth of 8 in. or 9 in. from the surface, have shown excellent results, so that one can practically depend upon getting an elongation of over 20 per cent. in 2 in., with a reduction of area exceeding 35 per cent. in a standard ½ in. test bar from a carbon-steel forging, giving an ultimate tensile strength of 70,000 lb. per square inch and a yield point of 35,000 lb.

Returning to the matter of the plates, when these can be obtained locally it is frequently convenient to use ingots of such size that one disc is obtained out of each plate, so that the complete plate can be delivered to the factory, put upon a boring mill and the required disc parted out of it, the scrap material being returned to the rolling mill. If the material must be transported over any considerable distance, it is satisfactory to rough shear the plates at the mill to an approximately circular shape ; in which case, with the thickness of plate mentioned above, it is sufficient to specify a rough diameter of about 2 in. to 3 in. greater than the required finished diameter. As regards thickness, the plate can easily be supplied flat enough for a ¼ in. allowance to be sufficient for machining both sides, especially as the diameter of the rabbet projection on one side of the plate is only about half that of the plate itself.

Whether the material is supplied sheared or in the rectangular plate, it is marked by the rolling mill to indicate the part corresponding to the top end of the ingot, and when drilling and assembling the plates this marking enables us to rotate each plate, say, 60 deg. with respect to the plate below it in a constant direction, so that in the complete rotor there is practically no remnant of the slightly different properties of the plate in directions along and across the direction of rolling.

The properties which can be expected from this material as an average are somewhat as follows :—

Ultimate strength	67,000 lb. per square inch.
Yield point	34,000 lb. per square inch.
Elongation	27 per cent. in 2 in.
Reduction of area	43 per cent.

For a cold bending test, a strip of the full thickness of the plate will generally bend through 180 deg. round a 3 in. diameter pin. For purchasing specification purposes, it is necessary to allow some margin on these figures, particularly in the matter of ductility. As regards the market price, this is in the neighbourhood of 0·8d to 1d. per lb. with ordinary conditions of the steel market.

Critical Speed.—The next question to arise is that of the critical speed. While many large rotors are running satisfactorily at operating speeds above their critical speeds, it is believed that there is a distinct advantage in keeping the critical speed above the running speed when this is feasible.

If it is decided to run below the critical speed in the case of these large machines, concessions must be made in nearly every feature affecting the critical speed. The rotor body must be as short and light as possible, involving a high air-gap density and a severe working of the stator material in the neighbourhood of the air-gap. The shaft diameter must be kept large, and high peripheral speeds must be tolerated for journals and slip-rings. The span between the journal centres especially must be kept small, which imposes some limitations upon the design of the stator end windings, and necessitates the omission of blowers from the rotor. The lengthening of the rotor span, entailed by the use of blowers on the rotor, is greater than corresponds to the axial length of the blower openings on account of the provision that has to be made in the end bells, and the necessity of being able quite easily to dismantle the end-bell structures without disturbing other parts of the machine.

In this connection it is of some interest to notice that a rotor constructed along these lines really has no true critical speed. The critical speed of a rotor of given dimensions depends upon its stiffness ; the inverse of the stiffness we may measure roughly by the deflection of the stationary rotor supported on its journals per unit load applied at its centre. Now the rotor body as constructed consists of, first, small cross-sections (bolts) under great tension, and, secondly, comparatively large cross-sections (the plate surface around the bolt holes) under compression. As long as these conditions subsist the stiffness is the same as that of a solid mass having no partition planes, and it is unaffected by the stress distribution. When, however, the deflection reaches an amount such that the compressive stress in the plate at one side of the rotor vanishes, the stiffness for further deflection is immediately reduced, the effective area of the metal on the tension side changing from that of the whole section to that of the bolts only, as far as concerns the ratio of the further incremental loads and strains.

Rotor Ventilation.—A matter requiring early attention would be the question of rotor coils and ventilation. The system of ventilation which lends itself best to the other features of the machine that we shall have to adopt is one combining an axial passage underneath the winding slots with a radial discharge distributed over a fairly wide central portion of the rotor. The plate construction lends itself admirably to our requirements, inasmuch as we can readily obtain the radial ventilating spaces by means of a simple "slab-miller" operation upon the individual plates before assembly. This provides a vent ⅜ in. wide in the region of the slots and teeth, leaving the plate solid in the region of the pole. This arrangement not only gives a very solid rotor, but also the extra metal in the region of the poles is needed for magnetic reasons. After assembling the discs and shafts, the bolt holes are reamed out, the bolts fitted and the winding slots cut.

Rotor Windings.—As regards the winding, it may perhaps be said, without further discussing relative merits, that a separately formed edge-wound coil, dropped turn by turn into the slots, is used, with solid mica insulation and a light steel cell to protect the insulation against the effect of the ventilating air. For several mechanical reasons concessions are made in the electrical requirements of the winding, so that a comparatively wide strip (about 1¾ in.) is used, with only three coils per pole—*i.e.*, six slots per group—in the four-pole rotor. The field windings, even when of this width, will be of substantial thickness, perhaps 0·1 in. for 220-volt excitation, and it is not altogether an easy matter to get such windings down solidly in the slot in such a way that no shifting will occur during running. It must be remembered that the pressure of the coils upon the wedges in such a rotor when running at 20 per cent. over speed exceeds

200 tons for each slot. As a matter of fact, it is hardly possible to put this pressure upon the winding during construction, but, fortunately, it seems that by a suitable succession of applications of considerable pressure, with baking processes interspersed, the further yielding of the windings with increased pressure is small, and quite good results can be obtained even when the pressures put upon the copper during construction do not reach those which will occur during the over-speed test. Finally, it is important that the retaining wedge should be put into position while the coil is still under considerable pressure. This, however, is almost impossible if it is attempted to drive the wedge over the top of the coil in an end-wise direction. The wedge construction shown in Fig. 1 is very effective in overcoming this difficulty, inasmuch as the central bronze part of the wedge can be inserted in the slot and pressed down upon the winding under great pressure while the two steel liners, one on each side, are driven into place without any friction on the top surface of the insulated coil. While this mechanical feature of the three-part wedge is important, there are also electrical advantages which the author describes.

Coil-retaining Rings.—As regards the part of the rotor windings external to the core, we have a very serious problem to meet in supporting this free copper. Of the methods so far used or proposed, the most satisfactory, for machines of the size considered here, is the use of a weldless chrome-nickel steel ring proportioned to carry its own load and that of the copper underneath it without any radial support from the rotor. We can depend on getting properties at least as good as the following :—

Ultimate strength	120,000 lb. per square inch.
Yield point	100,000 lb. per square inch.
Elongation	18 per cent. in 2 in.
Reduction of area	50 per cent.

The importance of inspecting and testing in the case of these rings is very great, and at least four test bars should be taken from each ring.

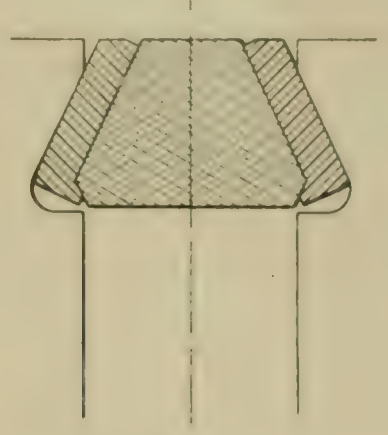


Fig. 1.

The rings must be positively driven by means of a key, and this is best located in the rotor body rather than in the outside end disc. In considering these details we have to provide for possible short-circuit conditions involving a considerable retardation shock to the rotor. For these reasons we make provision for driving forces of the various parts, which would otherwise appear to be unnecessary.

Steel is used for the retaining rings, in spite of the electrical and magnetic difficulties which it introduces, because in such matters the mechanical considerations must take precedence over everything else. It will, however, be noticed that the rings tend to form a magnetic short-circuit from pole to pole, and, in fact, they do account for a large leakage. The design of the tip of the ring, and its connection with the rotor body, are arranged to reduce this evil as far as possible, and a comparatively slight variation in this respect can make a large difference in the leakage in the case of a four-pole rotor. The two-pole machines of large size saturate their ring cross section almost necessarily, and in this case the end disc, which centres the ring at its outer end, is made of manganese bronze to obviate further leakage. In the four-pole machine this disc is made of steel, without appreciably affecting the leakage.

So long as the load on the generator is a nearly balanced three-phase (or two-phase) load the objection to a magnetic end ring is chiefly on account of the extra flux with which it burdens the rotor. It is true that the projecting stator coils to some extent overhang the steel ring, and that the leakage flux from these penetrates the ring and is increased by the presence of magnetic material there, but this flux sufficiently approximates to a rotating field of constant magnitude for comparatively small losses to appear in the rings on its account. Occasionally, however, the system of distribution from the power house is such that a balanced condition of phases cannot be obtained ; in this case the leakage flux from the stator coils is no longer a simple rotating field, and very large losses would occur in the magnetic steel end ring in consequence.

While this matter had been recognised by us for many years, it first became necessary to tackle it seriously when the problem arose of building several four-pole 60-period generators of nearly 20,000 k.v.a. rating which would be required to operate upon a considerably unbalanced three-phase load. Such preliminary investigations as could be made upon a similar existing distribution system indicated that we ought to provide for unbalanced conditions equivalent to a three-phase load of half the rated kilovolt-amperes, upon which was superposed a single-phase load of the same number of amperes. A little investigation shows that a comparatively thin sheet of drawn copper outside the ring would carry sufficient current to protect the magnetic material below it from this stray flux. The sheet, however, would require an increased cross-section at the outer end of the ring and again at the end near the rotor body, unless the sheet could be effectively connected electrically to the slot wedges of the rotor. For the machines above referred to, for unbalanced load conditions, the difficulty was overcome by dividing this sheet into a number of hard-drawn copper strips about $\frac{3}{16}$ in. thick, which were driven and caulked into axial dovetailed grooves upon the surface of the ring, thus covering about 80 per cent. of the entire perimeter with copper and maintaining a thoroughly substantial construction. In order to provide the copper for the circumferential path of the protecting current, dovetail grooves were turned in the chrome-nickel steel ring near its outer end ; into such a groove was fitted a pair of heavy copper strips of rectangular section side by side, and by means of hydraulic pressure these strips were pressed in and made to expand and fill the dovetail section of the groove. For mechanical reasons this copper was distributed in two grooves instead of one. As it was not feasible to depend entirely upon the electrical connection of the ring with the rotor body, it was necessary to provide similarly a circumferential path at the other end of the ring, and for this purpose a short section of ring was made of manganese-bronze and securely united to the chrome-nickel steel ring. While the short length of manganese-bronze rings could, if necessary, be carried as a load by the steel ring, it was desirable to make this, so far as possible, self-supporting and to obtain the very best properties in this material. The following figures indicate the results of tests on these bronze rings :—

Ultimate strength	75 to 86,000 lb. per square inch.
Yield point	60 to 73,000 lb. per square inch.
Elongation	12 to 15 per cent. in 2 in.
Reduction of area	20 to 30 per cent.

It will be noticed that, in addition to this bronze ring being necessary owing to electrical considerations, we gain the magnetic advantages of having a separator between the steel ring and the rotor body.

It is hardly necessary to point out that the unbalanced load affects the flux conditions in the main body of the rotor also, and must be provided for by heavy longitudinal dampers. In the slotted region of the circumference the slot wedge is used for this purpose, being made in continuous lengths and of hard-drawn copper ; elsewhere special dampers are inserted. These dampers complete their electrical circuit by means of all the circumferential copper and bronze of the end rings ; and the design of the bronze section of the ring is such as to ensure the electrical connection being improved rather than the reverse by the stresses arising upon rotation. The adequacy of this rotor protection is best illustrated by test figures. Single-phase and three-phase short-circuit runs were made upon these machines, the power absorbed being measured, less that due to friction and windage. This was found to be only 10 per cent. greater when the machine was delivering rated current on a single-phase short-circuit than for the same current on a three-phase short-circuit, thus indicating only a very small additional loss due to the unbalanced single-phase effect. In similar machines without this balancing device the extra power absorbed on a single-phase short-circuit is very high indeed. Perhaps it may be well to mention here that in the case of turbo-generators the total loss on a short-circuit test is very great in comparison with the product of the square of the currents flowing and the resistances of the stator windings. Hence the fact that in the single-phase run only two-thirds of the winding is involved does not vitiate the excellent nature of the single-phase short-circuit results given above.

Rotor Coil Bracing.—The necessity of a positive key drive for the rotor end rings has been indicated. In a similar way the problem of the circumferential bracing of that part of the rotor winding which is external to the core must be faced. In the case of four-pole machines having only three heavy coils per pole of less than 90 deg. pitch no very special means are needed. In the case, however, of two-pole machines where the coil-span is twice as great, and where

we have of necessity more coils per pole, involving a greater length of straight extension from the slot, it is important effectively to brace the windings. Fig. 3 illustrates the system of blocking adopted for a 21,000 k.v.a. two-pole machine in which a light built-up steel driving horn is located on the interpole centre line of the rotor, being firmly attached to the shaft by heavy chrome-nickel steel bolts. The shaft diameter at this place is but little smaller than the inside diameter of the coils, so that a very effective stay is obtained. With this provision made for the coils of largest span it merely becomes necessary to block the succeeding coils from these and from one another.

Stator Construction.—We have so far dwelt upon the difficulties of rotor construction, inasmuch as these were felt to be, perhaps, the hardest of solution. The electrical conditions to be met in the stator are by no means easily provided for; some of them will be briefly touched upon. Reference has already been made to the high air-gap inductions and the severe way in which the annulus of stator material in the neighbourhood of the slots must be worked. The comparatively small air-gap and considerable length of the machine forbid the use of radially-disposed stator vents receiving their entire air supply from the air-gap. Some system of axial ventilation is practically imperative, and in these machines very complete axial ventilation is provided. The provision for the air supply is particularly liberal immediately behind the teeth; in fact, behind each slot are arranged three oval ventilating openings, with only a narrow strip of punching separating them from one another and from the slot; in this way the amount of core cooling surface is properly proportioned to the cross-sectional area of the air vent.

On account of the length of these machines the cooling air is admitted at each end of the stator and discharged at the centre, avoiding the considerable difference of air temperature between inlet and outlet involved when the air is passed along the entire length of the machine. The total volume of cooling air required by such a machine is in the neighbourhood of 60,000 cubic ft. per minute, and in order to accommodate these volumes a large central opening is necessary. This could be provided in the form of a number of vent

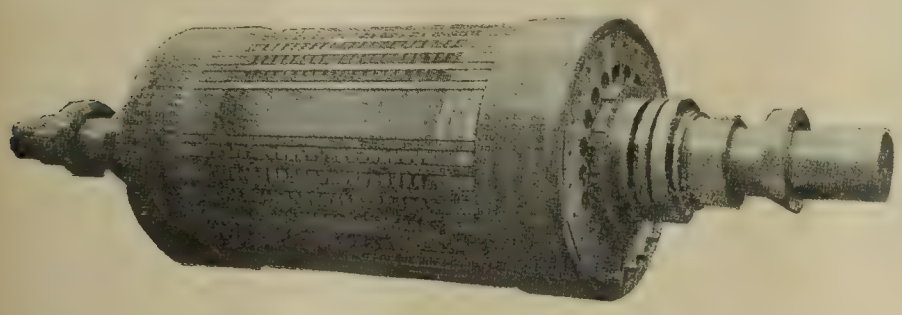


Fig. 2.

ducts, but a large amount of resistance to the air flow would be occasioned by so much breaking up of the continuity of the axial air passage. It becomes desirable, therefore, to attempt the equivalent of a single central opening. This provision must be made in two ways: First, by properly proportioning the flux per inch of core immediately next to the vent; and, second, by taking care of the large stray flux leaving the rotor from this vent zone. The stray flux can be taken care of by placing a couple of packets of punchings in the centre of the vent with the teeth cut back somewhat, the thickness of the packet being properly proportioned with respect to the increased air-gap of this part of the core, so that each packet will carry a correct amount of flux. The conditions at the end of each half of the core can similarly be taken care of by cutting back the teeth in steps, so that the air-gap is graded here to allow for the fringing effect from the rotor.

External Short-circuits.—One of the great difficulties anticipated from the start in the case of these large machines was the conditions arising in the case of a feeder short-circuit or its equivalent, and much discussion has arisen with regard to the advisability of using large reactance coils between the generators and their 'bus bars. While a certain amount of external reactance has its use in some cases, it has been felt by some of us that these large machines should in any case be so built that they could be "dead short-circuited" at their terminals when running excited and giving full voltage. While this should be no excuse for slackening the precautions taken in the rest of the system to avoid serious short-circuits, and while repeated short-circuits at the terminals should not be countenanced, it did not appear unreasonable that a purchaser should desire to see his machine short-circuited in this way on the test floor or after erection. The author has referred elsewhere* to some of the characteristics

* A. B. Field, "Operating Characteristics of Large Turbo-generators," "Transactions" of the American Institute of Electrical Engineers, Vol. XXXI., p. 1645, 1912.

of recent large machines in this respect, and has drawn attention to the fact that where these units are required it is seldom of importance to have a close inherent regulation—rather the contrary. A poor regulation and a comparatively low ratio is desirable between the excitation required for full voltage at no load, and that required for full-load current on short-circuit.

In the Paper referred to above the author indicated in a rough, practical way a picture of the conditions occurring with regard to stator and rotor flux on a short-circuit, and it has since been possible to obtain some confirmation from oscillograph tests on certain of these large generators.

An appreciation of the general nature of the distortions arising on short-circuit is of some importance, indicating among other things the great gain that may be expected by providing what will be, from this point of view, an increased air-gap—that is to say, by increasing the physical distance between the stator copper and such part of the rotor (generally very near to the surface) as is effective in carrying large currents. The author does not believe that there is much to be gained by the presence of magnetic material in the interspace between the windings. For instance, a partial closing of the stator slots by overhanging tooth tips would not be of appreciable benefit under short-circuit conditions. The chief requirement is more space. In the machine mentioned this increased space is obtained by a device which became necessary owing to entirely different relations; it is obtained by the use of the laminated magnetic slot wedge described below. The results of short-circuit tests on a 20,000 k.v.a machine with this construction showed by oscillograph tests how effectively the maximum short-circuit current had been kept down. The maximum possible short-circuit current found at full voltage amounted in this machine to only about 14 times the maximum of the full-load current wave.

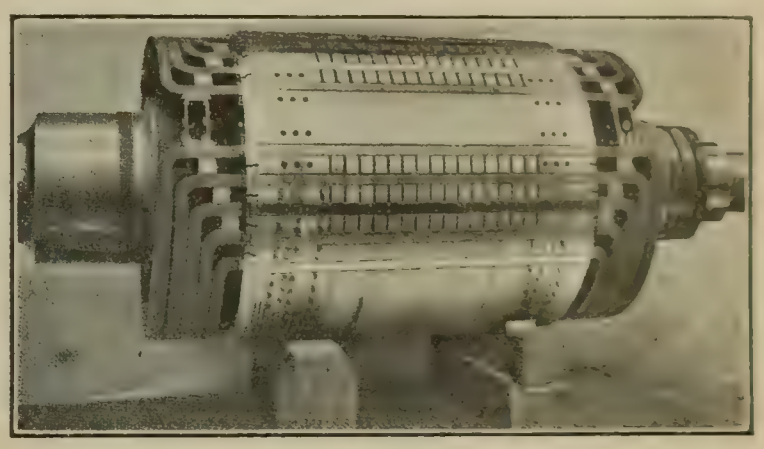


Fig. 3.

Stator-coil Bracing.—As regards protecting the part of the winding external to the core, the means adopted in this case are believed to be more substantial than ever before used. Bracing is effected by means of bronze herring-bone castings placed between the two layers of the end-connection winding, the casting having fins projecting between the coils on each side of it, thus locking the two layers together and entirely providing for any tendency of the one layer of winding to shear relatively to the other. In fact, we have at every one of the 16 metal supporting brackets practically slot conditions reproduced.

Rotor Surface Losses.—It has seldom been the case in the past in turbo-generator work that with reasonable design it has been necessary to pay much attention to the qustion of rotor-face losses occasioned by the open stator slots. With reasonable stator slots the air-gap has been generally ample, even in spite of the very great peripheral speed of the rotor. In the present case, however, with an air-gap of only about 1 in. radially and with the very high air-gap inductions involved, great caution was needed. It happened that, in the first few machines concerned, the stator voltages were sufficiently low to enable a cautious compromise to be adpoted, with a size of slot that did not appear in involve too great risks. such slot, however, being smaller than is desirable from an electrical point of view. However, some orders having been taken for machines of high voltage (such as 13,200 volts), it was obviously necessary to discard compromise and devise a means of using a large stator slot without serious rotor loss. In this connection it may be pointed out that, while for low peripheral speeds and machines of the type common in engine and waterwheel practice we have sufficient data to determine fairly well what will be a harmful configuration of slot, air-gap, air-gap induction, &c., we have not got these data for turbo-generator conditions. According to Mr. F. W. Carter,* a figure

* "Air-gap Induction," "Electrical World and Engineer," Vol. XXXVIII., p. 884, 1901.

involving the following factors should be some criterion of the amount of loss per square inch: A factor depending upon the ratio of slot to gap, which can be most easily obtained from a curve; the square of the ratio of the rotor ampere-turns for the gap to the gap length; the perphieral speed of the rotor to the 1·5th power; and, finally, the square root of the slot pitch. The other quantities involved may generally be considered constant from one machine to another.

Another group of investigators,* having carried out experimental researches on the pole face due to open slots, give the factors involved as follows: Air-gap density to index 2·5; peripheral speed to index 1·55; ratio of slot width to air-gap to index 1·88; square root of slot pitch. This differs from the previous one chiefly in the way in which it involves the ratio of slot to gap.

This criterion may be valuable for speeds and conditions in the neighbourhood of those corresponding to the experimental researches, but again it cannot be applied to turbo-generator conditions on a comparative basis. Also, comparing one turbo-generator with another, the relative merits on the basis of this criterion will be quite different from those on the Carter basis. There is, in fact, room for further experimental investigation on this matter at the actual high peripheral speeds, great air-gap inductions and other relative proportions involved in recent turbo practice.

Tests were made on the completion of the first machines, in which, as mentioned above, a compromise width of stator slot was used, this width being considered to the best of our knowledge to be just on the margin of safety. These tests indicated that we were not far off in our judgment, and while we had commenced to incur some little rotor losses, which would have been serious had the slots been larger, it was not necessary to use the semi-magnetic wedges that had been prepared as a precautionary measure for these slots. For the 13,200-volt machines a built-up magnetic slot wedge had been devised, consisting of a group of punchings assembled between little flanged brass end plates in sections of about 3 in. in length. These wedges had a very light magnetic material bridging the slot and a large clear vent space through the centre. The wedge was put in



Fig. 4.

place in the slot, and a small fibre wedge of rectangular section driven between it and the coil. Fig. 4 shows the laminated wedge and the parts from which it is assembled. This device, which enabled us to use with a 1 in. air-gap a stator slot 1·62 in. wide and a suitably proportioned stator coil, saved the situation.

The problem of devising a stator conductor of the size required, and with the eddy-current losses kept down to a sufficiently small value, is not an easy one. With the protection afforded against external flux by means of the magnetic wedge there is no great objection to using a strip about ¼ in. wide across the slot, and the conductor can be built up of a number of such strips in parallel. It is usually sufficient with such a winding to have the strips insulated from one another, and arranged so that at the end of the coil the conductor is turned over in such a way that the strand which in the one slot is nearest to the air-gap takes a position nearest to the bottom of the slot when it occurs in the other half of the coil. It can easily be shown to what extent this transposition will avoid eddy-current losses, and that in the case of the present machine, where the total depth of the strands of each conductor amounts to 1·25 in., there being two such conductors in the depth of the slot, and where the active length of the conductor is a large percentage of the length of the turn, this disposition is not sufficient to bring down the loss to a reasonable figure. It therefore becomes necessary to use a slightly more complicated connection at the end of the coil, the coils being connected together strand by strand or in groups of strands in such a way that there is a more thorough transposition of the location of the strands in the slot. Effectively we obtain the result of a much smaller conductor with a several circuit winding, except that this is so arranged that there is but an insignificant voltage between the several parallel conductors, avoiding the loss of space that would be entailed were we to use a multiple-circuit winding and insulate the conductors accordingly. In view of the considerable length of the machine and the somewhat severer conditions obtaining at the centre than near the ends, and also the smaller facility than usual for endwise conduction of heat along the copper, it was considered desirable to use a stator insulation as nearly fireproof as possible, merely as a precautionary measure. For this purpose mica wrappers were applied by machine to the coil, giving an exceedingly solid insulation, having some 70 or 80 per cent. of solid mica.

Considerations such as the above, however, bring home forcibly the fact that the difficulties that we are encountering are largely connected with the size of the conductor that we have to use, and that increasing the copper section to relieve the temperature conditions tends to introduce troubles as fast as we cure them. For instance, were it possible to use, say, a fused silica tube for stator insulation, we could immediately cut down the size of the slot copper, at the same time overcoming much of our eddy-current trouble; and we should have no reason to be alarmed even should the central part of the active length of the conductor occasionally reach very high temperatures. Some of the characteristics of fused silica, and the recent rapid commercial development of this material, are promising as far as they go, but many obstacles to its use for this purpose remain.

* C. A. Adams, A. C. Lanier, C. C. Pope and C. O. Schooley, "Pole face Losses," "Transactions" of the American Institute of Electrical Engineers, Vol. XXVIII., p. 1133, 1909.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Continued from page* 207.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

Case of Wave-wound Rotor. It is reasonable to assume that, if we go a step further, and suppose that the number of rotor slots *per pole* is no longer a whole number, the general formula will still hold good provided all slots are equally wound, and the conductors per pole of each phase are concentrated as much as possible so that but little overlapping occurs between the conductors of different phases.

Now this is practically the case of a wave-winding in the form generally applied to the rotors of induction motors, where, in order to avoid excessive leakage, special connections are arranged so that the conductors per pole of any one phase only occupy approximately one-third of a pole-pitch instead of two-thirds, as they would do in the unmodified wave-winding. It is assumed that the winding steps are equal, so that each step is very nearly equal to a pole-pitch (reckoned in conductors).

In this case the increase of leakage which is caused by any small variation of winding step from an exact pole-pitch must be relatively small.

On these general grounds it may reasonably be concluded that the formula for $\sigma_{peripheral}$ may be employed in the case of wave-wound rotors as well as for those with the hemitropic form of winding. No rigid proof is attempted, because when the number of slots per pole is not a whole one, the simple formula ($\tau - 2\gamma$) for the linkage between two coils no longer applies, and the treatment on the lines described in the previous pages would become too cumbersome.

Before concluding this section on the main dispersion we shall consider the leakage when two alternative methods of

winding the rotor in hemitropic manner are employed, the number of rotor slots per pole being a whole number, not a multiple of 3.

First Alternative Method.—The same case as before will be used as an example, namely $S_1=12$, $S_2=16$.

In this winding, which is represented in Fig. 13, no slot contains conductors of more than one phase, but in order to effect

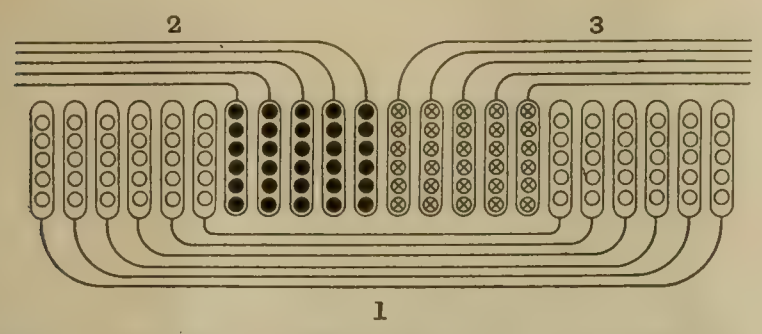


FIG. 13.—CASE OF 16 ROTOR SLOTS PER POLE. SECOND METHOD OF WINDING.

this all slots do not contain the same number of conductors, since these are arranged in 6 slots per pole for phase 1 and in 5 slots per pole for phases 2 and 3. The number of conductors per phase being, of course, the same for each phase, it follows that the slots of phase 1 have only five conductors to every six in a slot of phases 2 and 3. It is unnecessary to go into the

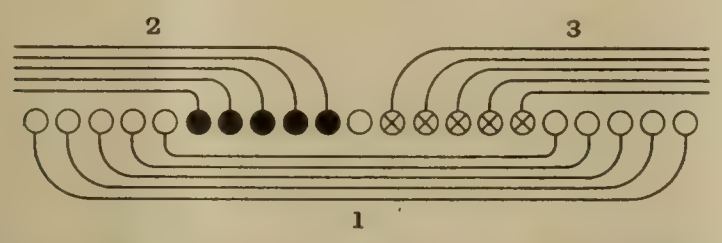


FIG. 14.—CASE OF 16 ROTOR SLOTS PER POLE. THIRD METHOD OF WINDING.

details of the calculation, which is made in exactly the same way as for the previous cases.

We obtain $\beta_s=\frac{810}{720}$,

$$\left.\begin{aligned}\beta_{r1}&=\frac{770}{720}\\ \beta_{r2}&=\frac{824\cdot4216}{720}\\ \beta_{r3}&=\frac{824\cdot4216}{720}\end{aligned}\right\}\quad\therefore\ \beta_r=\frac{806\cdot2811}{720}.$$

For position of minimum σ_1—

$$\left.\begin{aligned}\beta_{m1}&=\frac{792\cdot9257}{720} & \beta'_{m1}&=\frac{777\cdot9340}{720}\\ \beta_{m2}&=\frac{808\cdot6710}{720} & \beta'_{m2}&=\frac{814\cdot6035}{720}\\ \beta_{m3}&=\frac{810\cdot0000}{720} & \beta'_{m3}&=\frac{818\cdot4282}{720}\end{aligned}\right\}\quad\therefore\ \beta_m=\frac{803\cdot7604}{720}.$$

$$\therefore\ \sigma_{1\min.}=2^{\left(\frac{\beta_s+\beta_r}{2}-\beta_m\right)}_{\frac{1}{2}(\beta_s+\beta_r)}=0\cdot0108.$$

For position of maximum σ_1—

$$\left.\begin{aligned}\beta_{m1}&=\frac{790\cdot2479}{720} & \beta'_{m1}&=\frac{787\cdot5471}{720}\\ \beta_{m2}&=\frac{804\cdot5330}{720} & \beta'_{m2}&=\frac{787\cdot5471}{720}\\ \beta_{m3}&=\frac{804\cdot5330}{720} & \beta'_{m3}&=\frac{823\cdot5898}{720}\end{aligned}\right\}\quad\therefore\ \beta_m=\frac{799\cdot6663}{720}.$$

$$\therefore\ \sigma_{1\max.}=0\cdot0210.$$
$$\therefore\ \sigma_{1\mathrm{mean}}=0\cdot0159.$$

Second Alternative Method.—The same example is taken. One slot per pole is left unwound, so that each phase has the same number of slots per pole though the coils of the different phases are not quite evenly distributed round the periphery of the rotor. The arrangement is indicated in Fig. 14.

$$\beta_s=\frac{270}{240},$$

$$\left.\begin{aligned}\beta_{r1}&=\frac{282}{240}\\ \beta_{r2}&=\frac{268\cdot2612}{240}\\ \beta_{r3}&=\frac{268\cdot2612}{240}\end{aligned}\right\}\quad\therefore\ \beta_r=\frac{272\cdot8410}{240},$$

For position of minimum σ_1—

$$\left.\begin{aligned}\beta_{m1}&=\frac{270}{240} & \beta'_{m1}&=\frac{280}{240}\\ \beta_{m2}&=\frac{269\cdot5570}{240} & \beta'_{m2}&=\frac{264\cdot1420}{240}\\ \beta_{m3}&=\frac{269\cdot5570}{240} & \beta'_{m3}&=\frac{264\cdot1420}{240}\end{aligned}\right\}\quad\therefore\ \beta_m=\frac{269\cdot5664}{240}.$$

$$\therefore\ \sigma_{1\min.}=0\cdot0133.$$

For position of maximum σ_1—

$$\left.\begin{aligned}\beta_{m1}&=\frac{268\cdot1404}{240} & \beta'_{m1}&=\frac{274\cdot1063}{240}\\ \beta_{m2}&=\frac{268\cdot1404}{240} & \beta'_{m2}&=\frac{274\cdot9395}{240}\\ \beta_{m3}&=\frac{268\cdot0489}{240} & \beta'_{m3}&=\frac{254\cdot3467}{240}\end{aligned}\right\}\quad\therefore\ \beta_m=\frac{267\cdot9537}{240}.$$

$$\therefore\ \sigma_{1\max.}=0\cdot0255.$$
$$\therefore\ \sigma_{1\mathrm{mean}}=0\cdot0194.$$

Comparison of the Three Methods of Winding.—In Table IV. the three methods of winding are compared.

Table IV.—*Comparison of σ_1 for the Three Different Methods of Winding.*

—	Description of winding.	σ_1 min.	σ_1 max.	σ_1 mean.
1st method	All slots fully wound.....	0·0090	0·0186	0·0138
2nd method	Some slots partially wound	0·0108	0·0210	0·0159
3rd method	Some slots left unwound.....	0·0133	0·0255	0·0194

From this comparison we see that the second method of winding increases the value of $\sigma_{1\mathrm{mean}}$ obtained with the first method by about 17 per cent., while the third method increases it by more than 40 per cent. On the other hand, of course, the first method possesses the disadvantage of having conductors of different phases in the same slots. This, however, occurs in all wave windings.

Case of Squirrel-cage Rotor.—There still remains the squirrel-cage type of rotor. In this case there may be any number (whole or fractional) of slots per pole. Moreover, the squirrel-cage winding differs from all forms of wound rotor in that there are as many phases as there are slots per pair of poles. No attempt will be made here to develop a separate theory to deal with this case. It will be assumed that the general formula for the mean value of σ_1 gives, in this case also, results of sufficient accuracy for the purposes of this article.

Section III.

Peripheral Dispersion.—Unlike the main dispersion, which is due to the main flux linking rather more effectively with the exciting than with the excited winding, peripheral dispersion is the result of actual leakage fluxes. These fluxes are, first, those composed of magnetic lines which pass across stator slots, and so do not link with any rotor coils, and, secondly, those composed of similar lines in the rotor which link with none of the stator coils.

The general distribution of these leakage lines is shown in Fig. 15 which represents the case of a motor having three semi-enclosed slots per pole per phase. This leakage may conveniently be separated into two parts—namely, those lines which pass across from side to side of the slots, and those which cross the tops of the slots from one overhanging tooth edge to the next.

Now, the reluctance of that part of the leakage paths which

lies in the iron is negligible compared with that of the part in air. Consequently the total reluctance is proportional to the number of slots per pole per phase. The number of turns with which the lines link is, however, also proportional to the number of slots per pole per phase. It follows that the magnitude of the leakage flux is independent of the number of slots, so



Fig. 15.—Distribution of Slot Leakage Lines.

that in determining this flux it will only be necessary to consider one slot.

Slot Permeance.—Referring to Fig. 16, if we suppose the slot contains a number of conductors n, then lines which pass across the slot at ab will link with only $\frac{x}{h}n$ conductors, h being the depth of the slot. If b denote the width of the slot, then the flux due to 1 ampere which crosses the slot in the strip ab of width dx, per cm. axial length of slot, is

$$0.4\pi \frac{x}{h} n \frac{dx}{b},$$

and the magnetic linkage of this flux (with the conductors in this slot alone) is

$$0.4\pi \left(\frac{x}{h} n\right)^2 \frac{dx}{b}.$$

The total magnetic linkage (again only with the conductors in the one slot) per cm. length of slot, due to that part of the flux which passes from side to side of the slot, is, therefore,

$$\frac{4\pi}{10}\left(\frac{n}{h}\right)^2 \frac{1}{b}\int_0^h x^2 dx = \frac{1}{3}\frac{4\pi}{10}\frac{h}{b}n^2.$$

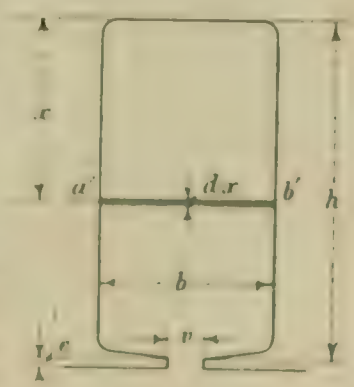


Fig. 16.—Calculation of Slot Permeance.

Now the permeance of the slot per cm. length (excluding still the slit between the teeth) is h/b, so that if *all* the leakage paths across the slots linked with *all* the conductors in the slot the total flux per cm. length would be $\frac{4\pi}{10}\frac{h}{b}n$, and the total linkage $\frac{4\pi}{10}\frac{h}{b}n^2$. Thus, the actual linkage is only one-third what it would be if the whole of the leakage paths across the slot were subject to the magnetomotive force of the currents in all the conductors in the slot. This part of the slot, therefore, may be said to have an *effective* permeance of $\frac{1}{3}h/b$ per cm. length.

In addition to the leakage flux calculated above there is that which passes across the slit in the top of the slot. The permeance of this part per cm. axial length is e/r, where e is the thickness of the overhanging tooth edge and r the width of the slit. This part of the leakage flux links with *all* the conductors in the slot; it is all effective. The resultant effective permeance of the slot per unit axial length is, therefore,

$$P = \left(\frac{e}{r} + \frac{1}{3}\frac{h}{b}\right).$$

P will be referred to simply as the slot permeance.

Permeance of Main Magnetic Circuit.—In the complete magnetic circuit the main flux crosses the air-gap twice. If there were no slot openings, nor very thin non-slot bridges, the air-gap reluctance per cm. axial length would be δ/τ, where δ is the radial length of air-gap and τ the pole-pitch. Slot openings cause this reluctance to be increased approximately to δ/τ_i, where τ_i denotes the pole-pitch reduced by the total width of slot openings per pole (mean of stator and rotor). The total air-gap reluctance per circuit is, therefore, $2\delta/\tau_i$. The reluctance of stator and rotor teeth and cores increases the total reluctance of the main circuit to $k_z 2\delta/\tau_i$, where k_z is equal to the ratio

$$\frac{\text{Ampere-turns per Circuit}}{\text{Ampere-turns for Air-gaps}}.$$

The factor k_z varies somewhat with different motors, but as a mean value for it we may take 1·2.

Then permeance of main circuit (per cm. axial length)$=\tau_i/2{\cdot}4\delta$.

(To be continued.)

ORGANISING BRITISH ENGINEERING INDUSTRY.

We have received a report, drawn up by the Special Committee of the Engineers' Club of Manchester, in which recommendations for organising British engineering industry are submitted. These are an extension of and are based upon the recommendations of the sub-committee appointed by the Engineers' Club to consider the effect of the war on the engineering industry (The Electrician, Vol. LXXIV., p. 813) The text of the report is as follows :—

The present is an opportune moment for the whole engineering industry of this country to re-organise and put its house in order. The development of our engineering export trade, in particular, has been highly unsatisfactory for some years, while Germany's rate of progress has been phenomenal. In our opinion, Germany's success has been due to education, to co-operation, and to organisation in manufacturing and selling, backed up by adequate financial support.

In Britain, on the other hand, education has been unsystematic, organisation weak, and co-operation between competing firms almost non-existent. The time has come when every British engineer must realise that his British competitor in some markets must be his friend and ally in others. The spirit of conference and co-operation is needed to leaven that British independence which, despite its fine qualities, has hitherto hampered combined action in the interests of the British engineering industry as a whole. We do not advocate trusts or combines that enforce uniformity and stifle individual initiative. But we feel the urgent need for some voluntary organisation of the whole industry, based upon a recognition of the interests common to competing firms and common also to employer and employed; and we believe that, by voluntary organisation and co-operation, a great deal can be done to improve manufacturing processes, to develop foreign trade, and to secure for employees better conditions of work and a larger share of the fruits of their labours

The capital invested in the British engineering industry is estimated at over 300 millions sterling. If firms representing this huge sum would co-operate and equip themselves for a determined and well-organised effort, there would be no question of their ability to secure a larger proportion of the trade of the world.

Your committee is convinced that advantage can best be taken of the present opportunity by the formation of an association on a non-trading and non-interference-with-prices basis. This Association should comprise British manufacturing concerns in all branches of engineering, aim at the inclusion of every such concern, have a constitution giving it a legal status framed on broad principles, and possess an efficient and energetic management. Such an Association would speak with a powerful collective voice in matters with which Parliament was concerned, would assist the Government in questions connected with industry and commerce, and would be entitled to representation on the Governing Bodies of Universities and Technical Colleges. The Association would not trade in any way whatever. It would assist members equally and without distinction in the obtaining of business, and would generally act in the furthering of the interests of the industry as a whole.

Ample funds should be secured from members, mainly in the form of annual subscriptions, not of uniform amount but according to a graduated scale. Even an annual subscription, equivalent to ¼ of 1 per cent. of the 300 millions capital, would provide an income of £300,000. The constitution of the Association would require careful framing. Membership of the Association should be restricted to approved British engineering concerns. A large majority, say, three fourths of the beneficial owners of every company or firm, seeking to become a member, should be British subjects. The general management of the Association should be in the hands of a thoroughly competent business man, of unimpeachable integrity, under the direction of a representative and periodically elected Council.

The headquarters of the Association should be situated in London or Manchester. Branch offices may later be established at suitable centres in this and other countries. Where such branch offices are not justified the Association may appoint, temporarily or permanently and for specific or general purposes, individual representatives, who would ordinarily be engineers of wide experience with an intimate knowledge of local require

ments. The Association's representatives should be in close touch with the British Consul, the Commercial Attaché, the Colonial Government, and the British Chambers of Commerce, and would do propaganda work in the interests of British engineering.

The work of the Association should be directed by the Council through the general manager. Standing committees should be appointed by or elected from the Council, including (if thought fit) co-opted members, in order to advise the Council in regard to the following departments of the work, namely :—

I. General Purposes.
II. Intelligence.
III. Production.
IV. Inventions and Patents.
V. Publicity.
VI. Finance.
VII. Education and Research.
VIII. Parliamentary.

Special Committees might also be appointed from time to time to deal with temporary or special matters.

The functions of the standing committees should include the following:—

I.—General Purposes.

1. To bring pressure to bear upon railway, canal and shipping companies for the improvement of conditions and reduction of freights.

2. To appoint arbitrators, or otherwise settle disputes arising between members.

3. To discharge such duties as may from time to time be assigned to it by the Council.

II.—Intelligence.

1. To control the Association's representatives and to collect, analyse and distribute (through the Publicity Department) amongst members the technical and commercial information they obtain.

2. To analyse consular reports, technical and commercial papers and other published matter, and to circulate the results amongst members.

3. To receive specific inquiries for business and to forward these to—

(*a*) Firms indicated if earmarked, or

(*b*) All members concerned if not earmarked.

4. To arrange conferences of members interested, to discuss general policy and joint action in connection with prospective business.

5. To recommend the Council and subject to its sanction to send out from time to time a commission to investigate matters of engineering interest in various parts of the world.

6. To recommend the Council to make temporary appointments from time to time of individuals, whether members or not, who have special information or facilities, to report on particular fields, industries, or specific cases.

7. To give introductions.

8. To recommend suitable agents and make inquiries of a confidential character into the standing of firms.

III.—Production.

1. To promote a better feeling between manufacturers to the mutual good.

2. To raise the standard of manufacturing methods and organisation, and with that object to direct the attention of manufacturers to engineering developments and improvements in workshop practice.

3. To stimulate manufacturers to adopt a progressive and enterprising policy, both in commercial as well as in technical and manufacturing matters.

4. To induce members to experiment continuously both on their own account and with the co-operation of other firms or outside institutions with a view to placing new or improved productions on the market.

5. To encourage a keener study and appreciation of customers' requirements, and a greater readiness to satisfy them—

(*a*) By supplying goods somewhat outside their usual range of production.

(*b*) By issuing comprehensive catalogues (*see* " Publicity ") ; and by sending abroad representatives with qualifications such as would be given by the training outlined under sec. VII., 1-*b*. ii.

(*c*) By fulfilling promises especially of delivery.

6. To recommend members to consider the advisability of marking their goods " British Made."

IV.—Inventions and Patents.

To consider and make recommendations to the Parliamentary Committee respecting questions of practice under, and amendments of the law relating to Patents, Designs and Trade Marks.

V.—Publicity.

1. To disseminate amongst members the information collected by the Intelligence Department.

2. To organise the preparation for distribution at home and abroad of printed information of all kinds relating to the British engineering industry for the purposes of increasing the demand for British products.

3. To organise schemes for advertising by means of exhibitions, showrooms and otherwise at home and abroad.

4. To undertake the translation and adaptation of members' catalogues for foreign markets. It is urged that these catalogues :

(*a*) Should be translated into the language and units of the country concerned by native engineers so as to ensure the terms being technically correct and the descriptive matter adequate.

(*b*) Should be fully priced and coded, sufficient data being given to enable purchasers to estimate the cost of goods delivered to their destination.

VI.—Finance.

To secure and preserve a sound financial basis for the association. To make arrangements for the better financing of the industry, both in manufacture and in relation to home and foreign contracts. To consider recommendations submitted by other departments.

VII.—Education and Research.

1. To advise Government Departments (Board of Education ; Home Office ; Civil Service Commission, &c.) ; Local Education Authorities and the Governing Bodies of Schools, Colleges and Universities in regard to the education of engineers of all grades ; and to advise members in regard to the education of their employees ; and in particular :

(*a*) To nominate representatives of the association to serve upon the Governing Bodies—or upon advisory committees of the Governing Bodies—of universities and technical colleges of university rank.

(*b*) To advocate :

i. The establishment of new schools and colleges where required ;

ii. The provision of suitable courses in existing schools, colleges and universities, and especially the provision in certain universities of technical-commercial courses which, when combined with practical experience, shall prepare future commercial representatives of engineering firms to understand their customers' interests, the conditions and language of the country in which they trade, the merits and uses of their goods, so that they may undertake successfully the selling part of engineering business ;

iii. The co-ordination of all schools and colleges in which engineers are educated ; and, in order that this co-ordination may be effected and the system thus formed thoroughly democratic ;

iv. The establishment of an adequate system of scholarships and bursaries so as to secure that no person, who, if he passed through a certain course, would be needed and demanded to fill some place in the engineering industry, should be prevented from taking that course for want of a scholarship or maintenance allowance.

(*c*) To encourage members in each area to establish, in co-operation with the education authorities of the district, a scheme for the advancement of apprentices and to urge every member to provide at least such minimum means for encouraging apprentices as are prescribed by the scheme in force in their district.

2. To encourage research in the following among other ways :—

(*a*) By making recommendations to the Finance Committee in regard to money grants to universities, technical colleges of university rank, and other institutions.

(*b*) By moving the Parliamentary Committee to secure adequate Government grants for purposes of industrial research.

(*c*) By undertaking, and recommending the financing of, particular researches in co-operation with universities and colleges.

(*d*) By advising members in regard to particular researches or tests which they may wish to undertake, or to have undertaken on their behalf, in the research or testing laboratories of some central university or college.

(*e*) By developing co-operation between engineering firms on the one hand and universities and technical colleges on the other (*see* sec. III. 4) so as to establish such "Schools of Thought" as exist in the research departments of great continental and American engineering firms, but cannot be fostered in the comparatively small establishments (and smaller research departments) of most British engineering firms.

VIII.—Parliamentary.

1. To induce the Government to take an active interest in trade in general, and engineering in particular, to bring pressure to bear on it, to create a Ministry of Industry and Commerce (the permanent secretary of which should be a man of great commercial experience and distinction), and to allocate to this department the purely commercial matters now handled by the Board of Trade.

2. To induce the Government to re-organise the Consular service so as to increase its utility to British trade, and in particular to appoint, as commercial attachés, men who have had a wide commercial training and experience ; when possible and desirable, to obtain the appointment of engineers of recognised standing as advisers to the national representatives abroad ; wherever possible to appoint natural-born British subjects as Consular officers, and to make the service a special medium for the furtherance of British commercial interests, *e.g.*, by the active dissemination of information, in the language of the country, concerning British industries and products.

3. To advise the Government on engineering matters when called upon to do so, and to tender advice to the Government on such matters in proper cases.

4. To deal with recommendations from the Inventions and Patents Committee and to take action thereon when necessary or advisable.

We have endeavoured in this report to outline what we believe to be the best way of advancing the interests of the British engineering industry. The multiplication of organisations is undesirable, and if an existing association would so modify its constitution and extend its operations so as to give effect to our suggestions, it would be better than to establish a new Association.

The whole-hearted support of the industry and adequate financial backing would ensure the success of the proposed organisation. The objects for which your committee have laboured will be secured if every British engineer approaches the matter in a spirit of true patriotism.

Your committee, therefore, recommends an Association on the lines indicated in this report to the serious consideration of the Engineers' Club.

Daniel Adamson.
H. Allcock.
W. T. Anderson.
J. A. F. Aspinall.
W. A. Bristow.
J. M. Dale.
Edward W. Donovan.
J. C. Maxwell Garnett.
Edmund L. Hill.
J. H. Hoseason.
E. T. Morland Johnson.
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H. Derwent Simpson.
Eustace Thomas.
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H. T. Wilkinson,
Hon. Sec. to Special Committee.

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PRO PATRIA.

Last winter a series of debates was held at the Engineers' Club, of Manchester, to discuss the effect of the war on the engineering industry. The first debate, entitled "That it is Essential that the Engineer put his House in Order," led to the appointment of a sub-committee to tabulate the results of the discussions and to consider what could be done to give effect to them. Subsequently a special committee was appointed to consider and report upon the whole matter.

As a result of its deliberations and inquiries the latter committee is convinced that the British engineering industry must organise without delay to take advantage of present opportunities and to meet the conditions which will follow the termination of the war. The committee finds that all that is needed to enable us to reap the harvest, already enriched by the blunders of our enemies, is an organisation that embodies a broader and loftier view of the responsibilities, the opportunities and powers of our engineering industry. Sacrifices of time, of some small measure of money, and a few concessions from the strongly marked individualism of our race, will be required of us before we can gain the full benefit of this proposed organisation. But, as the committee points out, in times when causes of tremendous import are in the balance, personal sacrifices have been and must long continue to be gladly granted. In submitting the proposals they have drafted the committee doubt not that their proposals will be received and carried out in a spirit of true patriotism.

From the text of the report given elsewhere it will be seen that the formation of an association on a non-trading and non-interference-with-prices basis is recommended. In the opinion of the committee this association should comprise British manufacturing enterprises in all branches of en-

gineering, should aim at the inclusion of every such concern, have a constitution giving it a legal status framed on broad principles, and possess an efficient and energetic management. Such an association would speak with a powerful collective voice in matters with which Parliament might be concerned, would assist the Government with questions connected with industry and commerce, and would be entitled to representation on the Governing Boards of Universities and Colleges. The association would not trade in any way whatever. It would assist members equally and without distinction in obtaining business, and would generally act in furtherance of the interests of the engineering industry as a whole.

It is suggested that ample funds would be forthcoming from members, mainly in the form of annual subscriptions, and it is very properly provided that such subscriptions be according to a graduated scale. The capital invested in the British engineering industry is estimated at over 300 millions sterling, and an annual subscription equivalent to $\frac{1}{10}$ of 1 per cent. would yield an income of £300,000 a year for carrying on the work of the association.

The appointment of standing committees is recommended in order to advise in regard to the following work, namely: general purposes, intelligence, production, inventions and patents, publicity, finance, education and research, and Parliamentary; and to deal with temporary or special matters the appointment of other committees is suggested. Thus it will be seen that there would be but little overlapping of the work of the proposed association and of existing institutions and associations. If the scheme fructifies there will doubtless be close co-operation. We notice that one of the objects of the association would be to undertake the translation and adaptation of members' catalogues for foreign markets. It is urged that these catalogues should be translated into the language and units of the country concerned by native engineers so as to ensure the terms being technically correct and the descriptive matter adequate, and it is further urged that catalogues should be fully priced and coded so as to enable prospective purchasers to estimate the cost of goods delivered to their destination.

A perusal of the report leads us to the conclusion that the ground covered is common to all branches of industry. It is characterised by the thoroughness and attention to detail that one associates with the work of the Manchester engineers. Of particular interest is the section devoted to education and research. To encourage the latter it is proposed to develop co-operation between engineering firms on the one hand and engineering colleges on the other so as to establish such "Schools of Thought" as exist in the research departments of great Continental and American engineering firms, but which cannot be fostered in the comparatively small establishments (and smaller research departments) of most British engineering firms. Particularly opportune is the suggestion that one of the functions of the Parliamentary Committee should be to induce the Government to take an active interest in trade in general, and engineering in particular, to bring pressure to bear on it, to create a Ministry of Industry and Commerce with an eminent business man as the head, and to allocate to this department the purely commercial matters now handled by the Board of Trade.

We venture to think that if an engineer asks himself the question: "Will such an association be of any benefit to me in my business?" his answer will be in the affirmative. Equally, we are of the opinion that shareholders will regard as a profitable investment such annual outlay of $\frac{1}{10}$ of 1 per cent. of their capital, provided that the proposed association is in a position to supply information the absence of which has handicapped their enterprise in the past.

The Engineers' Club is to be congratulated on its foresight in electing a committee—composed of men of ripe judgment and wide experience—competent to deal in a comprehensive manner with the difficult question of organising British engineering industry, and to the committee credit is due for framing a report which looks like business. The regrettable feature is that during the past year our engineering institutions have been busily engaged in discussing matters of little importance, while the matters which count have been left for a relatively small body of engineers to consider. On this account the action of the Manchester engineers is all the more worthy. Many of our people have yet to learn that Britain owes more of her prosperity to her engineers than to debates in Parliament, and that she owes her existence to-day to the efforts of her engineers rather than to the putterings of her politicians.

REVIEWS.

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Alternating-Current Work. By W. PERREN MAYCOCK. Pp. xxiv. +415. (London: Whittaker & Co.) 6s. net.

On the title page it is stated that this book is an enlargement of and an improvement upon a former work by the author on "The Alternating-current Circuit and Motor," and it is called an introductory book for engineers and students. It was not our privilege to read the former work, but the book under review is carefully edited, is well got up, and many of the diagrams have a workmanlike appearance. To those whose knowledge of higher mathematics does not extend beyond simple arithmetic, elementary algebra and hazy notions of trigonometric functions the book will appeal. After reading the book a few times such "engineers" and "students" will be able to talk glibly enough about alternating currents, but there cannot be much real *knowledge* behind.

In these days of cheap education it is largely a man's own fault if, with very little outlay combined with perseverance and grit, he is unable to acquire fair mathematical knowledge. In alternating-current work such knowledge takes one a very long way. The author states that the calculus has not been allowed to show its fearsome face within the pages of his book, and remarks that the very little trigonometry he uses is briefly explained. He tells his readers that good mathematical knowledge is an accomplishment worthy of great respect, and continues: "But those who . . . are unable to rise to such heights may comfort themselves with the reflection that there is plenty of room for distinction in other ways. . . . Then there is the indispensable 'commercial engineer,' who often does not possess very special knowledge of either theory or practice."

As a rule, it is only to those who do not know the meaning of the calculus that the face of the latter is fearsome. To our mind the author's indispensable commercial engineer who does not possess special knowledge of either theory or practice is neither an engineer nor is he indispensable. There is no question that this class of engineer can only prove a source of weakness to this country.

The use of very little trigonometry in the book shows itself thus: Writing on the two-wattmeter method of measuring power in a three-phase circuit, the author states that it can be shown mathematically that the algebraic sum of the readings on W_1 and W_2 will give the total power under all conditions of load, and continues: "The reasons for the above procedure cannot be explained here, as this would entail a certain amount of trigonometry." Again, it is stated that capacity

reactance $=1 \div 2\pi fK$, and in a footnote: "This expression must be taken for granted."

The examples given by the author constitute as varied an assortment as were ever bound together in one volume. It is unusual to find in an introductory book a large number of questions from Honours Papers, from A.M.I.E.E. Papers and so forth, and students sitting for these examinations would do well to remember that when examiners set simple questions they expect something more than superficial answers to such questions. As we have said, the book will interest those who have not the inclination to become conversant with elementary mathematical processes. Such men, happily, grow less in number each year. A careful perusal of the book has not convinced us (and we have endeavoured to look at the matter from the point of view of the beginner) that the volume "really opens the gate of the field of what might be termed alternating-current engineering." The book that does this with "very little trigonometry" has yet to be written.

Grinding Machinery. By JAMES J. GUEST. (London: Edwin Arnold.) Pp. xi.+444. Price 15s. net.

In this work the author deals with the subject of precision grinding, giving a very original treatment of the theory of the subject, whilst at the same time he approaches the practical side of the subject from the position of a manufacturer of grinding machinery.

Chapter I., on "Grinding and Manufacturing," treats of limits and the relative merits of the hole and shaft basis for limits, and then goes on to discuss the action of a wheel and the basis of accuracy of grinding. Chapter II., "The Abrasives and the Wheel," deals with the abrasives used and the various kinds of wheels and their suitability for different classes of work. In Chapter III. on "The Wheel and the Work" we have one of the most original and valuable chapters in the book. The author first discusses the most suitable abrasives for working on different materials. He combats the idea that particles of grit get embedded in the work being ground, commenting on the difficulty of getting diamond dust into soft steel laps. Mr. Guest states that he has failed to detect embedded particles of grit either by microscopic examination or chemical tests. The rest of the chapter is devoted to the question of work speeds and wheel speeds.

The author is opposed to the commonly accepted view that the surface speed of the work in cylindrical grinding is independent of the diameter of the work. He develops a theory of the cutting action and expresses it in a formula. If v = velocity of work surface, D and d the diameters of the wheel and work respectively and t the diametrical reduction of the cut, then if the expression $v^2 \cdot \frac{D+d}{dD} \cdot t$ exceeds a certain value the wheel disintegrates too rapidly, and if below another value the wheel glazes. Mr. Guest also advocates the use of a finishing speed for the work of from 25 to 75 per cent. greater than the roughing speed.

In Chapter IV. wet and dry grinding are discussed and reference is made to the distortion produced by the latter. The effect of distortion due to internal stresses is also considered. In dealing with the question of vibration the author goes into the theory of forced and free vibrations and the conditions necessary for correct balance. The rest of the chapter is taken up with a description of a universal grinder by Brown and Sharpe, as illustrating modern practice. Subsequent chapters deal with external and internal grinding and cutter sharpening, being well illustrated with numerous examples of standard machines, the author confining himself to those details which are interesting from a grinding point of view and omitting those details only interesting as mechanisms.

In Chapter XI. form grinding and grinding by the generating method are described and the application of the latter to the grinding of wheel teeth is illustrated.

Lapping and polishing are discussed in Chapter XII., and in the last chapter (XIII.) is a description of exact measuring appliances.

An appendix gives numerous examples of grinding times, limits and allowances for different classes of work, and wheel and work speeds. The work is well printed and the illustrations are well drawn, reference letters being extensively used.

E. D. F.

Micrometers, Slide Gauges and Calipers: Their Construction and Use. By A. W. MARSHALL and G. GENTRY. (London: Percival Marshall & Co.) Pp. 77. 6d. net.

This is a small treatise of 77 pages, the scope of which is indicated by the title. The principles of the vernier and micrometer are explained and the different forms of calipers and micrometers well illustrated and described. The section on micrometers would have been more complete, however, if an internal micrometer gauge had been shown. We can recommend the book to those anxious to get a clear insight into the working of vernier and micrometer gauges. E. D. F.

MR. C. P. SPARKS' PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.*

The last Presidential Address called attention to the importance of every individual member working "in the best way he can for the good of King and Country." After 15 months of war on an unprecedented scale the present need is not less urgent, the last recruit and the last round of ammunition being the deciding factor. While the bulk of our 7,000 members are engaged in maintaining the public services or, directly or indirectly, in the manufacture of munitions of war in comparative safety our hearts go out to the 1,150 members of the Institution who are on active service in answer to the national call. It is the earnest desire of the Council to take all possible steps to enable our organisation to be of still further use in the national service.

NECESSITY FOR MANUFACTURING PROFIT.

As one-half of my career has been spent in the manufacture of electric supply plant, and the other half as engineer to electric supply undertakings, I desire to say a few words on a subject of special interest to all sections of the Institution.

It is sometimes suggested that commercial matters should not be dealt with by engineers, who should confine themselves to technical questions. I disagree with this view, and believe that the commercial engineer is just as much a recognised member of our profession as a pure scientist.

Now, as to the acceptance of the lowest tender, whether it be British or foreign, it must always be remembered that the onus of development and the successful carrying out of a contract is borne by the contractor, and that if a reasonable margin of profit is not secured the contractor cannot in the long run do his duty by the purchasers. First, the contractor is crippled, being unable to make provision for development, since without profit new capital cannot be attracted; but, what is more serious, provision cannot be made for improvements, without which we cannot keep pace with our world competitors.

No industry has suffered more from competition than our own, and the continued acceptance of the lowest tender in the past has so limited the resources of certain sections of the manufacturing industry that only a minority of manufacturers have been able to make a reasonable return to their shareholders, and, owing to the restricted profits in recent years, inadequate amounts have been spent on developing new inventions.

The national interest would be better served by encouraging private enterprise to develop invention, by allowing manufacturers a reasonable margin of profit, than by securing—for the moment only—slight fractional reductions in the costs of public service undertakings through acceptance of the lowest tender, which is not always necessarily the most favourable.

I propose to follow the example of many of your Past Presidents by reviewing the position of that section of the industry with which I have been closely associated.

EFFECT OF LEGISLATION.

No industry received earlier recognition by Parliament than ours. Unfortunately, the advantages of encouraging private enterprise were disregarded. In the case of gas supply, after competition had been tried over a long period, monopolies were granted to private enterprise to supply gas over large areas, the price being controlled by a sliding scale connecting the price of gas and dividends. This method of operation has resulted in the greater part of the metropolis being supplied by two gas companies representing the amalgamation

* Delivered November 18, 1915. Abstract.

of 19 smaller undertakings (the Gas Light & Coke Co. supplying an area in and around London of 125 sq. miles, from six main stations all supplied in bulk from the main down-river station at Becton, 12 miles from the centre of the metropolis). Under this method of control, gas is supplied at a low price, at the same time allowing the gas companies to earn such dividends that there has been little difficulty in financing the undertakings.

In spite of this precedent, Parliament in passing the Electric Lighting Act of 1882 decided that the unit of area in the case of our industry should be a parochial one. In each area the local authority had the first right to supply electricity, and could obtain without difficulty a Provisional Order giving perpetual rights; but if a company wished to supply an area, they could only do so by obtaining either a licence for seven years by consent of the local authority, or, subject to the approval of the Board of Trade, a Provisional Order for 21 years with a chance of renewal for seven-year periods, the undertaking being liable to purchase by the local authority on terms most unfavourable to the operating company.

The Act of 1888 afforded some relief, but another 21 years had to elapse before further general legislation was secured, when the Act of 1909 gave substantial concessions.

Following the Act of 1888 came the Marindin Inquiry and the report of the Board of Trade, covering the Model Order, which made it clear that private enterprise was still to be hampered. The London County Council was not made the purchasing authority until 1908, when the companies obtained the right of association under the London Electric Supply Act.

The main results of the Marindin Inquiry were: The splitting-up of London among a number of separate undertakings, each with one or more generating stations, the majority operating with low-tension continuous current, although it was known that the limiting distance for transmission from continuous-current stations was at that time half-a-mile. The more important question of supplying London as a whole was disregarded. The model order issued after the close of the Marindin Inquiry did not deal with the question of system, and the difficulty and expense of change of system was not foreseen.

Thus badly equipped by legislation, the industry started in 1889 to engage in competition with well-established gas undertakings operating under perpetual powers.

Electricity Supply in the Metropolis.

Unfortunately, owing to the legislation previously referred to this area has been sub-divided between so many electrical undertakings that the question of general supply cannot be considered from an engineering point of view. The present position arises through a series of initial mistakes, and future improvement is more a matter of adjusting numerous municipal and other vested interests, than an engineering question.

Since 1882 two names stand out in special prominence in attempts to rectify the position. The first is that of Mr. S. Z. de Ferranti, who advised the group now known as the London Electric Supply Corporation (Ltd.). The second is that of Mr. C. H. Merz, whose Bill was lost through Parliamentary procedure.

Table I. illustrates the progress made by the supply undertakings operating in London and giving a general supply apart from traction.

Direct comparison of the prices charged by the companies and the local authorities is not possible. The western and central areas where the principal demand is for lighting, are supplied entirely by the companies, and, although the average rate for the companies appears to be 24 per cent. higher than that charged by the local authorities, a correct comparison can only be made when the relative proportions of lighting and power supply are known.

Table I.—*Revenue from Sale of Electricity.*

In 1894.	Units sold.	Revenue from sale of electricity.	Average revenue per unit sold.
Companies (10)	13,487,400	£336,900	5·99d.
Local authority (1)	719,500	15,930	5·32d.
Totals	14,206,900	£352,830	5·96d.
In 1904.			
Companies (13)	109,113,000	£1,630,100	3·59d.
Local authorities (13)	27,353,200	369,000	3·24d.
Totals	136,466,200	£1,999,100	3·52d.
In 1914.			
Companies (13)	211,709,500	£1,866,900	2·12d.
Local authorities (14), ex. Woolwich	122,733,200	875,500	1·71d.
Totals	334,442,700	£2,742,400	1·97d.

Table II.—*Capital Expenditure.*

Companies (14) at Dec. 31, 1914	£15,036,000
Local authorities (14) at March 31, 1914	6,777,500
	£21,813,500

Progress during the first six years after 1888 was at the rate of 2·3 million additional units sold per annum, during the next 10 years 12 million additional units per annum, and during the last 10 years 20 million additional units per annum, although the use of the more efficient metal filament lamp increased the light obtainable per unit more than threefold. The density of the sales for general supply in the metropolis, apart from those for traction, is now about 3 million units per square mile, 45 million units being used annually per square mile in the area of densest demand. General supply is now being given in the metropolis (an area of 117 sq. miles) by 28 separate undertakings.

	Square miles.	
Area scheduled in Provisional Orders and supplied by 13 companies	76·25	
Competitive area between companies included in above	11·87	
Net area supplied by companies		64·38
Area supplied by 14 local authorities	54·47	
Bethnal Green (work in hand)	1·19	
		55·66
		120·04
Companies and local authorities in competition		3·14
Total		116·90

The effect of allowing so many undertakings to operate in this area is shown by the following figures:—

	Metropolis. Total.
Number of separate undertakings:	
General supply in the metropolis	28
Traction supply in the metropolis	10
	— 38
Number of power stations:	
Supply undertakings	38
Traction	10
	— 48
Number of different frequencies:	
Supply undertakings	8
Traction (3) (additional to above)	1
	— 9

In view of the successful results obtained in this country outside the metropolis by concentration and the recognised practice of the rest of the world in allowing one authority to operate over a large area from a minimum number of power stations, there is little to be said on the London question from an engineering point of view; but in spite of the extreme difficulty in carrying through any scheme dealing with the whole area, it is clear from the results obtained elsewhere that London will be divided eventually for electricity supply purposes into a reasonable number of areas, even if a scheme embracing the whole metropolis is not carried through.

The two main difficulties to be met when approaching this matter from an engineering point of view are as follows:—

1. Owing to the large sums invested by a number of separate undertakings in small power stations and special distributing systems, any comprehensive scheme must suffer a disadvantage in the first instance due to the added cost of—

(*a*) New high-pressure network, and
(*b*) Cost and loss in conversion plant.

From past experience distributing systems have been the only part of a supply undertaking which has not shown serious obsolescence, and there is now every reason to consider the return on the necessary expenditure in any new high-pressure network over a period sufficiently long to allow the undertaking to develop, rather than to look on the immediate result.

2. Reliability of supply is of the first importance and of far greater importance than the provision of a supply at a minimum cost. It is, therefore, argued that it would be unsafe to supply the metropolis from a few stations, special objection being taken to any scheme which commences by adding one new power station of considerable magnitude.

It will be agreed that adequate safety can be secured with far less than the present number of power stations (38 in number), and as most of the individual undertakings are being supplied by a single power station unconnected with any other undertaking, the general safety of supply would be improved if the separate undertakings were inter-connected and supplied from a suitable number of modern power stations, each capable of dealing with demands of not less than 100,000 kw. A commencement could be made with one station to supplement the supply from existing stations, and as the less efficient

of these passed gradually out of use the main power station would be supplemented by a second or further stations as required.

Main Engineering Features.

While many inventions of value have resulted in improving the reliability of supply and in greater economy of production, progress is primarily due to the following improvements :—

1. Three-phase transmission.
2. Lowering of frequency.
3. Parallel working of alternators.
4. Development of the steam turbine and improved condensing plant.
5. Improved steam-raising plant.
6. Paper-insulated lead-covered cables.
7. Conversion of alternating to continuous current by rotary converters.
8. Development of reliable meters.
9. Metal filament lamps.
10. Reduction in the first cost and the improved control of motors.

1. *Three-phase Transmission.*—This system gave economy in first cost and was able to serve every class of demand over a large area.

2. *Lowering of Alternating Frequency.*—To keep down cost and to raise the efficiency frequencies of 80 to 100 cycles per second were originally selected. Although not recognised at the time, the choice of these high frequencies made the development of single-phase alternating-current motors almost impossible.

3. *Parallel Working of Alternators.*—No material progress was made in the operation of alternators in parallel as standard power station practice until after Mr. W. M. Mordey* laid down the principles and demonstrated the theory by the practical parallel working of the alternators of his design. This pioneer work of Mr. Mordey at once had a far-reaching effect on power station design and methods of working. It improved the reliability of the supply and lowered the operating cost by enabling the running plant to be worked at its most economical rating; it also showed the possibility of converting single-phase alternating currents into continuous currents by the use of synchronous motor-generators.

4. *Steam Turbine and Condensing Plant.*—The development of the steam turbine, due to Sir Charles Parsons, of Newcastle, together with the adoption of superheated steam and suitable condensing facilities, have entirely changed the character of supply undertakings. It has enlarged their scope by increasing the possible size of operating units, has greatly reduced the first cost of generating and boiler-house plant and buildings, and has lowered operating cost.

The use of turbo-generators enables a watt-hour to be generated in large power stations supplying diversified demands for 20 to 25 B.Th.U. (say, 1½ lb. to 2 lb. of average coal per unit), as compared with 100 to 150 B.Th.U.† (or 8 lb. to 12 lb. of average coal per unit) originally required in the small stations using non-condensing reciprocating engines supplying lighting demands.

The maximum size of turbo-generators is not yet in view; machines rated at 30,000 kw. and 35,000 kw. and made by the General Electric Co. (U.S.A.) are at work, while machines of still larger capacity are being designed. The upper limit in the size of generators is at present fixed by the extent of the system to be supplied and the limitations of the method of control, rather than by any limitations in the design of the turbine or electric generator.

5. *Improved Steam-raising Plant.*—The main improvement in steam-raising is the universal use of large boilers of the water-tube type, combined with superheaters and mechanical stokers using small coal of medium calorific value, as compared with small boiler units of various types, hand-fired with coal of high calorific value. Great progress has been made in furnace design and in mechanical stokers, thereby enabling small coal of comparatively low calorific value to be efficiently and smokelessly burnt. This has resulted in the average efficiency in conversion of the heat energy of the coal being raised from 65 to 85 per cent. on test and from 50 to 75 per cent. under operating conditions, with a material saving both in the cost of fuel and in labour.

Also, due to mechanical stoking, boilers now give their full output efficiently and continuously for long periods, compared with the fluctuating output in the case of hand-fired boilers due to the necessity of cleaning fires. This factor is of prime importance in reducing the amount of boiler power required. Again, the use of small coal enables the entire coal supply to be handled mechanically, and the development of the suction ash-conveyor has reduced to a minimum the amount of labour required in the boiler house.

As a result of the improved thermal efficiency of the boiler house and resulting low temperature of the gases, mechanical draught has become a necessity, the old difficulties of induced-draught plant, due to action of the hot gases on the fan and casing, not occurring with the lower temperature at which the gases are discharged from the boiler.

Instead of duplicate steam ranges of cast-iron, with copper bends, single steel mains are used, while the continuous flow of steam required by turbines, as compared with the intermittent flow of steam with reciprocating engines, has further reduced the area of steam pipes exposed to condensation.

Through the introduction of turbo-driven machinery, which requires no internal lubricant, the durability of the boiler plant has been much improved.

6. *Paper-insulated Lead-covered Cables.*—All transmission cables are now paper-insulated, lead-covered, armoured and laid direct in the ground; while for distributing purposes in the more central areas, paper-insulated lead-covered cables drawn into conduits are largely used. When it is considered that some 40 per cent of the capital outlay in the electric supply business is due to distribution, of which the cost of cable represents the greater proportion, the importance of this development is apparent.

7. *Conversion of Alternating to Continuous Current by Rotary Converters.*—No conversion was possible in the early stages owing to the want of an alternating-current motor, and it was not until the difficulties of this development were overcome by a reduction of frequency that any general supply of continuous current could be given from an alternating-current system. It was not until 1905 that satisfactory 50-cycle rotary converters were developed. This development was rendered possible by the introduction of interpoles, which allowed higher speeds to be used, thus securing reasonable spacing for commutation. The development of the 50-cycle rotary converter has resulted in reducing the space occupied by transforming plant to one-half of that required by motor-generators; the first cost has been reduced to between one-half and two-thirds, and the efficiency of conversion has been raised from 88 to 94 per cent. at full load.

8. *Development of Reliable Meters.*—The metering of electricity was a great difficulty in the case of early undertakings. The first meter developed for continuous-current supply was of the electrolytic type. No meters were available for alternating-current systems, and electricity was sold by annual contract. Although the development of the continuous-current meter appeared simpler in the early stages, more difficulty is now experienced in maintaining its accuracy over a given period than with the alternating-current type.

No method of metering energy has been brought to greater perfection than the metering of electrical energy, and the ease and accuracy of measurement have played a great part in enabling losses to be analysed and improvements made by increasing the efficiency of apparatus and the operation of the system. As an instance of close calibration and accuracy over a considerable period, I give the reading of three motor meters, the power factor of the supply varying from 0·8 to unity and the demand from 2·5 to 60 per cent. of the rated capacity of the meters.

	Meter (1)	Meter (2)	Meter (3)
Number of units registered ...	1,955,700	1,945,800	1,952,300
Mean reading units	—	1,951,266	—
Error from mean units	−4,434	−5,466	−1,034
.. .. .. per cent....	+0·23	−0·28	−0·05

9. *Metal Filament Lamps.*—The introduction of the metal filament has resulted in increasing the candle-power hours derived from one unit of electricity threefold, as compared with the carbon lamp, to 800 c.p.-hours per unit. The recent development of incandescent lamps with nitrogen-filled bulbs has again more than doubled the number of candle-power hours obtainable per unit, the figure now being 2,000.

10. *Motors.*—The high efficiency of conversion from electric to mechanical power in the motor as originally developed left little room for improvement. The main efforts of designers have been devoted to reducing the weight and thus lowering the first cost, which has fallen 50 per cent. in motors of moderate size during the last 15 years.

Direction of Further Progress.

In the light of our present knowledge there are four main reasons why we should expect a large further expansion in the general supply, apart from the extension of electric traction and the use of electrical energy for electrochemical purposes. These reasons are as follows:

1. Necessity for fuel economy.
2. The extension of lighting.
3. The increased range of transmission.
4. Domestic use of electricity.

1. *Necessity for Fuel Economy.*—The economical use of fuel has been hindered in this country by its low price. Until some other

* W. M. Mordey. "Alternate-current Working." "Journal" I.E.E. Vol. XVIII., p. 583, 1889.

† R. E. Crompton, "Cost of Electrical Energy." "Journal" I.E.E. Vol. XXIII., p. 396, 1894.

primary source of power and heat is found the world may be considered to be living on its capital, *i.e.*, the stored energy in the coal, and to be using fuel wastefully to the prejudice of future generations.

Only a fraction of the total coal consumed is at present used for centralised source of supply of power and heat; the principal future economy in fuel is to be found in increasing the use of such centralised supply to allow the most efficient use to be made of the world's coal supplies. In the absence of any prospect of the development of an economical system of storage for electricity, which would at once raise the present load factors of from 25 to 35 per cent. to nearly 100 per cent., and thus materially lower the cost of generation, or until some new method of converting the heat energy of coal to electricity is discovered, one of the next steps to lower the cost of production of electricity will be the gas-firing of boilers, the gas being obtained from producers worked at a low temperature. This will provide by-products from the distillation of the coal as a raw material for other industries. The sizes and positions of most of the present power stations prevent this system being used, as by-product processes can only be successfully worked on a large scale and with plan operating at a high load factor; but the increase of electrical energy taken from centralised sources of supply, and the gradual change from comparatively small stations to main power stations will allow of this method of generation.

2. *Extension of Lighting.*—Apart from hygienic reasons, it is certain that electricity will prevail more and more as an illuminant owing to the greater number of candle-power hours that can be obtained from a ton of coal by using electricity as compared with gas. With electrility generated in modern power houses using 25 B.Th.U. per watt-hour, and with 85 per cent. efficiency of distribution, the number of candle-power hours obtained per ton of coal is, with metal filament lamps of 15 c.p. to 20 c.p., no less than 750,000, as compared with 260,000 in the case of gas, gas mantles of 20 c.p. and 13,000 cubic ft. of gas per ton of coal carbonised being assumed. The amount of coal required with electricity for small units of light is thus only one-third of that necessary for an equal illumination with gas.

3. *Increased Range of Transmission.*—Further research should result in improved dielectrics, which would allow higher working pressures for underground cables, thus lowering the cost of transmission, increasing the size of each centralised undertaking, and again raising the operating load factor by the greater diversity in the demand.

Pending this development, the economical radius of transmission can be increased by using overhead lines outside the thickly populated districts; and it is not too much to expect legislative action in the national, as against private, interests. Statutory powers should allow the erection of transmission lines along the most economical routes, reasonable rents for wayleaves being fixed by an independent tribunal.

4. *Domestic Uses.*—There is no section of the general supply that opens up greater possibilities than electric cooking and heating, since at a low estimate the units required for these purposes would be 10 times those required for lighting. This development would utilise to much greater advantage the distributing mains in residential areas, which are at present only fully loaded during a few hours per annum. The development has so far been slow because (1) only 15 per cent. of the heat energy of the coal can be delivered electrically to the consumer; (2) the present cost of apparatus and its maintenance is high; and (3) the rates charged are in many cases not sufficiently low to encourage consumers.

CORRESPONDENCE.

"SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The question whether a magnetic field does or does not rotate with the solenoid or magnet producing it can easily be settled experimentally. In Poincaré's experiment described by Prof. Howe (*see* p. 171) the E.M.F. may be due to the stationary field cutting the rotating disc or to the rotating field cutting the stationary wire joining the condenser plates. In either case the transient current and all the observed phenomena would be the same. To get rid of this uncertainty, remove the wire and attach the plates to the ebonite disc. If the rotation is maintained for a sufficiently long time the charges will leak through the ebonite and the rotation can then be stopped and the charges immediately tested. Alternatively, the edge of the disc could be moistened and the rotation continued until it was quite dry. This test should be made first with the disc revolving and the magnet fixed, second with the disc fixed and the magnet revolving, and third with both magnet and disc revolving, the charges being tested with all parts brought to rest.

Another possible method of proof provides points of some interest. Fig. 6 of Prof. Howe's Paper shows a magnet having a positive charge at its centre and a negative charge at its poles, as a result of rotating about its axis and cutting its own flux, supposed stationary. Now, the earth is a magnet, and if the supposition of the stationary flux is correct, there should be a negative charge towards the Equator and a positive one towards the poles. The E.M.F. in this country along a line of longitude would be about 12 volts per kilometre (taking the vertical intensity of the earth's field as 0·42), or, say, 12,000 volts between Land's End and John o' Groats. This could be easily tested by, first earthing and then insulating a conductor in the north and then carrying it south; but such a result is incredible, and, indeed, in a dry climate, it would add a new danger to railway travelling. But the hypothesis that the field stands still while the magnet (or the earth) rotates can, I think, be disproved on theoretical grounds. Retaining it for a moment and returning to John o' Groats, no work is required to bring our positively charged conductor south, because the electrostatic force, due to the charges at the pole and the equator, urging it southward is balanced by the electromagnetic force urging it northwards. Also, as our positive charge comes south, an equal positive charge moves north through the earth, in order to maintain the equilibrium. Imagine, however, that the earth is a perfect insulator, so that the separation of charges to the poles and equator has never taken place. There is, therefore, no electrostatic force, and work must be done against the electromagnetic force to bring a positive charge southward. This work must appear somewhere, and it appears as an increase in the earth's speed of rotation, due to the sideways (easterly) drag on the conductor as it travelled south. This easterly drag is an action which must have an equal and opposite reaction. On what is this reaction? Not on the earth, or its velocity would not have increased. It must be on the stationary magnetic field—that is to say, on the ether. I think this conclusion justifies the statement that the earth does not cut its own flux, but that its flux rotates with it. Similar reasoning applies to any magnet or solenoid.

Prof. Howe says: "The peculiar condition of the ether which we call the magnetic field is absolutely constant in direction and magnitude at every point . . . and it seems impossible to attach any definite meaning to the question as to whether this peculiar condition of the ether is rotating or not." The same argument in the same words might be applied to the electrical field in the neighbourhood of a charged annular conductor; yet we know that the rotation of such a conductor produces a magnetic field which is quite a new condition of the ether. A rotating electrical field produces a magnetic field at right angles to the motion and at right angles to the electrical force, and, conversely, a rotating magnetic field produces an electrical force or an E.M.F. at right angles to the motion and at right angles to the magnetic force. The motion must, of course, be relative to the observer. A man standing on the rotating charged ring would find no magnetic field, nor would a line of longitude experience an E.M.F.

Stafford, Nov. 22. J. C. WILSON.

TRANSFORMER CORE LOSS AS AFFECTED BY TRIPLE HARMONICS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of October 22nd appeared a letter from Mr. Clinker referring to our Paper on "Transformer Core Loss as Affected by Triple Harmonics," which was published in THE ELECTRICIAN for September 17th.

No originality is claimed in the Paper for the peculiarities of the curves obatined. It was impossible in such a short

Paper to enumerate the work which has already been done on the subject, and we were forced to be content with the mention of the latest work. If Mr. Clinker will refer to the Paper by Mr. Nicholson he will see that the idea of our putting forward these results as novel is an erroneous one.

The hysteresis loops obtained, however, were both peculiar and, as far as we know, original. To publish this result it was necessary to describe the experiments performed, and the curves were given as a matter of interest, showing the harmonics to a marked degree.

Mr. Clinker concludes by remarking upon the practical uselessness of the results. The Paper was written not in the hope of revolutionising the design of transformers, but because the experiments we made lead to interesting results.—We are, &c.

H. M. LACEY.
Stretford, Nov. 15. C. H. STUBBINGS.

FREQUENCY, FREQ., OR CURL?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your review last week of Tolmé Maccall's excel'ent "Continuous-current Electrical Engineering" you comment on the unwieldiness of the word *frequency*, and suggested it should be abbreviated verbally to *freqs*.

May I be permitted to say that the same idea struck me some five years ago in connection with certain revision work. I then suggested that in reading formulæ the symbol should be called *freq* and pronounced *freek*. For example, 2πfreq L.

Some people say *curl*, but this, obviously, is not so good; although, by the way, it expresses the effect on the hair of the student in difficulties.—I am, &c.,

West Norwood, S.W., Nov. 20. W. PERREN MAYCOCK.

[There can be no question that the term curl should not be introduced for such a purpose.—ED. *E.*]

PHYSICAL SOCIETY.

At the meeting held on Nov. 12, 1915, at the Imperial College of Science, Dr. A. RUSSELL, Vice-President, in the Chair, a Paper on

"The Effect of Electric Oscillations on the Magnetic Properties of Iron, Investigated by the Campograph,"

by Prof. J. A. FLEMING, F.R.S., and P. R. COURSEY, was read by the former.

At a meeting of the Society in March, 1915, Dr. J. A. Fleming exhibited an instrument which he called a campograph, for photographing and delineating physical curves. Since then the optical arrangements have been greatly improved, and the point of light travelling over the photographic plate is now extremely small and sharp. With this improved campograph the authors have investigated the effect of electric oscillations on the hysteresis and permeability of iron. The general results are as follows: (1) When an iron wire is taken slowly through a magnetic cycle and a superposed high-frequency magnetising force is also applied, then, if the maximum value of the slowly-periodic longitudinal magnetic force does not exceed a certain value, the effect of the oscillation is to increase the area of the hysteresis loop and to increase the magnetisation at the ends of the cycle. (2) If the slowly periodic force has a large maximum value then the hysteresis loop is diminished in area, but the maximum magnetisation remains unaltered. (3) The increase in area of the hysteresis loop is generally less for high frequency than for low frequency oscillations, because in the latter case the oscillatory flux penetrates further into the iron wire. (4) If oscillatory currents are passed along the iron wire whilst at the same time the iron is taken slowly through a longitudinal magnetic cycle with continuous current, then when the oscillatory current has a small R.M.S. value the effects are generally similar to those produced by longitudinal oscillatory magnetic forces. If the oscillatory current is relatively large then their effect is to reduce the hysteresis and magnetisation at the ends of the cycle. This last action is due to the circular magnetisation produced by the longitudinal current, which grips the magnetic molecules of the iron, and prevents their longitudinal colineation and reduces also the hysteresis. The same effect is seen when a longitudinal continuous current is passed along an iron wire. (5) The effect of superimposing on a steady feeble longitudinal magnetic force an alternating magnetic force either by undamped or damped oscillations is greatly to increase the permeability at the ends of the cycle, provided the oscillatory force does not exceed a certain value. Beyond that a diminution sets in. Photographs of the various effects were shown.

Prof. HOWE thought the Paper was a valuable addition to the knowledge of the effects of oscillatory fields on the magnetisation of iron.

Mr. D. OWEN thought the rapidity with which investigations could be made with the instrument was very helpful. One would expect that the effect of a strong current passed along an iron wire which was magnetised longitudinally would be to remove the longitudinal magnetisation completely. This, however, was not the case. In some experiments he had once performed on the effect of currents along the wire superposed on a longitudinally magnetising force it appeared to be immaterial whether the currents were alternating or direct.

Lieut.-Col. SQUIER admired the instrument. The results would, he thought, repay careful study.

Dr. C. CHREE was reminded by many of the results described of the combined effects of mechanical stresses and magnetic forces. Mechanical oscillations produce many similar effects, and he thought it possible that some of the observed phenomena were due to such mechanical oscillations being set up by the alternating magnetic forces.

Dr. S. W. J. SMITH also thought that the results were mainly due to mechanical oscillations set up by the varying fields. Considerable work had been done on the subject. He quoted several observers who had described very similar phenomena produced by mechanical treatment, and indicated how oscillation of the molecular magnets gave rise to several of the effects.

Prof. FLEMING, replying for the AUTHORS, said that it had only been possible to give a very rapid sketch of the phenomena. Many observers had worked on the subject, and he did not think any of the results described in the Paper were antagonistic to those already accepted. The principal point of the present Paper was, however, to indicate the rapidity and ease with which such experiments could be made by means of the campograph.

Demonstrations of—

(1) **A Hydraulic Analogy of a Wheatstone Bridge,**
(2) **A Lecture Table Method of Obtaining Recalescence Curves,**
(3) **The Leeds and Northrup Recorder**

were given by Mr. R. S. WHIPPLE.

A Hydraulic Analogy of a Wheatstone Bridge.—The analogy of the flow of water along pipes is frequently used when teaching Ohm's law, but the author does not know of a published description of a simple model. In the model shown glass and indiarubber tubing with some glass taps are all that is required. The solution used is water coloured with ink, and this is allowed to flow slowly through the bridge-circuit. The galvanometer or detector is simply a large air bubble in a horizontal glass tube placed across the bridge arms. A tap is placed in the tube for adjusting the size of the bubble. When the capillary resistance of the tubing on each side of the bridge is equal the bubble stands stationary in the centre of the tube. As soon as the balance of the bridge is disturbed by either partially closing a tap or by introducing another length of tubing by the opening of a tap, the want of balance is shown immediately by the movement of the air-bubble. Balance is restored by introducing or diminishing the resistance in the opposite arm of the bridge.

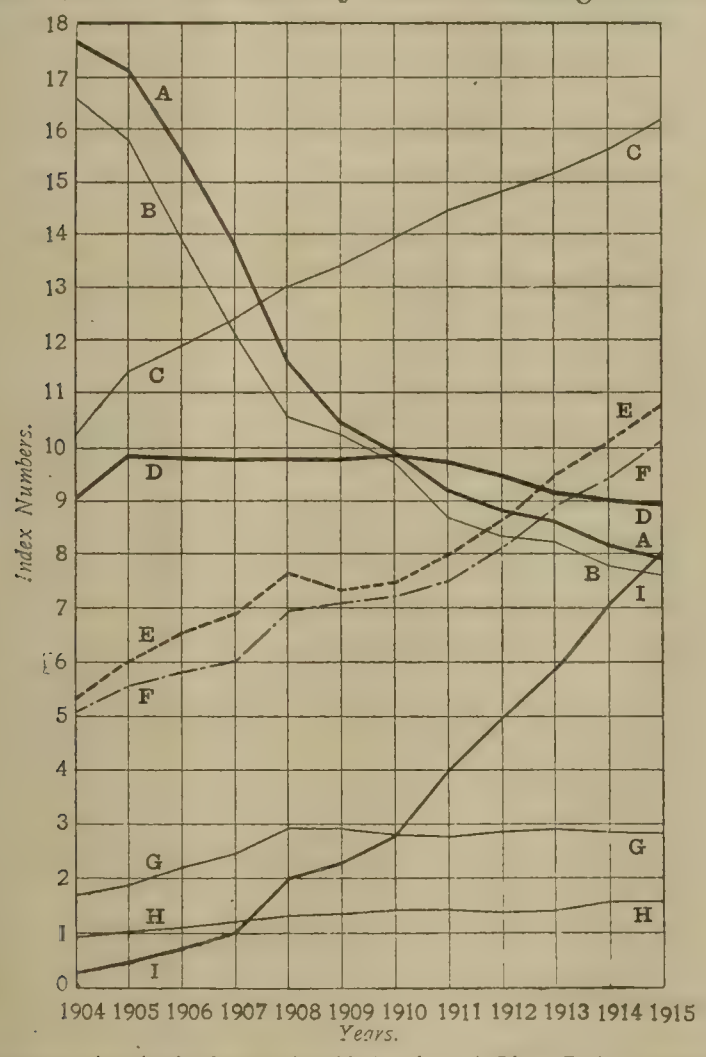
Recalescence Experiment.—In his Rede lecture Sir J. A. Ewing showed the point of recalescence in a steel wire through which an electric current was passing by the variations in its length, which took place when the critical points occurred. In his experiment a wire of about 2 metres in length supported a weight, the vertical movement of which actuated a pointer over a dial. As the wire was heated by the current it lengthened, causing the pointer to fall. At the change point when the temperature fell momentarily the pointer rose—owing to the contraction of the wire—falling immediately afterwards as the wire lengthened with the continued heating. The reverse phenomena occurred when the wire was allowed to cool. The only novelty in the experiment shown was in the addition of a camel hair brush attached to the pointer at the suggestion of Mr. W. H. Apthorpe. The brush is filled with ink and allowed to write upon a drum. The movements of the extremity of the wire are then drawn upon the drum and the point of recalescence shown.

Leeds and Northrup Curve Drawing Recorder.—The Leeds and Northrup recorder is in its main principles not dissimilar to the Callendar instrument, but is modified in many important details. In the Leeds and Northrup recorder the relay is entirely mechanical. The coil is provided with a short boom at right angles to the face of the coil, which hangs untouched in the zero position. When the coil is deflected, owing to a want of balance in the bridge, the boom is gripped mechanically by a lever in the position in which it is resting. As a result of this grip a simple mechanism is brought into action, which moves a slider over a bridge-wire, and thus increases or diminishes a resistance in the bridge circuit. Two of the gripping levers are provided, so that the boom is gripped either by the right or left hand one depending on the side to which the coil is deflected. The details of the mechanism were illustrated by a series of lantern slides.

MANCHESTER CORPORATION ELECTRICITY SUPPLY ACCOUNTS.

The accounts of the Manchester Corporation Electricity Department for the year 1914-15 show an increase of 9,806,844 units output, which is not quite so great as the increase of 13,581,907 units from 1912-13 to 1913-14. The increase has averaged about 10,000,000 units for the last three or four years, and is almost entirely due to sales for power. In spite of the increased output the units lost in distribution and unaccounted for have dropped to practically the same as for 1912-13.

The average consumption of coal per unit sold has fallen 0·27 lb., and a further decrease is expected during the coming year. This has kept the cost of coal for the year down to practically the same as for the previous year (about £120,000), so that the cost per unit has decreased from 0·25d. to 0·22d., but as other expenses have risen the total cost per unit, excluding capital charges, has only decreased from 0·56d. to 0·55d. A large item is the war service allowances that have increased the wages bill, and (in a smaller proportion) that of the engineers' salaries. These amount to £6,015, and the war has also caused an additional income tax of £3,283. The expenditure also includes £3,166 for Parliamentary costs in obtaining the Act of 1914.



A. Average price obtained per unit sold: in ½d. or ·125d. B. Average cost per unit sold: in ½d. or ·125d. C. Outlay and Assets, less Sundry Liabilities: in £200,000. D. Mortgage Debt: in £200,000. E. Income: in £50,000. F. Expenditure: in £50,000. G. Traction Sales: in 10,000,000 units. H. Lighting Sales: in 10,000,000 units. I. Power Sales: in 10,000,000 units.

The efficiency of the distributing system as a whole is 85·87 per cent., *i.e.*, the loss is 14·13 per cent. of the energy generated, or a decrease of 1·38 per cent. on the loss the previous year.

A contract for a bulk supply at 11,000 volts to the Middleton Corporation has been commenced during the year.

The general progress of the undertaking is well shown by the accompanying diagram.

The following table shows some of the more interesting statistics for the last three years :—

	Year ended March 31.		
	1915.	1914.	1913.
Number of units sold for—			
Private consumers	98,063,210	88,396,086	74,326,680
Public lamps	380,747	200,569	198,810
Traction	29,291,689	29,332,147	29,821,405
TOTAL OUTPUT	127,735,646	117,928,802	104,346,895
Total number of units generated.	162,699,530	154,760,670	136,820,180
Quantity used on works	11,976,752	12,828,141	10,391,092
Units lost in distribution, &c.	22,987,132	24,003,727	22,082,193
Percentage of this to units generated.	14·13	15·51	16·14

The following is an analysis of the accounts for the year ended March 31, 1915, the amount for each item per unit sold being given for that year, and for the year ended March 31, 1914 :—

	1914-15.	Per unit sold — 1914-15.	1913-14
Generating Costs.			
Coal, &c.	£119,840	... 0·224d.	... 0·25d.
Oil waste, water, &c.	5,219	... 0·011d.	... 0·01d.
Salaries and wages at stations*	24,712	... 0·053d.	... 0·04d.
Repairs and maintenance	25,087	... 0·054d.	... 0·05d.
Sundries	1,669	... 0·003d.	... 0·00d.
Compensation *re* accidents	14	... 0·000d.	... 0·00d.
Total Generating Costs	£176,481	0·33d.	0·35d.
Distribution Costs.			
Salaries and wages*	£21,872	... 0·04d.	... 0·04d.
Repairs and maintenance	17,674	... 0·03d.	... 0·04d.
Street lighting	1,120		
Compensation *re* accidents	56	0·01d.	... 0·01d.
Sundries	2,461		
Total Distribution Costs	£43,183	0·08d.	0·09d.
Management Costs.			
Salaries and wages*	£13,552	... 0·03d.	... 0·03d.
Printing, stationery, &c.	1,231	... 0·00d.	... 0·00d.
General establishment charges	1,232	... 0·00d.	... 0·00d.
Subscriptions to Royal Infirmary, &c.	153	... 0·00d.	... 0·00d.
Law and Parliamentary charges	3,718	... 0·01d.	... 0·00d.
Special charges	2,447	... 0·00d.	... 0·00d.
Bad debts (amount written off)	346	... 0·00d.	... 0·00d.
Total Management Costs, &c.	£22,679	0·04d.	0·03d.
Rents, rates and taxes	£53,101	... 0·10d.	... 0·09d.
TOTAL COSTS (*ex.* capital charges)	£295,444	0·55d.	0·56d.
Capital Charges.			
Interest	£68,667	... 0·13d.	... 0·14d.
Sinking fund account	111,987	... 0·21d.	... 0·21d.
Instalment of loan repaid	7,105	... 0·01d.	... 0·01d.
Renewals suspense account (being supplementary to sinking fund)	25,618	... 0·05d.	... 0·05d.
Total Capital Charges	£213,377	0·40d.	0·41d.
TOTAL COSTS (*inc.* capital charges)	£508,821	0·95d.	0·97d.
Revenue.			
Sales of current	£530,740	... 1·00d.	... 1·02d.
Rental of meters and switches	493	... 0·00d.	... 0·00d.
Rental of motors	8,870	... 0·02d.	... 0·02d.
Sales of steam	2,155	... 0·00d.	... 0·00d.
Miscellaneous	1,287	... 0·00d.	... 0·00d.
Interest on India 3 per cent. stock	202	... 0·00d.	... 0·00d.
TOTAL REVENUE	£543,747	1·02d.	1·04d.
Balance (surplus)	£34,926	... 0·07d.	... 0·07d.

Of this balance £30,000 (or 0·056d. per unit) is paid over to the City Fund in aid of rates, and £4,926 (or 0·009d. per unit) is paid as capital expenditure, for which borrowing powers are unobtainable.

The capital expenditure during the year amounted to £92,511, bringing the total expenditure to £3,052,315, made up as follows :—

Land and buildings (Dickenson-street)	£101,174
,, ,, ,, (Bloom-street)	71,612
,, ,, ,, (Stuart-street)	235,434
	£408,220
Machinery and plant (Dickenson-street)	£183,576
,, ,, ,, (Bloom-street)	139,164
,, ,, ,, (Stuart-street)	498,691
	£821,431
Stuart-street railway	£82,038
,, ,, water supply	6,461
Distributing stations	426,151
Mains	1,053,880
Services	48,907
Meters	71,774
Time switches	1,652
Motors	56,485
Electrical instruments	1,255
Cable stores and workshops	30,520
Street lighting	4,915
Cottage property	3,993
Chemical works	1,298
Warehouse property	33,335
TOTAL CAPITAL EXPENDITURE	£3,052,315

[* This includes war service allowances.]

EDUCATIONAL NOTES.

Glasgow University.—At the recent meeting of the University Court it was reported that Major J. Garroway had presented an electric clock for installation in the tower on the buildings at Gilmore-hill.

Prof. J. Ferguson has retired from the chair of chemistry at the university.

Sheffield University.—The Treasury have made a special grant of £2,000 to the university in respect of the years 1914-16, in view of the great loss of income through the enlistment of so many undergraduates.

The new grant is made on condition that any contributions hitherto made by local education authorities are continued on the same basis as before the war.

Leeds University.—In view of the loss of income which the university has sustained through the large proportion of its undergraduates who are on active service, the Treasury have conditionally made a special grant of £3,500 in respect of the two years 1914-16.

Manchester University.—The report of the Council states that in 1913 there were 1,529 students, but at present the number was 1,075.

The number of men had fallen away by 485, but there had been some increase in the number of women students. There were serving in H.M. forces 65 members of the staff and 377 students; 45 had been killed, 5 were missing and many were wounded. Of past and present members of the university 1,200 were serving in the war. The treasury had conditionally made a special grant of £5,000 in respect of the two years 1914-15 and 1915-16. This sum would meet the deficit on those years without compelling the closing of departments or the reduction of any of the real educational work.

Armstrong College, Newcastle-on-Tyne.—The Treasury have also made a special grant of £3,500 to this college for the years 1914, 1915 and 1916 and on the same condition.

Birmingham Municipal Technical School.—In a review of the work of the school, the principal (Dr. W. E. Sumpner) states that the last session was a very successful one in spite of the war.

The total number of students showed a decrease of about 22 per cent. (3,025, compared with 3,958 for 1913-14); but that decrease was less than had been experienced by the larger technical schools in the country. After making allowance for the falling off of students, the number of school candidates at the various public examinations was as satisfactory as ever, while the percentage of successes obtained was slightly higher than in the previous session. Among the distinctions were five silver and four bronze medals, and seven money prizes awarded to students of the school by the City ond Guilds of London Institute. At the Board of Education examination one student was commended for an engineering design for a pressed-steel carriage bogie, and another student (Mr. S. W. Wilding) gained a Royal scholarship of the value of £60 per annum for three years, tenable at any of the national science colleges. At the examination of the Birmingham University three students got scholarships; two students passed the matriculation examination, six the intermediate examination (three in science, two in engineering and one in metallurgy); and six former students obtained the final B.Sc. degree. Seven students obtained the B.Sc. (Lond.) (four in science and three in engineering). At least 149 students of the preceding session had since joined the Army. That number could only be a portion of the total, which had been increased during the session by a large number of students who had ceased attending their classes owing to enlistment. Of the school staff one of the permanent teachers, 12 of the class teachers, three clerks, and 10 other members of the staff had enlisted, and in several cases had gained commissions. Two permanent teachers and a large number of students had gained posts in chemical, engineering and other works, where their special abilities and skill were being utilised on the manufacture of war material. A large amount of testing of Government material had been carried out during the year by the metallurgical and the electrical and mechanical engineering departments. The head of the chemical department (Dr. Price) and two of the permanent teachers of his department had been working during the year—in conjunction with Prof. Frankland and the staff of the university—on the manufacture of certain special chemicals for the Government. The School Committee decided to reserve, entirely for that purpose, the electro-chemical laboratory, in order that the work in question could be carried on without interruption or publicity. The most important effort of the school in connection with the war had been the institution of the munitions classes. The idea of those classes originated with Mr. Reid, head of the engineering department. They had been carried out with great skill and success, and had been since imitated by a large number of technical schools in various parts of the country.

Since October, 1914, the physical, metallurgical, civil, mechanical and electrical engineering departments of the Birmingham University had been transferred to Suffolk-street. The arrangements had worked very smoothly, in spite of the fact that the Central Secondary School (containing 300 boys) had also to be carried on in the technical school buildings. That result had been possible because the advanced laboratories of the technical school, while quite suitable for university students, were filled with appliances of too advanced and technical a character to be suited for the education of youths. The school buildings had never been so fully occupied; no session had ever been so busy or so trying to the staff. The Board of Education had intimated their desire that the class work should be carried on as far as possible, and had promised that in awarding the grant for the session due allowance would be made for the natural effect of the war on the size of classes.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

10,048 Signal Ges. Device for use in connection with electric motors directly coupled with pumps, water sirens and the like. (18/8/13. Addition to 7,821/14.)

10,562 La Cour. Double-pole electric rotary converter, also applicable as a double current generator or motor. (Convention date not granted.)

Comprises an alternating-current machine and a direct-current machine combined together on one rotor core and one stator core, the direct-current machine and the alternating-current machine having different numbers of poles, in which the secondary winding of the alternating-current machine is combined with the compensating winding of the direct-current machine.

11,837 Falkenthal. Apparatus for converting direct into alternating currents, and vice versa.

Consists in the addition of capacities to the direct current circuits of the pendulum transformer for the purpose of obviating defects which may be produced by the self-induction of the primary winding of the pendulum transformer due to the fact that the latter are periodically cut out of circuit by the armature contacts.

16,850 Heneage Greville Finch (Lord Guernsey) & Poynter. Manufacture of incandescent electric lamps.

20,009 Hausrath. Thermopiles and thermo-electric measuring apparatus.

21,143 Mellersh-Jackson. (Commonwealth Electric Tool Co.) Electrically-actuated tools.

21,338 Smith. Telephone systems. (22/10/13.)

21,474 Stratford-Andrews & Orling. Receiving arrangements for wireless telegraphy.

A mounting for a rectifier, such as a crystal rectifier, displaceable to connect the rectifier to means for ascertaining its direction, such as a galvanometer, and to connect the rectifier in alternative directions in the receiving circuit.

21,509 Jacobson. Regulators for charging electric secondary batteries. (3/12/13.)

21,512 Jacobson & Gustagson. Electric starting systems for internal-combustion engines for automobiles. (3/12/13.)

21,609 X-ray apparatus.

21,761 Midland Electric Mfg. Co. & Barber. Electrical switches.

21,978 Midland Electric Mfg. Co. & Barber. Electrical switches.

22,639 Thompson & M.L. Magneto Synd. (Ltd.) Coil-winding and similar machines.

23,485 Ward & Richard Pape (Ltd.) Secondary batteries or accumulators.

24,419 B.T.-H. Co. (G.E. Co.) Moulded compositions for electrical insulation and the process of making the same.

1915 Specifications.

378 Railing & Garrard. Electric cable joint boxes and the like.

900 Midland Electric Mfg. Co. & Barber. Distribution fuse-boards for electrical circuits.

901 Midland Electric Mfg. Co. & Barber. Electrical switches.

3,513 Cable Accessories Co. & Reeves. Electric heating element. (Addition to 24,565/13.)

3,570 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electric motor control system.

4,776 Siemens & Halske Akt.-Ges. Manufacture of filaments, rods and other bodies consisting of or containing graphite-like carbon. (28/3/14.)

5,395 Thofehrn. Electric batteries.

6,217 Agner. Wireless telegraphy. (8/6/14.)

7,244 Yarwood. Means for starting electric motors.

8,173 British Westinghouse Electric & Mfg. Co. Vapour electric rectifier systems (11/7/14.)

Consists in the combination with a source of alternating current of a plurality of vapour rectifying units, a plurality of voltage taps on the source, switching devices whereby any one or all of said rectifying units may be connected to said source through said taps, and switching devices whereby the voltage applied to any rectifying unit may be varied by connecting an anode of that unit to a tap of the desired voltage before disconnecting the working anode from the tap of initial voltage.

8,203 Hackett. Telephone transmitters.

11,112 Kennedy. Mechanical buzzer for practising the Morse code.

APPLICATIONS FOR PATENTS

Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked • are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.

November 1, 1915.

15,369 Graham. Telephonic receivers.•

15,379 Evershed & Vignoles Ltd., Shaw & Finnis. Electrical instruments.

15,395 [illegible] & Hallen. Fluid-wave transmission.•

November 2, 1915.

15,406 Ri[illegible] & Gill. Electrical indicating devices for electrical plants and the like.

15,421 D[illegible] & Brown. Electromagnetic power transmission and conversion system.

15,427 M[illegible] Electric[illegible] Ltd. [illegible]

15,447 Wi[illegible] & B.T.-H. Co. Electric switches.

15,448 B.T.-H. Co. (G.E. Co., U.S.) Circuit connections of electron discharge apparatus.

15,459 [illegible] (Louis Rosenthall & Charles Seymour, Transvaal.) [illegible].•

15,460 [illegible] (Louis Rosenthall & Charles Seymour, Transvaal.) Electric[illegible].•

15,471 Ha[illegible] & H. W. C[illegible] & Co. Apparatus for adjustably holding X-ray tubes.•

November 3, 1915.

15,513 C[illegible] Co. Electric[illegible] metallic sheets with lead.

15,514 B.T.-H. Co. (G.E. Co., U.S.) Electric[illegible].

15,518 Ge[illegible] Ltd. [illegible].•

15,526 C[illegible] & Ha[illegible] Compensating for leakage in wave transmission systems.•

November 4, 1915.

15,539 A[illegible] Telephone Co., Savin & Smith. Alarm gates for telephone, telegraph and like systems.•

15,555 B.T.-H. Co. (G.E. Co., U.S.) Electric resistances.

15,563 M[illegible] [illegible] of electric switches.

15,579 M[illegible] (Western Union Telegraph Co., U.S.) Telegraph apparatus.•

15,582 P[illegible] Engineering Co. (Harold Hastings, Spain.) Lightning-arresters and like apparatus.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	289	Lighting and Power Notes	295
Imports and Exports of Electrical Manufactures	290	Traction Notes	295
Legal Intelligence	290	Telegraph and Telephone Notes	296
Parliamentary Intelligence	293	Foreign Notes	296
Business Notices	294	Miscellaneous Notes	296
Electricity Supply	294	Tenders Invited	297
The Round Table	51	Tenders Received & Accepted	297
Surge Protection. Illustrated	52	Companies' Meetings and Reports	298
Distance Thermometers. Illus.	54	New Companies, &c.	299
Monometer Tinning Furnace. Illustrated	56	City Notes	299
An Attractive Fire Booklet. Illustrated	58	Electrical Companies' Share List	299

COMMERCIAL TOPICS.

Castner-Kellner Alkali Profits. In its earlier years the Castner-Kellner Alkali Co. (Ltd.) was not as successful as its progenitors had anticipated. It was slow to get into a dividend-earning position, but of late years it has made up for its early disappointments by a continuous course of prosperity. The record for 1914-15 shows really the best results of any year's operations, and presents the company's shares as an electrical investment of the first order. As our readers are aware, the operation of the company's undertaking is of a purely electrical character, and the war has undoubtedly passed a great deal of the industrial chemical business into the company's lap. The gross profits are over £87,000 in excess of the previous year, and more than double the amount earned by the company only a few years ago. Although 20 per cent. is not the highest rate of dividend the company has ever paid, it is declared under conditions that are more satisfactory than at any previous period. The depreciation reserve is increased from £32,500 to £50,000, and the balance forward has increased from £18,000 to £61 000 The outlook for the company seems exceedingly bright, as in the future division of trade in the chemical section the Castner-Kellner Company, with its splendid equipment, is in a position to supply the requirements of a rapidly-growing industry on a large scale. The investment value of Castner-Kellner shares and debentures at the present crisis is tempting.

* * * *

Overseas Trade. In connection with the subject of overseas trade, no part of the world is more likely to prove attractive to British enterprise than South America, and especially Brazil, where British interests are already large, but are generally considered to be of a less expanding character than those of Germany before the war. Amongst the companies which stand for development and progress the Southern Brazil Electric Co. (Ltd.) may be given a prominent place. The company was incorporated as recently as March, 1913; it has a controlling interest in a number of electrical undertakings, chiefly in the State of São Paulo. It is also half proprietor of a firm of electrical engineers and contractors doing a considerable business in Brazil—Byington & Co. Already, we believe, there is a good deal of business between the manufacturers and suppliers of this country and the Southern Brazil Co., and consequently its operations have a particular interest at the present time. The war has interfered somewhat with the progress of the company, but mainly on the financial side owing to the depreciation in Brazilian exchange. The development of the work of electrification of some of the company's traction undertakings is making progress, and an exclusive 30-year concession for an important electric tramway has recently been secured. It is anticipated that, when the war terminates and business becomes normal, the development of the Southern Brazil Electric Co. will be rapid Even in the present period of depression the full debenture interest and all working expenses in London and Brazil have been earned, and a substantial balance is carried forward.

A Plea for the Commercial Engineer. In his Presidential Address to the Institution of Electrical Engineers, Mr. C. P. Sparks made the following reference to the commercial engineer: "It is sometimes suggested that commercial matters should not be dealt with by engineers, who should confine themselves to technical questions. I disagree with this view, and believe that the commercial engineer is just as much a recognised member of our profession as a pure scientist." This is probably the first utterance from the presidential chair of the Institution which would lead one to believe that it has the interests of an exceedingly large body of its members at heart. We recognise that the Institution has an important function to perform in its relation to matters of a technical and purely engineering character. On the other hand, there is a growing circle of men who have received an engineering training, but whose subsequent business in life is concerned with the commercial aspect of important industrial and cognate undertakings. In this capacity their engineering experience has proved a useful groundwork for commercial action, but once their attention has become regularly absorbed by business matters they lose their former zeal for purely technical and engineering questions. We should like to see Mr. Sparks' outspoken opinion followed up in the Institution, if not during the present session, at any rate in the subsequent one. The programme for the present session has been prepared and published, and is concerned exclusively with technical matters. There are many members of the Institution who would have welcomed the opportunity to discuss, say, for a couple of evenings, one or two subjects of specific commercial interest. It would not be necessary to prepare an elaborate Paper; a discussion could be worked up in a somewhat similar manner to that on the subject of electric vehicles, which was introduced with a short dissertation by Mr. Ayton last year. Mr. Sparks is essentially a man of wide engineering knowledge, and probably his experience of the commercial and industrial side of electrical engineering is unique. As he has made so bold as to give utterance in his Presidential Address to his opinion as to the status of the commercial engineer, he may see fit to make some other suggestions as to how the interests of this class of membership of the Institution can be furthered during his term of office.

* * * *

Ave Manchester! Following Mr. C. P Sparks' presidential comments upon London's electricity supply comes a survey by Mr. S. L. Pearce, city electrical engineer, Manchester, of the public supply to Cottonopolis. In an address to the Manchester Association of Engineers on Saturday last Mr. Pearce dealt historically with the famous undertaking, described its present plant and supply system, and gave his audience a look into its immediate future. We are glad to see that Mr. Pearce is not afraid to compare his undertaking with those of the great Continental and American cities. The following figures are taken from his lecture, and the comparisons are most significant:—

	Population.	Area served sq. miles.	Units per head of population.
Paris	2,800,000	31	27
Berlin	2,200,000	24	111
Hamburg	1,000,000	30	43
New York	4,750,000	131	360
Boston	1,000,000	597	400
Chicago	2,185,000	191	425
Greater London	7,250,000	693	130
Manchester	750,000	46	157

We must confess our own surprise to find that Manchester consumes more energy per head of population than Greater London, and our readers will probably share our surprise. The figures ought to stir up friendly rivalry among the undertakings in our great provincial centres, though we imagine that such places as Birmingham and Glasgow will not be far behind the Manchester undertaking.

* * * *

Development of Natural Sources of Power. From time to time we come across cases of the disregard by Government officials of the necessity of encouraging the development of our natural sources of power, and of making the most of our economic resources. A good illustration of this bureaucratic attitude towards modern enterprise is to be found in the treatment

meted out to the Burma Corporation. At the recent meeting of the company (reported in our issue of the 12th inst., p. 216), it was stated by the chairman (Mr. R. T. Smith), that owing to the onerous conditions and the unnecessarily heavy charges imposed upon their proposed use of water power the company had had to employ oil engines for the generation of electrical energy, and they had been obliged to go to Switzerland for the purchase of a Sulzer-Diesel oil engine. Officials are, no doubt, justified in laying down reasonable conditions for the utilisation of water power in a district and providing against the acquisition of monopolies which may be ultimately injurious to the common good of the community. There is, however, a tendency to impose unnecessarily severe restrictions upon the use of water power, and we are convinced that in the present instance the Burma Corporation received no encouragement to utilise a dormant asset or to increase the wealth of the community. This is unfortunate, particularly at the present time when everything possible should be done to encourage the development of Colonial and imperial enterprise.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Nov. 15, 1915, *to* Nov. 20, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

BRISTOL.—*France:* Elec. lamps, 12 pkgs.
[illegible] *France:* [illegible]
LIVERPOOL.—*U.S.A.:* Unenumerated, 125 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £2,886; carbon candles, £1,489; elec. lamps £183; telephone materials, £359; lamp parts, £693; unenumerated, £4,901. *Holland:* Elec. lamps, £2,323—30 pkgs.; elec. machinery, £425; unenumerated, £357. *France:* Elec. machinery, £680; carbon candles, £204; unenumerated, £693. *Denmark:* Elec. machinery, £314; unenumerated, £815. *Italy:* Elec. wire, 23 pkgs.; wire and cable, £1,499; carbon candles, £67.
SWEDEN.—Lamp parts, £219.
JAPAN.—Unenumerated, £71.
MANCHESTER.—*U.S.A.:* Carbon electrodes, 67 pkgs.
SOUTHAMPTON.—*France:* Unenumerated, 32 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Unenumerated, £25. *Melbourne:* Elec. machinery, £1,911; telephone cable and parts, £3,479; wire and cable, £2,509; unenumerated, £756. *Sydney:* Elec. machinery, £450; wire and cable, £436; elec. motors, £150; unenumerated, £1,240. *Wellington:* Wire and cable, £2,006; unenumerated, £636. *Brisbane:* Elec. machinery, £257; unenumerated, £457. *Dunedin:* Wire and cable, £267; unenumerated, £460. *Lyttelton:* Wire and cable, £92; unenumerated, £406. *Adelaide:* Elec. machinery, £32; telegraph material, £50; unenumerated, £1,389. *Hobart:* Wire and cable, £283; unenumerated, £43. *Newcastle:* Unenumerated, £56. *Perth:* Wire and cable, £172; unenumerated, £231. *Launceston:* Elec. machinery, £29. *Jesselton:* Unenumerated, £53.
AFRICA.—*Durban:* Unenumerated, £649. *Port Elizabeth:* Wire and cable, £672; unenumerated, £189. *Zanzibar:* Telegraph material, £32. *Cape Town:* Unenumerated, £32. *Beira:* E. Africa, unenumerated, £54. *East London:* Elec. machinery, £270.
EGYPT.—*Port Said:* Elec. machinery, £41. *Alexandria:* Unenumerated, £3 [illegible]
[illegible] £137,110; unenumerated, £1,168. *Talara:* Elec. machinery, £129. *Talcahuano:* Unenumerated, £135. *Rosario:* Unenumerated, £985. *Puerta Arenas:* Unenumerated, £44. *Antofagasta:* Unenumerated, £308. *Bahia Blanca:* Unenumerated, £55.
U.S.A.—*New York:* Elec. machinery, £22; unenumerated, £36.
CANADA.—*Montreal:* Unenumerated, £110.
HOLLAND.—*Rotterdam:* Wire and cable, £387; unenumerated, £200. *Amsterdam:* Wire and cable, £1,334; unenumerated, £120.
SWEDEN.—*Stockholm:* Unenumerated, £30.
[illegible] £63
[illegible] £1,842; [illegible]
[illegible] £145 [illegible]
[illegible] £210; wire and [illegible] £464; wire and cable [illegible] unenumerated, £218. *Ceylon:* [illegible] wire and cable, £180; unenumerated [illegible] *Allahabad:* Elec. machinery, £160.
CHINA. *Shanghai:* Elec. [illegible] £2,266; unenumerated, £41 [illegible] £11
WEST INDIES.—*Trinidad:* Unenumerated, £9.
MALTA. Telegraph material [illegible] £24
PORTUGAL.—*Lisbon:* Elec. machinery, £125.
GIBRALTAR.—Unenumerated, £358.
SPAIN. *Bilbao:* Wire and cable £165; unenumerated £96
FRANCE. *Paris:* Unenumerated, £163 [illegible] Wire and cable, £375; unenumerated £6[illegible]

FOREIGN GOODS (duty paid and free).

Durban: [illegible] £1,038 *Singapore:* Unenumerated, £10.

IN TRANSIT.

Adelaide. [illegible] *Auckland.* [illegible] *Melbourne.* [illegible] *Newcastle:* [illegible] *Invercargill:* Elec. lamps, &c., £1,360

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Devonport Tramways Arbitration.

The arbitration proceedings as to the price to be paid by Plymouth Corporation for the undertaking of the Devonport & District Tramways Co. have been continued before the arbitrator (Mr. Hall Blyth).

Mr. H. ENGLAND, general manager of the Yorkshire (West Riding) Tramways Co., gave evidence as to the valuation of the undertaking, the receipts, &c. Between Oct. 2, 1915, and Aug. 12, 1919, assuming that gross receipts were as he estimated, he assumed that they would carry the population in 1916 98 times, in 1917 107 times, and in 1918 116 times. The result would be that the Devonport tramway system would, on those figures, be well below the average figures for the other tramway systems of the country. It showed that there was a large margin of expansion. The total estimated profit, subject to depreciation, from Oct. 2 last to Aug. 12, 1919, he put at £77,011. He allowed 0·623d. per car-mile for depreciation, and, estimating car-mileage in the period at 3,379,193, the total was £8,782, to which had to be added £400, which he considered would be the loss on the re-sale of the extra rolling stock, giving a total depreciation of £9,182. Deducting that from the total estimated profits, the total net profit for the period was £67,829. From the point of view of public convenience and of expediency for the local authority and tramway company, he thought through running could not have been postponed. The effect of through running between towns like Plymouth and Devonport would be very marked indeed. There was a large traffic waiting to be developed. Through running affected not only long-distance passenger traffic but also the traffic around the terminus of each line. At present a man living within half a mile of the Pennycomequick terminus, and wishing to go to Plymouth, would certainly not join a Devonport car and then change. Such an area was sterilised for traffic purposes. There was a sterilisation of both lines there. His calculations were based on experience of other places. He put the value of through running to the Devonport tramways at 1¼d. per car-mile over the whole car-mileage of the company. On the basis of through running he estimated that in 1918 the tramway would be carrying the population 128 times, which was well below the average for the tramway systems of the country. The estimated profit arising from through running from Oct. 2 last to 1919 was £17,598. The value of the light railway as a going concern was a difficult matter. Approaching it from the point of view of what it would enable him to earn as owner of the tramways, he realised it as a connecting link, enabling through running to be put into operation. Without gambling or making a shot in the dark, but treating the matter as a business proposition, he put the value at £10,000. Nobody could find a basis for the valuation. It was simply what a business man would pay for the junction, provided he could get through running.

Mr. CECIL BRAITHWAITE, of Messrs. Foster & Braithwaite, gave evidence as to the provision of capital for companies such as the Devonport & District Tramways Co. Provided the Treasury gave their sanction, it would have been fortunate if the capital could be raised on a basis of 10 per cent. discount. He had assumed £160,000 as the capital, which, at 10 per cent., would be £16,000. It depended upon circumstances as to whether 10 per cent. should apply to a municipal corporation raising money. The brokerage usually paid on an undertaking of the kind—that was, in actually placing the stock, and it had nothing to do with underwriting—would be at least 1s. a share. The cost of the undertaking would be 6 per cent. at least. Then he estimated £800 as commission would be paid to various agents all over the country.

Mr. ENGLAND was recalled for cross-examination. He stated if the company had remained in possession there would have been a thorough understanding before now. As to the valuation of the light railway, which was only about 70 yds. in length, if he treated it as earning, say, one-eighth of the tramway, and split up the income accordingly, the sum would be more than the £10,000 he had estimated.

This concluded the case for the company.

Mr. LLOYD, K.C. (for the Plymouth Corporation), said that the arbitrator was faced with a difficulty which undoubtedly had never before been presented to any arbitration tribunal dealing with tramways. The case of the company involved figures which were out of all proportion to the figures that would have been put forward in normal circumstances. In 1911, 1912 and 1913 there was very considerable activity in the dockyard. The whole question was whether the resultant prosperity to the tramways was natural or supernatural; whether it was constant and likely to go on for all time. He attributed great importance to local knowledge, and yet Mr. Sellon and Mr. England had practically no connection with Devonport, except for the purposes of that arbitration. Devonport was largely dependent on the dockyard, and that the ups and downs of the dockyard practically made or marred the undertaking. In 1902, continued counsel, Devonport appeared to be rapidly increasing, and it was in a very prosperous condition, as large works were being carried out. But Devonport had not gone on increasing, for when the works were completed the men went away, and the Government, having spread their work over various dockyards, the men employed at Devonport Dockyard decreased by about 5,000 or 6,000. In 1902 the company paid a dividend of 4 per cent., and in 1904, when the extension had been opened, although that was the year in which the property of Devonport was at its highest point, the dividend fell to 2 per cent. Since 1904 the dividend had disappeared altogether, and if proper allowance for depreciation was made the tramways would really only be carried on at a loss.

As regarded the light railway as a going concern, inasmuch as it would be by itself absolutely useless, and its only value was as a link with the tramways for running powers, and as it was said that from a pounds, shillings and pence point of view it would not matter whether there was a back shunt or not, the question seemed not worth discussing. Comparing the figures for the various items on which the parties had not agreed, submitted by Mr. Sellon and Mr. England, and those which he now presented for the Corporation, the following results were disclosed :—

	Corporation.	Mr. Sellon.	Mr. England.
Permanent way	£28,500	£60,000	£58,000
Overhead equipment	3,000	4,938	4,230
Cables, ducts and manholes ...	5,300	7,950	7,797
Depot permanent way.....	1,000	1,809	2,028
Depot overhead equipment ...	135	285	256
Cars.....	7,000 to 10,000	21,545	21,026

The company also claimed 5 per cent. interest on capital, which, at £160,000, made £8,000, whereas his figures for that item would be nil. For the cost of raising capital the company claimed 10 per cent., and his figure would be nil. The company claimed that they were entitled to base the "then" value on the price of materials under the abnormal conditions prevailing on or about Oct. 2 last, but he submitted that the arbitrator had not to take the "then" cost in fixing the "then" value.

The ARBITRATOR: Supposing an abnormal state of affairs existed, and the price of steel rails fell from £7 to £2 or £3 per ton; would not Plymouth Corporation have argued that that was the basis of the then value ?

Mr. LLOYD: I would not say they would not, but I am sure my learned friends then would have argued the contrary. It is for you to decide what is the proper cost. He submitted that the arbitrator was not bound slavishly to take artificial figures existing on Oct. 2. It was ridiculous to take an actual date. He could not get the price on that day.

The ARBITRATOR: You can arrive at it.

Mr. LLOYD said he could get a value by estimating the cost, but that cost could not be the actual valuation on that particular day. It was his opinion of the value that he had got to arrive at, and it was nonsense to say he must accept the particular price quoted on that day. No one suggested there was any likelihood of constructing a tramway under existing circumstances. Even if they could get the money they would have the greatest difficulty in getting materials and labour. On the claim of the company for interest on capital during construction, based on the National Telephone Company case, counsel pointed out that the National Telephone Co. was not a statutory company or limited in the same way as that company. There was no power of that kind for a statutory company unless it was specifically given, and no such power was given there. He went further, and said that the principle was contrary to the policy of Parliament, and it was only in exceptional cases that it could be allowed. With regard to profits, the company had undoubtedly been affected for the better by the war, but it was quite a different thing to build the future upon that. Last year was exceptional, and 1911, 1912 and 1913 were also years of great activity in the dockyard. The prospective gross receipts estimated by the company were much over-rated, while their working expenses were underestimated, with the result that the figures were unduly in favour of the company. The so-called estimate of the future was "dabbling with figures," many of which were incorrect, by two gentlemen having no knowledge of the local circumstances, and with deductions which they could not even justify.

Mr. J. H. ELLIS, town clerk of Plymouth, gave evidence as to the local conditions, &c. The object of the Corporation in taking over the tramways before 1919 was public convenience and not profits, although it was thought that economies amounting to £7,000 would be effected in conjunction with the Plymouth, Stonehouse and Devonport tramways and their own. While the war lasted it would be a period of exceptional prosperity to the Devonport tramways, but the top had been reached and traffic would now progressively go down, though pre-war conditions would not be reached for a very long time. The Plymouth Corporation as now constituted would not have negotiated with the company for through running had the undertaking not been acquired But for the purchase the improvements would not have taken place before 1919.

Mr. WM. CASH, C.A., said he had estimated the net profits that would be available for dividends, after deductions for renewals and depreciation, on the basis of the company's forecast of earnings in the succeeding years up to August 12, 1919. These varied from 9·2 per cent. in 1916 to 18·3 per cent. in 1919. He had never heard anything approaching those figures in any tramway undertaking ; the highest he could find for any company was 8½ per cent. in August, 1915. A Corporation such as Plymouth could obtain the money for constructing tramways at 5 per cent.

Mr. J. B. HAMILTON put the price of rails at £8. 5s. per ton. The average life of the tramway lines was about 21 years, assuming present traffic conditions. He had taken the granite setts at the price at which he could have got them just before the war, and he assumed that they would be patched from time to time until the rails were worn out, and the line had to be replaced. Allowing for redressing those which were suitable, he valued the setts at £1,497. As to the overhead equipment, he gave no residual value to the poles. The life of the poles he put at 30 years. It was impossible now to get copper delivered for any purpose except on a certificate of the Minister of Munitions, and that would not be granted unless the material was for an absolutely necessary purpose. As to future profits, he thought it was absolutely unlikely that the year 1915 would repeat itself, and that the earnings would be on the downward grade in 1916. The light railway was essential to through running, and had no value at all without it.

The proceedings are adjourned to December 15.

Osram Lamp Works Ltd. v. Merryweather & Sons.

A pending action, in which pl[illegible] claimed an injunction, was mentioned to Mr. Justice Scrutton last week.

Mr. H. BRANDON (for plaintiffs) stated that defendants were supplying fire apparatus for plaintiffs when some coal fell upon one of their employés. She was seriously injured, and plaintiffs had a counterclaim for, in respect of which they claimed an indemnity from defendants. The girl had named a lump sum which she would accept in full settlement, and the parties had arrived at a settlement. Notice would have to be given to the girl that it was to apply for the approval of the Court, and his lordship ordered the action to stand out generally, with liberty to apply to restore it when ready.

Osram Lamp Works Ltd.) v. Pope's Electric Lamp Co. (Ltd.

The hearing of this case has been continued in the Court of Appeal (the Master of the Rolls and Lords Justices Bankes and Warrington), on plaintiffs' appeal from the judgment of Mr. Justice Joyce, holding that defendants had not infringed plaintiffs' patent.

Mr. T. TERRELL, K.C., on behalf of respondents, contended that there was no invention in the selection of tungsten for lamp filaments. There was nothing new in the treatment with an organic binding material. The carbonising process was known. The patentees had made it an essential part of their process that the electric current should be passed through the filament. It was not known that the only object of passing the current through was to heat the filament or that external heating would have the same effect. Defendants did not use the equalising process, which was an essential part of the invention. Defendants had not any of the three points put forward by the patentees as being essential. The process of building up a filament was well known. Welsbach's process was known to be applicable to many metals, and all that the patentees did was to tell one to try it on another metal. There was no subject matter in merely taking a substance well known to be suitable for a particular purpose, though it might not have in fact been used for that purpose, and applying it to a well-known purpose. He contended that defendants did not infringe because they did not use an atmosphere of steam and hydrogen. Defendants did not infringe because they did not carbonise. Plaintiffs had not brought before the Court evidence as to any experiments which showed that in defendants' process water reaction had taken place at all.

Mr. WALTER, in replying on behalf of appellants, contended that upon the evidence there had been clearly infringement by respondents of plaintiffs' patent. He submitted that the evidence of Mr. Ballantyne (a witness for the defence), elicited in cross-examination in the Court below, really amounted to an admission of infringement by defendants. He contended that plaintiffs were clearly entitled to judgment on the issue of infringement.

The MASTER OF THE ROLLS stated that the Court would take time to consider its judgment on the issue of infringement, and should it be thought desirable to hear further argument on the other issues in the case an intimation to that effect would be sent to the parties.

Electricity Works Assessment.

At the London Quarter Sessions last week the Brompton & Kensington Electricity Supply Co. (Ltd.) appealed against the assessment of their undertaking by the Kensington Assessment Committee. It was proposed to increase the rateable value placed upon the company's works and mains by £1,000 in view of certain structural alterations at the works at West Brompton, and also of an increase in the net profits in 1912 and 1913, compared with the years 1909 and 1910, which were considered at the time of the last quinquennial revaluation in 1910.

Mr. Ryde, K.C. (with Mr. G. F. Spear) appeared for the appellants, and Mr. Clavell Salter, K.C., M.P., with Mr. C. Whiteley, represented the Kensington Assessment Committee. Expert evidence for appellants was given by Mr. H. M. Carpenter (Messrs. Humphreys-Davis & Co.) and Mr. G. W. Spencer Hawes (Messrs. May & Hawes) ; and evidence was also given by Mr. Thomas J. Owens, the company's secretary. For respondents' the witnesses were Mr. W. H. Eve, Mr. A. L. Ryde and Mr. W. Chambers Leets.

Mr. SPENCER HAWES said that certain alterations and additions had been made to the undertaking since 1910, including the replacement of four small steam engines and alternators by two turbo-alternators, and the laying of additional mains. Economies had been effected by the new plant, the business had been extended and the receipts had increased, but it was necessary in ascertaining the annual value of the increased earnings to make a fair and reasonable allowance in respect of the additional capital required to earn the additional receipts and in respect [illegible] annual average cost of repairing, maintaining and renew[illegible] to the tenants' chattels and to the plant and mains. [illegible] if determined on a proper basis with a reasonable provision for the tenants' capital and with due regard to the probable period of useful service of the meter, plant and mains absorbed a sum in excess of the average annual value of the expanded receipts, and therefore there was no ground for any increase in the rateable value of the undertaking as from 1910 to the end of 1913.

After hearing the evidence, the Court decided to reduce the rateable value by £460, leaving a net increase of £500 upon the quinquennial assessment settled in 1910, and awarded a proportion of their costs to the Assessment Committee. The chairman, in giving the decision of the

Court, stated that appellants had appealed against a provisional supplemental valuation list made in 1913 in which the appellants were assessed at £22,800 gross, and £12,000 rateable value, the rateable value at the preceding quinquennial valuation in 1910 having been fixed at £11,000. There could be no dispute whatever at to the law applicable to cases of that kind. No one suggested that what were called general causes, operating upon all undertakings in London, could be given by an assessment committee as a reason for making a provisional list and afterwards putting it into a supplemental list. The causes that operated must be causes peculiar to the particular undertaking, which was the subject matter of the appeal; it was not enough to show general operating causes. In the present case, before the property could be put in a provisional list at all, the Assessment Committee had to find that there were circumstances in regard to the particular undertaking. They proceeded to do so, first by giving evidence in regard to the receipts of the undertaking, the gross receipts and the net receipts—and comparing the year 1913, in which the provisional list was made, with 1910, the year of the quinquennial valuation; but also both sides put in other figures to show whether they were, what are called, mere fluctuations in the trade of a particular undertaking. That was quite right, and nobody could object to that. There was evidence that that undertaking in 1913 had gross receipts £6,000 in excess of those of the quinquennial year. There was evidence also that the net receipts had increased by several thousand pounds as between the two years. There was further evidence given in regard to causes operating to produce that—the fact that in that particular year some £8,000 worth of new machinery had been supplied in place of older machinery which was not so effective for its purpose; there was evidence that the mileage of the company's mains had been increased by 6, and there was also a variety of other evidence. The number of customers, he thought, had increased. The Court thought there was evidence which established the proposition that those causes which had been given in evidence were the operative causes which produced the result in the increased value of the undertaking in 1913. They were of opinion that it had been amply proved that the operative causes given in evidence did produce the result of an increased value of the undertaking in 1913. That being so the only other question which remained for their consideration was how far had the value of the undertaking been increased. The amount by which the Assessment Committee had increased the rateable assessment was £1,000. How they arrived at that figure, of course, it was very difficult to say, but it was not, perhaps, difficult to surmise. Everyone knew that in those cases there were compromise arrangements by which each party hoped to avoid the necessity of going to the House of Lords and to prevent the great costs of an appeal; and no doubt that was brought about in the same way. That was their estimate of what a fair figure would be. They did not think that they perhaps took sufficiently into consideration a cause which operated upon the other side, and that was in regard to the increased capital which would be required. What they had to consider, of course, in connection with those cases was what would the so-called hypothetical tenant gives for the undertaking, and a very serious matter for his consideration undoubtedly would be the increased capital both in regard to the return which he expected and also in regard to the return of his capital itself—what he might call its insurance value year by year. Those were all elements which he had to take into consideration. They thought that there was an allowance to be made on that side of the account, and in regard to the deduction which they made for extra capital they had fixed it at £400. They thought that taking £1,000 as the figure at which they had fixed the increase and reducing it by £400 they would fix the increased rateable value at £600, making the rateable value of the premises £11,600. What the gross value would be is a matter of calculation which was much more interesting for the parties to work out than for the Court, and they had not done so. They would do so afterwards in their leisure hours. They fixed the rateable value at £11,600. That brought them to the question which always was the most interesting in those cases, the question of who was to succeed, and who should have the costs of those proceedings. Having regard to all the circumstances of the case, they thought that the practical success was on the side of the Assessment Committee, but they did not think that they had completely succeeded, and therefore they only allowed them two thirds of the costs of the appeal.

Re British Electric Traction Co. (Ltd.)

Last week Mr. Justice Astbury heard a petition to sanction a scheme of arrangement and confirm a reduction of capital of the company from £4,000,000 to £2,998,397. 15s.

Mr. F. Russell K.C. (for the company) said the petition was opposed by certain persons who held income certificates. The scheme had been approved by overwhelming majorities. The company had large holdings in various traction companies. The issued capital was £403,592 6 per cent. cumulative preference stock, £807,090 7 per cent. non-cumulative, £1,000,000 6 per cent. preferred ordinary and £666,000 deferred ordinary. Those all ranked equally as to capital. In addition, there were £1,052,000 ordinary shares unissued and income certificates of the face value of £266,371, issued in 1911 and representing arrears of dividend down to July 31, 1911, in respect of the old preference shares. In that year there was a rearrangement of capital, one of the main objects of the scheme being to arrest the accumulation of preference dividend. There was no reduction of capital then, but the time had arrived when a reduction should take place by reason of the depreciation of the company's assets, and that the loss should be borne entirely by the preferred and deferred ordinary capital, the holders of which, however, were to get certain benefits. The income certificates were to be cancelled, and the holders would get 35 per cent. of the face value of the certificates, 10 per cent. in new preference and 25 per cent. in ordinary stock to be created, the balance being wiped out.

Mr. Clauson said the company proposed to give, in exchange for the income certificates some shares which would be fully paid. If he took those shares, and if the company went into liquidation next year, the liquidator would say to him, "Did you pay cash for these shares, or how are they fully paid up?" He would have to say he never paid cash, but they had been fully paid by allocating to the shares some portion of the reserve fund which was in existence in 1915. The liquidator would then say he had to prove that the reserve fund existed, and he (counsel) ventured to say that his Lordship would find no evidence that that reserve fund did exist. If the company were to pay him let it pay him, but not with a share that might be subsequently challenged.

Mr. Russell said the point raised would necessitate going into evidence as to the reserve fund, and the petition was allowed to stand over in order that the point might be met.

Liability of Local Authorities.

The House of Lords recently delivered an important judgment on the scope of the Public Authorities Protection Act, 1893. The point was raised in an action brought by one Myers against Bradford Corporation for damage caused by a servant of the latter. By sec. 20 of the Bradford Corporation Gas & Improvement Act, 1871, the Corporation were empowered "to make, store and supply gas . . . and to sell, manufacture and dispose of coke, &c." Myers ordered from the Corporation a ton of coke which was delivered, but in shooting the coke down the coal hole the shop window got broken. Myers sued the Corporation in the County Court, and the jury returned a verdict for £17. 2s., but the County Court Judge held that, as the action had not been begun within six months of the injury complained of (as laid down by sec. 1 of the Public Authorities Protection Act, 1893) the Corporation were protected, and he entered judgment for the defendants, with costs. On appeal to a Divisional Court, Mr. Justice Bray held that the Corporation were protected by the Act, but Mr. Justice Lush was of opinion that the section did not apply as the Corporation had entered into contractual obligations towards Myers. The Court of Appeal, however, concurred in Mr. Justice Lush's view and allowed the appeal. The Corporation appealed to the House of Lords and legal arguments were delivered in July last.

In delivering judgment the Lord Chancellor dissented from the reasoning of Mr. Justice Lush. He said that it was not because the Act out of which an action arose was within their power that a public authority enjoyed the benefit of the Statute. It was because the Act was one which was either an act in the direct execution of a Statute or in the discharge of a public duty, or the exercise of a public authority. He regarded those latter words as meaning a duty owed to all the public alike or an authority exercised impartially with regard to all the public. It assumed that there was a duty and an authority which was not a public one, and that in the exercise or discharge of such a duty that protection did not apply. That distinction was well illustrated by the present case. It might be conceded that the local authority was bound properly to dispose of their residual products; but there was no obligation upon them to dispose by sale, though that was the most obvious and ordinary way. Still less was there any duty to dispose of them to respondent. No member of the public could have complained if respondent had not been supplied; nor had any member of the public the right to require the local authority to contract with him. The Act complained of arose because one of the servants of appellants, acting in the course of an errand on which they had power to send him, but on which they were not bound in the execution of any act or in the discharge of any public duty or authority to send him, in breach of his common law duty to his fellow-citizens, caused damage by his personal negligence. In his opinion an action for such negligence was not within the class of action contemplated by the Statute. The difficulty was to draw a line between the class of cases that were within and those that were without the Statute. From the wording of the Statute it was not easy to draw a clear distinction and there might well be cases about which greater doubt might arise and more uncertainty be felt than about the present, which to his mind lay clearly outside the area of Statutory protection.

The other Lords gave judgment to the same effect, and the appeal was dismissed with costs.

Dexter v. Aldershot Urban District Council.

This action came before Mr. Justice Neville last week. Plaintiff (Mrs. Harriet M. Dexter) claimed an injunction to restrain defendants, their servants and workmen from working the plant and machinery at their electric supply station in such a way as to cause nuisance or injury to plaintiff.

Mr. Jenkins, K.C., and Mr. Church were counsel for plaintiff, and defendants were represented by Mr. Peterson, K.C., and Mr. Stamp.

In opening the case, Mr. Church said the nuisance complained of was twofold, first with regard to an engine house, and secondly with regard to a water tower. Plaintiff was owner and occupier of Cargate House, Aldershot. The water tower discharged a lot of vapour which settled and caused considerable nuisance. Plaintiff's and defendants' premises

adjoined, and defendants' electricity station, in which a Diesel engines was worked, was 155 ft. 3 in. from the back of plaintiff's garden. The condensing water tower was 66 ft. 9 in. from plaintiff's premises. Plaintiff's house was built in 1887-1888. Defendants had obtained a provisional electric lighting order, and their station and undertaking were carried on under the powers conferred by that order. At the time the present action was started the water tower was not in existence ; it was not until after the pleadings were closed that the water tower was erected. The writ was issued on June 3, 1914, and afterwards leave was obtained to amend the pleadings so as to include the water tower. A section of the Electric Lighting (Clauses) Act provided that nothing in the order should exempt the undertakers from the consequences of any nuisance if they committed one. In their defence the Council admitted that there had been some vibration from their engine, but denied that there had been enough to cause injury to plaintiff or her house. They had done their best to cease all vibration, and hoped in time to be perfectly successful. At present they were only working from 6 a.m. until 9:30 p.m. on Saturdays and from 6 a.m. until 8 p.m. on other days, and they were willing to undertake to restrict their working to these hours until means had been found for satisfactorily preventing any vibration. They had also paid £5 into Court to satisfy any damage plaintiff might have suffered.

Lieut.-Col. POTTER said he was home from the front on leave. He lived in plaintiff's house with his wife from October, 1913, until February, 1914. As soon as he went there he noticed a humming noise coming from defendants' works, which was very annoying. It lasted from early morning until about 11 at night. It was usually worse after five o'clock in the evening. There was considerable vibration.

Mr. Samuel Flemming, M.Ch., Mrs. Potter and plaintiff also gave evidence of the noise, vibration, &c.

Evidence of plaintiff's experts, who attended the joint inspection of the works and premises, was to the effect that both noise and vibration were distinctly noticeable in the house. On placing a hand on a mirror on the wall vibration could be distinctly felt. The noise from the exhaust, however, was not loud when the windows were closed. The moisture from the water tower was plainly visible, and fell in the form of a Scotch mist. The vibration ceased when defendants' machinery was stopped. There was still noise and vibration discernable after the engines had stopped, presumably coming from the condensing plant.

Mr. A. H. DYKES, who had inspected defendants' premises, said he found there four Willans-Parker continuous-current machines, and also a Carels-Diesel generating set. All were set in substantial buildings. On the visit made in March to plaintiff's house those engines were run at varying speeds, and though the vibration was noticeable the whole time the difference in the running did not make any appreciable difference in the vibration. It was less when the Diesel engine was not running.

For the defence, Mr. STAMP contended that having regard to the character of the neighbourhood there was no such noise or vibration emanating from defendants' works as to constitute an actionable nuisance.

Mr. GARSIDE, electrical engineer to defendants, described the working of their plant, and said he had visited plaintiff's house with others, and heard nothing that would justify any complaint.

Prof. C. VERNON BOYS, who also visited plaintiff's house, said he could not detect any vibration or noise. When he was there a number of people were present, and he agreed that if he had been in the room by himself at night with everything quiet he probably might have been able to detect something. He did not think, however, there would have been anything that would have disturbed him.

In delivering judgment, his LORDSHIP said the evidence on behalf of plaintiff had been free from the exaggeration that was often imported in those cases, and he had also had the evidence of some perfectly independent witnesses. He had come to the conclusion that the noise and vibration complained of amounted to an actionable nuisance, but the evidence as to a nuisance arising from the water tower was very slight. He would grant the injunction asked for against noise and vibration, but he thought that, having regard to the pendency of the war, he ought not to make the injunction immediately operative. He would, therefore, stay the operation of the injunction until three months after the declaration of peace.

Workmen's Compensation.

At Coventry County Court, on the 10th inst., Henry Philpott, painter, sued the Coventry Ordnance Works (Ltd.) for £100 damages for injuries caused by a paint. It was stated that, prior to April 26 last, the company were engaged in the manufacture of aeroplanes, and plaintiff was employed as a workman to cover the wing of the aeroplanes with a substance known as cellon aeroplane dope and rectified benine. It was alleged that in consequence of the obnoxious fumes evolved plaintiff's health was injuriously affected, and he became incapacitated from work. It was contended that the company was guilty of negligence.

His HONOUR said the points were : Whether "doping" was a dangerous occupation ; did the employers know that and the workman did not ; were proper precautions taken to provide against any danger which existed. He asked how did the employers know that doping was a dangerous occupation, as the disease seemed to have come on everybody as a surprise.

Mr. URRY (for plaintiff) : The smell of the solution should have put defendants on their guard. They ought to exercise care in new processes, otherwise there was a dangerous prospect before workmen.

His HONOUR, without calling on defendants' counsel, held there was no evidence that plaintiff suffered from that new industrial disease (which was scheduled only in July last), or that defendants were neglectful after February, when the deleterious character of dope was brought to their notice. There was nothing to go to the jury, and plaintiff was non-suited.

Export of Prohibited Goods.

At Woolwich (London) Police-court last week hearing was concluded of several summonses brought by the Commissioners of Customs and Excise against the Western Electric Co. (Ltd.) for exporting to Norway on certain dates parcels of telephone materials, the export of which was prohibited without a licence. For the prosecution it was said there was no suggestion that any of the goods were intended for the enemy, but proceedings had been taken because the authorities considered that there had been carelessness on the part of defendants in dealing with prohibited goods.

For the defence it was submitted that the offences had been committed through misunderstanding on the part of certain of the company's staff, and that there was no intention or desire to infringe the regulations.

A series of fines and costs was imposed, amounting in all to £58 2s.

Liability for Articles Lost on Tramcars.

Last week Sheriff-substitute Guy, of Edinburgh, delivered judgment in a small debt action by Miss I. Baird against Musselburgh & District Electric Light & Traction Co. for the value of a chatelaine bag left behind by her in an electric tramcar at Prestonpans. The Sheriff-substitute, who dismissed the action, stated that the conductor, finding the article, placed it in a tin box under the stairs on the rear of the car, whence it was stolen by an unknown thief. He held that while it was a good act of management that the company should request their conductors to take possession of articles left by passengers it did not make the company liable for the value of the goods if they were lost while in the custody of the conductor. If the article had been taken to the company's offices and there lost the case might have been different.

American Wireless Patents.

It is reported that the marconi Wireless Telegraph Co. recently applied to Judge Hough for an injunction against Mr. Emil Simon to prohibit him from installing and using certain electrical apparatus which it was alleged infringed marconi patents. Judge Hough, however, refused to grant the injunction, stating that without the use of the apparatus some vessels in the American Navy could not be put into commission.

PARLIAMENTARY INTELLIGENCE.

ELECTRIC POWER STATION EMPLOYEES.

In reply to a question in the House of Commons the Parliamentary (Munitions) Secretary to the Munitions Department (Col. A. Lee) recently stated that the Minister had power to issue badges to indispensable men engaged in electric power stations supplying current for war purposes. Badges had been issued in such cases wherever application had been made.

AMENDMENT OF MUNITIONS ACT.

It is announced that a Bill for the amendment of the Munitions Act is being prepared. The Minister of Munitions intends to ask for futher powers to enable him to take over as controlled establishments undertakings like electric power stations and other businesses essential to munition work.

Finance Bill.—On Tuesday the Committee stage of this Bill in the House of Commons was concluded, and it was reported, with amendments, to the House. Among the amendments were the following :—One allowing a deduction for any sum paid in respect of profits on account of any excess profits duty or similar duty imposed in any country outside the United Kingdom. Another provides that where any company owns the whole of the ordinary capital of any other company carrying on the same trade or business, or so much of that capital as a single shareholder can legally own, the provisions as to excess profits duty and the pre-war standard of profits shall apply as if that other company were a branch of the first-named company, and the profits of the two companies shall not be separately assessed. A third amendment provides that where, in the case of any trade or business (*a*) the percentage standard is adopted as the pre-war standard of profits ; (*b*) the net result of the trade or business during the three last pre-war trade years has shown a loss ; and (*c*) any part of the profits has been applied in extinction of that loss, then in estimating the profits a deduction shall be allowed equal to that amount of profits so applied.

Patents & Designs Act (Partial Suspension) Bill.—On Tuesday this Bill passed through all its stages in the House of Lords. The Royal assent has since been given to the Bill.

BUSINESS NOTICES.

Carbon Supplies.—The India Rubber, Gutta Percha & Telegraph Works Co., of Silvertown, London, E, notify that they can supply carbon in almost any shape or size.

Among the articles manufactured by the company are: Plates for batteries, electrical furnaces, &c., rods for batteries, rings, tubes, blocks, discs, buttons, &c., contacts for electrical apparatus, carbons for lightning protectors, telephones and other instruments. The company, which have been manufacturing carbons for nearly 50 years, are one of the pioneers of the trade in this country, and they carry large stocks of carbon pencils for pocket light batteries.

Mr. B. Sleath and Mr. J. S. Carter, travellers for Messrs. Chamberlain & Hookham (Ltd.), have both joined the Motor Transport Section of the A.S.C.

Messrs. Wallis-Jones & Dent announce that, in consequence of the absence of Capt. Wallis-Jones on active service, Mr. Harold W. Couzens (of Messrs. Couzens & Brown) has kindly undertaken t execute, on their behalf, all work now in hand and any future work that may be entrusted to the firm. Mr. Couzens will have th services of Mr. Tate, for many years chief assistant engineer t Messrs. Wallis-Jones & Dent, and he will, therefore, be in a position to deal effectively and promptly will all commissions which may be entrusted to the firm, whose postal and telegraphic address remain as heretofore, but the telephone number will now be Victoria 5029.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Electricity Committee are considering the question of providing additional generating plant at an estimated cost of £16,000.

Bo'ness.—The Secretary of Scotland has now replied to the request for approval of the scheme for the extension of the burgh electricity works.

The National Electric Construction Co., which maintains the works, estimated the total cost of the extensions at between £6,000 and £7,000. The Secretary for Scotland states that on the understanding that the additional plant is in the opinion of the Council and their consulting engineer urgently required in order to enable the undertaking to meet the demands during the ensuing winter of works engaged in providing munitions of war, he would offer no objection to an arrangement being made with the company on the lines suggested. It would be a matter for consideration when sanction for a loan was applied for to what extent the expenditure of £3,400 mentioned in the correspondence—part of which refers to work of a temporary character, of which the cost would be written off in a few years—may be included in any sanction then given.

The Council has now asked the company to submit to the consulting engineer for the burgh plans, specifications and prices of the proposed work before coming to any final decision.

Dundee.—In connection with the £20,000 recently sanctioned for the extension of Dundee Post Office, the Postmaster-General states that the original scheme involved the enlargement of the sorting office and the provision of accommodation for the new telephone exchange.

The former had been deferred owing to the war, but the existing telephone exchange was so old that there was grave danger if it were not replaced of the whole of Dundee being deprived of telephone service.

Durham.—The County Council have sanctioned an expenditure of £820 for the wiring and fitting of Holywood Hall Sanatorium.

London County Council.—On Tuesday sanction was given to the following loans for electricity purposes: Islington Council £5,455, and Woolwich Council £4,700 (for linking up Council's undertaking with that of the South Metropolitan Electric Light & Power Co.).

Poplar (London).—The L.C.C. has agreed to sanction a loan of £3,688 required for mains extensions, subject to the Borough Council agreeing to limit expenditure out of the loan during the war to purchase for the furtherance of the war.

It is proposed to advance the money out of the superannuation and pension funds when a sufficient sum is available. Mr. H. E. Harper and Mr. W. F. Bate have been appointed chairman and vice-chairman respectively of the Electricity Committee for the ensuing year.

The Committee has considered the question of consumers who, taking supply under the contract system, have been compelled to restrict lighting in accordance with Police instructions. A reduction has already been made by the alteration of the fixed charge on capital expended by the Council for services, meters and wiring installation from 12½ to 8½ per cent. per annum, and the undertaking is one of the few that has not considered advancing charges owing to war conditions. The Committee does not recommend any reduction on the fixed kilowatt charge (at present £8 for inside and £6. 10s. for outside lighting). Every consumer has a right to change over from the contract system, at the expiration of his agreement, to the flat rate of 3d. per unit plus 8½ per cent. per annum on the capital expended by the Council for wiring premises, but any change of this sort must be for a period of not less than 12 months. Under the circumstances, the Committee does not consider it advisable that any rebate should be made in the kilowatt charge under contract for shop lighting. They suggest, however, that consumers should be allowed to purchase installations should they elect to change over to the flat rate system at the original cost, less 5 per cent. per annum for depreciation.

GENERAL.

Buxton.—The Council have received sanction to a loan of £445 (repayable in 15 years) and £150 (five years) for the electric supply department.

Cahiravien (Co. Kerry).—Electric current was switched on for the first time on the 4th inst.

Cardiff.—The Council have sanctioned the temporary expenditure out of the rates of about £2,000 on completing the electric installation, &c., at the new technical college.

Carlisle.—The new Mayor, Ald. W. P. Gibbings, J.P., is chairman of the Electricity Committee.

Carmarthen.—The Council have declined to allow the local electric supply company to increase the price of current to consumers by 10 per cent. Under an existing agreement the company cannot increase the price beyond 5d. per unit without the consent of the Corporation.

Doncaster.—The Mayor (Councillor Balmforth) has been elected chairman of the Tra..ways and Electricity Committee.

Dublin.—Last week the Electricity Supply Committee reported on the tenders for an underfeed stoker at the Pigeon House generating station, and recommended the acceptance of a tender. An amendment to refer the matter back was, however, carried.

Gillingham.—At the last Council meeting applications were sanctioned for additional supplies of electric current being given for camp lighting, &c., to the extent of about 1,120 8 c.p. lamps. Supply is also to be given to premises in Rainham-road, just outside the borough boundary.

Greenock.—The total units generated in the month of October amounted to 2,288,261, compared with 1,336,728 in the corresponding month of 1914.

Hindley.—The Council have consented to Wigan Corporation giving a supply of electric current to Messrs. E. Whalley & Co., but they reserve the right to give a supply when in a position to do so.

Holme (Yorks.).—The formal inauguration of the local electricity supply works took place on the 13th inst.

Hull.—The Electricity Committee have decided to increase the charges for electric current for lighting on the flat rate by ½d. per unit and for other purposes by 15 per cent. upon existing charges, except where supplies are being furnished under unexpired agreements.

Islington (London).—The Council have adopted the report of the Parliamentary and General Purposes Committee on the application for a war bonus to all municipal employés.

The committee stated that they had considered a letter from the Municipal Employés' Association asking that any decision which may be arrived at by the Council in regard to the payment of a war bonus shall apply to the whole of the Council's employés, failing which steps would be taken to bring the matter before the Board of Trade for arbitration. The committee pointed out that there was justification in granting a temporary increase of wages to employés at the electricity works on account of the peculiar and technical character of the work and the prevailing exceptional circumstances connected with their employment. The committee recognised that all classes were affected by the war, and the association had advanced no special reason why exceptional treatment should be accorded to the comparatively few employés of the Council whom they represented.

Llanfyllin.—A local builder (Mr. R. A. Jones) recently offered to supply electric current for public lighting from a new plant which he proposes to instal, and the Council have decided to permit him to experiment with the scheme on the understanding that the Council do not bind themselves to adopt electricity for public lighting.

Manchester.—The Electricity Committee reports an unprecedented increase in the consumption of electrical current, and the estimate made in the earlier part of the year as to the probable demands on the department has been nearly doubled.

The increase in the demand for current for power is fully 30 per cent. over that in pre-war times, and it is anticipated that the increase, great as it is at present, will be much more before the winter is over.

It is reported that on the 17th inst. (which was a foggy day) there was a record consumption of electric current. The total units metered were 709,400, an increase of 20 per cent. compared with the corresponding day last year, and an increase of 27 per cent. over the corresponding date of

1913. Salford electricity department also experienced a record day, and the consumption of electricity in the borough exceeded that of the corresponding day of last year by from 40 to 50 per cent.

The Ministry of Munitions has written to the committee pointing out the enormous importance of the continuity of the electricity supply in view of the large demands which were being made by the many firms engaged on munition work.

St. Pancras (London).—The Finance Committee reports that it feels it would be purposeless to proceed further with any opposition to the terms of the L.C.C., whereby the latter are prepared to sanction the borrowing of £15,000 for the new 5,000 kw. turbo-generator, provided the Borough Council will agree to an accelerated repayment of the existing indebtedness on the 42-year loans.

As it would cost on an average about £3,000 per annum during the next 13 years to adopt the full proposals as to accelerated repayments, the Committee is of opinion that it would be the best course to offer the L.C.C. to make an increased repayment of loans amounting to £1,500 per annum during the next three years, and thereafter to make the accelerated repayments in full.

Street.—The Urban Council have decided to enter into an agreement with Messrs. Christy Bros. & Co. for the erection of electricity works for the supply of electric current for private and public lighting.

The firm possess a provisional order for the district, and it was intended to transfer this to a company to be formed for the purpose, but owing to the ewar this cannot be done at present.

Tunbridge Wells.—The Council have resolved that, in view of the desirability of having a free hand to obtain the opinion of any consulting engineer they may select upon such questions as may arise with respect to the municipal electrical undertaking, the appointment of Mr. Horace L. P. Boot as consulting electrical engineer of the Corporation be cancelled.

Tynemouth.—Reference was made at the last meeting of the Electricity Committee to the requirements of the Newcastle Electric Supply Co. with regard to the running of the Corporation's generating plant during the winter months.

In this connection the electrical engineer (Mr. C. Turnbull) reported that, as a result of an interview which the chairman and he had had with the company, a letter had been received expressing appreciation of the assistance the Council had been giving and are about to give the company by the running of the steam plant at Tynemouth at the Council's own cost during hours other than those mentioned in the agreement between the two parties.

The Committee has refused an application for energy to be supplied for bioscope purposes at power rate.

Whitehaven.—Ald. Musgrave, chairman of the Electric Lighting Committee, has been elected mayor for the current year.

LIGHTING & POWER NOTES.

Electric Driving in Wagon Building Works.—At the Swindon wagon building works of the G.W. Railway Co. there is gas-driven plant for supplying current for power and lighting. The plant includes three producer plant supplying gas to three 290 B.H.P. Campbell gas engines direct-coupled to G.E.C. 150 kw. compound-wound generators.

Newton Abbot.—The Rural Council has authorised the Dartmoor Electrical Supply Co. to erect electric light standards in Union-street and near Edgehill.

Sherburn (Durham).—The revised agreement with the County of Durham Electrical Power Distribution Co. for the supply of electric current has been agreed to by the Parish Council, but the original agreement is to be returned to when the restriction as to public lighting is removed.

TRACTION NOTES.

Bournemouth.—After Dec. 1 the Tramways Committee recommends that the tramway service be suspended each night at 10 p.m. instead of 11:30 p.m., owing to the darkened streets and the decreased staff.

Bradford.—The general manager of the municipal tramways (Mr. C. J. Spencer) has reported to the Tramways Committee on the position of the undertaking.

Mr. SPENCER states that in consequence of the great recruiting effort there is such a shortage of labour that immediate action is necessary to avoid serious consequences. Recruiting affected the department by taking away men necessary to run, clean and maintain the cars, and it also caused a great financial drain by the increased amounts payable for separation allowances under the resolution of the Council. The present staff of 1,281 employés was absolutely necessary to maintain the service apart from overtime. Of that total 818 were of military age and 151 were married. Under Lord Derby's scheme it could be reasonably expected that a call of 100 or 200 men in a batch was not impossible, and the department was not in a position to replace men quickly, if at all, when called up in their order. The allowances to dependents of men who had enlisted were costing £8,000 per annum, and in the event of 1,130 more being called to the Colours that figure could easily be multiplied by three. The men who had enlisted and those who were possible candidates for enlistment represented the best men in the service, and the value of the labour of the new men was considerably less, and was having a marked effect on the cost of operation. The consumption of current had increased by over 5 per cent., representing £3,000 for the year. In addition, accidents had increased considerably, partly due to new men and partly, it was believed, to lighting restrictions. The curtailment of the service would temporarily meet the shortage of labour, but it would be at the expense of national interests, public convenience and finance. From early morning to 9 a.m. the cars are crowded to excess, and in order to meet the demand 153 cars have to be manned and maintained. The cars could be stopped at 9 p.m., but that would only shut down a proportion of the expense. If curtailment of the service was necessary, it is suggested that the Sunday service and the late cars at night could be considered, but even that would be against the interests of those munition factories which were working seven days and nights a week. Considerable difficulty had been experienced in replacing labour by men of non-military age. It had been found that men over 40 could not undertake with satisfactory results the duties of a conductor. The alternative appeared to be female labour. Female conductors had been accepted in a good many towns, and according to the reports of the managers of the various undertakings they had been satisfactory; but, notwithstanding that, Mr. Spencer states that in looking into the peculiar conditions of Bradford, both tramways and otherwise, he should not willingly recommend the employment of female conductors. There was, however, no alternative, except the one of very greatly curtailed services. The position so far as drivers were concerned was very difficult. The employment of females for driving was entirely out of the question and impossible under any circumstances in Bradford. Men of mature years and of non-military age might possibly be trained to drive if they were available.

At a special meeting of the Committee on Monday the points raised in the report were discussed, as was an application from the Bradford branch of the Amalgamated Association of Tramway and Vehicle Workers asking for an advance of 5s. per man per week, or 1d. per hour for those men paid on that basis.

In reply to a letter from the town clerk (Mr. F. Stevens), the Minister of Munitions (Mr. Lloyd George) has intimated his agreement with the view that the maintenance of an adequate tramway service is necessary in the interests of munition workers. In the circumstances he promised, in consultation with the War Office, to consider whether it is possible to protect the Corporation tramways against losing the irreducible minimum of skilled workmen required for the proper working of the tramway service by means of the issue of badges.

The Minister has had several deputations from tramway authorities in different parts of the country, and instructions have been given that in certain cases the recruiting officer must not accept any men unless he brought a note from the tramways manager giving him permission to enlist.

Colwyn Bay–Llandudno Tramway.—Hitherto only single-deck tramcars have been used on the line between Colwyn Bay and Llandudno, and the local tramway company has been authorised by the Board of Trade to augment the service by putting on a number of double-deck cars.

Colwyn Bay Council, however, are opposing the change. They allege that the steep Penrhyn Hill midway between the two towns would render the use of double-deck cars dangerous, and they also contend that such cars would not be in keeping with the character of the district.

Croydon.—The overhead wire on the Addiscombe route is practically worn out and requires renewing.

The cost is estimated at £432, but having regard to the excessive price of copper wire the Committee recommends the removal and utilisation of the wire on the disused Whitehorse-road route at a cost of £188.

L. & S.W. Railway.—Electric trains have made trial trips on the Kingston round-about loop of this railway, and it is announced that electric trains will supersede the steam service on the 28th inst.

The trains consist of six coaches, with first and third class compartments only, and there will be a much accelerated service during the day. Teddington, Kingston, Hampton Wick and Strawberry Hill will have a train to and from Waterloo every five minutes, while on the Thames Valley line there will be half-hourly services, which will be diverted through Kingston to Waterloo, instead of through Richmond.

Portsmouth.—The Tramway Committee anticipate the loss of a number of their eligible employés who are anxious to join H.M. Forces, and the general manager (Mr. W. R. Spaven) has been instructed to report how the present service of cars can conveniently be curtailed.

West Ham.—The Tramways Committee proposes to purchase four lathes at an estimated cost of £800.

Women Tramcar Conductors.—The Highways Committee of the London County Council state that the precise conditions under which women tramway conductors will have to work can only be settled after some experience has been gained and after it is seen how many men will be called up under Lord Derby's recruiting scheme

After discussion on the committee's report on Tuesday, the chairman (Mr. Prestige,) promised that for the present they would not take any women except those who were willing to work full time. Then, if they found that the work was heavy for them, the matter could be referred to the Conciliation Board, so that some scheme of part-time work might be drawn up. They would be paid at the same rate as the men.

The report was then adopted.

Women are now employed on the tramway systems at Burnley, Croyden, Darwen, Lowestoft, Plymouth, Stockport and West Ham.

TELEGRAPH & TELEPHONE NOTES.

Municipal Telephony.—On Monday Hull Telephone Committee resolved, on the ground of national economy, to spend no money in costly extensions.

The manager (Mr. Holmes) reported that out of the 63 members of the staff who presented themselves for enlistment under Lord Derby's scheme 53 were passed and placed in the Army reserve. Fourteen members would be glad to be allowed to enlist at once, and also two members of the night operating staff. Should all of the 53 members be withdrawn it would not affect the operating for the time being, but the lack of maintenance would lead to a complete stoppage as it would be impossible to repair any of the plant when it became faulty. Should the single men only be withdrawn it would mean that the committee would have to abandon the maintenance of 7,000 subscribers' instruments.

The committee refused to sanction the immediate enlistment of the 14 members on the ground that they cannot be spared.

FOREIGN NOTES.

Argentina.—Mr. S. S. Dickson, lately British Consul at Port Madryn, reports that the situation in Patagonia appears to be favourable for British trade.

He says although such development as has taken place in that Province was initiated by British enterprise, and although conditions favoured a British monopoly, British manufacturers are far from enjoying a monopoly at present. A non-British group of importers owes its importance to one firm through whom the buyer in Patagonia is offered a German or Austro-Hungarian article for every similar article imported from the United Kingdom. Patagonia has been and should be a British market, and the time is propitious for some effort to be made to check the German and Austro-Hungarian competition which, coming in through neutral channels, has assumed large proportions during recent years. In the Patagonian market German goods have been able to compete with British-made articles, even in the case of articles which are staples of export from the United Kingdom. The inherent defect which has done harm to British trade is want of adaptability on the part of the manufacturer, and of his traveller when he sends one. The German traveller is not necessarily the employee of one particular firm. He is often the emissary of an export agency, through which he, indirectly, represents a number of firms and manufacturers. His mission is to investigate and ascertain, within certain lines, the requirements of the local market and take the requisite steps to meet those requirements. His employers act on his report, and no local preferences or prejudices are ignored. He will have samples specially manufactured and sent out, on approval, to customers or possible customers. He is always prepared to obtain any modification from the manufacturer that his client may point out as necessary. Of equal importance is the question of credits. The German exporter studies the circumstances of the local market from the point of view of his client (the importing firm or merchant) and gives him every facility as regards terms of payment. It is in these respects that British manufacturers fail. Mr. Dickson says this is the view of the local merchant who wants to do business with British manufacturers. The German trader comes to him and studies his requirements. To get British goods he has to make the advances and then adapt himself to the terms and conditions of the British seller.

A decree has been issued granting a 30 years' concession to Don Ramon T. Demaria for establishing and working a public telephone service in the districts of Bernascom, Villa Alba and Jacinto Arauz (Central Pampa territory).

China.—There is at least one British Consul who does not write in unqualified praise of German business methods abroad, for in a report on the trade of Tsinan and Tsingtau for 1914 H. M. Consul Mr. J. T. Pratt writes :—

It is well known that German merchants will take great risks, but it is frequently forgotten that those risks often lead to heavy losses. That has certainly been the case in Tsinan, where the German merchants have needlessly increased the amount of their losses by foolish efforts to impress the Chinese with a sense of their grandeur. For many years the German exporter in Tsinan, occupying palatial premises, has made little or no profit for his firm, while the British exporter, living inhumble quarters, has spread over the province organisations for the distribution of imports from which a golden harvest has been reaped. The German exporter has for practical purposes already disappeared from Shantung. It is probable that his place will be taken to a large extent by the even more ubiquitous Japanese, but there is little prospect that any British merchant will find conditions sufficiently attractive to induce him to open a branch there.

Russia.—The Budget for 1916 has been introduced. The Minister of Finance proposes to levy a tax on electrical energy, a general graduated income tax is also proposed.

Spain.—In a report by the United States Consul at Seville it is stated that properly equipped commercial travellers visiting Spain may secure orders at present.

These orders include oil presses, electrical machinery and supplies, electrical and gasoline pumps, refrigerating and ice-making machinery, agricultural machinery and implements, machine tools, motor vehicles, railway ties, hardware, iron and steel products, tools, paints and varnish, lubricating oils, chemicals and drugs, fans, wire fencing, &c.

It is proposed to establish a State telephone system between Bilbao, Guernica, Durango, Plencia, Miravalles and other places in the Province of Biscaya.

MISCELLANEOUS NOTES.

Exports to Switzerland.—The Société Suisse de Surveillance Economique, at Berne, began operations on Nov. 16. The articles of which the society will take delivery, and for which it will in future be the only authorised consignee in Switzerland, include those given in the following list :—

The articles can only be consigned to the society if its written consent has first been obtained by the ultimate consignee, and no export or transit licences will be granted in respect of such articles unless the application is accompanied by the document proving the consent of the society. Articles destined for Switzerland from the United Kingdom, France, Italy and Russia in respect of which export licences have been granted or conditionally authorised before Nov. 16, and articles from neutral countries in respect of which transit permits have been similarly granted, may be exported or allowed to pass in transit without being consigned to the society, in virtue of the special guarantees already given by the Swiss importers.

The articles referred to in the first paragraph include electric accumulators, acids (hydrochloric, nitric, sulphuric, &c.), aeroplanes and airships and engines and parts, aluminium, ammonia, antimony, asbestos, machine belting, bichromate of soda, caoutchouc, carbide of calcium, celluloid, chlorates and perchlorates, chrome (ore and metal), copper, detonators, diamond drills, electric fire lighters, carbons for electrical purposes, insulated wire and cables, batteries, electrodes, &c. ; emery wheels and grindstones, explosives, ferro-chrome, ferro nickel and other ferro alloys ; glasses for optical instruments, &c. ; graphite, instruments (observation, optical, nautical, &c.) ; iridium, iron, lead, lubricants, machine tools and parts, electrical machinery and parts, machinery for manufacture of munitions and weapons of war ; magnesium, magnetos, manganese, metallic perotides ; mica, miners' fuses ; molybdenum, munitions, nickel, osmium, packings (engine and boiler), platinum, potash, potassium and potash salts, ruthenium, rubber, gutta percha and ebonite, salts of copper, chrome, tin, thorium, titanium, molybdenum, vanadium and other salts of rare earths, selenium, silican, shipbuilding materials, steel, sulphate of copper and cuprous powders ; sulphur and pyrites, &c., scrap metals (steel, copper, tin, zinc and their alloys), telegraph material, tin, tools, tungsten, vanadium ; vehicles of all kinds, zinc.

Inquest.—Last week an inquest was held at Edmonton on a boy named Arthur E. Morley, who was found dead at the rear of his employers' premises on the 12th inst.

The manager of the shop stated that at eight o'clock on the evening of the 12th inst. deceased was sent to unpack some casks of eggs at the rear of the shop. His absence was noticed, but as witness was busy he had not time to search for him. Shortly after he was informed that deceased was found dead in the back yard. An electric wire ran along the fence near which the boy was found. The wire was encased in an iron tubing, which was broken in one place. There was no light in the yard, and the boy would have had to pass close to the wire to get to the boxes.

Mr. C. Barnet, resident engineer of the North Metropolitan Electric Power Supply Co., said the connections were made at the shop by his company in 1908. Neither he nor any of his men knew that the wire extended from the shop to the warehouse, as they had not made the connection themselves, nor had any intimation been received from the owners of the shop (Messrs. Lipton) that such a connection had ever been made. In his opinion the tubing in which the wire was encased was not suitable for out of doors, and it had worn considerably. The voltage of the electric current carried over the wire was 240. His theory was that the boy had accidentally broken the wire, and that he had placed his hand on the leakage whilst getting to the boxes, and that the current had passed through his hand into his body. Owing to the dampness the

volume of current was increased. His company would not have passed the tubing for out-door use, as it was not thick enough.

A representative of Messrs. Lipton said that an electrical contractor had been engaged to make the additional connection.

After hearing medical evidence, the jury found that death was caused by "an electric shock through coming accidentally into contact with an unprotected live wire."

Patent Agents and Alien Enemy Patents.—The Board of Trade remind patent agents that it is not permissible to receive from agents in enemy countries instructions or documents in respect of applications for the grant or the renewal of patents or applications for the registration of designs or trade marks in the United Kingdom on behalf of persons in neutral countries. Patent agents should satisfy themselves that any instructions or documents which they may receive on behalf of a person in a neutral country have not passed through the hands of an enemy.

Will.—Lieut. Thomas Lindsay Bainbridge, electrical engineer, formerly with Messrs. Swan, Hunter & Wigham Richardson, who was killed on April 27 last, has left estate valued at £32,443 gross, with net personalty £32,016. He left his shares in the Northern Aircraft Co. and his 100 H.P. airplane to Mr. W. Rowland Ding.

TENDERS INVITED.

Electric Cable and Wire.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders for the supply of Electric Cable and Wire for one year from Jan 1, 1916 Forms of tender, &c , from the Controller of Supplies, 18, Queen Anne's Gate, Westminster, S W., and tenders (by 11 a m , Dec 9) to the Secretary, H M Office of Works, &c , Storey's Gate, London, S W. *See an advertisement.*

Telephones, Cables, &c.

The Corporation of DURBAN (Natal) invite tenders for the supply and delivery of Air-space and Paper-insulated Cables for their underground telephone service, together with Silk and Cotton Lead-covered Cable, 30,000 Paper Sleeves and 30 sections Protector Mountings. Particulars from Messrs. Webster, Steel & Co., agents for the Corporation, 5, East India-avenue, Leadenhall-street, London, E.C., to whom tenders are to be sent by Wednesday, Dec. 1. *See also an advertisement.*

Cast-iron Pipes.

DURBAN Corporation also require tenders by Wednesday Dec. 1 for 3½ in. and 3 in. c.i. Pipes for Telephone Cables. Specifications from Messrs. Webster, Steel & Co., agents to Durban Corporation, 5, East India-avenue, Leadenhall-street, London, E.C.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of g.i. Wire (specification No. 301 ; schedule No. 402), and c.b. Multiple Switchboard for Adelaide telegraph exchange (specification No. 552 ; schedule No. 405) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-st , London, S.W. *The dates and plans for the receipt of tenders are given in an advertisement.*

Tenders are required by Dec. 7 for the supply of the following articles for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department : Zincs, Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks and Resistance Boxes. (Schedule No. 1,273).

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. Dec. 7 for supply of Electric Motors, Polarised Relays, Morse Sounders, Telephonometers and Voltmeters (schedule 1,272), and by 3 p.m. Dec. 14 for 18,670 c.b. Wall-pattern Telephones (schedule 1,264) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept.

Tenders are invited (by Dec. 8) for supply of 294 Accumulators, each of 15 ampere-hour capacity, and a Power Board and Associated Apparatus to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Sydney, requires tenders by 2:30 p.m. Dec 20 for 3,750 c.b. wall pattern and 300 c.b table Telephones, 150 Magneto Wall Telephones and 50 Portable Telephones (schedule No. 454) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General, Sydney.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Brisbane.

The SLIGO, LEITRIM & NORTHERN COUNTIES RAILWAY Co. require tenders by 10 a.m. Dec. 1 for 12 months' supply of Stores, including Telegraph Materials, Rubber Goods, Lead, Oils, &c. Forms of tender from the Secretary, Enniskillen.

Tramway Rails.

DUNDEE Town Council require tenders by Nov. 29 for 600 tons Steel Tramway Rails and 15 tons Steel Tiebars. Forms of tender from the City Engineer.

Public Electric Lighting.

ATHY (co. Kildare) Urban Council require tenders before 11 a.m. Dec. 6 for the electric lighting of the town on a three years' contract. About 50 Lamps of 50 c.p. each will be required for public lighting, and it is estimated that 300 private consumers can be obtained.

Electric Pumps, Motors, &c.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Dec. 20 for supply of three Centrifugal Pumps and Electric Motors, each to pump 6,300 gallons per minute and one to pump 15,100 gallons per minute, with switchboards, starters, &c., and spare parts. Specification, &c., from the Board's offices, 341, Pitt-street, Sydney, N.S.W.

Motor-Generator, Switchboard, Transformers, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections (contract No. 29,491), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fishplates (contract No. 28,685). Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Dec. 6 for 33,000-volt Outdoor Three-phase Transformers and Switchgear, with Spares for 12 months, or (alternatively) Single-phase Transformers to be operated in banks of three. Specification, &c., from the City Electrical Engineer.

Boiler.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c , of two Water-tube Boilers and Accessories at Newcastle Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

ST. PANCRAS (LONDON).—In March tenders were received for the supply of carbons for the ensuing year, and the tender of the General Electric Co. was accepted for a four months' supply, on the understanding that if the Council took the remainder within the year the price quoted would stand. The balance of the quantity tendered

is now required, and the Electricity Committee recommends the acceptance of the firm's offer for the balance of the carbons at £1,022. 13s. 4d.

LONDON COUNTY COUNCIL. The following tenders have been accepted for supplies of electrical sundries :—

For all asylums : A. F. Goodwin & Co., £145. 0s. 5d. : Edison & Swan United Electric Light Co., £40. 1s. ; General Electric Co., £4. 18s. 11d. Cox-Walkers, £3. 19s. 10d. : G. Maclellan & Co., £1. 6s. 3d.

Electric lamps for Bexley, Claybury, Horton, Long Grove and Epileptic Colony : Pope's Electric Lamp Co., £182. 11s.

DARLINGTON.—The Council have accepted the tender of the Worthington Pump Co. for the supply of condensing plant.

EDINBURGH.—The Corporation have accepted the tender of Charles Brand & Son (at £24,515) for shafts and tunnel for obtaining sea water for Portobello power station.

RATHMINES.—The Urban Council have accepted the tender of the British Thomson-Houston Co. for the supply of a motor generator, at £108. 7s.

ISLINGTON.—The tender of V. G. Middleton has been accepted for wiring the South East Branch Library.

WEYMOUTH.—The Town Council have accepted the tender of Brooking & Co. for wiring the municipal dwellings.

Government Contracts.—The following tenders were accepted by the British Government departments during October :—

War Office.—Bullers (Ltd.), Douglass Bros. and Vulcan Co., insulators, British Insulated & Helsby Cables, Callender's Cable & Construction Co., Craigpark Electric Cable Co., I. Frankenberg & Sons, W. T. Glover & Co., A. Green (Ltd.), W. T. Henley's Telegraph Works Co., Johnson & Phillips, Liverpool Electric Cable Co., C. Macintosh & Co. and Western Electric Co., electric cables and wires, &c. ; Automatic Telephone Mfg. Co., S. G. Brown and H. White & Co., telegraph commutators ; Hearl, Heaton & Sons, cable drums ; Austin Motor Co. and Fyfe, Wilson & Co., engines, dynamos, &c., Litholite (Ltd.), and T. De la Rue & Co., insulators ; British Thomson-Houston Co. and General Electric Co., electric lamps ; Clegg Bros., Cook, White & Co., C. Jennings & Co., Mackenzie & Moncur, C. R. Pettit & Son, E. Pollard & Co., J. Sadd & Sons, J. & H. Steaves and Whitstable Shipping Co., telegraph poles ; Beck & Co., E. Deane & Beal, Duke & Ockenden, J. Evans & Sons, Hattersley & Davidson, Lee, Howl & Co., Stereophagus Pump & Engineering Co. and C. Winn & Co., pumps, motors, &c. ; Automatic Telephone Mfg. Co., telephone switches ; Berry & Hayward, General Electric Co., Laing, Wharton (Ltd.) and Veritys (Ltd.), switches ; Chloride Electrical Storage Co., accumulators (Park Hall Camp, Oswestry) ; Wimbledon Electric Supply Dept., electric wiring ; Lowdon Bros. & Co. (electric wiring, &c., Redford)

India Office.—Elliott Bros., apparatus ; Marconi's Wireless Telegraph Co., coils, &c. ; Peel-Conner Telephone Works, condensers, &c. ; Taylor, Tunnicliffe & Co., insulators ; Medway's Safety Lift Co., electric passenger lift, Ministry of Munitions.

Post Office.—Siemens Bros. & Co., protective and telephone apparatus ; Automatic Telephone Mfg. Co. and British L.M. Ericsson Mfg. Co., telephone apparatus ; Telegraph Construction & Maintenance Co., submarine and telephone cable ; W. T. Henley's Telegraph Works Co., Johnson & Phillips, and Union Cable Co., telephone cables ; Western Electric Co., telephone cable and telephone exchange equipment extension, Norwich ; British Insulated & Helsby Cables, telephone cords ; General Electric Co., telephone lamps ; Lead Seal Mfg. Co. and I. N. Lyons (Ltd.), lead seals ; T. Bolton & Sons and F. Smith & Co. (inc. in London Electric Wire Co. & Smiths), bronze wire ; J. C. Fuller & Son and Chas. Macintosh & Co., flameproof wire ; Dorman, Long & Co., g.i. wire ; A. Hawkins & Sons, elec. lighting Supt. Engineer's office, London-S.E. ; Tudor Accumulator Co., replating battery, Avenue Exchange, London ; Peel-Conner Telephone Works, telephone exchange equipment, Manchester.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Edison & Swan United Electric Light Co. (Ltd.)

The 32nd ordinary general meeting was held on Thursday, Nov. 18, Mr. C. J. FORD presiding.

The SECRETARY (Mr. R. H. Parker) read the notice and the auditors' report.

The CHAIRMAN said the increase in the balance-sheet under the head of sundry creditors and credit balances was wholly due to the larger turnover which had taken place, and was correspondingly represented by increases in the items of stock and sundry debtors. With a view to extending the company's manufacturing facilities, £8,690 had been expended on additional buildings to cope with the increased trade, and plant and machinery for a similar reason had been increased by £8,706. One of the principal items included in this additional expenditure had been in respect of glass furnaces, and these were now equipped for an output of lamp bulbs of practically double the capacity which existed heretofore. They had in the past year found no difficulty whatever in disposing of the whole of their output of lamps, and they could undoubtedly have sold more if their manufacturing capacity had been greater ; but it was only within the last few months that the additional furnaces and plant had been available, and further moderate expenditure would be required. There had also been a considerable increase in the sale of goods produced in the engineering side of the works. In normal times the sales of lamps they had made would undoubtedly have shown a considerably greater profit, but while the selling price of the drawn-wire lamp could not be increased, and was more likely to be reduced, the cost of manufacture had risen to an abnormally high figure in consequence of the increase in wages and the cost of raw materials. The company, however, had undoubtedly established the reputation of the "Ediswan" drawn wire lamp, and unless something altogether unforeseen should happen he saw no reason why the increased sales should not continue. The company had now 1,505 fully-paid preference shares and 6,699 deferred shares (out of 7,000 issued) in Altrincham Electric Supply (Ltd.), a further sale of preference shares having been made in order to provide additional working capital. The item of general expenses had been reduced by £4,825, and amounted to £17,038, whilst the balance of gross profit brought from trading account had been increased from £51,244 to £56,962, the net result being that they had made a profit for the year under review of £14,146, against £4,695 in the previous year. This, in all the circumstances, the shareholders would, he hoped, consider fairly satisfactory. He much regretted that it was not possible for the directors to recommend payment of a dividend. On previous occasions he had pointed out that it was absolutely essential that before any dividend could be paid they should accumulate a very substantial reserve fund, which meant that, instead of dividing the profits they would keep them in the business and employ them as additional working capital. For this reason the board recommended that a start be made in this direction by transferring £15,000 to reserve and carry forward £4,878. The past year had been a trying and anxious time. They had experienced great difficulty in finding adequate labour ; a considerable percentage of their employés had joined the Forces, and the company had been met at times with almost insurmountable difficulties in carrying out orders. Their anxieties had been accentuated by the great rise in the price of raw materials, and in many instances the difficulties of obtaining them at any price. Two years ago he pointed out that the company was in need of additional working capital, and although the disposal of a large portion of their holding in the Altrincham Company had been of great benefit to them, it had not been nearly sufficient, and if the business increased in the future as it had during the past two years the question of finance would become a still more urgent one. Unfortunately, there did not appear to be any existing means of providing further working capital except through the medium of holding up profits. One of his colleagues (Mr. Gimingham), in the early part of the present year, made a tour of inspection of the company's Australian and New Zealand branches and agencies, and visited the chief commercial centres there, and in due course a considerable expansion of the company's trade in Australia should result therefrom. He moved the adoption of the report and accounts.

Mr E B ELLICE CLARK seconded the motion

In reply to Mr Hicks, the CHAIRMAN gave as an instance of the difficulties with which they had to contend that they had to send their own motor vans to Birmingham to fetch metal. Wages and raw materials had both gone up after contracts had been entered into, but the price of their lamp could not be raised, although the cost of producing them had gone up 33 per cent. In normal times they wanted a minimum reserve fund of £50,000, and to-day they wanted more. Their profit to-day was after taking stock, debtors and all assets at a most conservative figure, and there was no question that they had the profit there.

The resolution was adopted, the retiring directors and auditors were re elected, and a vote of thanks to the chairman and directors closed the proceedings

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PROVINCIAL TRAMWAYS CO.—The report for the year ended Sept. 30 states that the net revenue received from the local companies was £48,789, against £40,297 last year and £41,683 in 1913. Adding amount brought forward (£4,935) transfer fees, interest, &c., the total is £56,142. The directors have set aside £12,000 for reserve and depreciation and have added £4,000 to reserve account, and they recommend a dividend on the ordinary shares of 10d per share, making, with 8d. per share paid in June last, 1s. 6d. per share, or 7½ per cent. for the year, leaving £11,880 to be carried forward.

SOUTHERN BRAZIL ELECTRIC CO. (LTD.)—Mr. E. H. Tootal, who presided at the meeting on Monday, said that the year under review was not an auspicious one for the company. The financial difficulties which prevailed for a considerable time after the outbreak of war rendered it impossible in most cases to effect payment of the successive instalments of their debenture issue at their due dates, and it was only in the beginning of the present month that the last calls in arrear were finally paid. The board were compelled to husband their resources and to delay and curtail the development and extension work contemplated in Brazil until their finances should be placed upon a better footing. The financial crisis in Brazil was aggravated by the war, and led to a material depreciation of the currency. Several of the States had lately been visited by severe and prolonged droughts, and the State of San Paulo in particular experienced last year a drought worse than anything known there for 40 years, which in several places compelled factories dependent upon water power to shut down for a time. During the whole of that period the supply of water to their several enterprises, though at times reduced, proved sufficient to enable all the different services to be carried on without interruption. Since Mr. Byington's return to Brazil he had been able to complete on satisfactory terms the negotiations for a concession during 30 years of a tramway service for the town and district of Piracicaba and the right of use of water for supplying power from there to other localities, which would enable the company to suppress some outlying power stations at a material saving in cost. The balance profit (£2,127. 4s. 8d.), the directors proposed to carry forward but the amount did not represent the result of a full year's working. It was proposed to alter the date of closing the financial year so as to coincide with that of the Brazilian concerns. The board were confident that given a return to normal conditions the company possessed the elements of a prosperous future.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANY.

SHEFFIELD ALLOYS (LTD.) (142,112)—Reg. Nov. 11, capital £30,000 in £1 shares, to carry on the business of manufacturers of and dealers in iron and steel and ferro alloys, brass, copper, zinc, tin and similar metals metallurgists, electrical engineers, &c. Private company. H. W. D. Fielding signs documents as "director." Reg. office: 45, Bank-st., Sheffield.

STATUTORY RETURNS.

BRAY, MARKHAM & REISS (LTD.)—Return to July 15 gives capital as £20,000 in £1 shares. 9,250 shares taken up and £8,850 paid. £400 considered as paid. Mortgages and charges: nil.

BRIMSDOWN LAMP WORKS (LTD.)—Return to Sept. 29 gives capital as £5,000 in 5s. shares. 12,580 shares taken up. £855. 10s. paid on 4,292, leaving £217. 10s. in arrears. £2,072 considered as paid on 8,288. Mortgages and charges: £40,000.

CRYSELCO (LTD.)—In return to July 8 capital is £15,000 in £1 shares. All shares taken up. £10,007 paid. £4,993 considered as paid. Mortgages and charges, £8,800.

D. P. BATTERY CO. (LTD.)—At July 21 capital was £10,000 in £1 shares (4,996 "A," 4,996 "B," and 8 others). All shares taken up and £10,000 paid. Mortgages and charges: £12,000.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—The capital at July 22 was £640,000 in 80,000 ordinary shares of £3 each, 40,000 cumulative preference shares of £5 each, and 40,000 non-cumulative preference shares of £5 each. All shares taken up. £600,400 paid on 66,800 ordinary, 40,000 cumulative and 40,000 non-cumulative preference. £39,600 considered as paid on 13,200 ordinary. Mortgages and charges, £467,683.

L. J. HEALING & CO. (LTD.)—The capital at Oct. 11 is £100,000 in £10 shares (5,000 preference and 5,000 deferred). 1,301 preference and 5,000 deferred shares taken up. £10 per share called up on 1,301. £13,010 paid. £50,000 considered as paid on 5,000 shares. Mortgages and charges: Nil.

HENLEY'S (SOUTH AFRICA) TELEGRAPH WORKS (LTD.)—The capital in return to Sept. 10 is £2,000 in £1 shares. All shares taken up. £20,00 paid. Mortgages and charges, nil.

SALFORD ELECTRICAL INSTRUMENTS (LTD.)—Capital at Sept. 29 was £20,000 in 10,000 preference and 10,000 ordinary shares of £1 each. All shares taken up. £10,000 paid. £10,000 considered as paid. Mortgages and charges, nil.

W. R. SYKES INTERLOCKING SIGNAL CO. (LTD.)—At Oct. 6 capital was £50,000 in 87,500 "A." and 12,500 "B" shares of 10s. each. 42,297 "A" and 12,500 "B" shares taken up. 3s. 9d. per share called up on 42,297 "A" £7,936. 18s. 9d. paid. £6,250 (10s. per share) considered as paid on 12,500 "B" shares, and £10,574. 5s. (5s. per share) on 42,297 "A." Mortgages and charges, £13,000.

MORTGAGES AND CHARGES.

G. DAVENPORT & CO. (LTD.)—Particulars of £2,000 debentures created Nov. 1, 1915, have been filed, whole amount being now issued. Property charged, company's property, present and futuer, including uncalled capital. No trustees.

CITY NOTES.

MEMORANDA (Nov. 24).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57¾. Consols Pay Day Dec. 1. Stocks and Shares Ticket Days Dec. 14 and 29. Pay Days Dec. 15 and 30. Price of silver, 29¾d.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. (less tax).

CONSOLIDATED SIGNAL CO. (LTD.)—After paying preference dividend, &c., for the past year, it is proposed to carry forward £5,475.

ELECTRIC CONSTRUCTION CO. (LTD.)—The directors have declared an interim dividend at rate of 7 per cent. per annum on the preference shares for the half-year ended Sept. 30.

MEXICO TRAMWAYS & POWER COMPANIES.—It is announced that, at the request of the holders of large amounts of the bonds of the various companies constituting the Mexico Tramways, Light & Power Group, the following gentlemen have consented to act as a committee to co-operate with the trustees, receivers and directors in taking such measures from time to time as will best safeguard the interests of the security holders: Messrs. E. R. Peacock (chairman), Stanley Boulter, H. F. Chamen, R. Fleming, H. Malcolm Hubbard and A. F. P. Roger. Communications to Mr. Thomas Porter, secretary of the committee, 34, Bishopsgate, London, E.C.

SHAWINIGAN WATER & POWER CO.—A dividend at rate of 7 per cent. per annum for quarter ended Dec. 31 has been declared.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 23. The greatest care is taken in compiling these figures but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Nov. 23.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 8 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum 2nd Pref.	9⅝	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	8 5/16	5 16 9	Mar Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 9 9	..
5	5%	Do. Ord.	4	6 7 0	Aug, Feb
5	4½%	Do. City Pref.	3½	5 13 5	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅛	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	88½	5 1 2	Jan, July
10	9%	City of London Elec. Lt. Ord.	11½	7 13 2	Feb, Aug
10	6/0	Do 6% Pref.	11	5 9 1	Mar, July
St	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9 1/16	7 0 1	Mar, Sep
10	6%	Do. 6% Pref.	10⅛	5 18 0	Feb, Aug
St.	4½%	Do. 1st Deb.	91	4 18 11	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 1 9	May, Nov
St.	4½%	Edmundson's Elec Supp. 4½% Debs.	76½	5 17 8	July
5	9%	Kensington and Knightsbridge Ord.	6⅝	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4⅛	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 6 4	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 7/16	7 3 7	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	95½	4 14 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 0	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/32	5 16 4	April, Oct
4	5%	South London E.S. Ord	3	6 13 4	May, Sept
5	10%	St. James' & Pall Mall Ord.	7	6 19 9	Feb, Aug
5	7%	Do do. Pref.	6 ⅛	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 0	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St	94	5 6 10	April, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 ⅛	7 10 7	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum Pref.	4 ⅛	5 7 5	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	April, Oct
St.	6%	Do 6% Cum Pref.	70	8 11 5	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70½	5 13 0	.
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	.
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St	4%	Do 4% Deb. St.	86½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅛	5 11 4	May, Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	⅝%	London Electric Ry. Ord.	1½	4 3 4	Jan, July
St.	4%	Do 4% Pref.	58	6 17 11	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St	1%	Metropolitan Ry. Con. Ord.	24½	4 0 10	Feb, Aug
St	3½%	Do 3½% Pref	77½	4 10 4	Feb, Aug
St.	3½%	Do 3½% Convertible Pref.	79½	4 13 8	Feb, Aug
St	3½%	Do 3½% A Debs	82½	4 4 0	Jan, July
St.	3½%	Do. 3½% Debs	83½	4 4 1	Jan, July
St.	.	Metropolitan Dist. Ry Ord.	15	.	Feb, Aug
St	4%	Do 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	9	4 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	113	5 6 2	Jan, July
St	4%	Do. 4% Debs	72½	5 10 4	Jan July
St.	4%	Do 4% Debs. (1903-5)	67½	5 18 0	Jan July
St.	4%	Do. 4% Guar. Stock	65	6 3 1	Mar, Sept
10	..	Underground E. Rys. of London Shares.	2	..	..
1/0	..	Do. A Ord.	⅛	..	..
St.	6%	Do. 6% Inc. Debs.	104½	5 14 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	NAME.	Price, Tues., Nov. 23	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways —*cont.*			
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	78½	7 13 4	Mar, Sept
..	4½%	Do. 4½% Bds.	99½	4 10 6	Jan, July
5	..	Yorkshire W. Riding Ord.	¾	..	March
5	6%	Do. Pref.	4⅛	6 19 2	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅝	6 2 9	Apl, Oct
1	6%	Do. 6% Pref.	1⅛	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	91½	5 9 2	Jan, July
1	6%	Do. 6% Pref.	⅞	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 8 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅛	8 5 4	April
100	6%	Do. 6% Prior Lien Debs.	101⅛	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70⅜	5 13 8	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅜	7 7 3	Jan, July
5	2/6	Do. 5% Pref	4⅛	6 3 0	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	15%	Castner Kellner	3⅛	4 18 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	62	6 9 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅜	7 4 6	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
..	10%	General Electric Ord.	10 7/8	9 11 7	July
10	6%	Do. 6% Pref.	9⅛	6 3 1	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12½	7 14 3	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91⅛	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7⅛	6 9 0	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34½	7 0 2	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅛	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	⅜	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	83⅛	4 15 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	102	4 8 3	Jun, Dec
		Telegraphs.			
St.	15/0	Anglo American 6% Pref. Ord.	100½	5 19 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22⅛	7 0 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	68½	5 16 9	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅞	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅔	6 11 3	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	124½	5 12 5	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80	5 0 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 1 11	Feb, Aug
10	7%	Do. Ord.	11⅛	5 17 0	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	34½	6 8 5	Ja, My, Jly
25	13%	Indo-European	47	6 18 4	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1¼	5 8 6	April
1	7%	Do. 7% Pref.	1⅛	4 4 6	July
10	1%	West India & Panama Ord.	1⅛ †	9 2 10	May, Nov
10	6%	Do. 1st Pref.	7½	7 11 2	May, Nov
10	7%	Western Telegh. Co. x d & bonus	12⅜ †	Mr,Jly,O,Dec	
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135½	5 7 10	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	76½	6 11 2	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅝	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101⅜	4 9 11	May, Nov
1	10%	*Oriental Telephone Ord.	1	5 4 11	Apl, Oct
St.	4%	Do. Db. St.	79½	5 0 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 8	Jan, July
5	8%	United River Plate Ord.	5½	6 19 2	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust.	10½	5 15 8	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10½	5 15 8	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	86½	5 15 7	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68½	5 16 4	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	81	6 3 5	Jun, Dec
St.	4½%	Do. 4½% Debs	75½	5 18 7	Jan, July
St.	4%	Do. 4% Debs.	76½	5 5 0	Jan, July
5	2/9	Do. 5½% 1st Pref.	4⅛	6 15 0	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3½	7 17 2	Jan, July
100	2%	Brazilian Traction Ord.	57½	6 19 2	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	93	6 9 5	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4⅛	5 5 11	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62	6 17 1	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅜	7 16 11	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	89	5 12 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4½	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	41½	..	Fb,M,Aug,N.
..	5%	Do. 5% Bds	50	10 0 0	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	96	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 5) yr. Bds	79	6 6 7	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 5	Mar, Sept
St.	5%	Do. 5% Debs.	97½	5 2 7	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10½	5 15 5	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, Jly
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4½	5 15 1	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	126½	5 10 11	Ja,Apl,Jly,O
St.	5%	Melbourn eElec. Supply5% 1stMt. Debs	93	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord	29	..	Ja,Apl,Jly,O
..	..	Do. Pref.	42	..	May, Nov
..	5%	Do. 5% Bds	48½	10 6 5	Jun, Jly
..	5%	Shawinigan Water & Power 5% Bds	102½	4 17 5	Jan, July
..	6%	Do. Cap Stock	143½	4 3 2	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	83½	5 8 1	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% P.	¼	..	Jan, July
—	5½%	Do. 5½% 2nd Mort. Debs.	94½	5 16 3	Jan, July

* And 13½% bonus. Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Nov. 24, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14½d.
Solid Drawn Copper Tubes	14d.
Brazed Copper Tubes	14d.
Brazed Brass Tubes	16½d.
Brass Wire	13½d.
Copper Wire	13d.
Rolled Brass	13½d.
Brass Sheets	14½d.

	per ton.
Copper Sheets	£110 0 0
Spelter	£90 0 0

	per ton
English Lead	£28 0 0
Antimony	Nominal.

Old Metals:	per ton.
Clean Scrap Copper	£71 0 0
Brazlery Copper Scrap	£64 0 0
Clean Scrap Brass	£55 10 0
Old Lead	£22 0 0
Old Zinc	£45 0 0
Hollow Pewter	£120 0 0
Black Pewter	£80 0 0
Gun Metal	£62 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Nov. 23, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£100 0 0
Clean Mixed Brass	£59 0 0
Clean Copper	£75 0 0
Brazlery Copper	£69 0 0
Gun Metal	£69 0 0

	per ton.
Old Lead	£23 0 0
Tea Lead	£21 0 0
Old Zinc	£64 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £74; Commercial Tinman's Solder, £93; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount.	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Nov. 17	1,607	+ 136	24	44,421	+ 2,375
Anglo-Argentine	,, 18	51,294	− 1,165	24	2,344,678	− 136,061
Ashton-under-Lyne	,, 20	405	+ 44	34	16,491	+ 1,195
Ayr Corporation	,, 20	229	+ 23	27	11,603	+ 634
Birkenhead Corporation	,, 21	1,286	+ 170	34	46,509	+ 3,758
Birmingham Corporation — Trams	,, 13	15,369	+ 3,360	33	459,798	+ 61,010
Birmingham Corporation — Buses &c.	,, 13	803	+ 120	33	28,042	+ 17,497
Blackburn Corporation	,, 17	1,065	+ 48	34	44,380	− 358
Blackpool Corporation	,, 18	610	+ 88	34	64,926	+ 1,449
Blackpool and Fleetwood	,, 20	284	− 6	46	37,295	− 254
Bolton Corporation	,, 21	2,460	+ 131	34½	91,258	− 1,925
Bournemouth — Trams	,, 17	1,726	+ 39	33	72,369	− 3,806
Bournemouth — Buses	,, 17	7	..	33	877	− 103
Bradford Corporation	,, 20	5,856	+ 426	33	221,576	+ 9,494
Brighton Corporation	,, 21	844	+ 77	34§	39,582	+ 216
Bristol Trams — Trams	,, 19	4,784	+ 716	46	216,655	+ 2,983
Bristol Trams — Buses,&c.	,, 19	4,812	+ 1,234	46	224,884	+ 40,712
Burmah E. Trams & Ltg.	,, 20	R4,241	+ R1,088	..	..	..
Burnley Corporation	,, 20	1,424	+ 169	7	10,697	+ 1,498
Burton Corporation	..	..	..	..	..	..
Bury Corporation	,, 21	1,147	+ 47	34§	46,564	− 564
Calcutta Tramways Co.	,, 20	¶R61,354	+ R532	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 18	442	− 3	46	23,215	+ 25
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	,, 13	1,054	+ 80	32	34,639	+ 961
*Derby Corporation	,, 20	979	+ 74	34	35,618	+ 1,035
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	,, 19	103	− 9	20	3,176	+ 96
Dublin United	,, 19	5,513	+ 145	46	282,054	+ 10,702
Dundee Corporation	,, 17	1,266	+ 88	27§	36,751	+ 2,009
East Ham Council	,, 20	1,217	+ 68	33	44,242	+ 5,745
Exeter Corporation	,, 19	303	+ 21	33	13,012	+ 765
Glasgow Corporation	,, 20	19,637	+ 796	25‡	539,992	+ 39,425
Glossop Trams	,, 20	121	+ 31	47	5,902	+ 202
Gloucester Corpn.	,, 10	285	− 5	32	10,975	+ 105
Halifax Corpn. — Trams	,, 16	1,914	+ 73	33	75,704	+ 972
Halifax Corpn. — Buses	,, 16	39	− 1	33	1,676	+ [illegible]
Hastings Elec. Trams Co.	,, 18	706	− 16	46	85,291	+ 180
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	,, 20	3,084	+ 187	33	102,486	− 3,180
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	,, 17	136	+ 20	33	4,499	+ 135
Ipswich Corporation	..	..	..	..	..	..
Isle of Thanet Co.	,, 20	218	− 40	7¶	2,035	− 751
Kilmarnock Corporation	,, 20	147	+ 11	27	4,632	+ 145
Lanarkshire Trams Co.	,, 18	1,904	− 282	46	91,391	− 4,858
Lancashire United	,, 17	1,537	+ 122	46	80,331	+ 4,988
Leeds Corporation	,, 20	8,437	+ 1,001	34	303,424	+ 24,031
Leicester Corporation	,, 20	3,027	+ 298	47	141,029	+ 8,140
Leith Corporation	,, 20	670	+ 57	27	21,138	+ 1,288
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	..	..	..	..	..	..
Llandudno&Colwyn BayR	,, 19	187	+ 40	51	17,123	+ 1,759
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	,, 18	179	+ 20	33	7,536	+ 183
Manchester Corporation	..	..	..	..	..	..
Nelson Corporation	,, 20	174	+ 46	33§	6,629	+ 183
Newcastle-on-Tyne Corpn	,, 20	5,897	..	..	213,125	..
Newport (Mon.) Corpn.	,, 20	751	− 65	34	28,395	+ 327
Northampton Corporation	,, 19	629	+ 36	33*	24,772	+ 4,617
Nottingham Corporation	,, 18	3,552	+ 393	33	125,101	+ 8,573
Oldham Corporation	,, 21	2,006	+ 170	35	80,558	+ 3,427
Portsmouth Corporation	..	..	..	..	..	..
Preston Corporation	,, 17	927	+ 118	33**	32,171	+ [illegible]
Rochdale	..	..	..	..	..	..
Rotherham Corporation	,, 17	1,174	+ 260	33	38,712	+ 4,235
Salford Corporation	..	..	..	..	..	..
†Sheffield Corporation	,, 21	9,086	+ 1,804	33§	308,634	+ 41,986
Southampton Corpn.	,, 17	1,425	+ 308	33	50,671	+ [illegible]
Southend Corporation	,, 17	576	− 40	33	29,112	− [illegible]
South Shields	,, 20	700	+ 66	33§	27,109	+ 1,034
St'lyb'dge,Hyde,&c.,Jt. B	..	..	..	..	..	..
Sunderland Corporation	,, 21	1,379	+ 62	34	50,872	+ [illegible]
Sunderland District	,, 17	510	+ 58	3	1,590	+ 91
Swindon Corporation	,, 17	173	− 19	33	6,655	+ 623
Tynesde Tram Co.	,, 10	521	− 33	19	12,012	− [illegible]
Wallasey Corporation	,, 21	1,060	+ 86	33§	44,155	+ [illegible]
Walsall Corporation	,, 20	707	+ 105	47	34,603	+ 5,1[illegible]
Wa[illegible]mpton	,, 20	718	+ 30	34	31,194	+ [illegible]
Warrington Corporation	,, 18	469	+ 55	33	15,231	+ 706
West Ham Corporation	,, 18	2,831	+ 141	33	104,025	+ 9,407
Wigan Corporation	,, 18	1,543	+ 188	33	51,307	+ 2,440
Wolverhampton Corpn.	,, 17	1,126	+ 115	7	7,599	+ 499
Yorkshire W.R. Trams	,, 21	1,420	+ 143	47	74,342	+ 6,123

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days. ¶ Plus 2 days. ** Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 301
Arrangements for the Week .. 304
Submarine Cable Rapid Telegraphy; Ocean and Intercontinental Telephony. By Béla Gáti. Illustrated 305
The Solution of the Traction Equation of a Vehicle in Motion by the Power Meter. By J. Carlier. Illustrated 308
Some Notes on the First Report of the Departmental Home Office Committee on Lighting in Factories and Workshops 312
Electric Light in Artisans' Dwellings. By J. Cleary. Illustrated 313
Annual Report of the Electrical Inspector of Factories 316
The Thermophone 317
THE LIGHTING OF ARTISANS' DWELLINGS 318
REVIEWS 319
Modern Boiler Room Practice and Smoke Abatement [Hodgson].
A Laboratory Course in Electrochemistry [Watts]: Reviewed by F.G.Donnan.
Some Difficulties of Design of High-Speed Generators 320
Radiation Pyrometers 322
CORRESPONDENCE 323
Some Problems of Electromagnetic Induction (G. W. O. Howe).
Frequency, Freq., or Curl? "Alternating-CurrentWork" (W. Perren Maycock).
Electrical Enterprise in India 324
LEGAL INTELLIGENCE 325
The "Electrician" Commercial and Industrial Section .. 327–334

NOTES.

Rapid Submarine Telegraphy.

MUCH interest has been taken of late in the methods of forming the signals which are to be transmitted through the submarine telegraph cable. The use of inverse currents, although old in principle, has recently come into great prominence, and is based on an endeavour to correct the deviations from the zero position of the siphon-recorder coil by reversing the polarity of the battery after every signal. Signals are distinguished on the Morse code—which affords advantages from the point of view of through transmission—either by the duration of the impulse, or by the magnitude of the E.M.F. employed. In the latest development of sine-wave telegraphy the latter plan is used, and the battery is replaced by a generator furnishing a smooth sine-wave of E.M.F., with the object of minimising the disturbance of the balance at the sending-end in duplex working. The method of transmission advocated by Mr. BÉLA GÁTI in his Paper read before the American Institute of Electrical Engineers, of which we give an abstract in the present issue, is entirely different in principle. Although here also alternating current and the Morse code are employed, a signal is not formed by a single semi-cycle, but by an interruption in the circuit of a high-frequency alternating current, as in the Mercadier system of land telegraphy.

THE objection which has been urged to the system proposed is that, if the frequency is high, the attenuation will be so great as to render the alternating current at the distant end too feeble to affect the receiving apparatus. On the other hand, if the frequency is lowered, the transient direct-current effects produced by starting and stopping the alternating-current will predominate and mask the purely alternating current ripple at the receiving end. It is the former alternative that is faced by the author, and to reduce attenuation he artificially increases the inductance of the cable. Loading by whipping he finds insufficient, and loading by series coils is rejected in favour of loading by shunt coils. Whether this choice is sound time will show; objections would certainly be raised to this form of loading on the score of earth currents, and its disadvantages for testing purposes. But a third and more serious objection is the tuned circuit produced by shunt loading, which would render it difficult to multiplex the system, and thus defeat one of its main objects. Nevertheless, although much work must be done before this method reaches the practical stage, it is of great interest as affording yet another instance of the undeveloped resources which are available for cable transmission.

Plans for the Future.

ONE of the most interesting statements recently published, and which may be said to have a particular bearing on the near future, is the announcement that the American Government will be asked to prepare and expedite the passing of legislation by which it will become unlawful for foreigners to dump manufactured articles on to the United States markets at a price below their actual cost of production. This is a species of Tariff Reform which will appeal to many persons who hold a strong general objection to the imposition of duties on manufactures; more than this, it is a class of legislation which will appeal to many who have a firm leaning towards Free Trade. Even in the United States, it must not be assumed that there is no Free Trade party, although it may be argued that this party is not a strong one, nor is it likely to become strong in the very nature of things in a country situated as America is—at any rate not until she is less self-supplying. The example of America in respect to the class of legislation to which we refer, if it should become law, may have far-reaching effects; and if the methods adopted by those entrusted with the preparation of this legislation are carefully considered beforehand, some of the more serious industrial and commercial problems may become easier of solution. Many convinced Free Traders already hold the view that dumping has been carried to excess in past years by the Central Powers of Europe, and it may be that legislation of the character indicated will prove the best means of bringing the dumpers to a sense of the necessity for a less aggressive policy in the future. It will not be without interest to watch the effect of legislation of the kind upon existing Commercial Treaties.

The Lighting of Factories.

LAST week a discussion took place at a meeting of the Illuminating Engineering Society on the report of the Departmental Home Office Committee on lighting in factories and workshops. The discussion was opened by Mr. L. GASTER

with a lengthy communication which was virtually a defence of the report, not officially, but by Mr. GASTER personally. We do not think there is any great need for a defence of what is certainly a good beginning, but it is useful to have Mr. GASTER's statement, of which an abstract will be found elsewhere, as it serves to clear up certain misconceptions. Perhaps the most vital point is the question whether an illumination of 0·25 ft.-candle is sufficient as a minimum value. Opinions on this point are likely to vary, and it is not improbable that what may be considered a high value to-day will be thought to be a low value in a few years' time. In this connection Mr. GASTER rightly points out that the value of 0·25 ft.-candle is a minimum below which prosecution might take place. It is, therefore, essential that too high a value should not be fixed in order to avoid hardship, and also if this is a minimum the average in all cases must be considerably higher.

THE fact that the report is of a somewhat legal character necessarily limits the directions in which recommendations may be made. It may be doubted whether detailed values for illumination should form part of a report of this kind except in very special cases; but it seems to us that much useful work might be done by the Society if a report were prepared by the Society itself, specifying the illumination which may be considered desirable for various classes of work. This would act as a guide to those who are concerned with the lighting of factories, workshops and other buildings. With regard to future work we are promised another report which will consist largely of data, and which should be of considerable value. We hope that this may possibly contain further information in regard to the financial advantages of good illumination, as it is the financial side which appeals to many people, more particulary those who are sufficiently short-sighted to approach the subject only from this point of view, and on the experiences of other people. Mr. GASTER also suggested work upon eye strain, methods of testing fatigue and an investigation of the connection between illumination and output. There is in fact a great amount of useful work that can be done, and we hope that the Society will not hesitate to take it up.

Factories and Workshops Report.

THE recently published Annual Report of the Chief Inspector of Factories and Workshops makes interesting reading. It differs in plan from those of earlier years, being arranged in chapters which are intended to record the year's work in a form more convenient for reference. In the chapter on Sanitation it is stated that the importance of adequate lighting, both natural and artificial, is being appreciated more every year. Very properly one of the Inspectors draws attention to the importance of well arranged artificial lighting, and reference is made to the injurious use of metallic filament lamps close to the eyes of the workers. It should surely be the pride and business of the electrical contractor to advise as to the best position of the lamps, and the subject is of growing importance. Another chapter likely to interest employers is that devoted to Emergency Overtime. Reference is made to the influence of fatigue on production. Although returns of overtime and output were obtained from a large number of works, owing to the complex and variable conditions, these did not lend themselves to statistical treatment. It is to be hoped that the report of the Committee appointed by the British Association to investigate the question of fatigue will throw further light on the subject. From the abstract of Mr. G. SCOTT RAM's sectional report, given elsewhere, it will be seen that ignorance and folly are responsible for most of the accidents, and misapplied ingenuity accounts for many others. Mr. RAM again emphasises the importance of artificial respiration in the treatment of men rendered unconscious by electric shock, and from the report it is evident that such emphasis is necessary.

Electricity Supply Works Assessment.

UNTIL the outbreak of the war there was everywhere a marked upward tendency in the local rates. It is not our purpose to inquire into the causes of this increase which has been apparent to everyone. Not only have all local rates advanced, but every opportunity has been seized of increasing the amount of the assessment of the property liable to be rated. It is, therefore, of the greatest importance for large ratepayers, such as electricity supply and tramway companies, to see that their undertakings are assessed at their proper figure. In our last issue we reported an interesting appeal by the Brompton & Kensington Electricity Supply Co. against the assessment of their undertaking, and we feel sure that the result will convince every business man of the need for a revision of the law relating to rating. We do not challenge the impartiality of the Court of Quarter Sessions, but we believe it to be entirely incompetent to deal with such highly technical questions as are involved in ascertaining the gross and rateable values of electricity supply works or tramway undertakings. A brief recapitulation of the facts and of the points at issue will be sufficient to show this. Like all electric supply companies, the Brompton & Kensington Company have made considerable progress in recent years, and the local Assessment Committee proposed to increase the rateable value of the Company's generating works and mains by £1,000 in consequence of certain alterations at their West Brompton works, and also of an increase in the net profit in 1912 and 1913, compared with the years 1909 and 1910, which were considered at the time of the last quinquennial valuation in 1910.

IT is unusual for an assessment committee to adopt the procedure of the Kensington Committee. The Company's undertaking was put into a provisional list for re-assessment, and then into a supplemental list. The parties had, we understand, several conferences on the question, and although the Company's experts put in figures which clearly proved that the revised valuation was too high, the Assessment Committee remained obdurate, and the Company were compelled to go to the great expense and trouble of appealing. It is clear that the Committee did not make sufficient allowance in respect of the additional capital required to earn the additional receipts, &c., for, after a lengthy hearing, the Court decided to reduce the proposed increase of £1,000 to £600; but the Assessment Committee got two-thirds of the costs of the appeal. Costs are in the discretion of the Court, but generally speaking, in similar cases when the Assessment Committee fail to establish their claim, costs are awarded to the appellants. It is evident that a more business-like tribunal is required for hearing rating and assessment appeals, and we hope that the matter will receive attention from our legislators when the war is over. Rating authorities and valuers have long been convinced of the necessity for a reform of the law relating to the assessment of property and to rating appeals. The members of the Assessment Committee should be fully qualified for their work, and they should not be members of the public authority whose duty it is to see to the levying and collection of rates; their sole duty should be the fixing of the gross and net value of property liable to be assessed, and they should have no interest, direct or indirect, in an increase or decrease of the assessment. Every tribunal which has to deal with questions relating to assessments or to rating should be capable of dealing with all technical and legal points that may arise, and it should be so constituted that ratepayers can have confidence in its decisions.

Verband Deutscher Elektrotechniker.—It is announced that there will be no annual meeting this year.

British Association.—A representative gathering was recently held at Newcastle, at which the Lord Mayor (Mr. George Lunn) presided. At this it was decided to invite the British Association to hold their annual meeting at Newcastle next year, on lines similar to those adopted at the Manchester meeting.

Electric Railways of the United States and Canada.—According to statistics recently compiled there are at present 3,157 route miles of electric railway equipped on the high-voltage direct-current system in the United States and Canada, and there are 711 miles of single-phase railway. At the end of 1914 the figures were 2,257 and 763 route miles, respectively.

London & South-Western Electrification.—Owing to an application in the Law Courts by the Postmaster-General on Saturday, in regard to alleged interference with telephone circuits in the neighbourhood of the electrified portion of the London & South Western Railway, the opening of the electrical service to the public on the Kingston " roundabout " line has been postponed.

Mechanics of the Electric Winder.—Entitled " Leonard Control Applied to Mine Hoist," Mr. R. Torikai recently contributed a mathematical Paper to the Memoirs of the College of Engineering, Kyoto Imperial University. The author considered the load diagram, the ampere rating, and the theoretical durations of acceleration and retardation of a continuous-current mine-hoist motor controlled on the Leonard system. The question of equalising apparatus was not discussed. Except in the case of the cylindrical drum hoist with tail-rope, the results, generally, are not of simple form. According to the author the reel hoist may be taken as representative, and any other type may be treated as a particular case.

Physical Limitations in Direct-current Commutating Machinery.—In continuous-current machines there are a number of apparently distinct limitations, such as sparking at brushes, flashing at the commutator, burning and blackening at the commutator face and picking-up of copper, which, in reality, are intimately related to each other. Mr. B. G. Lamme, in an informative Paper read recently before the American Institute of Electrical Engineers, brought out such relationships and showed that all these actions are special cases of well-known phenomena. In this Paper the theory of commutation is considered only in its relation to the E.M.F.s generated in the coils short-circuited by the brush ; and the limiting E.M.F.s per commutator bar and per brush are shown to be fixed principally by brush contact resistance. The effects of the negative coefficient of the contact resistance is also referred to briefly. The limitations set out above are next considered in some detail, and, in conclusion, a brief chapter is given on design limitations of large capacity high-voltage machines as fixed by commutator peripheral speed. A useful appendix is added covering a method for determining the maximum capacity of continuous-current machines in terms of the short-circuit volts per commutator bar when the various constants in the machine are given certain limiting values. The results show that in large high-speed machines the maximum capacity is considerably above present practice.

OBITUARY.

C. J. Wollaston.—We regret to record the death of Mr. Charlton James Wollaston, which took place on Saturday at Burnham, Somerset.

According to " The Times," Mr. Wollaston, who was born at Clapton in 1820, was one of the engineers in charge of the work of laying the first submarine cable between France and England, the concession for which had been granted by Louis Napoleon. The cable was placed on board the " Goliath," and a start made on Wednesday, Aug. 28, 1850, from Dover to lay the line under the Channel to Cape Grisnez. This line consisted of a single wire $\frac{1}{10}$ in. in diameter, encased in a tube of gutta-percha, and it was coiled on a drum measuring 15ft. by 7 ft., which was mounted amidships on the vessel. The wire, which weighed 5 tons, was paid out over a roller at the stern, square leaden clamps weighing from 14 lb. to 24 lb. being fastened to it at intervals of $\frac{1}{16}$ mile, in order to sink it to the bottom of the sea. Cape Grisnez was reached in the evening, and at 8:30 the correspondent of " The Times " transmitted from that point by submarine telegraphy the information that the land connection with the cable was being run up the cliff, and that complimentary interchanges were passing between France and England " under the sea " and through it for the first time." The line soon ceased to work, and on Aug. 31 a piece of it was picked up in the trawl net of a Boulogne fisherman. The possibility of communication had, however, been proved, and another concession was obtained from Louis Napoleon for permanent communication, which was to be established by Oct. 31, 1851. The Submarine Telegraph Co. was formed to work the concession, and a real cable, containing four copper wires, was manufactured for the purpose. Each of the wires was encased in a covering of gutta-percha $\frac{1}{4}$ in. thick ; the whole was protected by a layer of hemp yarn impregnated with pitch and tallow and by an outside covering of galvanised iron wires. The electrical testing of the cable, which weighed about 200 tons, was carried out by Mr. Wollaston, who was also on the Government vessel " Blazer," by which it was laid. The vessel started from the South Foreland on the morning of Sept. 25, 1851, and, after landing the shore end, started across the Channel. At 10 o'clock in the evening the " Blazer " had anchored within $3\frac{1}{2}$ miles of the French coast, and at 6 p.m. on the 28th intelligence was received at the South Foreland, by the submarine telegraph itself, of its completion to the French coast near Calais, though a miscalculation had been made in the length of the cable and a temporary connection had to be employed for the last half-mile at the French end. The cable was opened for public use on Nov. 13, 1851. Mr. Wollaston was in receipt of a Civil List pension, which was granted in March, 1900, in recognition of his services in the introduction of submarine telegraphy.

H. C. Donovan.—We regret to record the death of Mr. Henry Cornelius Donovan, M.I.E.E., who was for many years in the service of the Telegraph Construction & Maintenance Co. Deceased was 73 years of age.

Killed in Action.—Captain John Harold Courtis, eldest son of Sir John and Lady Courtis, was killed in action in Mesopotamia about November 22.

Major John Lewellyn Davies, son of Mr. and Mrs. D. J. Davies, of Neath, has been killed in action. Major Davies obtained a first class in the National Science Tripos at Cambridge in 1904, and was a science master at the Perse School, Cambridge, when war broke out.

From the second edition of the " Staff War Bulletin " of the County of London Electric Supply Co. and its associated companies we regret to learn that the following have been killed in action : Privates E. Gordon Morley and G. W. R. Peek and Corporal S. A. Wood (of the mains department of the County of London Co.), and Private J. C. Wooster (clerk in the service of the Richmond (Surrey) Electric Light & Power Co.).

PERSONAL.

Mr. J. W. Meares, electrical adviser to the Government of India, is coming home on seven months' leave. Mr. C. C. J. Eastgate is acting as interim adviser.

Mr. N. W. Prangnell, distributing engineer, Metropolitan Electric Supply Co. (Ltd.), has obtained a temporary lieutenant's commission in the R.N.V.R., and is taking up his duties in the electrical department of H.M.S. " Vernon."

The friends of Mr. Arthur M. Sillar, consulting engineer, will sympathise with him on the death of his wife, which occurred on the 29th ult.

APPOINTMENTS VACANT AND FILLED.

Oldham Corporation Electricity Committee invite applications for the position of shift engineer. Wages £2 per week. Applicants must have had good mechanical and electrical training and have had previous experience in generating station giving l.t. and e.h.t. supplies. Applications to Mr. Fred. L. Ogden, joint electrical engineer and manager, Greenhill electricity offices, Oldham, by Monday, Dec. 13. *See an advertisement.*

The Calcutta Electric Supply Corpn. (Ltd.), 2, Broad-street-place, London, E.C., advertise for a station engineer, with practical experience of h.t. three-phase a.c. turbo-generators and Stirling and Babcock boilers. Commencing salary £290, rising by £20 annually to £350, with free bachelor quarters.

Junior engineers in-charge and switchmen's services are urgently required for electricity supply works. Applicants must have had experience of steam plant and rotaries. *See advertisement.*

A manager is required for their stock room by Messrs. Morland & Impey (Ltd.), Kalamazoo Works, Northfield, Birmingham. Commencing salary £175. *See an advertisement.*

There is a vacancy on the professional staff of Bennett College, Sheffield, for a tutor in the electrical department. Commencing salary, £200 per annum. *See advertisement.*

Mexborough Urban District Council invite applications for the appointment of electrical engineer, at a salary of £200 per annum. Applicants should be competent mechanical and electrical engineers, and have had commercial experience. Applications to the clerk of the Council (Mr. J. W. Hattersley) by Dec. 6.

There is a vacancy for an inspector of the private telephone system of the electric supply department of the City of Birmingham. Applications to the city electrical engineer and manager, Mr. R. A. Chattock, 14, Dale End, Birmingham.

Mr. E. J. Foster is recommended to fill the appointment of temporary draughtsman at West Bromwich electricity works at £2. 5s. per week.

INSTITUTIONS AND SOCIETIES

Electric Vehicle Committee.—The following letter has been sent by the Electric Vehicle Committee to Town Clerks, Borough Surveyors, Chief Constables, Chief Officers of Fire Brigades, Tramway Managers, Medical Officers of Health, Superintendents of Refuse Disposal Departments, Gas Engineers, Water Engineers and Central Station Engineers :—

DEAR SIR : The Manchester Corporation have recently served notices upon a large number of owners and tenants in the city to abate an alleged nuisance by discontinuing to keep horses on their premises. It is likely that this commendable action by the Sanitary Committee of the Manchester Corporation will be followed by other progressive cities and towns, since it is admitted by all who are qualified to give an opinion that the presence of stables in urban areas is harmful to the public health.

If horses are to be displaced in this way, motor traction in some form will have to be adopted.

From the standpoint of public health, the petrol vehicle is also most objectionable, owing to the noxious gases emitted by the exhaust and also to the nerve-racking noises caused by the engine and gears, especially at central garages.

On the other hand, the electric battery vehicle is in every way an ideal vehicle for town use. It is odourless, silent, and by far the cheapest to run. It also causes considerably less road wear than the petrol vehicle.

My Committee, therefore, suggest that municipalities should make special efforts to encourage the use of the electric battery vehicle in the areas under their control. The most convin ing way of doing this is to set the example by using such vehicles for municipal work, such as watering roadways, scavenging, house refuse removal, cartage of road and other materials, ambulance work, fire brigade work, cartage of coal and ashes, as well as for passenger transportation by means of electric battery omnibuses. Smaller electric vehicles can also be used to advantage for the transportation of officials in performance of their duties.

Not only will the adoption and use of electric vehicles in these directions gradually have the effect of doing away with stables, but it will, in addition, bring a handsome revenue to the electric supply undertaking, which nearly every municipality nowadays owns.

My Committee wish particularly to emphasise the point that there is nothing experimental about the modern electric vehicle. It has been evolved out of years of experience. Many thousands are now in use in America, and the results obtained there prove that, as regards low running cost and reliability, it cannot be approached by any other system of road haulage.

It also has the added merit of depending for its source of energy upon the natural fuel of this country, *i.e.*, coal.

In bringing the above facts and suggestions to your notice my Committee have every confidence in asking you to give them your careful consideration and to examine for yourself the examples of electric vehicles that are daily becoming more numerous in this country. I am, SIR,

Yours faithfully,

F. AYRTON, *Honorary Secretary.*

Diesel Engine Users' Association.—The November meeting of the Diesel Engine Users' Association was held at the Institution of Electrical Engineers. The acting hon. Secretary reported the names of further undertakings and firms who had joined in the movement to endeavour to obtain more favourable terms from the Inland Revenue Authorities in the matter of the allowance off profits for depreciation of Diesel engine plant before assessment for income tax purposes.

A short discussion took place on the serious increase in prices charged for supplies of fuel oil, and on the possibility of making use of fuel oil supplies from other sources.

The discussion on the subject of cracked and seized pistons was resumed by Mr. J. M. Ferguson, who had been invited to attend the meeting. He spoke of the practice and experience of Messrs. Willans & Robinson (Ltd.) on these points, and laid stress on the great importance of using metal of the special quality necessary for pistons of Diesel engines. He considered that the casting should be carried out in the engine maker's own foundry under his direct control and supervision. He also referred to an arrangement devised and patented by Mr. P. H. Smith for a renewable plug or core in the piston head. Mr. P. H. Smith, who also attended the meeting by invitation, remarked that the fundamental cause of cracks in Diesel engine pistons was a highly heated core trying to expand, but being restricted in so doing by a comparatively cold and very stiff ring of metal surrounding it. The consequence of the core attaining a higher temperature than that of the remainder of the metal of the piston was distortion and buckling, and in cooling after the engine was shut down the core did not quite resume its original unstrained condition. This action being progressive with alternate heating and cooling, the stresses became higher until fracture occurred. It was noticeable that Diesel engines working continuously day and night gave very little trouble from cracked pistons as compared with other similar engines working more intermittently. Some makers were endeavouring to find a cast-iron for pistons which would not "grow" on repeated heating and cooling. Mr. Smith then referred to two general systems of piston construction which had found favour in the case of larger sizes of pistons, namely, pistons with renewable heads and water-cooled pistons. He himself had not much faith in the renewable head, though it had some advantages. The renewable head was introduced, not so much with the idea of preventing fractures, as to reduce the cost of replacing a fractured piston. It did not remove the cause of cracking, as there was still the very hot core surrounded by a stiff colder ring, though it must be admitted that some renewable heads were designed in such a manner as to carry away a greater amount of heat from the hot core than was possible with ordinary methods of piston construction. He then described his arrangement of a renewable core in the piston head, which had already been referred to by Mr. J. M. Ferguson, and which he considered would provide a solution to the trouble of cracking. This was made in two parts so as to reduce stresses to a minimum in the core as well as in the piston. The core proper, or inner portion, was fixed on to a recess in the piston head by a gas tight joint well removed from the region of highest temperature, and was surrounded by a separate annular ring. The core was free to expand laterally and longitudinally, and the annular ring was similarly unrestricted.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Dec. 6th.

ROYAL SOCIETY OF ARTS.

4:30 p.m. Meeting at John-street, Adelphi, London, W.C. "Cantor Lecture" by Dr. W. Rosenhain, F.R.S., on "Optical Glass" (Lecture II.).

TUESDAY, Dec. 7th.

RONTGEN SOCIETY.

8:15 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Papers on "Fluorescent and Intensifying Screens," by Mr. L. A. Levy, and on "Localisation," by Mr. G. G. Blake.

WEDNESDAY, Dec. 8th.

YORKSHIRE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at the Philosophical Hall, Leeds. Paper on "Some Difficulties of Design of High-speed Generators," by Prof. A. B. Field.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7:30 p.m. Meeting at St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Ammunition Manufacture," by Mr. A. E. Penn.

THURSDAY, Dec. 9th.

STUDENTS' SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:45 p.m. Meeting at Victoria Embankment, W.C. Address by Mr. J. E. Kingsbury on "The Institution."

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding : Lieut.-Col. C. B. CLAY.

The following Orders have been issued for week commencing Dec. 6, 1915 :—

Drills, 6.25 to 7:25 p.m. 7:25 to 8:25 p.m.

Saturday, Dec. 4th.—Parade in uniform at East Putney Station at 2.45 p.m. See below.

Monday, Dec. 6th.—Sections 1 and 2, Technical ; Sections 3 and 4, Squad. Signalling sections and Recruits.

Tuesday, Dec. 7th.—School of Arms with Architects' Corps, 6 to 8 p.m.

Thursday, Dec. 9th.—Sections 1 and 2, Shooting.

Friday, Dec. 10th.—Sections 3 and 4, Technical ; Sections 1 and 2, Squad. Signalling Sections and Recruits.

Saturday, Dec. 11th.—Instruction Class at 2.30 p.m.

Sections for Technical parade at headquarters, London Electrical Engineers, 46, Regency-street, S.W. Sections for shooting parade at miniature ranges. Unless otherwise ordered, all parades at Chester House. Train on Saturday for East Putney on District Railway, leaves Mansion House Station at 2.22 p.m. Members who have not yet been measured for uniforms must call at Samuel Bros., Ludgate Hill, as soon as possible. Payment for uniforms to be made to the Adjutant. Volunteers for trench work on Sunday are desired to give their names to their Section Commanders as early as possible.

SUBMARINE CABLE RAPID TELEGRAPHY: OCEAN AND INTERCONTINENTAL TELEPHONY.*

BY BÉLA GÁTI.

Summary.—In this Paper the author enumerates the tendency and researches with reference to improvements in both cable telegraphy and long-distance telephony. The various cable-relays are discussed, as also are the attempts with the high-frequency system on ordinary cables. The theory of the resistance of the cable is given, and different cables are taken into computation. The problem is nearly the same also for ocean telephony. For connecting continental circuits strong current microphones, more sensitive receivers, improved single wire loaded circuits and telephone relays can be applied.

I wish to enumerate the tendency and researches with reference to improvements in both cable telegraphy and long-distance telephony. There is in reality no difference between the two kinds of communications. Both the telegraph and telephone employ electrical impulses which are conducted far out upon the electrical conductors. The number of the impulses only is different. We use in the human speech sounds whose frequencies are as great as 20,000 per second, but are generally only about 1,000 per second; in the telegraphy even the most rapid system does not endeavour to exceed the speed of the human speech, which is about 20 letters per second.

Table I. shows the instrument speeds of different systems per minute :—

Table I.—*Instrument Speeds of Different Telegraph Systems.*

Name of system.	No of signals per minute.
Morse, ordinary	70
Sounder, ordinary	95
Hughes	160
Baudot	150
Murray simplex	600
Buckingham simplex	500
Wheatstone simplex	1,500
Siemens-Halske simplex	2,000
Pollak-Virag simplex	5,000
Recorder	120

According to this table the cable recorders work with two impulses per second; the highest speed is reached by the Pollak-Virag system, 83 impulses (rounded out to 100) per second. This system is not used in practice. In commercial traffic these speeds cannot be maintained regularly.

Reading quickly, we exceed the speed of 60 printed letters per second; thus only the yet unused Pollak-Virag system records the telegraphic impulses quicker than we could read them. One hour's reading matter makes for the submarine cables more than one day's work. Considering the limited number of the submarine cables in use to-day, it is certain that the present conditions must be improved, because it is an impossibility that there should be no necessity for more exchange of thoughts between the people of two continents, America and Europe, which count some hundred millions of people, than what one person can read during 24 hours.

To understand why the Pollak-Virag speed cannot be attained on long lines, and especially on the submarine cables of to-day, I wish to explain how an impulse is formed, what its appearance is at the outgoing station, how it arrives at the incoming station. Fig. 1 shows the telegraphic impulse at the beginning and at the end of an aerial bronze wire circuit 2,120 km. long. The duration of the signal is about 0·1 second, that is 100 milli-seconds.

We see that in the first milli-second the intensity of the outgoing current is about twice as great as at the end of the impulse. The circuit forms a condenser; the charging current of this condenser is large, hence the greater strength is obtained. Using inductances before the line, we get the form of Fig. 2, in which the high peak is rounded out. Returning to the study of the Fig. 1, we see that one milli-second of time in this case was long enough for all the transient phenomena to be displayed. The nearer part of the circuit being charged, the current becomes smaller and after about the twentieth or thirtieth milli-second it reaches a steady value. Looking at the form of the arriving impulse (upper oscillogram), we see that the starting points do not coincide at the two curves. The electricity needs time to traverse the 2,120 km. wire. The speed is not so great as in free air oscillations—300,000 km. per second—but only about 200,000 km. per second, or 200 km. per milli-second. Hence we see that about 10 milli-seconds of time was necessary for the arrival of the signals (in the oscillogram the distance EC corresponds to this time). The strength of the arriving current has also changed; from C, during 30 to 40 milli-seconds of time, the curve begins to be steady till it reaches point D; this latter point corresponds to the termination of the outgoing current. From this point the discharge of the electric current commences with its own natural frequency, which has nothing to do with the superimposed frequency of the transmitted impulses. If the distance between the transmitted impulses is less than the time of discharge of the received currents, the signals overflow. If the outgoing impulses are short and too near to each other, the overflow is such that the signals are not readable.

Up to this point we had to do only with unidirectional direct-current impulses. Using alternating current, the second half-wave counteracts the charge of the first half-wave; the cable cannot keep a constant charge, and cannot be discharged at its own natural frequency, which is very low on long cables. Fig. 3 shows the result when alternating current of 500 cycles per second was used. The distance AB is the same as CD; EC is the time necessary for the propagation of the electricity. We have no lengthening of the signals.

Of course, the frequency must not be too low, because at the first half-wave of the alternating current and at the last half-wave, there

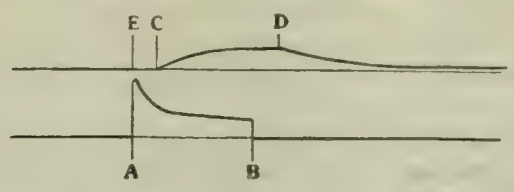


FIG. 1.—THE LENGTHENING OF THE DIRECT CURRENT IMPRESSES.

might be some lengthening effect. For example, it can happen that the breaking of the current occurs in the microsecond in which the current has its maximum value; in this case the compensation of the preceding half-wave is not perfect; the difference in the compensation manifests itself as a direct-current impulse discharging at its arrival with the natural frequency of the cable, and so causing the lengthening. But if we do not choose the frequency too low, the charging time being under one milli-second, the charging is not done at such a rate that it would become troublesome. During one milli-second, eventually 0·1 milli-second, that the transient phenomena take place, the charging current has not reached its steady value and so its effect does not become harmful.

We use for receiving the alternating-current signals, special apparatus, which responds only to alternating currents, and, therefore, the lengthened direct-current part of the impulse does not introduce trouble at the receiver.

We see from Fig. 3 that the use of alternating currents has an indisputable advantage; the lengthening of the signals, and, therefore, the overflowing is overcome. The arriving alternating current, however, is very small, and, therefore, this system can not be used on the present submarine cables. The whole resistance of the submarine telegraph cables of to-day is very large for currents of moderate frequency. We shall treat this matter later in more detail.

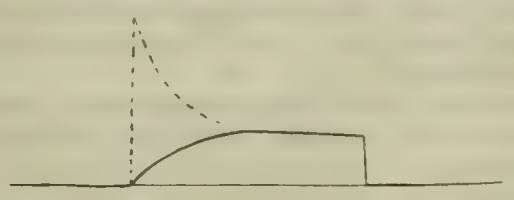


FIG. 2.—OUTGOING CURRENT OF LANDLINE, WHEN AN INDUCTANCE IS INSERTED.

Instead of ordinary alternating current, attempts were made in the first years of the cable telegraphy with inverse currents. With the aid of inverse currents, it is possible to fully annihilate the discharging current, or at least to diminish it considerably. Mr. Whitehouse, the physicist of the Atlantic Telegraph Company, noticed as early as in 1856 that the speed of telegraphy can be raised when the polarity of the successive impulses of the signals is changed.

In 1898, Mr. Pierre Picard proposed his system, which is employed between Algiers and Marseilles, and even between Algiers and Paris. With the aid of this system, Baudot type-printers are worked over 900 km. cables.

In the nineties of the past century the inverse current question was discussed; Mr. W. H. Ash, the superintendent of the Eastern Telegraph Co. at Porthcurno, gave some suggestions to Mr. A. Fraser; the method did not come into general use.*

Mr. Delany, in his patent No. 21,629 in 1893, described the inverse current system, but did not give details for the sending apparatus.

* Abstract of a Paper presented at the Panama-Pacific Convention of the Am. Inst. E.E.

* "Telegraphy with Inverse Currents," A. Fraser, THE ELECTRICIAN, 1913, March 7th issue, p. 1018.

Mr. P. O'Neil was granted the British patent No. 16,462 in 1907 for telegraphing over submarine cables in type or Roman characters by means of consecutive alternating impulses.

Mr. John Gott, consulting electrician of the Commercial Cable Co., made experiments with his inverse current system between London and New York with satisfactory results; the reports appeared in the daily press in the first month of 1913. According to THE ELECTRICIAN, February 21, 1913, p. 923, "Each unit of a letter is formed by an inverse current, so that during the transmission two currents of the same polarity never follow one another. At the receiving end the signals are re-transformed into ordinary Morse." Gott uses a polarised relay and the change of the polarity is obtained automatically. Gott employs the ordinary transmitting key, but instead of the ordinary transmitting key the Wheatstone transmitter can be used also. "In order to transform back again from the Morse alphabet with inverse currents to the ordinary Morse, the two contacts of the receiving relay are connected together electrically, so that a change of polarity makes no difference, and the signals are transmitted as if they were made continually upon one contact."

According to the opinion of Dr. Malcolm it is certain that Gott's method does not reach a much greater speed than hitherto; its advantage, beside the simplicity of Morse-inkers, is that the land lines could be connected with submarine cables, and so a saving in operators is possible. Rapid cable telegraphy, however, by means of this method is not obtainable.

Investigators and inventors have done a great deal of research work in the direction of the improvement of relays so as to make it possible to re-establish the original shape of the curve. The researches require a very complicated and minute study; we describe only those relays which have been proved in practice. It is quite certain that many new forms have not yet had an opportunity to work on real cables. I have spoken before about Picard's relay; Picard's inverse-current system and the Picard relay made it possible to keep in constant work the Baudot type-printers in the longest submarine cable practice. It is the aim of future progress to have multiplex type-printers work on the Atlantic and Southern Pacific cables. The relays in use to-day do not yet permit this progress, but they make the shape of the received current better, and so raise the speed by 20 per cent.

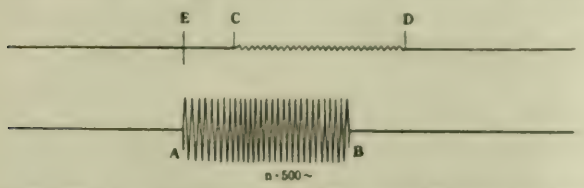


FIG. 3.—THE LENGTHENING OF THE TELEGRAPH SIGNALS DOES NOT TAKE PLACE WITH THE ALTERNATING CURRENT IMPRESSES.

One of the oldest relays is Mr. K. Gulstad's vibrating relay. The Great Northern Telegraph Co., of which Mr. K. Gulstad was engineer-in-chief, has been using it more than 20 years; in recent years it has been used by other telegraph companies to a small extent. The relay may be best used on all land lines and on submarine cables up to $cr = 0{\cdot}5$ to 0·75 second.

We need for Atlantic cables a more sensitive relay, which is suitable for cables with $cr = 2$ or 3 seconds. Muirhead exhibited at the English Festival of Empire Celebration (1911) a relay, with aid of which the time of transmission from New York to Buenos Ayres can be reduced from 20 to 3 minutes. This is owing to the fact that the number of re-transmissions by hand is reduced from six to one.

A successful cable relay was constructed by Mr. E. S. Heurtley. Heurtley's relay was adopted by the Pacific Cable Board to magnify the signals on Fanning Island, especially those coming from Vancouver Island. These signals, owing to the great distances, are necessarily feeble, and the magnification of them by means of the Heurtley magnifier not only tends to accuracy of transmission, but sensibly increases the speed at which messages can be sent, by as much as 25 per cent. Heurtley's magnifier was tried at first on the Emden-Vigo cable; the relay increased the speed by 40 per cent.

There are other descriptions of cable relays, namely, in various patents. I wanted to mention only those which were proved under ordinary traffic conditions. We see that the increase of the speed is not even 100 per cent. The inventors sought the solution of the rapid cable telegraphy in another direction.

It was Mr. F. Weinberg who proposed first, in the "E.T.Z.," 1909, p. 160, the use of high-frequency current for submarine telephony. I have shown in the same periodical, that the high frequency resistance of a submarine cable of to-day is so large for Weinberg's currents (about 10^{+8} ohms), that only infinitely small currents arrive at the receiving end (10^{-75} amperes). The proposition was not a practical one.

Mr. George O. Squier,* on the ground of actual experiments on telephone cables, believed that with electric waves (high-frequency currents) long-distance telephony and a more rapid cable telegraphy and ocean telephony will be possible. According to Mr. Squier the ohmic resistance of the wire plays a comparatively unimportant part in the transmission. In the discussion of Mr. Squier's Paper I have shown the real effect of the ohmic resistance. Actual experiments on submarine cables were not made either by Mr. F. Weinberg, Mr. Squier, nor by Mr. Gustav Maior. The latter is a staunch advocate of the use of high-frequency currents for submarine and rapid telegraphy and ocean telephony purposes.

To show the impossibility of the high-frequency current telegraphy on the submarine cables of the present day, it is necessary to compute the actual resistances of these cables. If the attenuation is under 10, we can use Kennelly's formulæ;† the transient phenomena, as I have shown in Fig. 4, are not at all dominant. When the cable is long and the attenuation is over 10, the transient phenomena begin to predominate, but in this case the arriving currents, according to Kennelly's theory, are so small, that telegraphy or telephony is impossible.

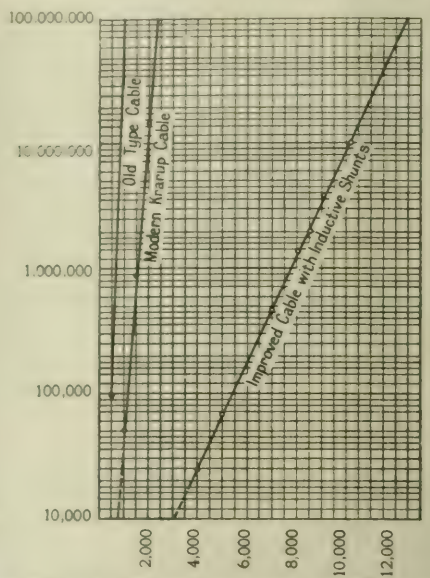


FIG. 4.—CURVES OF TOTAL RESISTANCE AND LENGTH OF DIFFERENT CABLES.

The incoming current at the end of the cable is:—

$$i_{arr} = E/Z_1, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

E is the E.M.F. at the sending end of the cable.

$$Z_1 = Z_s \sinh(L\beta) + Zr \cosh(L\beta); \quad . \quad . \quad . \quad . \quad . \quad (2)$$

L is the length of the cable, Zr is the impedance of the receiver apparatus, Z_s is the sending end impedance (wave impedance).

$$Z_s = \sqrt{\{(r+jlw)/(g+jcw)\}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\beta = \sqrt{\{(r+jlw)(g+jcw)\}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where r is the effective resistance in ohms,

l is the effective inductance in henrys,
g is the reciprocal value of the insulation in mhos,
c the effective capacity in farads,
$w = 2\pi \times$ frequency, $j = \sqrt{(-1)}$.

For simplicity, we suppose $Zr = 0$; this makes the computations easier. The hyperbolic sine and cosine functions being over a certain value nearly equal,

$$Z_1 = (Z_s + Zr) \sinh(L\beta) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

can also be written.

Neglecting the value of Z^r merely makes a certain percentage correction necessary in each case; the value of Zr is not important in the comparison of the cables themselves.

The data of an old type ocean cable are: $r = 0{\cdot}9$ ohm; $c = 0{\cdot}23 \times 10^{-6}$ farad (0·23 mfd.); $l = 10^{-1}$ henry; and $g = 10^{-6}$ mho.

Computing for $w = 5{,}000$, we get: $Z = 25{\cdot}79 - j15{\cdot}16$; $\beta = (17{\cdot}47 + j29{\cdot}66)10^{-3}$, and the total resistance is shown in Table II.

Applying at the sending end 100 volts and using recorders, which still work at 0·1 milliampere received current, the resistance at

* "Transactions" of the Am. Inst. E.E., 1911, pp. 1617-1664.

† "The Alternating-current Theory of Transmission Speed over Submarine Cables," A. E. Kennelly, "Transactions" of the International Electrical Congress of St. Louis, 1904, Vol. I.

Table II.—*Total resistance of an Old-type Ocean Cable at Various Lengths.*

Length of the cable in kilometres.	Total resistance of cable in ohms.
500	93,000
640	$1{,}000{,}000 = 1 \times 10^6$
1,000	578×10^6
1,500	$3{\cdot}61 \times 10^{12}$
2,000	$0{\cdot}022 \times 1^{18}$
3,000	$0{\cdot}86 \times 100^{24}$
4,000	33×10^{30}

which this current comes in will still be 1,000,000 ohms. As we see, we can use this cable without improving it for merely 640 km. distance; at this distance the value of 1,000,000 ohms is reached for the speed $w=5{,}000$. The increase of the resistance is very rapid; instead of $\sinh(\beta L)=(e^{+\beta L}-e^{-\beta L})/2$ we can use only $\frac{1}{2}e^{+\beta L}$, $e^{-\beta L}$ being negligibly small. The curve is pure logarithmical, appearing as a straight line drawn on semi-logarithmic paper (Fig. 4).

The old type cable does not permit the passage of any high-frequency currents at all. The fact is to be remembered that $g=10^{-6}$ is hardly obtainable for currents which have only telephone frequency, $w=5{,}000$ to 16,000; for frequencies used by Messrs. Weinberg, Squier and Maior, $w=\pi$ 100,000 or higher the total resistance will be very much higher.

Choosing another modern cable, which is wound with iron spirally (Krarupised), we get the following data:—

$r=1{\cdot}2$ ohms; $l=3{\cdot}6\times10^{-3}$ henrys; $g=4{\cdot}37\times10^{-6}$ mhos; $c=0{\cdot}3\times10^{-6}$ farads; and $w=10{,}000$;

And so $Z_0=331-j4{\cdot}819$ and $\beta=(5{\cdot}712+j328{\cdot}4)\ 10^{-3}$.

Table III. shows the total resistances.

Table III.—*Total resistance of a Modern Krarupized Ocean Cable at Various Lengths.*

Length of the cable in kilometres.	Total resistance of cable in ohms.
1,000	50,100
1,500	876,000
1,525	1,000,000
2,000	15,160,000
3,000	4,500,000,000
4,000	$1{\cdot}37\times10^{12}$

For 1,000,000 ohms we find the length of 1,525 km., which is not sufficient for rapid telegraphy on ocean cables. We must investigate how the attenuation can be decreased.

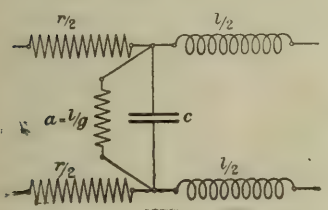


Fig. 5.—Scheme of a Normal Cable Element.

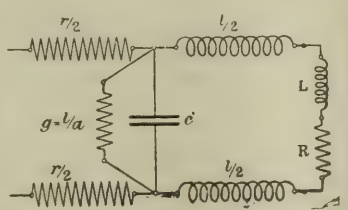


Fig. 6.—Scheme of a Cable with Inductive Shunt.

Fig. 5 shows a cable element, which is designed for use in telephony. For telegraphing, the two $r/2$ and $l/2$ values may be replaced by r and l.

The electrical coefficients which are connected in series appear in the formula of β with direct values (r and l); the line coefficients, which are connected in shunt in the cables appear in the formula of β with inverse values. The insulation is a; its inverse value is $g=1/a$; that is, for one megohm insulation, we write in the formula $g=10^{-6}$ mho. The capacity-resistance is $1/jwc$; its inverse value in the formula will be jwc.

When we use an inductive shunt, the scheme of the cable element will change, as Fig. 6 shows.

In formula (4) we must substitute for $g+jwc$,

$$g+jwc+(1/R+jwL), \qquad (6)$$

where R is the effective resistance of the shunted coil and L is its inductivity. Let us eliminate the imaginary quantity in the denominator, and we get * for β:—

$$\beta=\sqrt{\left[(r+jwl)\left\{\left(g+\frac{R}{R^2+w^2L^2}\right)+j\left(wc-\frac{wL}{R^2+w^2L^2}\right)\right\}\right]} \qquad 7)$$

* "L'amélioration des Communications Téléphoniques Sous-marines au Moyen des Dérivations Inductives," Béla Gáti, "La Lumière Electrique," 1913, Juillet 26. *See also* The Electrician, Vol. LXXII., p. 648.

It is possible to choose all the coefficients in such a manner that β may be a minimum. In this case the value of β depends only upon r and g, being

$$\beta \text{ minimum} = \sqrt{(rg)}. \qquad (8)$$

For instance, choosing R=0·0189 ohm and L=0·01348 henry, we get for an old type cable: $r=0{\cdot}9$ ohm, $g=10^{-6}$ mho, $c=0{\cdot}27\times10^{-6}$ farad, $l=10^{-4}$ henry, and $\beta=0{\cdot}001$.

Computing with these values gives the results shown in Table IV.:

Table IV.—*Total Resistance of an Old-type Cable with Modern Inductive Shunts.*

Length of cable in kilometres.	Total resistance of cable in ohms.
4,000	24,680
5,000	67,800
6,000	182,400
7,000	493,000
7,700	1,000,000
8,000	1,340,000
9,000	3,670,000
10,000	9,961,000
15,000	1,487,800,000

We reach the limit of 1,000,000 ohms at 7,700 km. of cable—that is, the question is settled for Atlantic ocean cables.

Using a high voltage and some sensitive relay, we may deem the question solved for the Pacific ocean also.

Of course, it is another question how these coils could be applied on cables already laid. The expectations from Pupin coils were abandoned; I shall explain the reason very briefly. We need for Pupinisation of a submarine cable, coils with an inductivity of

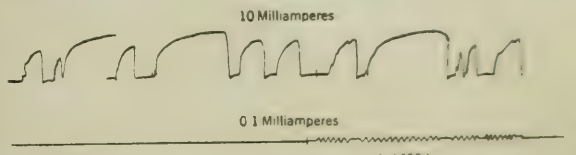


Fig. 7.—Transformation of Alternating Current Signals to Direct Current Impresses.

0·2 henry per kilometre. It is impossible to apply Pupin coils every 2 km. to 4 km.; it would be very expensive. Using them at each 100 km. distance, one coil ought to have less than 18 ohms resistance and a self-induction of 20 henrys. This coil, if not in itself an impossibility, would have such dimensions as not to be applicable in submarine cables.

Using inductive shunted coils, as computed before with $R=18{\cdot}9\times10^{-3}$ ohm and $L=43{\cdot}48\times10^{-3}$ henry, the coil in each 100 km. must have only 100th part of this value (the coils being connected in parallel), and so the actual coil hasthe dimensions at each 100 km. $R=0{\cdot}189\times10^{-3}$ ohm and $L=0{\cdot}4348\times10^{-3}$ henry.

In reality the shunted coil will have $100\times100=10{,}000$ times less inductivity than Pupin coils, applying them at each 100 km. Pupin coils shorten the wave-length; shunted coils lengthen the wave-length of the alternating current, but the explanation of this would need a more detailed mathematical solution.

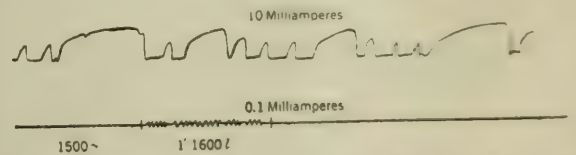


Fig. 8.—Transformation of Alternating Current Signals to Direct Current Impresses.

We have seen from Fig. 4 that old type telegraph cable fitted with inductive shunts could be used for transmitting alternating-current impulses. Our type-printers and all writing apparatus work with direct current; it is necessary to transform the arriving alternating-current signals to direct-current impulses. Figs. 7 and 8 show what can be done with alternating-current signals.

The Baudot, Murray, Morkrum and Siemens-Halske printers work with direct-current impulses, and with aid of the described relay they can be used for alternating-current rapid telegraphy also. With this the question of rapid cable telegraphy is settled; of course, the construction of the shunted coils and their application in the already laid cables needs yet further investigations and practical researches. I do not speak of the multiplex cable telegraphy; this is solved for alternating-current telegraphy also—namely, the Mercadies-Magunna system, which was tested for land lines only.

The high-frequency current cable telegraphy with aid of inductive

shunts has so many features in common with the ocean telephony that we can treat at once the question of the ocean telephony, too. There are two distinct features, which differ in the ocean telephony from the rapid cable telegraphy. In the cable telegraphy we need a minimum attenuation only for one separate frequency; in telephony we need the minimum for all frequencies of the human speech, at least between 100 and 1,000, ultimately up to 2,000. The voltage of the outgoing telephone current in commercial discourses is about 1 volt; the incoming current at the distant end is 0·1 milliampere; sometimes only 0·05 milliampere (100 to 50 microamperes). Hence the total resistance of the cable at ordinary microphones and telephone-receivers cannot be higher than 10,000 to 20,000 ohms. We ha] as the limit in the rapid cable telegraphy 1,000,000 ohms.

We see from Tables II., III., and IV., and from Fig. 4, that old-type cables cannot be used for telephony even to 500 km. distances; the continuously-loaded cable would be good for 600 km. to 700 km. (continue the straight line downwards in Fig. 4). Only the shunted coil cable is suitable for ocean telephony, its resistance being only 24,680 ohms at 4,000 km. The length of the South American and African connecting cable is less than 4,000 km., and so on these cables ocean telephony is already possible; naturally only with the aid of the one frequency system.

Prof. Silvanus P. Thompson, 22 years ago, delivered at the Chicago Worlds' Fair his lecture, stating the possibility of the ocean telephony with the aid of shunted coils. He failed in the dimensions of his coils, believing the coils must possess a large resistance, so as not to cause considerable leakance.

The shunted-coil cables keep their minimal resistance for one frequency only, although there are now in preparation coils which work equally for all telephone frequencies. the attenuation of the cable remaining about the same for the diverse frequencies of the human speech.

Employing the high-frequency telephony system of George O. Squier on the South American and African cables, we are in need to increase the distance of commercial speech for aerial lines and for other cables, too. This can be done by various means, which are briefly enumerated in the following: (1) We employ a higher voltage for the outgoing current, and the use of strong-current microphones. (2) We use more sensitive telephone receivers, which transmit the human speech more distinctly than before. The arriving current can be less, and so the whole resistance of the line greater, and the speaking distance can be increased. (3) We lessen the whole resistance of the line, for instance, using one-wire telephony for long distances, or Krarup Pupin methods,' inductive shunted coils. (4) We employ telephone relays for strengthening the received currents

Strong Current Microphones.—By using a higher voltage in the ordinary microphones the speech causes greater variations in the current strength of the microphone circuit; our outgoing telephone current will have 30 to 40 volts tension instead of 1 volt, as with the ordinary microphone. In such a manner the expression of $Zo \sinh (Ls)$ can be increased, and still we get the received current strong enough for commercial purposes. The author gives oscillograms illustrating the effect of the strong current microphone compared with an ordinary microphone at various distances, and the results are set out in Table V.

Table V.

Distance in Km.	Strong current microphone. Outgoing. Current in microamperes.	Strong current microphone. Received. Current in microamperes.	The received current in percentage of the outgoing.	Ordinary microphone. Outgoing. Current in microamperes.	Ordinary microphone. Received. Current in microamperes.	Remarks.
404	16,625	2,363·8	14·22	6,125	848	8 km cable*
922	17,500	1,484	8·48	7,000	296·8	8 ,, ,,
1,188	15,750	720·8	4·57	5,250	190·8	8 ,, ,,
1,592	18,025	265	1·47	7,000	127·2	16 ,, ,,
2,110	16,625	159	0·956	7,000	0	24 ,, ,,
2,514	21,875	50	0·23	4,375	0	30 ,, ,,

The microphone tested was constructed by the author; it had a water-cooling device. The strong current microphone could not come in general use; only in Sweden are the Egnér-Holmström microphones commonly used. They can be used only in those countries where the insulation of the long-distance lines is well maintained, and the public is more accustomed to the separation of the speaking from the listening position.

Because the tension of the outgoing current is greater, the insulation of the line is decreased. Using 10 times greater voltage, the insulation is decreased about 50 per cent. In the formula of the minimum attenuation, $\beta = \sqrt{(gr)}$.

g is increased by this and so β is increased also. We have with strong current microphones on poorly insulated lines a worse effect than with an ordinary microphone.

The outgoing current is strong; we cannot keep the receiver to the ear for the outgoing current. We must change the speaking and listening positions. This is not possible in every country, because the change requires a specially intelligent subscriber. The method is used in the Scandinavian countries, where the Egnér-Holmström microphones attained a better result.

Telephone Relays.—The considerable strength of the disturbing currents hinders the use at present of telephone relays. I have found that the disturbing effects over 1,000 km. have already a greater intensity than the incoming current itself. By relaying these currents, the disturbing currents will become magnified, and finally, totally obliterate the speech currents.

Considering the problem from this point of view, the author discussed briefly the relays which might be successful in the future, especially on one-wire transcontinental telephony free from disturbances, and continued:—

Telephone-relays will play an important rôle in the future of transcontinental and ocean telephony. We need to-day better circuits and fewer disturbing effects, which can be obtained only through a careful investigation and research organisation. Because these electron relays are not in common use yet, I will not go into details. I have explained in this Paper the present situation and the hopes of the rapid cable telegraphy, and of the ocean and transcontinental telephony, and I presume that the prediction made in Prof. Silvanus P. Thompson's lecture in 1893 will soon become a reality, and thus the telephone communications across the Atlantic and the continents will be able to aid future generations in avoiding misunderstandings.

* With paper insulation was also connected into it.

THE SOLUTION OF THE TRACTION EQUATION OF A VEHICLE IN MOTION BY THE POWER METER.*

BY J. CARLIER.

The apparatus here described indicates and registers:—1. Time. 2. Distance. 3. Real accelerations of speed and accelerations resulting from working and resisting pressures. 4. Speeds. 5. Variations in acceleration by fitting in the apparatus a speed acceleration regulator. 6. The total power expended in propulsion, as well as the power absorbed by the kinetic energy of the body in motion, and that absorbed by resistances of all kinds, acting on it. 7. Eventually the pull on the draw bar. It is then necessary to use at the same time a traction dynamometer, as in the case of locomotives. 8. Declivities. 9. Transverse oscillations.

The apparatus is entirely independent of the trajectory followed by the body. It is attached to the latter by the point of suspension of an inertia pendulum, the property of which is to collect all the accelerations, however small, of the body to which it belongs. It follows that the slowest and slightest movements are indicated by the apparatus, to the degree of sensibility it is considered advisable to give it.

Generalities.—The traction equation of a body in motion includes several factors. As regards railways, the traction equation can be written, in a general way, in the following form:

$$P = P_1 + P_2,$$

in which P is the total power on the rim of the driving wheels corresponding to the speed V. P_1 is the power necessitated by the acceleration F to bring the train from a speed v to speed V. When the required speed has been reached this power becomes equal to zero, and the traction equation then becomes $P = P_2$. P_2 is the power absorbed by resistances of any kind applied to the train, which include: (1) friction of the wheels on the rails; (2) journal friction of the axles; (3) resistance due to oscillations and shocks; (4) air resistance; (5) resistance due to gradients; (6) resistance due to curves. These resistances can be calculated, but the result of the calculation is always only approximate. Therefore various experimental methods, more or less perfect, have been devised.

Role of Testing Cars.—Testing cars were designed for the purpose of measuring most of the traction factors of railway trains. They generally consist of traction and compression springs, very minutely calibrated, the indications of which are inscribed as ordinates on a strip of paper unrolled in proportion to the road traversed. Summing

* Abstract of an article in the "Génie Civil."

up, the principal measurement, which is made in this way, is that of the work or power supplied by the locomotive to the train.

The most recent testing cars do more, thanks to the work of the late Messrs. Desdouits, chief engineer, director of rolling stock and traction of the French State Railways, and Joseph Doyen, chief Belgian State engineer.

Desdouits' inertia dynamometer, or ergometer, completed by Joseph Doyen, measures the work on the rim of the driving wheels or effective working of the locomotive, in the same way as in fixed engines the effective working is measured by the brake. Here the brake is the train itself, with its various resistances and the kinetic energy it stores up when the speed increases.

Joseph Doyen's ergometer, accurately measuring the work supplied by the steam in the cylinders to the rim of the driving wheels, permits the determination of the output of the locomotive, considered as a steam engine, by estimating exactly the quantity of steam supplied to the cylinders, either by a steam meter or by indicator diagrams. The steam meter is not yet used on locomotives; it is preferred to draw a series of indicator diagrams and measure them with a planimeter.

Utility of the Ergometer.—Thanks to the ergometer, which comprises also a totalising efficiency indicator, we can compare the consumption of coal and water, or electrical energy in the case of electric engines, with the work furnished to the complete train (locomotive and tender included), or with the power furnished, by noting the time during the trials This is one of the most useful things to know, in view of inciting the operator to decrease the consumption of energy necessary for the propulsion of vehicles. It would be desirable to be able to determine this permanently for all trains, so as to interest the driver or motorman in saving, as much coal or electrical

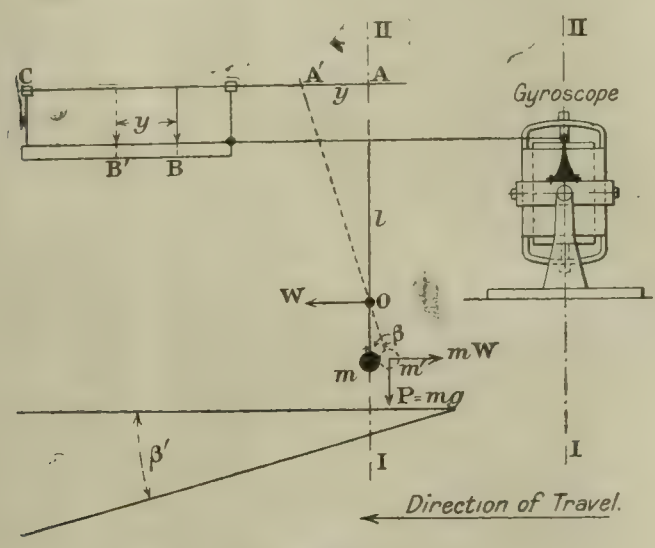


FIG. 1.

energy as possible. On the engine itself should be found the power meter which should register continuously the mechanical power supplied to the train by the engine.

The Power Meter.—The ergometer is not applicable to the study of the movement of a vehicle having no fixed trajectory in space; the rails on a railway form this trajectory, and the distance, which is the factor to be multiplied by the resultant of the pressures applied to the train, is measured on this trajectory fixed beforehand. This measurement, by using one of the wheels of the testing car, is not strictly correct, although satisfactory in practice, as regards accuracy. It is, however, better, when possible, to obtain this value by mathematical deductions. The measurement of distance and quantities such as speed, power, &c., of moving bodies, the trajectory of which in space is not fixed continuously, offers certain difficulties.

To be able to obtain without a fixed trajectory in space the values of distance and speed, which are the elements of the calculation of the power, it is necessary to know two principal factors, viz: (1) Real acceleration of speed, positive or negative, at each moment; (2) the time. The time is measured by a clock; the real acceleration (declivity to be deducted) is measured by Desdouit's inertia dynamometer, the vertical axis of which is fixed in space, whatever the inclination of the vehicle carrying the dynamometer may be, by means of a gyroscopic mechanism.

AO*m* (Fig. 1) is a pendulum which can oscillate round a point O, the latter forming part of the body the acceleration, W, of which we wish to measure. On account of its inertia, the weight *m* remains at the rear and takes up a position *m'*, in which it is balanced by the action: (*a*) Of the tension of the bar *om'*, (*b*) of the inertia force *m*W, and (*c*) of the weight *mg*.

Relatively to O, we have for the total of the moments of the forces,

$$mW.Om'\cos\beta - mg.Om'\sin\beta = 0,$$

whence $$W = g\tan\beta.$$

The ordinate traced by the long arm AC of the pendulum is equal to $$y = l\tan\beta,$$

whence $$\tan\beta = \frac{y}{l} \text{ and } W = \frac{g}{l}y.$$

Real Acceleration of Speed.—This ordinate *y* gives the value of the real acceleration of speed applied to the vehicle if it remains horizontal during running, which means that the axis I, II, by which we measure β, itself remains vertical. But the perpendicular line of the vehicle does not always coincide with the direction of gravity angle β is decreased by an angle β', or increased by an angle β', altering by so much the value of the ordinate *y*. It follows that the real acceleration of speed applied to the vehicle is not measured accurately. Now, this accuracy must be *absolutely correct* if we wish the quantities which are deduced from it to be accurate. The ordinate *y* will always be the true expression of the real acceleration applied to the vehicle, on condition that the vertical axis I, II is materialised in some way in space and that the position of the pendulum O*m* is constantly marked relatively to this vertical line.

For this we use a gyroscope, which, as we know, has the power of retaining the original position it assumed when starting, in spite of the influence of external forces. It will, therefore, be sufficient to note carefully the zero of the acceleration meter when the vehicle is at rest with the position of the gyroscope when it started. The use of gyroscopes in the Navy as compasses has become most prevalent. The Sperry Company have applied gyroscopic compasses in hundreds of ways, the results of which are most appreciated in navigation. Any other device permitting the accurate marking of the true vertical axis with the pendulum, subjected to the forces of acceleration and gravity, will give the solution; but, in another way, that is not easy.

Measurement of Speeds.—The pendulum combined with the gyroscope (Fig. 1) thus corresponds to the equation $j = dv/dt$, whence $v = \int_0^T j\,dt$. To effect the integration of the accelerations from the instant 0 to the instant T it will be sufficient to measure with a planimeter the curve of the accelerations recorded on a strip of paper, moving with time, or work out their integration by means of Abdanck-Abtkadonowicz's integrating wheel. The real speed of the vehicle is thus given by means of accurate mathematical deductions from measurements of accelerations of speed and time. Now, the accuracy of the measurement of time is extremely great, that of the measurement of acceleration, thanks to the practically frictionless suspension of the pendulum, can at least be equally so. The value of the speed which results will, therefore, be at least as accurate.

Measurement of Actual Power Supplied.—The acceleration multiplied by the mass M of the vehicle gives the value of the accelerating force F, which is the resultant of the driving and resisting pressures which act on it.

$$F = MW = \frac{P}{g}\frac{g}{l}y = \frac{P}{l}y,$$

the value *y* being that obtained in Fig. 1, if the vehicle is taken as horizontal. Here P is the weight of the pendulum whose mass is M.

On an incline, if the train is at rest, the pendulum takes up a position inclined to AO, but when the train is in motion on an incline the acceleration due to gravity just wipes out this inclination. Thus, the ordinate traced by the pendulum is a measure of the acceleration due to the driving or resisting forces excluding gravity.

The record on the sheet of paper, the abscissæ of which are proportional to the distance run (actuated by one of the wheels in the testing cars), of the resultant of the driving and resisting pressures, or resultant acceleration, gives a diagram, the area of which, measured by a planimeter and multiplied by the weight M of the vehicle, expresses the value of the effective work supplied to the vehicle. To determine the power it is necessary to note the time which elapses between two periods of running.

If, instead of making the integration of the resultant of the driving and resisting pressures (F=MW) operating for a distance, it is worked out as operating for speed, we shall at once have the value of the effective power supplied in this way to the train. This is an exceedingly useful result. By using the integrating wheel of Abdank Abakadowicz, direct readings are obtained by means of integrating meters. The distance is obtained from the speed curve. The power meter gives, in general, the expression of the following factors: Time, distance, speed, acceleration, the resultant pressure applied to the vehicle, the power supplied, the declivity of the trajectory followed by the body, the lateral inclinations. All these

results are obtained by means of apparatus entirely independent of the trajectory followed by the body in motion.

Description of the Power Meter.—The power meter includes (Fig. 2) a pendulum P of great weight suspended to a frame, A, by means of flexible steel blades *s*. The weight P has a fork-shaped lever with arm *l*, very long, which carries the levers *m* and *n* rotating on the axes I and II. The axis of rotation (II) of the lever *n* is

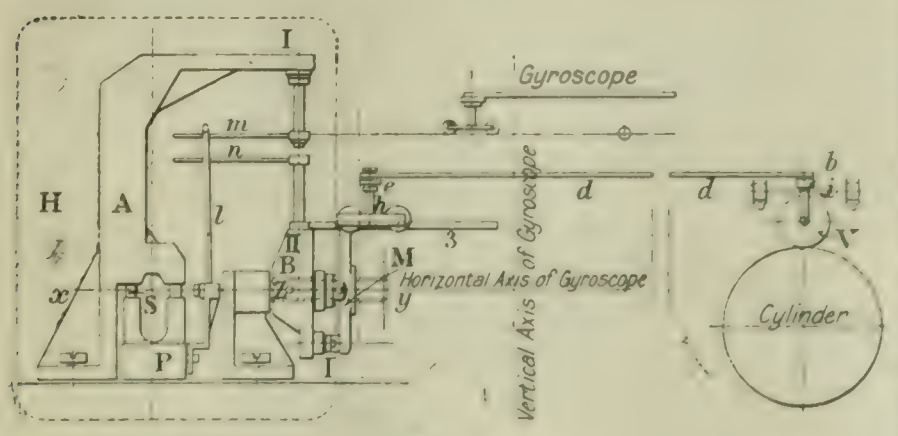


FIG. 2.

mounted on a piece, B, which can turn on an axis, *xy*; the piece B is subject to the gyroscope G by means of the crank M and the connecting rod I. Thus any angle taken by the pendulum P is compensated by the gyroscope for the effect of gravity, and the acceleration stresses alone cause the rod 3, moving round the axis II, to assume an angle proportional to that of the pendulum P relatively to the crank B, which marks continually in space the true vertical.

It is the angle taken by 3 relatively to the crank B which gives the value of the real acceleration impressed on the body in motion. The lever in moving round I, a fixed axis, takes any angle given by the pendulum, but it has been demonstrated previously that during the motion of the vehicle this angle indicates the value of the resultant of the driving and resisting pressures applied. It is, therefore, not necessary to know the true vertical axis and to mark the position of the pendulum P relatively to this axis. The angle taken by the rod 3 (Fig. 3) is transferred to the cylinder *a* through the inclination of the strongly bevelled wheel V, which is actuated by the parallelogram formed of the rods *b*, *c*, *d* and *e*, and of which the axes of rotation of the pieces *e* and *b* are applied to the trolly *h* and the wheel V. The wheel V is surmounted by a trolly *i*, guided by rods *j* and *k*. The position of the trolly *i* relatively to the guide rods *j* and *k*, gives the expression of the product of the real acceleration (inclination of the wheel V) and of the time—that is, of the speed when the cylinder *a* is moved proportionately to the time. The links l and the pointer *m* indicate the speed on a dial, and the links *n* and *o* record it on the paper band. Should the lurching motion of the vehicles be very pronounced, the position of the pendulum P would be modified in such a way that it maintained its vertical position in plane H (Fig. 2), and for this purpose the whole system, pendulum, frame, crank B, &c., is balanced and made to move on the axis ZZ_1, round which the gyroscope G_1 moves the system.

The angle taken by the lever *m* is reproduced by the cylinder *q*, the speed of which is proportional to the position of the trolly *i* on the guides *j* and *k*, by means of a parallelogram. To the trolly *s* is pivoted a sharp edged intersecting wheel, *r*, the angle of which in any position of the trolly *s* is the same as that of the arm *m*. The multiplication of this angle by the speed gives the power. An indicator in a single direction totalises all the displacements of the trolly *s* in a positive direction (direction of motion), whilst the indicator *u* totalises all the displacements of the trolly in an opposite direction. The power expended in propulsion is then recorded as *t*, that absorbed in retardation (braking, &c.) is recorded as *u*. The distance being the product of speed by the time, it suffices to reproduce the speed on the time cylinder by the inclination of a wheel, V. The displacement of trolly *z*, which carries the wheel V, set up by an appropriate parallelogram and arm, and the position of which corresponds to that of the speed, gives the distance. A special indicator marks this position.

The gyroscope actuates the part B (Fig. 2), and a hand, *r*, as well as a stylus at the end of the rod indicate and inscribe the values of the gradients. Likewise the gyroscope G_1 can indicate and inscribe the transverse oscillations, and drives the balanced arrangement H (Fig. 2). The cylinder *q* rotates at a speed proportional to the position of trolly *i* on the cylinder *a* proportionately to the speed. For that a variable speed motor (or differential of two motors revolving at equal speeds and in an opposite direction when at the zero speed, and one of the two is affected by the influence of the position of trolly *i* on the cylinder *a*) is controlled by the speed indicator. The sheet of paper can travel proportionately to the road traversed; and in these conditions the distance meter, a trolly drawn along by the cylinder, controls the travel of the sheet.

Experimental Researches by Means of the Power Meter.—The formula of resistance R of the train includes a series of terms, as has been seen above. If we omit curves and gradients we get four terms which can be grouped in a general formula—

$$R = A + BV + \frac{CSV^2}{P},$$

in which A, B and C are experimental coefficients.

V = the speed in kilometres per hour.
S = the cross section of the train.
P = the weight of the hauled train.

Several practical formulæ have been proposed in consequence of trials carried out in different countries. Such are :—

Harding's formula (1846)—

$$R = 2{\cdot}72 + 0{\cdot}094V + 0{\cdot}00484\frac{SV^2}{P}.$$

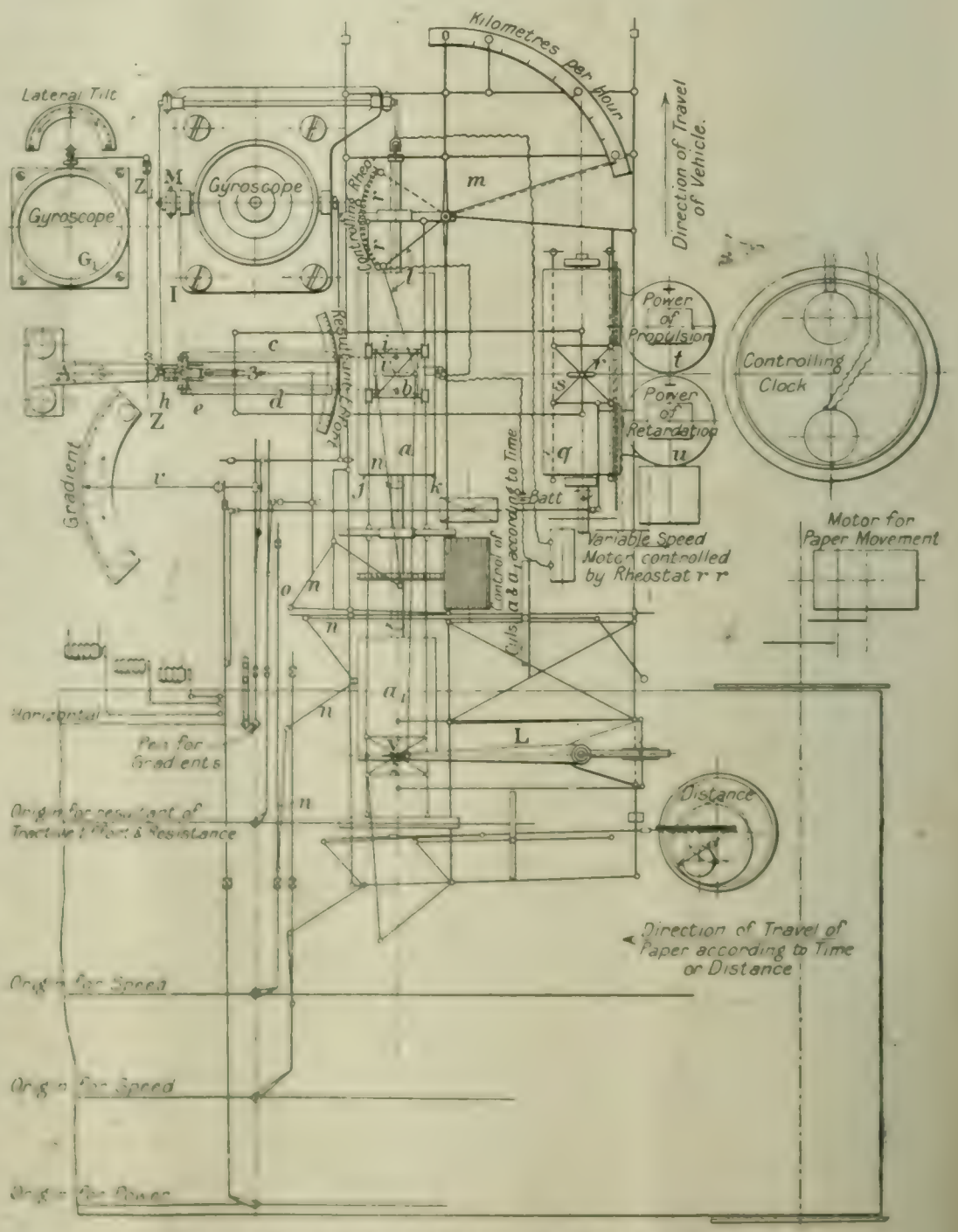


FIG. 3.—GENERAL ARRANGEMENT OF APPARATUS.

Meyer's formula—

$$R = 2{\cdot}5 + 0{\cdot}001V^2.$$

Barbier's formula (Northern Railway Co., 1895)—

$$R = a + bV\frac{V+c}{1.000}$$

in which a, b and c are the coefficients which differ according to the type of material concerned.

Thus we have—

For carriages with two axles and large wheel base,

$$R = 1{\cdot}4 + 0{\cdot}20V\frac{V+85}{1{,}000}.$$

For carriages with bogies,

$$R = 1{\cdot}4 + 0{\cdot}20V\frac{V+80}{1{,}000}.$$

Resistance of the Train Hauled Alone.—The value R of the train hauled alone cannot be determined easily by a traction dynamometer. In the case of a motor train or boat, the traction dynamometer becomes useless, as, the motor forming an integral part of the body in motion, the resistance to the running of the whole has alone to be considered. If the power motor is utilised concurrently with the traction dynamometer, the deflections of which are inscribed on the diagram paper which is actuated by the path traversed, the determination of the resistance of the train hauled alone is possible.

In effect, the pressure on the draw bar (traction dynamometer) is equal to the resistance to the motion of the material hauled, increased by the positive or negative pressure of acceleration, and the positive or negative force of gravity.

If r = the resistance to motion per ton.
p = the weight of the material hauled.
γ = the acceleration.
i = the gradient or slope in millimetres per metre.
ψ = the stress on the draw bar,

we find that:

$$\psi = \frac{p}{1{,}000}r \pm \frac{p}{g}\gamma \pm \frac{p}{1{,}000}i, \quad \ldots\ldots\ldots \quad (1)$$

γ being the real acceleration—that is dv/dt.

The diagram V (Fig. 4) traced by the inertia dynamometer (not corrected by the gyroscope) gives at each instant the ordinate y,

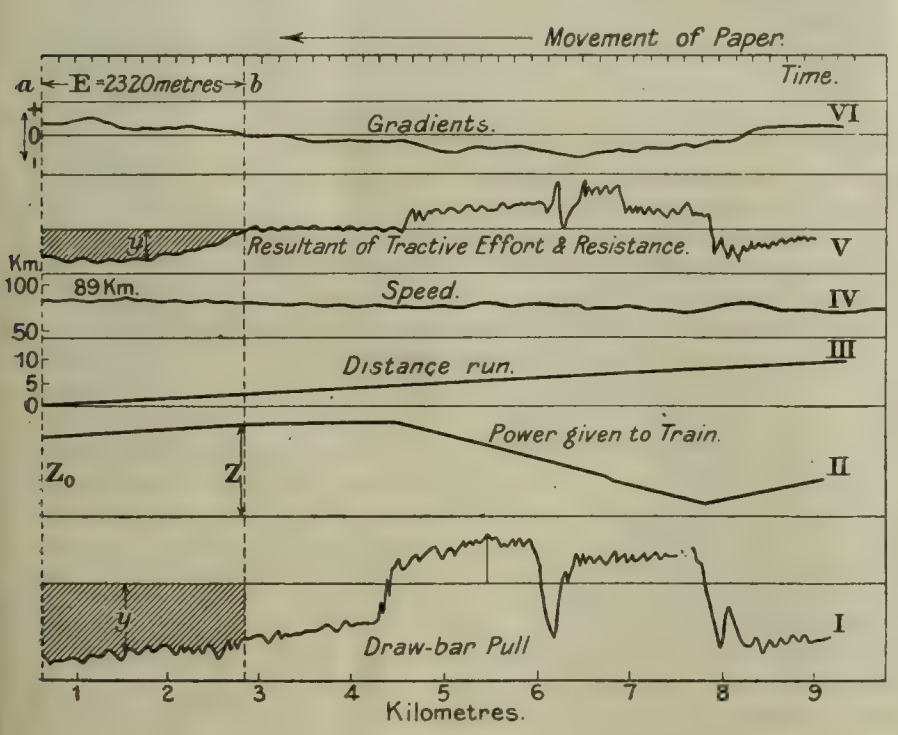


FIG. 4.—AN EXAMPLE OF RECORDS OBTAINED.

which measures the value W of the acceleration produced by the resultant of the driving and resisting pressures whatever the profile of the track may be.

The expression (1) thus becomes

$$\psi = \frac{p}{1{,}000} \pm \frac{p}{g}W;$$

whence we obtain

$$r = \frac{1{,}000}{p}\psi \pm \frac{1{,}000}{g}W; \quad \ldots\ldots\ldots \quad (2)$$

as the value of the resistance to the motion of the train. We can also record on the sheet of paper of the power meter the gradients and the real acceleration γ. In inserting these values with their respective signs in the expression (1) we obtain the value r.

It is more rational and more exact to take the value of the algebraical resultant of the real acceleration and that of the gradient, and to insert this value in the calculation of the formula (2).

Fig. 4 is a facsimile of the graph which should be made by the power meter combined with a traction dynamometer travelling over a railway line. The tractive force ψ on the drawbar is measured to a constant nearly, by the positive or negative ordinates y of curve I. The ordinates y of diagram V measure the resultants W of the real accelerations and the effect of gradients. Although it is difficult to measure exactly the ordinates at any time on irregular curves of this kind, the mean ordinates over any period can be obtained readily by means of the planimeter.

The totalling of the power supplied to the train is effected by the bevelled wheel r which is carried by the cylinder q (Fig. 3), and actuated in proportion to its speed. The totalling of the positive and negative powers is likewise made by means of the meters t and u. For totalling the work of the tractive efforts, a recorder has been attached to the bar which traces the ordinates y (curve I.), this recorder consisting of a plate revolving in proportion to the distance traversed, and of a roller carried by this plate; this roller is displaced from its centre proportionately to the tractive effort ψ.

Let us suppose that the diagram of Fig. 4 has been obtained with a train of 200 tons. On the track, E = 2,320 metres, the resistance r is given by the formula (2), in which $\frac{1{,}000}{g}W$ = the accelerating effort per ton of train = F.

$$r = \frac{1{,}000}{p}\psi \pm F.$$

Multiplying by dE and integrating we have:—

$$rE = \frac{1{,}000}{p}\int \psi dE \pm \int F dE, \quad \ldots\ldots \quad (3)$$

r being the mean resistance on the course E. $\int \psi dE$ is given by the integrating indicator of the work on the drawbar. $\int F dE = K(Z - Z_0)$. Z_0 being the ordinate of the curve II. at the beginning, Z being the ordinate of this curve at the end of the course and K being a constant.

Curve II. gives in reality $\int F dv$, but if in the constant K we also include the time which has elapsed from a to b we can admit that the expression $K(Z - Z_0)$ gives the work of the accelerating forces F.

The formula (3) then becomes:—

$r = \frac{1{,}000}{pE}$ × the number of kilogrammetres read on the integrating indicator of the pressures on the drawbar during the course E (or inscribed on the diagram from a to b) + $K(Z - Z_0)$. . (4)

Let us suppose that the number of kilogrammes read on the indicator of the pressures from a to b is 3,350,000; K of the power meter being $\frac{10{,}000}{t} = \frac{10{,}000}{96''}$, we get

$$K(Z - Z_0) = 104{\cdot}16(67 - 56) = 1{,}145{\cdot}76.$$

By substitution in (4) we find:—

$$r = \frac{1{,}000}{200{,}000 \times 2{,}320} \times 3{,}350{,}000 - \frac{1{,}145{\cdot}76}{2{,}320} = 7{\cdot}2 - 0{\cdot}49 = 6{\cdot}71 \text{ kg.}$$

at the speed of 89 km. per hour, indicated by diagram IV.

We can also find the term $\int F dE$ of the expression (3) by giving the reading of the meter t, which totalises the powers, from the difference in the numbers indicated when the train is at a (Fig. 4) and when it is at b. We get in effect:—

$$P_F = F \times V \text{ and } P_F \times \text{time} = F \times E.$$
$$R = 6{\cdot}71 \times 200\ t = 1{,}342 \text{ kilogrammes.}$$

Resistance to Rolling of the Entire Train (Locomotive and Tender Included).—This is also the case of motor trains and boats. This measurement must also be effected by means of the power meter. For this the stop valve of the locomotive is closed (a similar course is followed with boats and in motor trains) for a distance E, R being the resistance of the entire train during this period, the speeds V and V′ at the beginning and end and the ordinates of the curve II. being Y and Y_0, the power absorbed by the resistance of the train will be

$$P_R = R \times \tfrac{1}{2}(V + V').$$

whence

$$R = \frac{\text{constant}}{\tfrac{1}{2}(V + V')}(Y - Y_0)$$

The meter u totalises the power absorbed by the resistances. In observing the meter before and after the closing of the stop valve we find the value of the power absorbed during this time. It will suffice to divide the number read by the mean speed.

There is an error in supposing that the law of resistance is a straight line between the speeds observed, but this error is very small.

Similarly, the total work done by the steam, excluding gradients, is given by the sum of the readings of the meters t and u.

The power meter thus enables data of the greatest importance in regard to transport to be determined.

D

SOME NOTES ON THE FIRST REPORT OF THE DEPARTMENTAL HOME OFFICE COMMITTEE ON LIGHTING IN FACTORIES AND WORKSHOPS.*

On Tuesday, November 23rd, a discussion on this subject took place at a meeting of the Illuminating Engineering Society. For the formal business the chair was taken by Mr. F. W. Goodenough, who then vacated it in favour of Dr. R. T. Glazebrook. As an introduction, a lengthy communication was made by Mr. L. Gaster, which we give in abstract below.

Mr. GASTER: My object in opening this discussion is to bring before the Society some aspects of the first report of the Departmental Committee on Lighting in Factories and Workshops, and to discuss how we, as a Society, can best give effect to its conclusions and assist the work of the Committee in promoting progress in industrial lighting. In doing so I should like to make it clear that I am speaking in a purely personal capacity and not as a member of the Committee.

The hygienic aspect of lighting has been largely responsible for the appointment of the Committee. The need for our investigation was justified by investigations carried out by the Factory Department of the Home Office for several years, much of which has appeared in the annual reports issued by the Chief Inspector. In addition the hygienic aspects of lighting in relation to industry were prominently brought forward at two most important recent international congresses, the Congrès International des Maladies Professionelles, held in Brussels in 1910, and the first International Congress for the Prevention of Industrial Accidents, held in Milan in 1912, at both of which I was present as a delegate from the Illuminating Engineering Society. Shortly after the Brussels Congress a committee with similar functions to our Departmental Committee was appointed by the French Government, and the American Illuminating Engineering Society has also been active in studying the subject and in encouraging appropriate legislation on the part of the various States.

The outstanding fact by which our Committee was faced was the absence of any general provisions in respect of lighting, analogous to those regarding temperature and ventilation, in the Factory Acts of the United Kingdom.

I would next like to deal with a point on which there has been a little misapprehension, the special conditions which necessarily limit a Government Committee. The preparation of an official report, to be regarded as a preliminary to legal requirements, imposes a special responsibility on the members of a committee. Its conclusions carry a weight which the suggestions of individual experts or even societies do not: and it must, therefore, be particularly careful to avoid giving expression to views which are not thoroughly authenticated, and to explain its recommendations in the clearest possible terms. While the information given in the appendices of the report is chiefly of utility to people who are more or less experts on lighting, the body of the report must be so drafted as to be intelligible to the general public and particularly to those who are concerned with the legal aspects of it, but are not necessarily experts on illumination

SOME POINTS FOR DISCUSSION.

The reception of the report in the Press has been, almost without exception, friendly, and in the one case in which its contents have clearly been misinterpreted and under-valued, it is not difficult to trace the motives of the writer. In dealing with some of the comments that have been made, therefore, I do so merely in order to clear up a few evident misunderstandings.

1. In a few cases it has been suggested that the report contains a needless amount of explanatory matter and even truisms in regard to illumination. But explanations which appear needless to a lighting engineer may be highly necessary to the general public, for example, to backward manufacturers who have not thought much about lighting matters. Moreover, factory inspectors will have to proceed cautiously and to gain their own experience; for their guidance full and explicit information, even on apparently elementary points, will be very helpful.

2. A few writers, particularly those who are accustomed to deal with lighting matters, and have, therefore, some knowledge of the order of illumination met with in modern up-to-date factories, have been disposed to think that the minimum values suggested are too low: or to question the principles on which they are arrived at. I need scarcely say that these values were not put forward without long and careful consideration. The aim of the report is to avoid at all costs recommendations which might subsequently be found to be too burdensome, and to involve unnecessary hardship to manufacturers. It is not enough to specify what is theoretically desirable one must make sure that what one desires can be actually carried out. The estimate was, therefore, checked by a very laborious series of measurements in many factories, and the "frequency of occurrence" curves presented in the report gave a clear guide as to the values which might be expected without hardship in factories at the present time. I may say that the minimum value prescribed in factories—0·25 ft.-candle—has been independently arrived at in other investigations. It is, for example, the minimum value found on the platforms of railway station platforms* (where the safety and general convenience of passengers is the chief consideration determining the illumination), and it was independently suggested years ago as a result of investigations in the United States.†

It must also be recognised that these values are not average but "practical legal minimum" values. I notice that this distinction is emphasised in the American Code on lighting. The *minimum* foot-candle intensity is fixed (quite independently) at 0·25-ft. candle for storage, passages, stairways and the like, but the *desirable* foot-candle is placed somewhat higher, namely, 0·25–0·5 ft.-candle; the latter value is not far from the actual minima met with in our investigations and recorded in the "frequency of occurrence" curves.

It need scarcely be said that with modern illuminants there is usually a considerable variation in the illumination furnished at different points in the room, so that a minimum of 0·25 ft.-candle at one point means that the illumination at most other parts of the room will be very much higher. Above all, it must be clearly recognised that these are values in the interests of safety and convenience merely, and that in almost all cases the necessity of providing suitable illumination for the work carried on will in itself go far towards providing higher minimum values. I think, therefore, that it will be conceded that the 0·25 ft.-candle value has justification. I notice that in one journal the suggested value of 0·05 ft.-candle in large areas is spoken of as absurdly low. On the contrary I, personally, would have doubted the wisdom of asking even this value were there not the exemption clause as a safeguard. The conditions in such cases are utterly different from those encountered in an interior. There is no material gain of light by reflection from surroundings, and the lamps have to be spaced so far apart that the variation in illumination is necessarily very large. The best analogy is supplied by the full data available on the pre-war lighting of London's streets, so ably dealt with in Mr. Trotter's Paper before this Society in 1913.‡ 0·05 ft.-candle is about the value met with in St. James's-square, while in the Marylebone-road and in Cambridge-street there was only half this value. The well diffused illumination from a full moon in a clear sky, about 0·02 ft.-candle, is regarded as a very useful degree of light for outside operations.

3. A desire has been expressed that something more definite should be said on the subject of glare, and that a provision limiting the contrast between the illumination on the work and of surrounding parts of the workroom should be inserted. As regards the avoidance of glare I think the report is sufficiently emphatic. At the present stage it is hardly practicable to include in the body of the report hard and fast rules for its avoidance. As regards the avoidance of excessive contrasts in illumination this is met by two requirements. Firstly, by the general requirement that there should be a reasonable constancy of illumination over the working area; secondly, by the fact that the minimum general illumination is 0·25 ft.-candle. According to Weber there is no impression of glare, provided a contrast exceeding 100:1 in brightness is avoided.

4. A few critics of the report have suggested that some more definite information should be given under the heading, "How to Light a Factory." In other words, that some form of specification should be prepared stating the amount of illumination for various processes and the desirable arrangement of lamps, &c. It is explained in the report that the specification of the illumination for the purpose of carrying out work has not yet been sufficiently studied to justify us in putting forward definite values.

5. I notice in one article on the report the following passage: "At present shop lighting is dictated on a generous scale in every up-to-date factory, because it is clearly recognised that parsimony in this matter is false economy indeed. The lighting arrangements are not planned with the aid of a photometer, because no one can calculate beforehand how much light will be required and how much will be obtained by any suggested arrangement." I venture to think the above statement exaggerates the difficulties.

6. The statement that daylight is in general preferable to artificial light, and the advice to make the best use of daylight illumination on this account, have been regarded as a truism. If so, this is a truism.

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* This report was given in THE ELECTRICIAN, Vol. LXXV., p. 870

* See discussion before this Society, "Illum. Eng." Jan., 1912

† "Resumé of Legislative Enactments on Illumination," E. L. Elliott, "Trans." Ill. Eng. Soc. (U.S.A.), Oct., 1911, p. 738.

‡ "Standard Clauses for Inclusion in a Specification on Street Lighting," by A. P. Trotter, "Illum. Eng.," Vol. VI., 1913, pp. 250, 251. THE ELECTRICIAN, Vol. LXXI., p. 46.

that those responsible for planning admission of daylight would do well to bear in mind, for insufficient window-space is a not infrequent fault, especially in old-fashioned factories.

7. Finally, I may mention a few criticisms based on the impression that the merits of one or another illuminant have not been sufficiently emphasised. As I have indicated above, I regard these disputed points as of secondary importance in comparison with the aim of studying factory lighting as a whole and bringing about an improvement in the manner in which the illuminants are used. I venture to think that keen partisans of particular illuminants do not sufficiently realise how greatly these presumed advantages depend on the local circumstances.

Suggestions for Future Work.

There is room for detailed and systematic study of the requirements in regard to lighting in specific industries, and no doubt this important piece of work will be undertaken in course of time. It is, however, work that obviously requires very careful treatment, and one cannot expect immediate results. In view of the large number of factories working overtime on Government contracts the present moment was considered opportune for the issue of a preliminary report summarising the work so far undertaken, and this, in itself, is surely a creditable result of two years' work.

There have been naturally some points on which evidence was less easily gathered than others, and I would like to refer to several particular lines of investigation which would be helpful. One of these is the effect of inadequate illumination in causing eye-strain or general fatigue.

There seems at present to be a need for some general method of testing fatigue of eyesight. Experiments in this direction have been undertaken in the United States, but it is obvious that in studying different systems of illumination the variety of test imposed must be very carefully considered.

Another line of investigations which perhaps offers even greater immediate prospects is the study of the connection between illumination and output and quality of work.

All these are lines of investigation which might very well be taken up now that the report has brought before the public mind the value of good illumination. If it only served to pave the way for such experiments the report would prove a most useful piece of work.

DISCUSSION.

Dr. R. T. Glazebrook, in opening the discussion, remarked that the present report was only the first of its kind, and that they would already have done more had it not been for the present state of the country. He and other members of the Committee were there to-night to obtain information so as to render the next part of the report still more useful. He thought that any steps taken to improve the efficiency of manufacturing conditions would be for the good of the country.

Dr. Rene Sand hoped that the Belgian Government, after the war, would take some such action as was proposed in the present report.

Dr. Ker remarked that the report had gone on general principles, and was, therefore, unassailable. Later, no doubt, the effect of different kinds of illumination on the eyes would have to be taken into account, as, for example, the effect of glare.

Mr. W. R. Cooper emphasised the importance of considering the money value of good illumination. It was impossible to obtain the best work except under the best conditions, and he thought that if more examples of the gain in work by proper illumination could be obtained it would be a great advantage. Personally, he felt a little doubtful whether the minimum of 0·25 ft.-candle for workrooms was sufficiently high. It might, however, be impossible to go further in a preliminary stage. The term "workroom" was vague, and he thought it would be necessary to sub-divide workrooms according to trades, as the desirable illumination must vary very considerably according to the nature of the work which was carried on. He felt that a warning should be issued as to the undesirability of exposing metal filaments to the eyes, more particularly in the case of half-watt lamps. He agreed with Mr. Gaster in the view that the combination of daylight illumination and artificial illumination was most undesirable and should certainly be avoided. The remarks that he made were not made as criticisms but rather as suggestions, as he personally thought that the report was a very satisfactory beginning of an important work.

Mr. A. Cunnington noticed that the Committee had depended more on actual measurements than on the opinions by witnesses. As an example of the latter he called attention to one witness, who suggested that the minimum for corridor lighting should be 2 ft.-candles, which was altogether an abnormal figure. In his opinion, too much light was as bad as having too little. For railway yards he thought that the minimum illumination of 0·05 ft.-candle was too high, and he suggested that it would be well where such minima were specified to calculate what the cost would be. In the case of a yard with which he was concerned the annual cost would go up from £300 to £1,500 if a minimum of 0·05 ft.-candle were adopted. He showed curves which brought out the fact that the number of accidents to railway employees showed a marked maximum in the winter time, which was doubtless due to the poorer illumination as compared with the summer.

Mr. C. C. Paterson thought that the railway accident curves shown by the last speaker indicated much more than was apparent, because the increases were due simply to certain hours of artificial illumination. He stated that the next volume of the report would form a unique collection of data.

Mr. J. Eck was of opinion that the Society might congratulate itself on its efforts being taken up by the Government. The effect of good and bad illumination upon eyesight was very important, and if proper attention to illumination would lead to fewer spectacles it would be a great advantage. The safety obtained by better illumination was most important. He had recently come across many cases of bad illumination in small works in London. From his knowledge of American works it seemed to him that the American Illuminating Engineering Society had not brought before the American manufacturers the importance of good illumination as forcibly as had been done by the English Society in the case of manufacturers in this country.

Mr. Solomon suggested that factory inspectors might collect a good deal of valuable information in regard to lighting.

Mr. Swinson expressed the opinion that adequacy of ventilation and heating would probably have to be taken into account as well as lighting in investigating questions of fatigue of workers.

Mr. Campbell regarded the report as a dismal disappointment, and thought the minimum of 0·25 ft.-candle was much too low.

Mr. Goodenough thought that the Committee had done wisely in not attempting to go too far. In work of this character it was necessary not to go too far in advance of public opinion. He thought that the present report did a service to the public while not putting any hardship upon the manufacturer.

Dr. R. T. Glazebrook, in calling on Mr. Gaster to reply, remarked that the discussion that evening had been valuable, as showing what direction further work should take.

Mr. Gaster replied briefly, and stated that it would have been impossible to cover so much ground had it not been for the work of the secretaries. It was necessary to remember that the minimum of 0·25 ft.-candle referred to the general illumination and was a minimum. It was often found that although the local illumination was good the general illumination was bad, and it should be improved from the point of view of safety. In making measurements it was essential that they should be on a comparable basis, taking into account the degree of ventilation, &c.

ELECTRIC LIGHT IN ARTISAN'S DWELLINGS.

BY J. CLEARY.

Summary.—The author describes in detail the methods adopted at Brighton for dealing with the problem of wiring artisans' dwellings on a remunerative basis.

Until such facilities are given that the electric light may find its way into the home of every artisan it cannot be said that the electrical engineer has fulfilled his mission. There is scope in every town for development in this direction, and, with few exceptions, well-directed effort in this field should produce better financial results with the higher priced unit than is now being obtained by pushing the cheaper unit for "other uses."

Owners of small properties are kindly disposed towards the change, as they now realise that by this means they can overcome the annual tax of about 20 per cent. upon the revenue from the property for re-decorating, &c. As the rooms are invariably small and of low pitch the ceilings very soon become blackened, the deterioration being proportionately greater than in larger houses. One estate agent, dealing largely in weekly properties, whose payments for re-decorating due to gas discolouration, &c., amounted to upwards of £2,000 per annum, has found the remedy in electric light, which he introduces at every possible opportunity, to the advantage of all concerned.

A couple of years ago the Health Committee of the Brighton Corporation, in its annual report, stated that the cost of re-decorating, &c., in the artisans' dwellings administered by them was absorbing more than a third of the rent, and even this amount was inadequate to keep pace with the deterioration, which was largely due to gas, and it was found impossible to keep the houses clean. Mr. John Christie, the electrical engineer and manager, took the opportunity of advising the use of electric light as an experiment in some of the houses, and put forward a scheme with an estimate of the cost. The Health Committee decided to install electric light in 12 houses as an experiment, if the tenants could be induced to use it, and also directed that the experiment should be made in Tillstone-

street, which consists of about 60 houses and flats, rented respectively at 11s. and 8s. 6d. per week. By the time the last installation was completed those first connected were in a position to tell their neighbours "how long a shilling lasts." It being summer time, it was found that a shilling lasted from three to four weeks, and was only equal to the rentals paid formerly for gas fittings alone, without the cost of gas. The applications then came along without canvassing, and the Health Committee sanctioned another dozen, and later a third dozen, and then the remaining houses as they became vacant, or as desired by the tenants. Both classes of slot gas consumers found that electricity was much cheaper. There is no doubt that electricity at 6d. per unit can displace gas at 2s. 10d. plus rentals, or 3s. 8d. per thousand with "free fittings," provided that a scheme is introduced for installing. The cost of consumption is so favourable that the consumers will do much to extend the business amongst their neighbours and friends. What is really necessary is that houses should be wired during construction. The cost of installing then could be reduced by 20 per cent. As the builders and agents are finding by experience that a house lets better if fitted for electric light, they are quite alive to the advantages, and are prepared for a workable scheme of assisted wiring.

Since electrical contractors are generally content to limit their activities to the business obtained from architects and builders, this being in the better-class houses, as they are built or remodelled, or concern themselves with a lucrative jobbing connection and the ever-increasing sales in lamps and accessories, it is not to be expected that they will become energetic in this wider sphere.

Every friendly contractor is a real asset to the undertaking, and the work that he has and desires may well be left in his hands; but he should, in return, be sympathetic to any proposals advanced by the supply authority to widen the scope of operations, and he should render assistance where possible. For, even though he may not participate in the work itself, he must share the benefits which will ensue from the cheapening of the service, due to the wider use of electricity. It should also be possible for a working arrangement to be made between the supply authority and the contractor, if he so desires, in which the latter could participate in the work of installation. The cost would be met by the Corporation, who could recover this by an additional charge to the consumer, the amount of the charge being only sufficient to pay off the cost of the installation, after which it should terminate.

The result of the Brighton experiment has been a three fold success. It has provided the tenants with a good light in each room, and proved to be more economical than gas; it has saved the cost of re-decorating for the Health Committee, and also improved the health conditions; and proved beyond doubt that this class of work, given favourable conditions, can be made remunerative, thereby opening up a vast field for future operations.

When Mr. Christie submitted his estimate he placed the revenue at 6d. to 8d. per week per house. It was found that during the full year the average worked out at 6d. per week, which is most satisfactory.

It must not be supposed that property of this class warrants a separate service for each house; neither is it necessary. On the other hand, it will not do to follow the example shown in some catalogues advocating systems of wiring—namely, to connect up a series of houses to one service by running the cable along the front of the house, taking a branch into each through the front wall. This was seen at the outset to be quite impracticable in Tillstone-street, as the design of both the houses (Fig. 1) and the flats (Fig. 2) made outside fixing prohibitive. It will be seen that, apart from the exposure of the cable, the mechanical strains and the damage by abrasion, to which the cable would be subjected in negotiating the projections and recesses of windows, doors, &c., would not be conducive to a long life. Even if the houses were built on a uniform front line, and all attached so as to obviate all bending of cable, the exposure to extremes of temperature would in a comparatively short time cause the rubber insulation of the cable to perish.



Fig. 1.—View of Houses in Tillstone-street.



Fig. 2.—View of Flats.

After a careful survey of the houses, and a thorough scrutiny of the various systems of sheathed-wiring in vogue, together with much data collected from various sources, it was decided to use Henley twin lead-covered R/C cable, but without any of the joint-box accessories and elaborate clamping devices. The introduction of these boxes for through connection and Tee-junctions to switches, costing from 1s. 6d. to 1s. each, only tend to pile on the burden of costs; they are not by any means indispensable in a case of this kind, whereas they can be omitted with advantage. The cable, as constructed, fulfils its purpose admirably; but every time the lead sheathing is stripped a weak point is introduced. This was overcome by maintaining the lead sheath intact on each cable length, which not only saved the cost of boxes, &c., but also the labour for fitting them, and necessitated bonding at fewer points. It will be seen (Fig. 3) that the houses are built in blocks, and it was hoped that one service would suffice for each block; but owing to objections, reasonable and otherwise, and hesitation on the part of some of the tenants, this could not be done in every case, although the services now provided will suffice for the remaining houses, as they become vacant or the tenants find it convenient to change. In the case of new buildings this could, of course, be obviated.

At Tillstone-street the house service is run into a position as central as possible. It is connected into the usual single-pole iron-clad fuses, having fuses sufficiently heavy to provide a margin of safety for the group to be supplied. Each house

is then served through a 5-ampere double-pole coupled main switch and its own 5-ampere single-pole fuses, making each independent of the other. Coupled in with No. 1 supply on the live side is the supply to No. 2, the lead of both being clamped under a tinned copper strap, which is bonded to a connection sweated on to the lead of the main service cable. This affords a most efficient earth, is easily accessible, and if necessary it can be disconnected for testing purposes. The earthing of subsequent installations is effected by clamping under tinned copper strap, as before, at every point where two or more cables converge. The cable used for looping from house to house is 3/20 lead covered, and that elsewhere 3/22 lead-covered, twin in both cases.

In all cases of wiring under floors or in the roof three-plate ceiling roses are used. This obviated any joints, and the lead on each of the three cables, the feed, loop and switch cables, are clamped at each point, making the earth bond continuous throughout. In the case of surface wiring it was found best to use a 6 in. switch block, which also took a 5-ampere single-pole fuse above the switch. This saved joints, and also obviated the need for more than one cable, which could be parted in passing through the block and the earth strap connected behind. Much cable can be saved, and also future trouble, by a careful planning of positions of lights and switches. Advantage should be taken of the small dimensions of the rooms to save cable and labour. One pendant with flexible 1 ft. 6 in. long in the centre of a 10 ft. square room is satisfactory for any purpose. The best position for switches is at least 6 ft. from the floor. In the ordinary way there is no reason for fixing

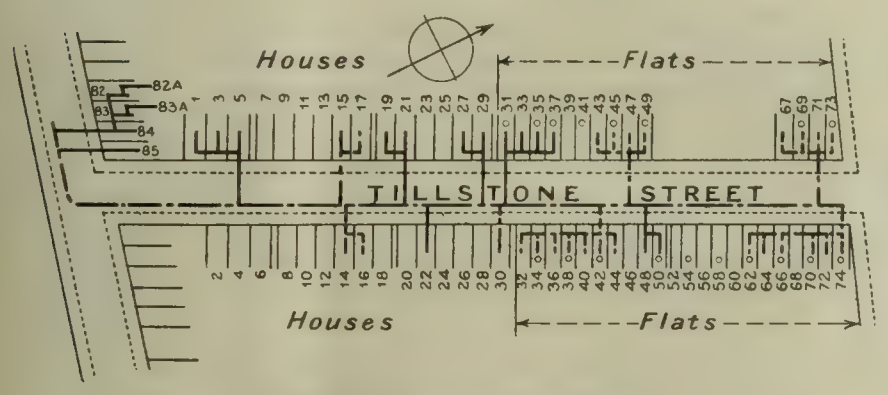


Fig. 3.—Plan of Services.

them so as to be an obstruction, as they often are. In this case the switch must be fitted sufficiently high to clear beds and other large furniture, and also out of the reach of children. This not only provides the necessary elbow room, but also saves cable and labour. The cable is easier to support, as this can be done, and made almost invisible, by pasting a well-matched strip of wall paper over it from the ceiling to the switch.

The method of connecting from house to house is also important. For obvious reasons this can be done better inside than out. Usually the best centre for distribution is a point high up in the bend of the passage. The ceiling can be pierced between the laths, and a hole made the exact size to take the cables side by side. All making-good can be avoided if care is exercised here, and another substantial economy effected. A gimlet hole, enlarged with the point of a pad-saw, or a pocket knife, from the lower side are better tools for this work than hammers and cold chisels, especially in inhabited houses.

The feed cable for house No. 2 is passed under the floor-boards through the party wall down to a similar position in the adjacent passage. The same applies to additional services. It will be seen that these will be long and short alternately. In the case of a long service, the cable will pass under the floor above the ceiling, and through the back bedroom of two houses to same position as before. These positions will afford complete protection for the cables. The holes through party walls can best be made by piercing the mortar only beside a "header" brick. This will avoid all hammering and the necessity for making good, as with a brace and a suitable drill the wireman can make a hole to fit the cable exactly, which is only about the size of a pencil.

In the case of flats the solution was the same. They are built in pairs with adjoining entrance doors, one each for lower and upper flat. The house service is taken in to a position at a ground-floor flat under the landing of the upper flat. The feed for the latter is then passed up to a position on the landing, but it should pass behind the skirting board and be fixed close to the architrave of the door for protection. Subsequent feeds are carried over, through the roof and down to the landing in the next upper flat, and then from there down to provide for the lower flat. This arrangement being repeated throughout the whole block. Advantage must be taken of constructional features which will save labour, materials and afford protection for cables.

The feed cable from house to house averages about 6 yds. each in length, and costs about 3s. This ensures a good cable of uniform quality, lead cased and earthed. The saving here is mostly in labour, as with the most inferior wood casing, or objectionable slip-tube work, the cost of labour for fixing is always the largest item.

The cost per point at Tillstone-street was 10s. 6d., including first quality switches, holders, ceiling roses and flexible cable. Opal shades were used, with the exception of two fancy shades being allowed for each house. The lamps are all drawn-wire tungsten.

This experiment afforded an admirable opportunity for deciding whether a scheme of high-grade work could be made to pay in this class of house. The results have proved so favourable, and the benefits so numerous, that now it is known it is welcomed by tenants and owners alike.

Another outstanding feature in this experiment is that it includes lamp maintenance. Here, again, it was quite evident, in the majority of the houses, that if the tenants had to replace lamps, when they failed it would militate against the scheme, for whenever a lamp failed the tenant could not afford to purchase a new one at 2s. 8d., but would ring the changes on the lamps until all were used up, when they would fall back again upon oil lamps, candles or whatever other means of illumination was most easily to hand. To overcome this difficulty it was decided to include lamp maintenance as a part of the scheme. Each consumer was given to understand that all lamps would be replaced free of charge, providing that they were electrical failures, and not mechanically broken. In the latter case they would have to provide replacements at their own cost. To prevent the lamps from being taken away they are all stamped "the property of the Corporation," and the tenants also have to return old lamps when the new ones are supplied. This proved to be quite successful. It was estimated and allowed for that there would be one lamp failure per annum per house. Instead of which, there were only seven failures for a complete year out of a total of 275 lamps fixed in 44 houses. This result will be welcomed by all interested in the extension of electricity supply into this new field of operations.

In future "free lamps" and "free wiring" should go hand in hand. This combination is essential to the success of the scheme, and it effects a balance which enables the scheme to pursue its course soundly. It also has a good effect upon the consumers; they realise that they have a good thing and do their utmost to retain it. They also know that if they abuse it the result will be to their own detriment. The drawn-wire lamp as now supplied by the best makers, although still at too high a price, is of uniform quality, life and efficiency. The average life of 1,000 hours' *use*, which means for bedrooms and similar places an average life of upwards of four years, will be more than realised. On this basis a 40-watt lamp will consume 40 units at least during its life, so that the additional charge for lamp maintenance need not be very high. If full advantage be taken of this, it will enable us to lead where our rivals dare not follow, as the gas mantle in a gust of wind is like a puff-ball reduced to powder. This is the reason that gas mantles have not been included in most of the maintenance contracts for outside shop lighting, and also the reason that in many places they failed. A high candle-power tungsten lamp would give

an average life of two years, whereas the life of the mantle was so uncertain.

There is much talk, some of it sincere, about the waste of all kinds which is common to-day and benefits no one. Surely that due to a cause which, if removed, will confer a benefit upon the whole community without any detrimental results should be the first to be tackled. The money, materials and energy wasted in artisan dwellings in trying to perform an impossible task is sufficient in itself to call for immediate action, apart from the great gain to the nation that would ensue from the improved health conditions of the people. The only opposition to the introduction of electric light for general use as an illuminant comes from those interested in the sale of gas and gas devices. This must be met and beaten in the interests of the community, as by the introduction of electric light a housing reform will be accomplished which will automatically overcome the great waste now caused by lamps and naked lights, and infant mortality will be reduced, thereby preventing the wastage of human life which the nation can ill afford.

An assisted wiring scheme, available only for slot-meter users, in properties where electricity would not otherwise be used, could not seriously be opposed by electrical contractors, and the Government should not withhold facilities from municipalities for carrying out the work, or at least financing it; for after spending large sums on buildings and plant it is only reasonable that the authorities should have the necessary powers to create a further outlet for the product they are empowered to supply.

ANNUAL REPORT OF THE ELECTRICAL INSPECTOR OF FACTORIES.

The annual report of the Chief Inspector of Factories has been issued, and contains among the sectional reports that of Mr. G. Scott Ram, H.M. electrical inspector of factories. In what follows is given an abstract of this report.

The mechanical accidents are fewer by 58 than in the previous year, a reduction of 13 per cent. They are such as are liable to occur in engineering works. A number were due to working on moving machinery One, causing two deaths, was due to the bursting of a steel bottle of compressed air for starting a gas engine.

The number of electrical accidents is slightly larger 99 as against 94 in the previous year, with four fatalities as against three. Under the first heading of the table some of the accidents were due to mistakes on the part of the switchman; others were due to matters beyond his control, either to faulty switchgear or to faults on the circuit at some distant point. In all cases the injuries were burns. In one the tank of an oil switch burst, and the attendant was injured by the burning oil. Six of the accidents occurred in the renewing of fuses.

One-half of the total accidents in electrical stations occurred to men when working on live conductors—mostly on switchboards. Eight occurred on extra-high-tension systems, and three on high-tension systems. Two cases were fatal. One of these occurred in a consumer's sub-station to a man dusting a switch (5,000 volts) in a compartment with a door normally kept locked, but which he had himself opened. The other case occurred to a man working in an underground sub-station making contact with an inadequately protected temporary cable (2,400 volts). In most of the high-tension accidents the injured persons were doing work which was unauthorised and were themselves to blame. Of the accidents on medium-pressure and low-pressure systems, 16 were caused by making short-circuits with ordinary spanners, screw-drivers or pliers. One accident was due to short-circuit in attempting to remove the tank on a live oil switch. Two other fatal accidents under this heading were reported, but they are not included in the table, as they did not occur on premises under the Act.

Under the next heading the fatality occurred to an engineer-in-charge taking hold of live conductors of a high-tension arc lighting switchboard, presumably thinking they were dead. A switch controlling the switchboard had apparently, contrary to the usual custom, been left on inadvertently from a previous shift. The victim was no doubt to some extent blameworthy in not ascertaining for himself whether the board was dead.

Under the miscellaneous accidents the fatal case occurred to a man who touched with his head a neutral conductor of a high-tension alternator. Several alternators were running in parallel, the neutral points of one being definitely connected to earth. It had previously been assumed that the neutral points of the other machines would have been very nearly at earth potential. In this case it proved that there was 500 volts pressure to earth. The machines were of different types, and the one in question was of lower voltage than the others and connected through a step-up auto-transformer.

Table I.—*Accidents at Electrical Generating Stations and Sub-stations in* 1914.

(The small figures relate to fatal accidents and are included in the principal figures.)

Description. (1)	Stations for public supply and electric railways and tramways. (2)	Other stations. (3)
Non-electrical		
At engines, pumps and generators	36	11[1]
At boilers and steam plant	76	1
At coal handling plant	18[1]	1
Falls	97[2]	5
Struck by falling bodies	35[1]	1
Miscellaneous	88[1]	12
Total	350[5]	31[1]
Electrical		
At switchboards when engaged in ordinary routine work	19	7
Cleaning, repairing, &c., at "live" switchboards or other "live" conductors	29[1]	20[1]
Cleaning, repairing or other handling of switchboards supposed to have been made "dead"	2[1]	
Adjusting brushes and cleaning commutators and flashing at commutators	2	4
Miscellaneous	13[1]	3
Total [3]	65[3]	34[1]

Table II.—*Electrical Accidents in Factories other than Electrical Stations in* 1914.

(The small figures relate to fatal accidents and are included in the principal figures.)

Arcing of	switches	38
	fuses	9
Shock or burns when replacing fuse wires		22
Portable apparatus, connectors and flexible wires		65[2]
Unprotected conductors, switches, terminals, fuses, &c.		36[7]*
Working on live electrical apparatus or conductors	skilled persons	42[1]
	unskilled persons	46[2]
Miscellaneous accidents in electrical manufacturing and repair works, mostly in testing operations		55[1]
Adjusting brushes and cleaning commutators and flashing at commutators		6
Miscellaneous		31[3]*
Total		350[16]

The electrical accidents in factories are fewer by 68, or 16 per cent., than in the previous year, the number of fatalities (16) being one less. The accidents in renewing fuses afford examples of the dangers of different types of fuses to which I have drawn attention in former reports. Most of the injuries are burns from short-circuit, but some from shock. In some cases short-circuits were made by getting the fuse wire or pliers or other tool across the terminals of both poles or between one pole and the metal case. In some instances the fuses had been protected by a switch, but this, being at a distance, was not used. In other cases where there was a switch at the fuses it was connected on the wrong side, so that the fuse terminals were live whether the switch was "on" or "off." Several occurred with fuses in porcelain carriers having the fuse wire in a groove in the front of the porcelain.

Of the accidents in the use of portable apparatus, 26 occurred in handling the flexible conductors. One case, having fatal results, occurred to a man when working on the wet floor of a dry dock. He was engaged in scraping a ship's bottom, and is supposed to have trodden on the flexible cable of a portable lamp cluster, a nail in his boot piercing the insulation of the cable. In many works there is no proper examination of the flexible conductors, which remain in use after being badly damaged and worn out. In some cases the metallic armouring of the flexible wires had broken and pierced the insulation. Metallic armouring, especially in the form of a wire helix, is not a desirable form of protection. The earth connection is liable to become disconnected, and through rough usage and constant bending the wire is apt to break and pierce the insulation, and becoming live is very dangerous. Other forms of protection, such as rubber or hard cord braiding, are generally preferable. Twenty of the accidents occurred in connecting the flexible wires to the circuit. In most of these cases the use of safety type hand shield plugs would have prevented the accidents. The short-circuits which occur in this way are often very heavy, leading to very severe burns, by reason of the circuit being too heavily fused. In one case it was found that the circuit for a hand lamp was fused for 60 amperes. Three cases of shock occurred from unearthed portable drills. Some cases of shock from hand lamps also occurred. It is noteworthy that safety type cargo fittings have been devised and are now on the market.

Under the next heading, "Unprotected Conductors," there were seven fatalities, of which six were due to contact with overhead wires. The wires, although out of reach from the ground, were so placed that work-

* One fatality, fall following shock.

men in the course of their duties might have at some time to get into close proximity to them. The braiding of wires without any insulating covering is quite useless, and may lead persons erroneously to suppose that they are insulated and safe to touch. Of the non-fatal accidents, nine were in connection with electric cranes. Five were by men touching the bare trolly wires when getting in or out of the cage. Four were due to unprotected conductors in the cage.

Under the next heading, "Skilled Persons Working on Live Conductors," the fatality occurred on a 440-volt three-phase system. Alterations had to be made to a motor circuit, and the electrician cut into a live wire with a pair of pliers. It was found that the fuses protecting the circuit had been removed from two of the wires, but not from the third. The accidents under this heading might for the most part have been avoided if the work had been done at night, when the works were shut down. Several occurred at switchboards when tightening nuts with ordinary uninsulated spanners.

The corresponding accidents to unskilled persons are less excusable. In many works no technically qualified person is employed, and unskilled workmen are consequently permitted to attempt repairs or alterations at great risk to themselves. The two fatalities occurred on travelling cranes. In both cases the system was 440 volts three phase. Of the non-fatal accidents, the victims were described as labourers (13), fitters (9), bricksetters, oilers, &c. They were mostly attempting to do some work on the electrical apparatus for which they were quite incompetent.

That the testing of electrical apparatus in electrical manufacturing works is largely carried on by apprentices and pupils is again indicated by the ages of the persons meeting with accidents. The fatal accident occurred, however, to an experienced electrician, who touched wires at 2,000 volts, apparently under the impression that they were dead. Artificial respiration was carried on for two hours without success. In another case a man touched some testing leads at 12,000 volts pressure. He was rendered unconscious, but was brought round by artificial respiration. In the other cases the injuries were mostly burns from short-circuits. The testing departments of electrical manufacturing works are often carried on in a very unsatisfactory manner. There is unnecessary exposure of live conductors where they are liable to be accidentally touched. Any old connecting cables with damaged insulation are considered good enough. Even in high-pressure testing unnecessary risks are run.

Amongst the miscellaneous accidents there were three fatalities. One occurred to an electrician in a large iron works in switching on a lighting circuit transformer, arranged across one phase of a 460-volt three-phase system, at a totally-enclosed ironclad switch, the case of which was not earthed. The switch was of a well-known type, having fuses in the same box so arranged that when the switch is in the "off" position the fuses are withdrawn from the contacts, and by opening the cover they can be renewed in safety. The apparatus was intended by the makers for use with cartridge type fuses. As so often happens, however, the cartridge fuses had been replaced by wires. At the inquest it was urged that the apparatus was advertised as being "fool-proof." It is evident that this description requires some qualification. In the second fatal case the man received a shock from a 200-volt two-phase motor, the frame of which was live and not earthed. He was about to start up the motor, and had turned on the main switch but not the starting switch. He was engaged in shifting the belt on to a loose pulley, and his hand was trapped between the pulley and the belt. A man who went to his rescue also received a shock. The third fatality occurred to a boy, who climbed up on to a roof and took hold of two wires of a 440-volt three-phase system. Amongst the non-fatal accidents two were due to stay wires of poles becoming live.

Amongst the electric shock accidents there were several cases where the victim was brought round by means of artificial respiration. On the other hand, in several of the cases which ended fatally no adequate measures were taken to attempt to restore animation. In my report two years ago I drew attention to a letter by Dr. R. Morton which appeared in the "Lancet" and other papers, pointing out that death from electric shock is in general at first only apparent, and that by means of artificial respiration promptly and carefully carried out patients may often be revived, even as long as two hours from the time of the accident. In general, however, the medical profession appears to be somewhat ignorant on this matter, with the result that in many cases adequate efforts at resuscitation are not carried out.

It will be noticed that all the fatalities were due to shock from alternating current; 18 were due directly to shock and two to fall following shock. 15 were from pressures of 440 volts or less. Most of the shocks being to earth from touching one conductor only of the system, the voltage received by the victim was less than the voltage between phases.

In my visits during the year I again found numerous examples of dangerous switchgear and other apparatus contravening the requirements of the Regulations. In high-pressure and extra-high-pressure stations switchboards without any protection of conductors within easy reach of persons in the passage-way were noted. In one case there were bare conductors at 10,000 volts along one wall with a gangway about 3 ft. wide; a single iron rail 12 in. out was all the protection. At the far end there were isolating switches requiring to be operated at intervals of a few days, necessitating the use of the passage while the conductors were live. In another case, although the passage was wider, there was not even a hand rail. The excuse sometimes offered is that only authorised persons are allowed in the passage-ways. In one case such a passage-way was also used as a store room. Sometimes, where 'bus bars and isolating switches are placed out of reach from the floor, lamps for lighting the passage-ways are placed close to them, so that when a lamp fails and requires renewing the attendant will have to get up dangerously close to the live conductors. In some cases where the protection was adequate as regards ordinary routine operations and inspection, and where duplicate 'bus bars were provided, the arrangement was such that when cleaning or other work should have to be done the advantage of the duplicate bars was lost. Thus the generator and feeder cells were arranged for connecting to either set of 'bus bars by selector switches. Both sets of selector switches were, however, in the same compartment, and the two sets of 'bus bars were not separated, so that when it should become necessary to clean the insulators of the isolating switches or 'bus bars or otherwise work upon them, it would be necessary to shut down on both sets, and therefore to stop the supply. This point has been overlooked in a number of public supply stations from which the supply is supposed to be continuous. In some cases a still more obvious mistake has been made in putting the isolating switches in the same compartment with the oil switches, so that unless special screens are provided for covering up the live side of the isolating switches, which is not always practicable, an oil switch cannot be overhauled without shutting down the whole switchboard.

Further examples of medium-pressure three-phase switchboards, mostly with oil switches, were found on works where the supply has to be maintained continuously, including night time and Sundays, and where no provision was made for isolating the oil switches or other parts when any work should become necessary. In a works using large electric welders the primary switchboards, 440 volts alternating, having bare switches, fuses, &c., were placed behind the welders, where they could only be reached by standing on the welding machines, and where the metal hoops being handled would be liable to be accidentally brought into contact with them. At a large new dock the cranes had bare switchboards in the confined space of the driving cabins. The connector plugs for the main cables to the cranes were not protected by switches, and were so designed as to be liable to short-circuit on plugging in. The most common faults in works concern the distribution fuse boards. Fuse holders which cannot be handled without risk of touching live metal and in which the fuse wires are unprotected are still supplied for new installations.

Table III.—*Showing Voltage and System in Fatal Cases.*

No. of fatalities.	Voltage of system.	Voltage of circuit or probable voltage of shock.	System.
1*	6,600	500	Three-phase.
1	5,000	2,900	,,
1	2,000	1,150	,,
1	2,400	2,400	One-phase
1	2,000	2,000	,,
1	500	290	Three-phase.
1	460	265	,,
2	440	440	,,
7†	440	250	,,
1	400	400	,,
1	400	230	,,
1	240	140	,,
1‡	200	200	Two-phase.

* Shock from neutral conductor. † One fall due to shock. ‡ One fall due to shock.

THE THERMOPHONE.

We understand that the British Post Office are investigating Mr. De Lange's thermophone, and have ordered a dozen telephones for their research department so that life tests may be made.

Among the points that at once arise in connection with this instrument are the possibility of fusion of the wire and the question whether the instrument is fragile. In regard to the first point, Mr. James Swinburne has reported that, after testing some of the telephones for speaking, the current was then increased to the fusing point. One telephone required an increase of 115 per cent., another 67 per cent., and a third 70 per cent. to cause fusion. As the resistance of the wire rises on heating, this means a very large margin of power, and shows that on circuits of small resistance the instruments largely protect themselves, taking something in the neighbourhood of four to eight times the speaking electric power to cause fusion. With regard to the question of fragility, Mr. W. Llewellyn Preece has tested one of the telephones by dropping it down a flight of stairs. After this treatment it was as serviceable as before, so that it cannot in any way be considered as delicate. Mr. Preece points out that, although the telephone is not yet suitable for distance telephony, the instrument is a distinct improvement on the magnetic telephone where the distances are short, as in houses, ships or aeroplanes, owing to the greater clearness of the speech, excellent articulation and an ample volume of sound.

Mr. De Lange has now produced small portable sets for the use of deaf people, and last Friday he gave a demonstration of the uses of the thermophone for such purposes before the Council of the Otological Section of the Royal Society of Medicine.

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THE LIGHTING OF ARTISANS' DWELLINGS.

There is a very large class of house property which so far has not received the benefits of electric lighting, although some successful attempts have been made to enter this field. We refer to artisans' dwellings and the smaller class of house in which the individual load is very small. It is quite clear that the tenant in such cases will not spend money in wiring his house, and it is equally clear that the landlord will not invest money in this direction. On the other hand, the load obtainable from this class of property is quite as valuable as any other lighting load, provided that the money spent in services, meters, meter reading, &c., are not so great as to leave little or no profit. Valuable work in this direction, to which we have referred at times, is being carried out by the Fixed Price Light Co. in London and at Wimbledon. Attempts have also been made by various undertakings to provide free wiring, and the opinion has been expressed more than once that there is such a thing as a "free wiring fallacy." It must be remembered, however, that conditions have changed within the last few years. In the days when we had to rely upon carbon lamps, and then had to make an additional charge per unit to cover the cost of wiring, this turned the electric light into a veritable luxury. Now, however, the metal filament lamp has changed the position of affairs. The amount of energy used is so much less that a substantial additional charge can be made, and even so the cost of electric lighting will not compare unfavourably with the cost of gas lighting. Nevertheless, it is essential that the first cost should be kept as low as possible, not merely in the house wiring, but in the services.

No doubt the problem of supplying this class of property is complicated by the necessity of weekly payments, for quarterly payments become impracticable. This fact affords a very good argument in favour of the prepayment meter, as visits of the meter reader are then reduced to a minimum. On the other hand, there is a good deal to be said in favour of the contract system, which is adopted so much abroad, and which has also found a place in some schemes to which we have referred. The cost of a shilling-in-

the-slot meter is about 35 to 40 per cent. of the total cost of an installation such as we are considering, and the elimination of this item is a compensation for a little uncertainty as to the amount consumed. In the better class of artisan consumers it should be practicable to collect monthly, instead of weekly, payments in advance.

On another page we publish an article by Mr. J. CLEARY describing what is being done in this direction at Brighton. In dealing with any class of property the most satisfactory course is, no doubt, to have the houses wired during construction, as there is material saving by so doing. Unfortunately, this is seldom done. The houses must be wired in their finished condition, and the cost must be reduced as far as possible by wiring on certain methods which are essentially simple. In some schemes the service cable has been run along the front of a block of houses, but at Brighton the special construction of the houses did not allow this simple course to be followed. In this case lead-covered cable has been adopted, and the houses are looped together, the work being carried out inside the houses. Similarly, twin lead-covered wire is used in the internal wiring, and thus the cost per point comes out at the low price of about 10s. 6d., including first quality switches, holders, ceiling roses and flexibles.

In work of this character it is desirable that free lamps should form part of the scheme, otherwise there is a tendency for the tenant to turn to some other illuminant when the cost of renewing lamps has to be faced. It is found that drawn-wire tungsten lamps have an average life of 1,000 hours' use. The price per unit is 6d., which includes free lamps, free slot meter and "free installation." The average receipts per week are about 6d. per house, and the result is found to be financially satisfactory. Lights are fixed in every room and in the hall, there being six points in the flats and seven points in the houses. Our readers will find many other interesting details in Mr. CLEARY's article.

In some undertakings (more particularly those having a large power load) it may be thought that this class of load is not worth much consideration. With this point of view we cannot agree. Apart from the idea that all classes of the community have the right to be considered by the Committee that is responsible for a municipal undertaking, the fact remains that the small consumer plays a most important part in the prosperity of the large London gas companies, and there is no reason why he should not be important electrically. Now is the time for making plans for the future, though the execution of such plans may, perforce, be deferred for a time. We, therefore, feel that a greater effort should be made to cater for this class of consumer, and we hope that other undertakings will follow the example of Brighton, and will look into the subject seriously.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s Add 10 per cent. for abroad or for foreign books.]

Modern Boiler Room Practice and Smoke Abatement. By JAS. T. HODGSON. (London: "Railway Engineer.") Pp. xv. +321. 3s. 6d. net.

All grades of coal have shown a marked advance in price during the last few months, and there is no reason to expect that there will be any great fall from current prices for a considerable period. As a natural consequence, every power engineer will seek the best means of utilising the potential heat energy of the fuel, which is another way of stating that the most suitable kind of coal for this particular type of boiler should be purchased; and also that the management of the grate should be more scientific. In other words, both manager and stoker are each required to perform his part. Of late, many books relating to boilers have been published nearly all of which deal with the selection of the right grade of fuel and the testing of the same; the design of the many different types of boilers met with in practice, and giving the efficiencies that each can be relied upon to show under certain conditions. Very few books, however, have been given to the public which aim directly at helping the manager and the stoker to get the best out of the boilers which they already have.

The volume under consideration sets out to do this, and contains within its 313 pages some excellent information on modern boiler room practice. At the beginning is a very clear synopsis of the contents of the book, in which the chief particulars of each chapter are lucidly set forth. For the purpose of review this synopsis can be reduced to Chapter I.: Introduction. II.: Coal and Its Combustion. III.: Natural and Mechanical Draught, Production, Control and Measurement. IV.: Hand-firing and Smoke. V.: Mechanical Stokers. VI.: Coal and Ash Conveyors. VII.: Flue Gas Analysis and Recorders. VIII. and IX.: Construction of Boilers, Mountings and Accessories. X.: Feed-water Impurities and Softening. XI.: Feed-water Heaters, &c. XII.: Feed-water Pipes, Pumps and Injectors. XIII.: Properties of Steam. XIV.: Superheaters. XV.: Steam Pipes and Traps. XVI.: Supervision and Testing of Plant. XVII.: Engineering Data. XVIII.: Instructions to Attendants. XIX.: Questions and Answers on the Maintenance of the Boiler House Plant. XX.: Questions and Answers on Coal, its Combustion, and the Prevention and Abatement of Smke.

In normal times the cost of the fuel for a Lancashire boiler, together with the interest on and depreciation of same, is, say, £600 per annum. Now, the labour charges of attendant part time bears a small proportion to this £600; hence, any extra economy of fuel will soon pay for extra wages given to better qualified men. Surely there ought to be some means of technically distinguishing between good and bad stokers other than by individual trial by each separate employer. Could not some steam users' association hold a practical and written examination, giving to the successful competitor a certificate, and those who hold such a certificate might reasonably ask for 3s. 6d. a week more than those who fail to obtain the same. The man who is keen to save his employer expense would then be remunerated. Such men would find much to help them in this book. The questions and answers given in Chapters XIX. and XX. give just the type of examination needed; in fact, every really good boiler attendant should be able to appreciate their value.

Pages 288 to 293 are unnecessary to the book, and some descriptions of apparatus, such as coal calorimeters and water recorders, could be better obtained from a book on boiler testing. The deletion of this part would leave the book smaller, but more handy and compact. As it stands, it is one to recommend to young engineers and others whose sphere of work is entirely in or about a boiler house. A. J. M.

A Laboratory Course in Electrochemistry. By OLIVER P. WATTS, Ph.D. (London: Hill Publishing Co.) Pp. 150. 4s. 2d. net.

The object and scope of this little book are indicated by the author's statement in the introduction—namely, that "The experiments in this manual have been chosen to illustrate the general principles which underlie the more important applications of electrochemistry."

The book is divided into 133 experiments, embracing the following topics: Specific resistance, polarisation, Faraday's law and coulombmeters, single potentials and E.M.F., discharge potentials, over voltage, passivity, corrosion of metals, electrolytic separation of metals, electrolytic analysis, electroplating, electrolytic oxidation and reduction, other electrolytic preparations.

In the case of each experiment, the method of carrying it out and the questions to be answered are indicated, but the results are not given. This is a good teaching method. In some cases references to larger works or to scientific Papers are given. The latter are mostly taken from the 'Transactions' of the

American Electrochemical Society and various American technological journals.

A very large amount of space—namely, about one-third of the whole book—is devoted to electro-plating.

As the author states in the preface, the book is a laboratory manual, designed primarily for use in his classes on applied electrochemistry in the University of Wisconsin. No doubt, when supplemented by Dr. Watts' lectures and personal instruction, the practical work indicated in this manual forms a very good course. Taken by itself, however, the book gives one the impression of being rather sketchy and superficial. In some portions—*e.g.*, in the part dealing with electro-plating—the author tries to give too much "technical information." Here one would like to have seen a much greater insistence on scientific method and less recipes. A thorough-going study of the electro-deposition of, say, copper and zinc, might very usefully have replaced a great deal of the recipe-mongering.

There is a curious omission in the book. Although the author devotes a considerable amount of space to methods for determining E.M.F.s, electrode discharge-potentials, &c., there is no mention of, and no exercises for determining, the energy expenditure or the energy efficiency of an electrolytic process. And yet that is the very first question the engineer asks the chemist!

F. G. Donnan.

SOME DIFFICULTIES OF DESIGN OF HIGH-SPEED GENERATORS.

The following is a report of the discussion at the meeting of the Institution of Electrical Engineers on Thursday, Nov. 25, on Prof. A. B. Field's Paper on the above subject. An abstract of the Paper appeared in our last issue.

Prof. Silvanus P. Thompson said he would like to examine machines such as the author described. One was not accustomed to deal every day with core discs without a hole in the middle and of a thickness of 2½ in., and when they were locked together so as to form a quasi-solid body one wondered whether the solidity was as real as it looked. In the Paper they were informed that "the rotor body as constructed consists of, first, small cross-sections (bolts) under compression," and "as long as these conditions subsist the stiffness is the same as that of a solid mass having no partition planes, and it is unaffected by the stress distribution." He was not going to challenge the statement; he would take it that Prof. Field was convinced that it was so, but he would like to know whether it was a pious opinion or a statement of the result of actual tests. Was it founded on good experience of a theoretical character and applied to that particular case, or was it an actual test fact? He confessed to some kind of doubt as to bolts that had to press together so many joints along their length. It was also stated: "The bolts are to be finally tightened up after the slotting and the heads of the nuts cut off." He thought there might be some loss in doing that, when one considered the extraordinary tensions the bolts were exposed to. When a nickel steel rod 4 in. in diameter was used, and was screwed up till it was pulled out a visible $\frac{1}{10}$ in., the strain on the nut must be great, and why it should be reduced by cutting the head off he did not see. The dodge of putting a wedge in in three pieces—putting a middle piece in that could be pressed down with great pressure and then pressing in the two side pieces—"feathers" he supposed they were—of steel seemed an admirable device. With regard to the rotor windings, Prof. Field referred to the insertion of a compressible steel cell on the top of the copper. He presumed those two end rings that were compressed down upon the end bends took the place of the bells that were formerly on the rotor. In the comparison of the magnetic leakages as between a balanced three-phase load and an unbalanced load, which was equivalent to a three phase load with a single-phase load superposed upon it, it was interesting to be told that the leakage was no more than 10 per cent. greater, but they had no figures as to what the leakage was; what would be the value of the ordinary Hopkinson coefficient in those large machines? A year or two ago Prof. Miles Walker read a Paper which referred to the subject. He explained that the great thing in the construction of an alternator rotor was to fill the space in the active part of the thing—its periphery—with as much copper as possible in order to get the machine to excite without too much waste, and also to fill it with iron, so as to have plenty of iron to carry the magnetic flux, so a compromise must be made between the two. Here was a novel solution offered of a problem of incompatibilities. By avoiding the radial ventilating ducts more iron was got in, and apparently the high densities used for the current and the copper had enabled the copper to do more duty, and so got nearer to the ideal condition. He wished Prof. Field had given further information about the structure by which the end bends of the stator windings were held. One of the illustrations gave a good idea of the two layers of end bends, like funnels one inside the other, and the author spoke of a herring bone bronze casing between those two layers, but that was not visible, and he (Prof. Thompson) wanted to know more about it. At the end of the Paper there was a vision of a time when even mica would be superseded as an insulator for stator windings in favour of some sort of fused silica. The use of that—bad mechanical material as it was—would be a welcome addition to the means of insulation at the disposal of the constructor. Another interesting feature was the magnetic wedge. The machine taken as typical was for 60 ∿. They did not know much about 60 ∿ in this country, but it was a standard in the United States. What was Prof. Field's opinion as to the advantage or disadvantage of fixing 60 ∿ instead of 50 ∿ as a standard? How did it work out for large installations and large machines?

Mr. F. N. Clough referred to the rating adopted, and said such a machine would be called a 14,000 kw. machine in England, the reason being that such a machine would be required to run at 80 per cent. power-factor, and would have to carry 25 or 50 per cent. overload. Assuming that it carried those overloads for two or three hours, it would carry 15 per cent. continuously and the rating would thus be 15,000 k.v.a. It would be desirable if they could come to some such basis of rating as had been adopted there. It would have been to the advantage of everybody to give a definite rating with no ambiguity about overloads. A committee was working at that question and he hoped they would soon come to some result. He appreciated cordially the manner in which the difficulties of design had been dealt with; especially, he thought the idea of putting in bolts under initial tension was exceedingly ingenious. It meant that the rotor material was already stressed, and it tended to keep the rotor rigid before any deflection took place, whereas with the ordinary rotor made of a solid forging deflection had to take place before any stresses came on the material, tending to restore the rotor back to its normal position again. Perhaps the same results could be obtained without resorting to that construction. The author said it was impracticable to use discs with holes through them and a through shaft. He was inclined to think that by proportioning machines slightly differently, say, with smaller diameter and slightly smaller length, a through construction would be possible. If that had been done he thought much larger holes for ventilating the rotor could have been used and on account of the additional ventilation considerably more ampere-turns could have been obtained and also on account of the smaller diameter considerably more copper could have been put on. The author did not state the actual amount of flux, but he said the rotor was saturated, and he gave the dimensions of the rotor, and one could guess fairly well what the flux of the machine was. In the stator there were two layers of winding, each 1¼ in. deep; they had seen a view of the slot, and they knew it was insulated for 13,000 volts, and they could make a guess as to the armature reaction. The machine would, he thought, have been better if it had a higher armature reaction and lower flux; close regulation was not aimed at, and, therefore, there seemed to be no reason why a higher flux should not be used. He was inclined to think it was preferable to have the fans on the rotor than to have external apparatus which meant more auxiliary machinery in the station. The rotor wedge described was ingenious, but it involved three parts instead of one, and he thought it was a pity to have more loose parts on a revolving rotor than were necessary. He thought one wedge would be sufficient, and that an excessive pressure in keeping the windings in place was not essential. The author mentioned that refinement in connection with the slots, but he (Mr. Clough) did not see how he could apply the same pressure to the coils at the ends of the rotor, and if they were not taken care of it seemed useless to expend so much trouble in compressing the coils in the slots themselves. If the machine were run up to full speed the coils would take their proper position and would not move appreciably afterwards. His (Mr. Clough's) company ran the rotor up to speed and then took it back to the winding department, where the coils were partly pressed. Rotor coil bracing was desirable, but he did not think the forces that came into play on the rotor coils were such as required any very special bracing. The rotor had such great mass and such momentum that the angular retardation was comparatively small. The forces coming on the coils were comparatively heavy, but the centrifugal force was so heavy that the friction against the retaining rings held them firmly in place with several hundred times the force necessary to displace them. It was easy to force the retaining rings against the body of the rotor. The Paper did not explain how the large coils at the ends were successfully dealt with, or how the bonding was done between the bars and the end rings. It seemed to him unnecessary to put unloaded copper on the end ring itself if the bonding on the rotor had been thoroughly carried out.

Mr. N. Burge, referring to the plates in Fig. 3, said, except for the copper winding in the slots, there appeared to be no positive means of preventing the plates sliding from one another circumferentially. In the event of a short-circuit, one might fear that the great forces resulting would set up a twist in the rotor and throw it out of truth. One problem dealt with was the keeping down of the size of the retaining rings. To increase the capacity at high speed one must eliminate the stray losses, such as those caused by dust in the solid pole faces, and those in the stator conductors due to eddies in the pole faces and the whole saturation of the field, causing eddies in the stator conductors. To that end the author had adopted stator wedges, which must be most useful in preventing eddies in the solid faces. It was remarkable even in smal machines, with an air-gap of about one-fifth of the slot width, how a light solid iron wedge would actually reduce the iron losses in the machine by 40 or 50 per cent., in spite of the fact that the pole shoe was already laminated. As regarded the eddies in the stator conductors, he thought the most effective way, and one which absolutely cured that trouble in deep slots, was to use a compressed stranded conductor with solid end connections. In that way each strand completely turned over every 2 in. or 3 in. in the slot, and eddies were practically eliminated.

Dr. S. P. Smith said the Americans obviously felt a difficulty on account of the 60 ∼. In this country, with the 50 ∼, the same difficulty did not seem to have occurred. The whole argument seemed to be based on the question of the critical speed and of obtaining a shaft of such stiffness that the running speed should be below the critical speed, and Prof. Field gave his reasons why that should be so. Could he give his reason why a shaft should vibrate worse between the first and second critical speeds than below the first critical speed ? If a rotor could be built satisfactorily to run above its first critical speed—between the first and second critical speeds—as, in fact, most rotors for continuous current were, the limit of output would be increased considerably. On the other hand, if the running speed were limited to a speed below the critical speed, the limit of output would soon be reached, and it seemed they had already practically done that with the present materials and with the electric and magnetic loadings that they could go to. If they were going to have larger units, it seemed that they could not do much more with the present restriction of running below the critical speed, unless they had a machine considerably longer. Could this idea of using through bolts near the circumference be used with a solid rotor, either cast or forged ? In case there was any uncertainty in such a rotor you could give it a certain factor-of-safety. The conditions in any case could be no worse than with Prof. Field's rotor, and they might possibly be better. What experience had Prof. Field as to the magnitude of the leakage and the trouble that might arise due to leakage increasing the saturation in the rotor ? Was it considerable in a long rotor, such as the one he described ? The overhang itself would add a considerable amount to the saturation of the end bolts, so it might not allow a considerable amount of flux to go out of the rotor. Perhaps with a long rotor, such as Prof. Field mentioned, it would be a really very small effect on the saturation that the flux leading into the end bolt could have. Had Prof. Field any figure to give them for the value of the stator leakage ? He would be pleased to get Prof. Field's opinion, to avoid the necessity of resorting to external reactances to make a machine safe against short-circuits. Had the author both slip rings at one end or one at each end? He (Dr. Smith) would have had one at each end. He would imagine the construction described for a two-pole machine would be rather clumsy, because two of the four bolts would come in an awkward part of the rotor. It seemed that it would rather limit its application to the large two-pole turbos, but it was an ingenious idea apart from its application. One doubted at times whether it was always necessary to use so much bronze for those wedges. They were expensive, and there was a big weight of them in the keyways. One wondered whether it would be possible to use cast-iron. He had found cast-iron quite satisfactory for small machines. It was easy to work, it was cheap and did its duty admirably, and the oscillograms one got of the flux distribution were very satisfactory. Had Prof. Field found any trouble due to the bolts going through the middle of the unslotted part of the poles ? There must be a gap of a small fraction of a millimetre, and when these bolts were drawn up it would certainly lead to some increase in the gap, however slight. Had he had any trouble due to the throttling of the flux there, as in the case of a steel bolt through a salient pole ?

Mr. W. M. Mordey said, in the section of the Paper on external short-circuits, the author referred to the effect of short-circuits at feeders and so on, and he said that " it has been felt by come of us that these large machines should be so built that they could be dead short-circuited at their terminals when running excited and giving full voltage." He said, further, " It did not appear unreasonable that a purchaser should desire to see his machine short-circuited in this way on the test floor or after erection." He (Mr. Mordey) thought it should be put into every specification to makers arranged to-day. It was done 30 years ago on smaller machines. One wanted a short-circuit dead across the terminals, not merely for the generator, but also for the engine or turbine. Prof. Field suggested that it should be made when running excited and giving full voltage. He (Mr. Mordey) went further, and said it should be made when running on full load. The end of the section referred to the satisfactory results of such a test of a machine with a certain construction. He would like to support what the author said there about the practical desirability of such a test as one that should be made on machines just once as a condition of their final acceptance.

Mr. R. Livingstone said he was somewhat surprised that it had not been asked why they were dealing with such large units. At the present time there were few stations in this country with a load exceeding 30,000 kw., and a single unit would not be put up in such a station. When railway electrification came along we might have 200,000 kw. stations. The limit of progress would probably be at 50,000 kw. machines. We should progress as far as the metallurgists would permit us. We were dependent on the metallurgists for the limits to which we could go in output. There was no difficulty in design provided we could obtain materials of any strength we liked. He thought the difficulties had probably been overestimated. When one thought of a flux of an alternator of 100,000,000 or 150,000,000 it was easy to realise that the amount of flux necessary to saturate the end ring was comparatively small. The only point in the end bell being made of magnetic material was that the flux at the end of the machine was not of the same intensity as towards the middle of the machine. There was a little unequal distribution. The same thing happened when air-gaps were provided in the centre of the machine for cooling. If the air duct towards the centre were ½ in. closer than at the ends you could appreciably increase the heating at the ends of the machine, whereas usually the highest temperature was reached at the centre. The size of conductor used in machines of such large output tend to eddy currents. He gathered that the conductor was twisted in the slot in a peculiar way. Perhaps the author could give them some information as to how it was manufactured. Using stranded cable avoided eddy currents, but at the ends of the conductor there was a weak place where the effects of shorts might be felt. A good many engineers favoured the use of fans on the rotor shaft, but it added to the length of the rotor, and when we had stations of 100,000 and 200,000 kw. capacity the time would come to instal plant for cooling the whole station. It was doubtful whether it was really necessary to use magnetic steel. He thought the ordinary steel alloy even would be a sufficiently good magnetic conductor, and enable the peripheral speed to be increased. He had noticed in connection with steam-driven turbo-alternators short-circuited on full volts and no-load that, although the speed fell very slightly, the governor levers at once opened up the throttle valve to its full extent, so at the time of short-circuit one probably had the same conditions as when running on full load, though not quite so severe.

Mr. R. S. Allen said it seemed to him the method adopted for keeping the tension on the bolts of the plates was crude—namely, using a spanner on the end of a crane. The author might have employed a hydraulic jack to get the pressure up to 20, 30 or 100 tons, and then apply the bolt and let the expansion of the metal give the tension desired.

Prof. Field, before replying to the discussion, read notes from Prof. Miles Walker, in which the latter said the construction of the steel body of the rotor described in the Paper was very suitable where rotors of large diameter were required to run at high speeds, say, at peripheral speeds of 24,000 ft. per minute. He gathered from the Paper that Prof. Field would recommend solid steel forgings where the peripheral speed was not too great—for instance, on a rotor running at 1,500 revs. per min.—and not measuring more than 50 in. in diameter ; it would appear that satisfactory solid forgings could be obtained. The makers of the forgings were willing to guarantee satisfactory test pieces taken from various parts of the forging in both a longitudinal and a tangential direction. As the present tendency was to build larger and still larger units, it was well that they had the steel plate construction described in the Paper, so that the peripheral speed could be still further increased without introducing an element of uncertainty. For small machines and for machines of medium output the separately-formed edgewise-wound coil had been found simple and convenient ; but he believed that for the very much larger machines likely to be built in the future a better type of winding should be put forward. He described such a winding which had already been used in a large number of generators. The main points in its favour were : (1) It supported the heavy end windings in a thoroughly mechanical manner between stout steel cheeks. (2) The factor-of-safety could be made much higher than where the windings were supported only by end bells. (3) The copper in the rotor slots consisted of deep bars, so that there was very little insulation to give way. (4) A proper provision could be made for the expansion and contraction due to the heating of the conductors. (5) The diameter of the rotor for a given output could be considerably reduced. To illustrate the advantages of this winding, he showed on the screen a lay-out of the end connectors for a 50,000 k.v.a. generator running at 1,500 revs. per min. The diameter of the rotor shown was only 58 in., so that the steel body could be built up with steel plates as described by Prof. Field, and the stresses would be less in it than in the 20,000 k.v.a. machine described in the Paper. It was found that owing to the extremely good ventilation of the parts of the bars which project from the slots the copper section could be cut down to about one-half. This reduced the diameter and gave plenty of room for the steel hoops. The total stress in the hoops was not more than 19,500 lb., and the factor-of-safety of the whole construction was a little over 6.

In reply to the discussion, the Author said he had felt sceptical about solid forgings of 15 in. diameter being used with a speed of 1,500 r.p.m. Prof. Walker said " the makers are willing to guarantee satisfactory test pieces taken from various parts of the forging in both a longitudinal and a tangential direction." He (the author) did not know whether they would do that if acceptance depended upon it. They would not accept the test in a radial direction immediately below the surface. They said it was impossible to get the necessary good properties with the ordinary radial forging, and tests made upon large forgings bore out those statements by the steel experts. Those who had had to cut deeply into large forgings might have come across shrinkage in one diameter. That brought home to one the enormous stresses in such structures. Prof. Walker's suggestions as to rotor windings were to be warmly welcomed. The question of rotor windings was, he thought, an unsolved one, and the method proposed in the Paper was apparently the best solution at the time ; there was plenty of room for a deal of improvement. Prof. Walker's suggestion brought down the depth of the slot, which was a great advantage. Dr. Thompson referred to rotor stiffness, and asked whether the matter was dealt with theoretically or practically. The rotors had not been placed between weights and the deflection measured, but the test applied was practically the same—viz., the running test. If the rotors were not as safe as they had believed them to be, they would have found a very low critical speed. No critical speed was noticed, which he thought proved they were rigid. The slotting of the material allowed any discrepancy of any individual plates to be taken out, the final tightening of the bolts being accomplished after the plates were slotted. With regard to cutting off the nuts, in a complete rotor it was necessary to have a smooth end. They had a hexagonal elongation to get the nut tightened up, and it was simply an extension of the nut. In the three-phase generators it was not the magnetic leakage that came into prominence but the losses in the rings. The special device used was to cut down those losses. In the illustration, wherever a plate with a series of bolts was seen there was underneath a conical end section—a metallic

bracket rigidly supporting those windings from the frame of the machine. Between the two layers of windings, and also supported by the bolts, was a herringbone casting with a number of fins going between the end connections, and in the bottom layer the involute was in another direction, so that the two layers of windings could not shear on one another, because of the sets of herringbone fins. He thought that 50 ∿ was desirable rather than 60 ∿, being a simple multiple of 25, but big rotary converters were runinng satisfactorily in the States on 60 ∿. Recent practice in the States for small units was rather in the direction of running up the turbine speed above the two-pole limit. Mr. Clough referred to the question of rating. Until five or six years ago in the States it was customary to rate machines on a normal basis, which was that a machine carried a certain load with a 40 deg. temperature rise, but manufacturers decided that it was best to state specifically what a machine was good for, and call that the rating of the machine. The engineer wanted to know its maximum output, and did not intend to load it beyond. With regard to Mr. Clough's reference to the initial stress in the bolts he (Prof. Field) could not quite agree with him, because the structure as a whole, after the bolts were tightened up, acted precisely the same as a structure without any stress in it at all; where there was a tensile stress in the bolt there was a corresponding compressive stress in the material round it. The question of external fans was a debatable one. He heard recently that the feeling among station engineers in the States was that the external fan had distinct advantages. In modern stations they had a regular air chute running the length of the station for the intake air and another for the exit air. One question referred to rotor pressing. In the case of the two-pole machines this was well worth doing. He could not recall any case of an impressed machine failing due to the rotor windings coming out, but he knew of troubles with one or two of the older machines which indicated that that defect could be looked for in the future in unpressed windings. He thought the nickel steel bolts fully took care of the risk of circumferential shearing of the plates one upon the other. He did not think compressed stranded conductors solved the problem of eddy currents in the stator conductors, as a rule. Many who had experience of them were chary of using them in big machines. If they were made by pressing cable which was originally in concentric layers thay did not get over the eddy currents. If it were done by a weaving of the wire, so that every wire took every position, a good result was obtained. He could not answer Dr. Smith's question with regard to critical speed and the vibration produced with short-circuited coils. He did not look upon the question of critical speed as limiting the output. One should work above the critical speed if he could not work below it, but if he could work below it there was some advantage. He must dissent from Dr. Smith's suggestion about the use of through bolts in solid copper, because the direction in which the material was unsafe was not in that direction; the direction in which it was unsafe was the radial direction. The leakage due to the end rings was a fixed leakage and differed from the other items, such as magnetic leakage. It only meant that they had to put a certain amount of extra iron in the rotor. He could not state the amount of armature leakage reactance. Cast-iron rotor wedges, suggested by Dr. Smith, sounded an excellent scheme. He did not know how it would work out in considerable stresses. He thought the short-circuiting of machines before acceptance, suggested by Mr. Mordey, would probably be a coming requirement of engineers.

DISCUSSION AT BIRMINGHAM.

Mr. F. W. Carter (in a written communication) asked whether the author had met with trouble from end thrust in the type of generator considered. With the usual flexible coupling between turbine and generator there was a tendency for the generator to be pushed with considerable force towards one end; the tendency could be balanced against a magnetic centering force, but this sometimes led to local heating from the undue crowding of flux in some of the end punchings of the stator. He believed the proper remedy to lie in attention to the correct design of the couplings which was undoubtedly the source of the end thrust. The author had referred to his (Mr. Carter's) formula giving the pole-face losses, and appeared in doubt as to what it represented. He would say that it was the result of a direct calculation starting with Maxwell's equations and carried through on orthodox lines. It represented very closely the actual loss under the assumed conditions, and he would himself trust it in preference to any empirical formula.

Mr. T. H. Hurst (Loughborough) spoke as to the desirability of a new specification being issued by engineers regarding the temperature rise permissible in large generators. He pointed out that the present restrictions unnecessarily limited the development of these machines.

Mr. F. H. Clough (Rugby) stated that the crux of the whole question of the design of large generators was, in the author's view, associated with critical speed. In his (Mr. Clough's) opinion the author had laid too much stress upon critical speed, and if he had regarded this fact a less he could have produced a simpler design at smaller cost. Machines were built to run satisfactorily through and above their critical speed. He could not approve of the author's three part wedge, as the coil could be pressed, and held in position without wedges. He also thought that a fan on the rotor was preferable to a separate fan.

Mr. R. J. Kaula (Rugby) said there was a great deal in favour of a separate fan system for the cooling of rotors as against the arrangement of the fan on the rotor itself. He also stated that solid couplings had been provided with satisfactory results on large machines for connecting the generator to the turbine.

Mr. B. A. B. Royce (Loughborough) commented upon the title of the Paper, and remarked that it related to high-speed generators. Seeing that there was no mention in the Paper of direct-current generators, he wanted to know if these were now completely out of date.

Mr. E. Kilburn-Scott asked for information as to the limit of size possible in machines of the type described by the author. In his view the limit would possibly determine the question as to whether or not the British Chemical industry could compete with Continental concerns deriving their power from hydro-electric systems. The latter were able to provide cheaper current than the present usual steam-driven plants. If the generating units of the latter could be so increased as to bring down the cost of current to a figure comparable to that of a water-plant then it would be possible for important electro-chemical industries to be established in this country.

Mr. H. W. Taylor (Rugby) also mentioned that there was no need to limit the speed of high-speed generators below the critical speed, as satisfactory running above that speed was obtained in practice.

Mr. A. M. Taylor (Birmingham), in commenting upon the author's statement that these large machines should be so built as to stand a dead short-circuit at their terminals, thought it preferable to have a certain amount of external reactance between the machine and the 'bus bars. The argument for the external reactance was briefly that there was a possibility of a short-circuit occurring in the end windings of the stator in such a position as to cut out a large proportion of the reactance of the stator; consequently, if connected directly with the 'bus bars to which many other machines were connected, the flow of current from these 'bus bars into the short-circuit would be many times that which would flow into a short-circuit at the machine terminals if fed merely by the machine itself. Hence a short-circuit test of the machine made after erection, which could only be tried under the latter conditions, would be no criterion as to what would happen under the former conditions; in this case such forces might be set up in a part of the winding of the alternator as to wreck the end connections. Probably the best combination of internal and external reactance was that which permitted the machine to be short-circuited on itself when on test, without its reactance, the (external) reactance being so designed as to pass only the same current from the 'bus bars. He thought it would be conceded that it was undoubtedly easier to insulate the turns of the reactance, when they were not cramped for room, than the end coils of the stator. With single-phase paper-insulated cables, and reactance coils of sound design, there ought to be practically no possibility whatever of a short-circuit exterior to the windings of the alternator. He believed that in the larger sizes of alternators the limit at which it paid commercially to stop the introduction of (internal) reactance was reached sooner than in smaller machines. It would be interesting if Prof. Field felt free to give the limit of size for, say, the introduction of a 7½ per cent. (internal) reactance, coupled with a statement as to the frequency, number of poles, and lowest power factor with which the machine was intended to be used.

RADIATION PYROMETERS.

To the "Bulletin" of the Bureau of Standards (U.S.A.) Messrs G. K. Burgess and P. D. Foote have recently contributed an informative Paper entitled "Characteristics of Radiation Pyrometers." An account is given of the principles which form the basis for the operation of total radiation pyrometers, and representative types of this instrument are described in some detail. The results are given of an experimental study of the calibration and behaviour of radiation pyrometers under various conditions of use, and as modified by changing the several factors which may influence the readings of such pyrometers. A considerable portion of the text is devoted to the examination of the sources of error and their elimination or correction.

In all, there were examined some 20 instruments, including all the ordinary types commonly met with in practice, such as the Féry, Foster, Thuring and Brown pyrometers.

Although the investigation, which is largely concerned with details of construction, does not readily lend itself to a brief summary, the following conclusions of a general nature may be mentioned:—

The Stephan-Boltzmann law $E = a(T^4 - T_0^4)$ is not, in general, except by accident, obeyed in its exactness by any of the pyrometers examined. The similar equation $E = aT^b \cdot T^{-4}$, in which b is slightly different from 4 (usually neglecting the T_0 term) is, however, obeyed with sufficient exactness by all total radiation pyrometers.

The main factors influencing the value of the exponent b are the geometry and mechanical construction of the instrument, the value of b for 20 thermo-electric pyrometers ranged from about 3·5 to 4·5. The same instrument of the Féry type may have a different exponent, according to its use with or without the sectored diaphragm for increasing the temperature range.

In general a radiation pyrometer behaves not as a "black" or total receiver of energy, but as a "grey" receiver for the ordinary range of temperatures. For the Féry pyrometer with a gold mirror, for example, the effect of selective reflection of the gold mirror does not become practically appreciable until above 2,500° C., but may cause an error of 500° C. at the temperature of the sun.

The auxiliary apparatus, galvanometer, or potentiometer, and recording devices, can be constructed so that their errors will be prac-

tically negligible. For work of the highest accuracy the potentiometric method of measurement is to be preferred with thermo-electric radiative pyrometers.

The principal errors to which the several types of instrument are subject are shown to lie in the design and mechanical construction of these instruments; and certain of these inherent errors, such as lag or slowness in reaching an equilibrium reading, require for satisfactory results that the pyrometer be calib ated and used under similar conditions of time and exposure, distance from and aperture of source. Wide variation in the lag effect exist among apparently similar instruments, ranging from a few seconds to an hour or more. These and other errors of appreciable magnitude, such as stray reflection, convection currents, intervening atmosphere, size of source, tarnishing of receiving mirror, &c., are discussed at length in the text. It is shown that errors greater than 100°C. may readily be caused by dirt on or oxidation of the mirror. The magnitude of errors due to varying the focussing distance may amount to several hundred degrees, if suitable precautions are not taken.

A convenient method for the rapid comparison of different types of pyrometer, and for determining the effects of size of aperture and focussing distance, was devised, consisting of a wide nickel (oxide) strip heated electrically, a series of circular water-cooled diaphragms, and an optical brush.

The methods in use at the Bureau of Standards for the calibration of radiation pyrometers by means of especially designed "black bodies" are described in detail and methods of extrapolation outlined, as well as methods of use of radiation pyrometers, including methods of obtaining approximately correct temperatures for the case in which a source of insufficient size is sighted upon. Finally, there is considered the application of the radiation pyrometer to the determination of the total emissivity of non-black substances and to the measurement of temperatures.

CORRESPONDENCE.

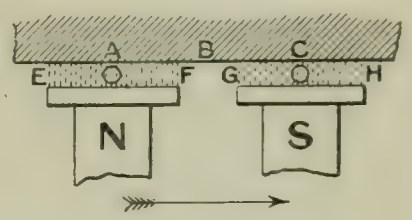
SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION.

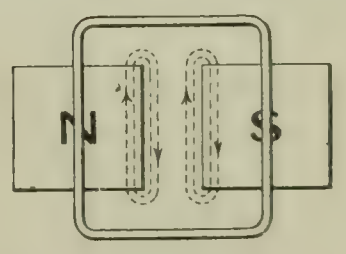
TO THE EDITOR OF THE ELECTRICIAN.

SIR: Judging from the letters of Messrs. Biedermann and Maccall my article on the above subject has not proved so convincing as I had hoped. I was aware that my remarks on rotating magnetic fields would run counter to the preconceived ideas of many.

Before answering the questions raised, I should like to say that in no case can the experiments described in the article be considered as crucial tests which might enable one to decide between the conflicting points of view. I doubt whether such a test is possible. The experiments were merely given as interesting examples by which to demonstrate my conception of the phenomena involved. As your correspondents say, they can be explained in other ways. My reasons for preferring one point of view to another were, as I stated, due to my inability to reconcile the idea of the rotation of a symmetrical magnetic field with my conception of the physical nature of the field. This may be due to some deficiency in my powers of conception; if so, I shall welcome enlightenment. Neither of your correspondents attempt to explain what they mean by the rotation of the symmetrical field of a cylindrical bar magnet or of a solenoid, although both use the expression. At no point is the field undergoing the slightest change in magnitude or direction. What do they mean by saying that it is rotating? To me it has no meaning unless the field be not uniform, but consist of discreet lines of force with gaps in between, so that any line may be earmarked and its movements traced. In our present ignorance of the fundamental nature of the phenomenon this seems to be an unnecessary and undesirable complication to introduce. A magnetic field at any point has a certain strength and a certain direction, either or both of which can be constant or changing with the time. Your correspondents wish to endow the field with a new characteristic, viz., velocity. If the field of the rotating bar magnet is not symmetrical, it is true that the dissymmetry of the field rotates as the field grows stronger and weaker alternately at successive points around the magnet, but this is a very different thing from the rotation of the field. A somewhat analogous example is the brightness of a screen illuminated by a projection lantern which produces a disc of uniform brightness; if now the lantern is rotated about its axis, does the brightness of the disc rotate? Of course, if the brightness is not uniform the want of uniformity rotates, but that is quite another matter; it is merely a convenient way of expressing the effect of a peculiar cyclical variation of the value of dI/dt (I=illumination) at every point of the disc. As in the magnetic case, if the want of uniformity is removed, the question of rotation appears to me to become meaningless.

Mr. Biedermann says that "nothing is more certain" than that E.M.F. is induced in a stationary conductor in the uniform field under the centre of a rotating pole and that "this proves that the magnetic field is in motion." If it did there would be an end of the matter, but, of course, it does nothing of the kind. The fact that E.M.F. is induced in the conductor merely proves that it is situated in an electric field. This electric field is undoubtedly due to changes in the magnetic flux in the neighbourhood of the conductor, but I fail to see why it must necessarily be due to that part of the field which is undergoing no change whatever either in magnitude or direction, when at other points in the immediate neighbourhood the field is undergoing rapid changes. In the figure the flux density is assumed to be uniform under the poles and zero between the poles, the conductors A and C are at rest while the poles are moving to the right; then in my opinion the conductors at A and C are not *directly* affected by the magnetic field since, so far as we know, the ether at these points is not undergoing any change whatever. At E, F, G and H, on the other hand, sudden changes are taking place in the condition of the ether, causing





the induction of loops of electric force, as shown by dotted lines in the figure, which are then propagated outwards with the velocity of light until they meet the wires at A and C or some other part of the coil. It is true that the expansion of the loops of electric force with the velocity of light is associated with the expansion of a magnetic field, which may be said to induce an electric field wherever it cuts; in this arbitrary way one can bring in the idea of cutting, but this is rather far removed from Mr. Biedermann's explanation of the phenomenon. The difference in our conceptions is essentially this: When the poles move Mr. Biedermann sees the ultimate cause of the electric force induced in the conductor at the point A itself, due to the forward "velocity" of the field at this point, whatever that may mean, while I see the ultimate cause at the pole tips, due to the change in the magnetic field at these points, in accordance with Maxwell's theory. I hope that Mr. Biedermann will agree that this is a correct interpretation of Maxwell's theory and that it accounts fully for the E.M.F. induced in the coil without the necessity of endowing the magnetic field with any new characteristics over and above those postulated in Maxwell's theory. The cause of the E.M.F. is seen to be, not the rotation of the field, but the rotation of the want of uniformity of the field, a very important distinction when one considers the limiting case of the rotating solenoid, where the rotation produces no change in the field strength.

Referring to the rotating bar magnet, Mr. Biedermann says "He is quite unable to agree with Prof. Howe when he says that the seat of the phenomenon is the surface of the magnet."

E

I thought I had made it clear that I favoured the view that the electric force was induced throughout the material owing to its movement through the field. Other writers, however, have maintained that the phenomenon is fundamentally due to the surface-curl produced at the cylindrical surface of separation between the magnet and the air, and I was merely explaining the ground of their argument.

In his closing paragraph Mr. Biedermann appears to believe that in the Lorenz disc there is cutting of lines but no change of flux through a circuit. This depends entirely on what he calls the circuit; when it suits his argument, he replaces the actual moving material of the disc by an imaginary stationary line, with what justification I do not know. As the result of this, however, Mr. Biedermann agrees substantially with my point of view, our only difference being that whereas I merely prefer one point of view to the other, he proves, to his own satisfaction but not to mine, that the other point of view is impossible.

I feel that our knowledge of the fundamental nature of the phenomena is too vague to justify us in doing more than seeking to explain them in as simple a manner as is consistent with our conceptions of the nature of the magnetic and electric fields. With fuller knowledge, "the two entirely different physical conceptions of one and the same phenomenon," to which Mr. Biedermann objects, may prove to be equally crude, but equally true.—I am, &c.,

South Kensington, Nov. 22. G. W. O. Howe.

FREQUENCY, FREQ., OR CURL?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of November 26th Mr. Maycock refers to the question of the symbol $\sim$ for frequency raised in my review of the previous week. He suggests that the symbol should be called freq. and pronounced freek, and, in so doing, misses the method of spelling the word that was intended to be conveyed in the review. By so doing he converts what was intended to be a sly dig at such non-alphabetical symbols into an expression of approval of their use.—I am, &c.,

London, Nov. 29. The Reviewer.

"ALTERNATING CURRENT WORK."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: A year or more ago there was a discussion in your columns as to whether reviews should be signed or unsigned, and you kindly allowed me to express myself on reviewing generally. Some readers of this letter may be interested enough to turn back to the above-mentioned discussion, &c.

Your review of my book in your last issue gives absolutely no information as to its scope save that it is not mathematical. Many would fail to gather therefrom that there were chapters on Alternators, Transformers and Motors; that Vector Diagrams were very fully explained, and that such matters as the Regulation of Transformers and the Circle Diagram of the Induction Motor were brought within the ken of the elementary student.

When quoting what I said about mathematical knowledge you left out the words *through lack of tuition or sheer mental inability*. If all the students and engineers (I include other than purely electrical) who suffered from one or other of these drawbacks had been debarred from acquiring knowledge of alternating-current principles and applications, that branch of electrical industry would never have developed. And if to-day the non-mathematical men were prevented from pursuing their work, there would be comparatively few left and the industry would fall to pieces.

Your reviewer is evidently a mathematical man, and, therefore, would probably be at home with advanced work of various descriptions. Now I would ask him how many of the following other occupations he would feel himself qualified to take up: Works managing, draughting, founding, construction, testing, sales managing, estimating, planning, outside selling, erecting, organising, running. If he feels that many of these occupations (and some others) are rather beyond him, it should be evident to him that few of the average men that do excel in one or more of them can be much good at mathematics. Yet men of all these classes (and many outside) are concerned with alternating-current work.

Regarding the Calculus, consider the "Calculus for Engineers," written by that giant of our profession—Prof. John Perry. The book is called an elementary one and is stated by the gifted author to have been written particularly for those with very little mathematical training. Nevertheless, I venture to state that the (fortunately) varied kinds of mentality amongst students and engineers (as well as other people) has rendered it absolutely impossible for many of them to grasp and retain such knowledge. And, on the other hand, it is equally impossible for some mathematical men to do some of the necessary things which some non-mathematical men find easy.

The comments regarding the problems or questions in my book are misleading, and it might be gathered that there was an enormous number of them. Omitting Chapter I., which has none, there is an average of 23 per chapter. The range is certainly wide (from Grade I., Wiremen's to A.M.I.E.E.), but it might have been stated that some are starred and some daggered to denote respectively (*) those that range slightly beyond the subject matter of the book and (†) those that can be only partly answered therefrom.

There is no harm in giving the best students an idea of what they will eventually have to work up to, and these questions also serve as guides to the lecturer in extending his subject.

It should surely have been mentioned that the answers to all the numerical problems have been worked out and stated; and that helps to the solution of some of the more difficult are given in the shape of "Auxiliary notes."

Perhaps, after all, your reviewer has unintentionally done me a good turn. He has made it so clear that the book is devoid of mathematics that some of the kind of people I have written for will conclude that its 400 pages and 258 illustrations will be helpful to them.—I am, &c.,

West Norwood, S.E., Nov. 29. W. Perren Maycock.

[Mr. W. Perren Maycock is mistaken in assuming that the reviewer of his book is a mathematician, and that he is without experience in several of the branches of electrical engineering mentioned above. To our detriment there are very few mathematicians, on the engineering side, in England at the present day.—Ed. *E.*]

ELECTRICAL ENTERPRISE IN INDIA.

A conference of electrical engineers and inspectors in the Government service was held last month in Calcutta, and among those present were Messrs. J. W. Meares (Electrical Adviser to Government of India), G. F. Adams (Chief Inspector of Mines), A. K. Taylor (Executive Engineer, Electrical Division, Calcutta), A. N McIntyre (Asst. Electric Inspector, Bengal), B. Raikes (Electric Inspector, Burma), W. F. Stuart Menteth (Electrical Engineer, Bombay), F. W. Wilson (Electric Inspector, Bombay), J. S. Pitkeathly, C.V.O. (Electrical Engineer and Inspector, Delhi), E. J. B. Greenwood (Electric Inspector, Madras), C. M. B. Mersh (Electric Inspector, Central Provinces), C. C. T. Eastgate (Electric Inspector, Punjab), and W. Bell (Officiating Electric Inspector, United Provinces).

In his opening speech the chairman (Mr. Meares) said that while the meeting had been convened at the suggestion of the Government of India, and with the concurrence of the respective Governments, his remarks were entirely personal and must not be considered in any way to commit Government. The first matter which he desired to bring before them was the question of the rules relating to electricity in mines. They had already seen a rough draft which he had prepared, based on the British Home Office rules. During the past week he had been in the coalfield districts; he had revisited some of the workings where power was used, and also had talked the matter over with those engaged in the industry and with their colleagues, the mining inspectors. The matter had already come before the Indian Mining Association, and he hoped to meet its technical advisers. Nothing should be done to interfere with that growing industry unless the higher interests of life and property demanded it. The result would, he hoped, be a revised draft which, after it had been put into legal shape, would meet with general approval when formally published for criticism. The Board of Trade rules, tho

adoption of which in their entirety was recommended from the Bombay side a few years ago, were, he ventured to say, somewhat of an anachronism. In India, however, it was a much more simple matter to revise statutory rules than in Great Britain. What they had to remember, seeing that Government must be largely guided by them in those matters, was that they were the official guardians of an industry which was now taking root in the country, but which was a very sensitive plant. It was common knowledge that the British Electric Lighting Act of 1882 stopped all progress for six years, and the very detailed and restrictive rules in force in the Old Country had been a byword for 30 years. In the course of the work that had fallen to his lot in connection with the Indian Acts of 1903 and 1910 he had had the valuable report of the Institution of Electrical Engineers on electrical legislation constantly in his mind, and he believed that the electrical industry in India had not been seriously handicapped by defects in the law. In the matter of rules, no matter how carefully thought out might be the draft, it was the administration of them with common sense that really mattered. If one could be quite certain that everyone manufacturing, selling or installing electrical plant would only put in the very best material in the very best manner, no rules would be needed for them; similarly, if everyone in charge or possession of installations had the necessary technical knowledge and skill, and the determination to use it, no rules would be necessary to control them. Unfortunately the millennium was not yet, and rules were a regrettable necessity. If they found a way of doing a given thing that was better than that prescribed by the rules, why then let the rule be relaxed, as it could be by Government? A lawyer would tell them that rules had the force of law; a constructional engineer would perhaps tell them that rules offered an opportunity to meddlesome people to show their authority. There was some truth in both criticisms, but provision was made in their present rules for relaxation by Government, and in some cases by themselves when it was necessary. It remained for them to use that power with discretion, for the good of the industry, while safeguarding life and property. Those latter considerations were conspicuously absent in the early days of electricity in America, and even in England. He was old enough to remember the original Brighton and Hove Company, which without statutory powers ran overhead wires all over the chimneys of those towns. From that pioneer concern of Mr. R. Hammond arose the prosperous Brighton Corporation undertaking, and the equally successful Hove Company. He also saw something of early American construction; in both cases the methods were bad. In England the drastic remedy delayed progress for a long time, while unhampered America saw that those methods did not pay, and reformed them from within, to her lasting advantage. He must admit having done some pioneer work himself in Darjeeling; it certainly gave an impetus to further development elsewhere. A matter which he had lately had occasion to discuss was that of the so-called "compulsory clauses" of the Electricity Act, and he invited their views on that subject. When a licence was granted for electric supply to a town, certain streets were specified in which mains must be laid down within a limited period. That may be done either in the licence or within six months after it was granted. A few years ago those provisions worked smoothly and without undue hardship, but he was by no means sure if that was likely to be the case in future. At present many large towns had a public supply, and investors in those companies had in most cases little cause for complaint. India, however, was a vast country; until the advent of the electric fan, and even with its help, the climate was not salubrious; and from every possible point of view they desired to increase the number of places which had the benefits of cheap electric supply. But outside capital had always been rather shy of India, and would be more so in the future, whilst the secret of unlocking the vast supplies of indigenous capital had only to a small extent been solved as yet. He was told that the fear of compulsory works being specified, in streets where no return was likely, was one of the chief causes of that shyness. If so, was it better to have no supply at all or to risk a licensee company failing to lay down works? If commercial men went to the trouble and expense of forming a company, paying a consultant and obtaining a licence, they did it with the laudable desire of making money; and the last way to achieve that object would be by refusing to extend their works. In his book on the first Electricity Act (of 1903) he spoke of a licence as a "valuable concession." So perhaps it was then, but he was no longer so sure about the matter. They ought to encourage promoters in every legitimate way to extend their operations, and not to restrict them more than was absolutely essential. If compulsory areas hindered enterprise, then, in his opinion, compulsory areas should be severely limited or altogether banished; and he believed that view would be generally accepted. In the Electricity Act of 1910 provision was made for undertakings of special character to work without a licence, under certain conditions. The clauses in question were not exactly as he wished them to be, but he thought they were workable. His view was that every encouragement should be given to such semi-public undertakings. The promoters of them might be trusted to foresee the effects of possible competition from other similar concerns or licensed undertakings, so long as it was fair and unhampered competition. Competition was mainly a matter of supply and demand, although, of course, the man in possession had a considerable pull. For his enterprise he deserved to have it, too. The next point he wished to raise was that of electrical installation work, which like the poor, was always with them. It was a dull but very necessary branch of their work, and a branch in which much Government capital was invested. Those of them who had been long enough in India would remember that private house wiring in early days was jerry wiring of the worst order, partly from sheer ignorance of local conditions and partly from ignorance on the part of the purchaser, who accepted the lowest tender and suffered for it. It was just possible that such things happened now, but not in Government buildings. He must admit that he had very scant respect for the lowest tender, though it always required some courage to ignore it. Where there were not strong reasons to the contrary he thought tenders should always be invited for Government work from firms of contractors of substance and repute. They seemed to be settling down to the use of the modern metal cased systems to a great extent. Steel conduit wiring had been used, but the high initial cost and trouble with condensation had combined to limit its use. The attempts made to use lead-covered wiring in India 20 years ago were a sad failure, owing to the necessity for thorough bonding and earthing not being recognised; at present copper, lead and an alloy of lead were used with more or less success according to locality and (perhaps) skill in erection. He did not suppose it possible, or even desirable, that there should be a rigid and uniform specification for electrical wiring all over India and Burma. At the same time, a measure of uniformity was desirable. The Bengal Government Specification originally drawn up by him for Government House, Calcutta, had been revised from time to time, and formed the basis, he believed, of those in use in most provinces. It must assist contractors who had branches all over India if the conditions to which they tendered and the material they had to supply was more or less the same everywhere. Those were some of the matters which they could usefully discuss. The provisions in the two electricity Acts for Advisory Boards remained a dead letter, but he should welcome the formation both of an Imperial Board, to meet in conjunction with their annual conference, and of a standing Provincial Board at the headquarters of each of the Provinces. That would ensure commercial questions being threshed out by commercial men. There were boundless possibilities in connection with electricity in India, and as yet only the fringe of them had been touched; they could do a great deal of good or harm according to the way in which they tackled the problems which came before them.

LEGAL INTELLIGENCE.

Vandervell v. A. P. Lundberg & Sons.

On Monday Mr. Justice Younger commenced the hearing of this action, by which plaintiff claimed relief in respect of an alleged infringement by defendants of his registered design for switch boxes.

Mr. Walter, K.C., and Mr. Hunter Gray were for plaintiffs, and Mr. Colefax, K.C., and Mr. Eric Bousefield for defendants.

Mr. WALTER said the action was an action for infringement of two registered designs, the first No. 562,949, registered in class 3, that class being for articles made in wood and applied to wooden switch boxes used in connection with electrical installations; that was registered on May 19, 1910. The other was No. 568,527, registered in class 3, which applied to metal articles, and was for application to metal switch boxes, and was registered on Aug. 19, 1909. The registration was under the Patent Act of 1907, sec. 69 of which dealt with registered designs. It provided that the Comptroller might, on the application made in the form and manner prescribed of any person claiming to be the proprietor of any new or original design, not previously published in the United Kingdom, register such design in the class to which such design was applicable. Sub-section 2 provided that the same design could be registered in more than one class. Sec. 83 of the Act provided that the registered proprietor should, subject to the provisions of the Act, have a copyright in the design for five years from the date of registration, and it was provided that the period might be extended for two further periods of five years on payment of certain fees. Another section made provision for what was to be done before delivery or sale of any of the articles to which the registered design was applied. Failure to comply with any of the requirements deprived the proprietor of any penalties or damages in respect of infringement, but did not, counsel submitted, deprive him of his right to an injunction. Sec. 60 related to the enforcement of such rights, and provided that during the existence of the copyright it should be unlawful for any person to apply the design to any goods in respect of which the design was registered or any obvious or fraudulent representation, except with the consent of the owner. Sec. 93 defined what was to be done, and showed that the protection was applicable to the design by whatever means it was applied. The protection was apart from the article itself, and could be applied to various articles. That particular design applied to switch boxes for electrical installations, but the circumstances were different to those in a patent action. The whole question was whether a new and original design had been infringed, and that was really a question for the eye—the instructed eye. To the instructed eye two paramount things were in evidence, two tumblers and six switches in line mounted behind the plate. At the bottom there were two little things that caught the eye; those were the terminals which took off the current. The question was not only the design, but any fraudulent and obvious imitation thereof. He thought, however, that the Court would have very little difficulty, having regard to the form in which those articles had been put upon the market, in coming to the conclusion that defendants' switch box was practically identical with plaintiff's registered design. It was not until the end of 1913 that it came to the knowledge of plaintiff that certain articles to which their design was applied were on the market. On those articles there was no name, and he could not for a long time find out who was putting them on the market. Finally, a circular issued by defendants came to his notice, and he discovered what they were doing. Defendants' articles had the switches arranged on the plate in the same way as plaintiff's, two circles at the top in the

same way, and the two terminals in the same place as plaintiff's. A closer copy, he submitted, his lordship could not conceive. Looking at a switch box made in accordance with plaintiff's design, and one of defendants', his lordship would find them identical.

Mr. COLEFAX: Except for the lugs at the side.

Mr. WALTER, continuing, said the writ was issued on June 3, 1914, plaintiff claiming an injunction, damages and a delivery up of the infringing articles. The defence put in alleged that plaintiff's design was not novel, that defendants had not infringed it, and, further, that plaintiff had used the number of his registered design upon articles that were not made in accordance with the design. With regard to the last part of the defence, in 1912 plaintiff introduced two new forms of switch boxes. In one the registered number was on the plate, but on the other no number appeared on the switch plate. That state of things remained until 1913, when at the time of the Motor Show plaintiff introduced a new switch plate. It was got out in a hurry, and the new plate should have had on it no number six plates, and six plates only were produced, but by some mistake the registered number got upon one plate, and that plate was used in connection with a switch box not of the registered design. That one, and that one only, had plaintiff been able to find, and immediately it was called to their attention they took the precaution of putting the registered number upon the wood of the switch box instead of on the plate. He submitted that defendants had taken the substantial part of plaintiff's design, and there was nothing whatever to deprive them of their legal rights under the Act.

Mr. COLEFAX said that one of his submissions would be that what was put in as an illustration of plaintiff's switch box was not, in fact, the registered design.

Mr. WALTER said the switch box produced was made from the design.

Mr. COLEFAX pointed out that it had no beading round it.

Mr. WALTER agreed, but said he would produce another which had the beading. It made no difference. Defendants' was substantially produced from plaintiff's design.

ALBERT MIDGLEY, chief electrical engineer to plaintiff, said they did a large business in supplying electric lighting installations for motor cars. In 1913 it first came to his knowledge that switch boxes similar to their switch boxes were on the market. At the time they introduced the switch boxes of registered design there was not to his knowledge any switch boxes like them on the market. In 1911 plaintiff introduced what might be called their No. 1 switch box, and on that the registered numbers appeared. Later Nos. 2 and 3 were put on the market, but on neither of them appeared the registered numbers. The same switch plate was used in the latter as in the former. He never knew that the registered numbers had appeared on a No. 2 switchboard until his attention was called to it after the present proceedings were commenced. In January, 1914, he received a stock of new switch plates, all of which had on the registered number, but they were intended for the No. 1 switchboard. He could not explain how one got to be used for a No. 2. He described the process adopted by plaintiff firm in constructing an article. The man responsible would have the drawing of the article before him to be constructed. He would send a requisition to the stores for the materials required. The finished article would be sent back to store, but before it was sent back the material used in its construction would be checked by the inspection department. As soon as his attention was called to one of the switch boxes of unregistered design having gone out with the registered number on the plates he checked every one of the plates in stock. He had not now got any switch plates with the registered number upon them. The registered number was now stamped on the wood work to avoid any possible error. There was no reason whatever for applying the registered design to switch box No. 2, and until his attention was called to the one instance adduced by defendants he did not know that it had ever been done.

Cross-examined, he said that at the time it was decided to put the registered number on the switch plates they had in stock switch plates which bore no number. Latterly they had no switch plates with the registered number upon them and they had largely advertised these switch boxes and had a large sale for them.

Sir GEO. CLAYTON MARKS said that he had had a lengthy experience of motors and motor accessories, and he knew of no switch box similar to plaintiff's registered design.

For the defence, Mr. COLEFAX said that the protection afforded by the design was very meagre, and the Court would not assist plaintiff to extend the protection he was entitled to. What was claimed here was a box with a sloping top and a plate in combination with a number of switches disposed in a line, probably a horizontal line.

Mr. WALTER: Six.

Mr. COLEFAX said his learned friend limited it to six, but he did not know why he should. He submitted that was not the registered design at all, and he also submitted that the thing could not possibly be done in the way plaintiff sought to have the drawing construed. But when it was done you must look at the thing as a whole. It was not right to pick out one or two features of the drawing and say they constitute the registered design. Everything shown in the drawing went to constitute the design as registered. Looked at in that way, defendants' article did not infringe, and it was impossible to say that the metal plate was not one essential part of the design. The first thing to notice in the drawing was that the top line of the sloping top was flush with a lamp. The second point was that the registered design showed a metal plate horizontally disposed covering the position of all the switches, and the third point was that the horizontal front of the box was unbroken by a hinge or otherwise, so far as anyone looking at the print could see. There were three features of the registered design, and the alleged infringement differed in each of those three respects from the registered design. There were other differences, but those were the ones on which he mainly relied, because they were all, he submitted, distinct features which were obvious to the eye. His second point was invalidity of the design. He agreed that, properly interpreted, the monopoly effected by this registration was valid, but he was not thereby admitting that the design interpreted as it was necessary for plaintiff to succeed on infringement was not bad for invalidity. You could not have an infringement action based upon relative invalidity, but you must look at the design in its entirety.

Expert evidence was given as to defendants' interpretation of the design.

Mr. WALTER, K.C., in replying, commented on the fact that defendants had not given evidence as to how they came to get out their design.

At the conclusion of the arguments his lordship reserved judgment.

Electric Railway Co. of London (Ltd.) v. Inland Revenue Commissioners.

The Court of Appeal (Lords Justices Swinfen Eady, Bankes and Warrington) has dismissed the appeal of the Underground Electric Railway Co. of London (Ltd.) and Messrs. Glyn, Mills, Currie & Co. from a decision of Mr. Justice Scrutton affirming a decision of the Commissioners of Inland Revenue. The question at issue was what was the proper stamp duty to be assessed upon a deed dated Dec. 13th, 1912, made between appellant company and Glyn, Mills, Currie & Co. (as the trustees), by which the company agreed, provided a sufficient number of holders of ordinary stock of the Central London Railway Co. would take guaranteed stock in exchange for their ordinary stock, to guarantee interest at 4 per cent. on such guaranteed stock payable half-yearly if and to the extent that the profits of the Central London Co. were not sufficient to pay that amount of interest. In the event of all the holders of ordinary stock acceding to the exchange, and if the Central London Co. made no profits in any year, appellant company would be liable to pay £120,000 in that year, being 4 per cent. upon £3,000,000 stock. In these circumstances the Commissioners assessed the instrument at a 10s. duty as a deed of any kind whatsoever in Schedule I. of the Stamp Act, 1891 (this was not objected to), and in £3,000, being 2s. 6d. for each £5 value on £120,000 as an instrument, being the only principal or primary security for an annuity or for any sum or sums of money at stated periods for an indefinite period, and it was against the latter sum that appellants appealed to Mr. Justice Scrutton.

Mr. Roskill, K.C., and Mr. Austin-Cartmell appeared for appellants; the Solicitor-General and Mr. W. Finlay, K.C., for the Commissioners.

Mr. ROSKILL, in support of the appeal, contended, first, that the deed was not liable to any ad valorem duty, and, secondly, that if it were so liable the duty the Commissioners had assessed was too high, and should only be assessed at £1,500, which was 2s. 6d. for each £5 value on £60,000 instead of 2s. 6d. for each £5 value on £120,000.

In the result their Lordships dismissed the appeal, with costs.

Liability of Tramway Undertakings.

Last week Glasgow Corporation were sued in the local Sheriff Court by Mrs. M. Kinnaird (or Young) for £150 in respect of personal injuries sustained by her on Jan. 2 while descending the stair of a tramcar. Pursuer averred that the car was at a standstill when it suddenly started forward with a jerk and threw her down the stairs and against the controller box. In his decision, Sheriff Lyell referred to pursuer's contention that it was the duty of the driver, after bringing the car to rest at the stopping place, to wait until he received the usual and proper signal from the conductor before again setting the car in motion. It appeared to him to be out of the question to suggest that the driver was in fault in starting a car when a passenger was coming down the stair, altogether out of the range of his vision. A passenger so descending, like a passenger walking from the inside of a car, must look after himself, and take the ordinary precautions to save himself from the possibility of the car stopping or going ahead when he was so doing. Judgment was, therefore, given for defenders.

BOOKS RECEIVED.

[illegible] THE ELECTRICIAN Office, post free [illegible], obtainable at the above price, viz., [illegible] Ltd. [illegible] Ltd.

"Handbook of Technical Instruction for Wireless Telegraphists." By J. C. Hawkhead and H. M. Dowsett. (London: Wireless Press.) Pp. xvi. + 310. 3s. 6d. net.

"Electro Ac Phenomena." By E. Rasch. Translated from the German by K. Lonberg. (London: Constable & Co.) Pp. xvi. + 194. 8s. 6d. net.

"Engineering" Directory, No. 61, October, 1915. (London: "Engineering," Ltd.)

"Diesel Engines for Land and Marine Work." By A. P. Chalkley, B.Sc. (London: Constable & Co.) Pp. xvii. + 368. 4th edition. 8s. 6d. net.

"The Telephone and Telephone Exchanges: Their Invention and Development." By J. E. Kingsbury. London: Longmans, Green & Co.) Pp. x. + 558. 12s. 6d. net.

"Relativity and the Electron Theory." By E. Cunningham, M.A. (London: Longmans, Green & Co.) Pp. 96. 4s. net.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	327	Steam Heater and Electric Fan System for Factory Heating. Illustrated	62
Imports and Exports of Electrical Manufactures	328	"The Magnet of Commerce." Illustrated	62
Educational Notes	328	Picture Lighting. Illustrated	64
Business Notices	328	"E.A.C. Notes." Illustrated.	64
Liquidations, &c.	328	Westinghouse Lantern Slides	64
Electricity Supply	328		
Traction Notes	329	Miscellaneous Notes	331
Empire Notes	329	Tenders Invited	331
Foreign Notes	330	Tenders Received & Accepted	332
The Round Table	59	Municipal Accounts	332
Shop Lighting. Illustrated	60	Companies' Meetings and Reports	333
"Pope" Carbon Lamps	60	New Companies, &c.	333
Simplex Inspection Lamp for Shells. Illustrated	61	City Notes	333
Lighting Efficiency. Illustrated	61	Electrical Companies' Share List	333

COMMERCIAL TOPICS.

A Commercial Electrical Association. Considerable interest attaches to a suggestion recently made by Mr. Howard Foulds, the secretary of the Birmingham electricity department, in a Paper read by him before the Birmingham Electric Club, on the subject of organising electric supply. Mr. Foulds put forward a plea for the formation of an association made up of the commercial men in the electrical industry. He argued, and rightly so, that there is a plethora of institutions and associations which have the interests of the technical and manufacturing sections of the industry at heart. There does not exist any body which can justly be said to devote itself exclusively to the interests of that very considerable body of individuals who act in commercial capacities in one form or another both in this country and abroad. In particular Mr. Foulds laid emphasis upon the immediate necessity of training young men for commercial positions in the electrical industry, and also to fit them to act as trade ambassadors in the Colonies and foreign countries. This suggestion is one which cannot fail to meet with general approval. It is evident from Mr. Sparks' references to the commercial engineer in his presidential address, that the industry is awakening to a sense of its responsibilities regarding this important section of its membership. As a class, commercial electrical men are closely attached to their duties, and are probably much more occupied as to time than any other section of the industry. This may explain their comparative inactivity in the past in organising themselves with the object of strengthening their position in the industry, and also to giving greater effect to the work which they have in hand. Mr. Foulds is a well-known personality in the business of electricity supply, and probably is brought more closely into contact with individual electrical men than many others in the industry. As this admirable suggestion has come from him, we think that he cannot do better than proceed to give effect to the ideas which he has developed out of his fruitful experience of electrical affairs. The association which he has suggested may also, we think, be useful in helping to get electrical men into Parliament. In this particular public capacity we have, unfortunately, too few representative characters. Those of our readers who know Mr. Foulds would pay him the compliment of wishing him a seat in Parliament. We hope that his valuable suggestion will not be shelved and that he himself will be able to devote the time from his multifarious and arduous duties to their prosecution in practice.

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Maintenance of Exports. Under present conditions it is very difficult for manufacturers to entertain any proposal for the export of electrical plant and supplies, but we would point out that it is, apart from purely trade considerations, a matter of the greatest national importance that the exports of goods should be maintained—nay, expanded and developed if possible. In this connection we desire to draw particular attention to the remarks of H.M. Trade Commissioner for New Zealand (Mr. W. G. Wickham), which are given in another column. Mr. Wickham suggests that British firms who are unable to supply the New Zealand market at present, either at all or on the same terms as previously, hould endeavour to keep their names before the public, not only by participating in an exhibition which is being organised at Wellington, but also that they should carry out a campaign in the local press, and tell the public (who are inclined to be sympathetic) exactly why the goods are not obtainable or why they are higher in price. There is a statement that there is a marked tendency on the part of local agents to look to foreign countries as a source of supply, and once American, Japanese and other foreign goods get on the New Zealand market it may not be easy to displace them.

In connection with the export of electrical supplies, we would also like to direct attention to an abstract of a report by the United States Commercial Attaché at Rio de Janeiro, which we give in another column. It is pointed out that in certain States of Brazil there is an urgent demand for goods, including electric light fittings, lamps, electroliers, tools, &c. From the electrical point of view Brazil is an important country, as there are some large hydro-electric works, tramways, &c., and as trade is beginning to revive again it should pay to nurse the Brazilian electrical trade, for which we predict a great future.

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Machine Tools Import. An Order in Council was issued on Tuesday prohibiting the importation into the United Kingdom of all machine tools and parts thereof, excluding small tools, except such as are imported under the licence of the Board of Trade.

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Indian Electrical Development. The address of Mr. J. W. Meares (Electrical Adviser to the Government of India) to the recent conference of electrical engineers and inspectors in Calcutta is published in extenso on another page, and is noteworthy as giving an excellent insight into the status of public and industrial electricity supply in the Dependency. Mr. Meares has dealt at some length with the Board of Trade rules, the regulations for the use of electricity in mines, &c., and it is refreshing to us in a legislation-ridden country to read, "In the matter of rules, no matter how carefully they might be drafted, it was the administration of them with common sense that really mattered. If they found a way of doing a given thing that was better than that prescribed by rule, why, then let the rule be relaxed, as it could be by Government." Mr. Meares further pointed out that in India statutory rules could be much more easily revised than they could in Great Britain, a fact which is regarded as the sheet-anchor of electrical enterprise in India. Other equally important matters will be found by a careful perusal of Mr. Meares' remarks, and we commend them to the notice of British firms who are interested in the development of electrical enterprises in India and the East.

We are in full agreement with Mr. Meares on the question as to the utility of including the "compulsory areas" clause in provisional orders or licences. Electric lighting was originally the main, if not the only, reason for giving a supply of electricity, and the principal residential districts in an electric lighting area were naturally looked upon as being the most likely places where there would be a demand for current. Nearly all towns and urban areas of importance have secured the advantage of electricity supply; lighting has ceased to be the most important branch of an electrical undertaker, and power supply has taken its place. Modern factories use the electric drive, but factories are located near railway sidings, canals, &c —in fact, works are to be found anywhere but in residential districts; consequently the "compulsory area" clause in Orders is now out of date, and serves only as a check upon progress. If the undertaker fails to utilise the powers of the Order then it should be revoked.

* * * *

Women Electricians. At a meeting of the Liverpool branch of the Electrical Contractors' Association on Tuesday the question of how to fill the deficiency caused by electrical workers being called on to take part in national and war service was under consideration, and after discussion the following resolution was passed unanimously: "That in the opinion of this meeting of the Liverpool branch of the Electrical Contractors' Association it is advisable in the interests of the country that a certain number of women should be trained in various branches of electrical work to ensure that the country's commercial work shall not suffer through the war; and this shall be strictly without prejudice to the electricians who have enlisted for national service, as we believe that in ours, as in other branches of national work, the soldier, after the war is ended, has the first claim upon the nation, but that we are emphatically of the opinion that the work of the country must go on, as without that we cannot beat the enemies."

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IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Nov. 22, 1915, *to* Nov. 27, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Unenumerated, 57 pkgs.
HULL.—*U.S.A.:* Elec. wire, 2 [illegible]
LIVERPOOL.—*Spain:* Elec. carbons, 101 pkgs.
[illegible]: *U.S.A.:* Elec. [illegible], £147; [illegible] £904; [illegible], £567; [illegible] £247; [illegible]; [illegible] £3,205 [illegible] 723 [illegible]. [illegible]: Elec. [illegible] 19 [illegible], £156; [illegible], £416; [illegible]; [illegible] parts, £93; [illegible] £979. [illegible]: Elec. [illegible] £14. [illegible]: Elec. machinery, £33; wire and cables, £795.
SWEDEN.—Lamp parts, £25.
[illegible]: [illegible], 23 pkgs., [illegible] pkgs.,
SWITZERLAND.—Carbon candles, £782; unenumerated, £874.
[illegible]: *France:* Elec. [illegible]
[illegible]: *U.S.A.:* Unenumerated, £5 [illegible].

EXPORTS.

[illegible]: *Auckland:* Unenumerated, £64 [illegible] Elec. [illegible] £1,152; wire and cable, £318; unenumerated, £1,323. *Sydney:* [illegible] £596; wire and cable, £25; unenumerated, £2,657. *Wellington:* Unenumerated, £637. *Brisbane:* Unenumerated, £12. *Dunedin:* Elec. machinery, £136; unenumerated, £167. *Lyttelton:* Unenumerated, £18. *Adelaide:* Unenumerated, £353. *Freemantle:* Elec. machinery, £142; unenumerated, £37. *New Plymouth:* Elec. machinery, £21. *Hobart:* Wire and cable, £122; elec. machinery, £51; unenumerated, £57. *Perth:* Unenumerated, £582. *Christchurch:* Unenumerated, £79.

AFRICA.—*Durban:* Elec. machinery, £10; unenumerated, £289. *Port Elizabeth:* Unenumerated, £405. *Delagoa Bay:* Unenumerated, £151. *Cape Town:* Elec. machinery, £1,462; unenumerated, £466. *East London:* Elec. machinery, £51.

EGYPT.—*Port Said:* Elec. machinery, £8. *Port Soudan:* Elec. machinery, £101; unenumerated, £45.

SOUTH AND CENTRAL AMERICA.—*Antigua:* Unenumerated, £24. *Buenos Ayres:* Wire and cable, £4,137; telegraph material, £90; unenumerated, £464. *Monte Video:* Unenumerated, £65. *Santos:* Unenumerated, £107. *Pernambuco:* Wire and cable, £53; unenumerated, £20. *Rosario:* Unenumerated, £98.

U.S.A.—*New York:* Unenumerated, £177.

CANADA.—*Montreal:* Unenumerated, £23. *St Johs's:* Unenumerated, £238.

HOLLAND.—*Amsterdam:* Wire and cable, £1,602; unenumerated, £223.

PORTUGAL.—*Lisbon:* Wire and cable, £604; unenumerated, £371.

SPAIN.—*Barcelona:* Unenumerated, £475.

DENMARK.—*Copenhagen:* Telegraph materail, £472.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Unenumerated, £148. *Calcutta:* Elec. machinery, £214; wire and cable, £50; unenumerated, £885. *Madras:* Unenumerated, £20. *Singapore:* Unenumerated, £183. *Penang:* Unenumerated, £82. *Karachi:* Unenumerated, £515. *Bankok:* Unenumerated, £55.

CHINA.—*Shanghai:* Wire and cable, £88. unenumerated, £331. *Hongkong:* Wire and cable, £1,681; elec. machinery, £280; unenumerated, £26. *Darien:* Unenumerated, £104.

JAPAN.—*Yokohama:* Unenumerated, £127.

JAVA—*Batavia:* Elec. machinery, £280; unenumerated, £69. *Sourabaya:* Unenumerated, £31.

WEST INDIES.—*Trinidad:* Unenumerated, £9.

MAURITIUS.—Unenumerated, £135.

MALTA.—Unenumerated, £76.

GIBRALTAR.—Elec. machinery, £70; wire and cable, £8.000; unenumerated, £23.

FRANCE.—*Dieppe:* Unenumerated, £194, *Paris:* Unenumerated, £269. *Dunkirk:* Unenumerated, £25. *Calais:* Wire and cable, £4,758: unenumerated, £207. *Havre:* Telegraph material, £722; unenumerated, £63, *Treport:* Unenumerated, £270.

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £75. *Barcelona:* Unenumerated, £298. *Durban:* Unenumerated, £20. *Melbourne:* Unenumerated, £54. *Buenos Ayres:* Unenumerated, £31. *New York:* Unenumerated, £944. *Dunedin:* Unenumerated, £330. *Lyttleton:* Unenumerated, £123. *Port Elizabeth:* Elec. cable [illegible] *Havre:* Elec. meter, £27[illegible]

IN TRANSIT.

Valpariso: Elec. lamps, &c., £1,200.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL NOTES.

University College of S. Wales and Monmouthshire.—Like similar institutions up and down the country, this College has been seriously affected by the war, and certain improvements which it had been intended to introduce in the teaching of electrical engineering have had to be abandoned.

All through last session students were leaving either to join H.M. Forces or to take up various forms of munition work. At the end of last June about 12 engineering students proceeded to the Royal Arsenal, Woolwich. Although it was originally intended that these students should return in October, practically all of them still remain at the Arsenal. During the summer the workshops under the direction of Prof. F. Bacon took up the manufacture of gauges for 18 lb shells. This work has continued to develop and at the moment teaching work is confined to a small class of first-year student, while the workshops, manned largely by students who have shown special aptitude for gauge making are working full time under the recognition of the Ministry of Munitions. Some important additions to the machine tool equipment are now being made to facilitate the production of gauges and any other form of Government work which it may be found possible to undertake.

BUSINESS NOTICES.

Messrs. H. Clarke & Co., Atlas Works, Hullard-street, Old Trafford, Manchester, supply insulating materials, mica channels, tubes, troughs, mica cloth and paper, insulating fibre, &c. The principal of the firm (Mr. H. Clarke) was formerly with Messrs. G. Schulz & Co.

Philip L. Dwyer and Percy R. Winterson (trading as P. L. Dwyer & Co.), electrical manufacturers and suppliers, 66, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Dwyer, who continues under the same style.

Patent Development.—The proprietors of patent No. 12,918/1909 are prepared to sell the patent or to grant licences thereunder. Applications to Messrs. Boult, Wade & Tennant, 111 and 112, Hatton Garden, London, E.C.

LIQUIDATIONS.

Holborn Electric Fires (Ltd.) is being wound up voluntarily, and Mr. W. G. Parratt, 163, Harringay-road, West Green, Middlesex, has been appointed liquidator.

Teleradio Co. (Ltd.) is being wound up voluntarily. Claims to the liquidator, Mr. E. H. R. Trenow, Balfour House, Fisnbury Pavement, London, E.C., by Dec. 11. A meeting of creditors will be held at Balfour House on Nov. 27.

Claims against the Stolz Electrophone Co. (1913), Ltd., 85, Fleet-street, London, E.C., are to be sent by Dec. 15 to Mr. H. E. Burgess, 33, Carey-street, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bolton.—Application has been made to the L.G. Board for sanction to borrow £2,215 for mains and transforming plant for the proposed supply of electrical energy for driving textile machinery.

Pembroke (Dublin).—A special meeting of the Council was called on Monday to deal with a tender of Messrs. Sulzer Brothers for a Diesel engine for the electricity works, but it was decided to postpone further consideration of the matter till a deputation had waited upon the L.G. Board in regard to a loan.

Sunderland.—The L.G. Board have sanctioned a loan for new plant at Dunning-street station.

Weymouth.—The L.G. Board have sanctioned the borrowing of £1,020 and £910 for electric supply mains and services, the periods granted being 15 years and 25 years respectively.

Owing to the abnormal conditions prevailing a meter charge of 2s. 6d. per quarter is to be made from the 31st inst.

Woolwich.—Arrangements have been made for extensions of the plant and mains, and for linking up with the system of the South Metropolitan Electric Light & Power Co. in order to provide for the increasing demand for power.

It is proposed to instal at the generating station a 3,000 kw. turbo-alternator set, condensing plant, switchgear, one water-tube boiler, pipe work, &c.; and also transformer plant and switchgear at Shooter's Hill sub-station in connection with the proposed linking-up. The estimated cost of the extensions, including the supply and laying of mains, will not exceed £24,225, and the Ministry of Munitions will lend the necessary money for the periods usually allowed for loans for similar work by the L.C.C. If during the period of the loan the plant is found to be in excess of what is properly required for the efficient supply of the Council's electric lighting area, the Ministry of Munitions (or their successors) will either take over the plant or write off so much of the debt in the event of the plant being retained by the Council as will prevent any loss to the Council in respect of the plant, all matters arising out of the agreement to be settled by arbitration.

The Finance Committee has recommended the Council to apply for sanction to borrow £24,225, made up as follows: 3,000 kw. turbo-alternator, boiler, switchgear and accessories, £21,000; transformer plant, switchgear, &c., for £2,700; mains, £525.

Mr. W. H. Dawson and Mr. L. C. Chasteauneuf, have been appointed chairman and vice-chairman, respectively, of the Electricity Committee.

GENERAL.

Belfast.—The Treasury have notified the Corporation that they are unable to sanction any capital expenditure or loans for laying electric service mains and meters to consumers. Exceptions will be made in certain cases of power supply, and applications may be granted where persons are willing to pay the cost involved.

Bethnal Green (London).—The Council are recommended to amend the scale of charges adopted in March last for the supply of current for either power or lighting purposes by substituting ¾d per unit for ½d in classes D and E.

Stepney borough electrical engineer (Mr. W. C. P. Tapper) thinks that this increase will sufficiently safeguard the interests of the Council in view of the increase in price of coal and other materials.

The Electricity Committee asks for permission to substitute 2½ for 5 per cent. in the clause of the general conditions relating to testing accuracy of meters, which provides that if upon official test the inaccurate of a meter or indicator exceeds 5 per cent. the Council is to pay the cost of the test, but if the inaccuracy is 5 per cent. or less the consumer is to bear such cost.

The Committee has received the following quotation from Stepney Council for the provision of house service fuses : Fuse boxes, 50 amperes, 2s. 6d. each ; 100 amperes, 3s. 6d. ; dividing boxes, two-way, 1s. each ; four-way 4s. ; fuseboards, two-woy, 1s. each ; four-way, 2s. 6d. ; meter boards, 18 by 18 2s. each ; 25 by 17 2s. 6d. In each case 10 per cent. must be added for supervision, &c. The Committee has arranged for the consulting engineer (Mr. Couzens) to order the quantities required.

Carlisle.—On the 25th inst. the employés of the Corporation electricity department. headed by the city electrical engineer (Mr. F. W. Purse) marched to the local recruiting office in order to get attested.

Already 18 employés had joined H.M. Forces, and 27 additional men have now decided to be attested. This accounts for nearly every employé of military age on the staff. Only two or three men were left to take charge of the works on the 25th ult., and they also will be attested in due course. This splendid exhibition of patriotism would be difficult to beat.

Dublin Electricians' Strike.—The Dublin electricians and wiremen who came out on strike a couple of months ago for an increase of wages have returned to work at their former wages, pending arbitration, over which the Recorder of Dublin will presided. The result of the arbitration has been an increase of ½d. per hour in the men's wages, and munition workers get a bonus of 6d. a day.

Hackney (London).—In February last the Borough Council instructed the Town Clerk to confer with Poplar Council, and to prepare a draft agreement containing the conditions of the proposed linking-up scheme, and authorised him to submit the draft agreement to the Board of Trade for their provisional approval.

In accordance with that resolution the draft agreement has been approved by the Poplar Electricity Committee. The matter has, however, been held up by reason of the Comptroller of the L.C.C. advising that the Treasury restrictions as to loans in war time would apply to the proposed expenditure on linking up. Recently the Council undertook to furnish a supply of electric current for power and lighting to a new factory in the district. A letter has now been received from the Ministry of Munitions stating that the linking up with Poplar could be done without difficulty by laying a cable and installing a certain amount of switchgear at a cost of about £3,000. The Ministry would be prepared to support the Borough Council's proposal to apply to the L.C.C. for sanction to raise the sum, and the scheme should be proceeded with at the earliest moment. The Electricity Committee, therefore, considers that steps should at once be taken to proceed with the linking-up scheme, and has recommended the Council to apply for sanction to borrow £3,000.

Infirmary Lighting.—The L.G. Board have authorised the Islington Guardians to adapt the present wiring and fittings at Highgate Hill Infirmary, and to take the current from Islington Borough Council, provided the cost does not exceed £500 and is paid out of revenue.

Liverpool.—The Electricity Committee recommends an increase of 12½ per cent. in the charges for the supply of electrical energy for lighting, power and other purposes, except in cases covered by special agreements containing express provisions with respect to the increase of charges in the event of any increase in the cost of fuel. The increased charges take effect as from the 31st inst.

Luton.—The electrical engineer (Mr. W. H. Cooke) advises the purchase of an electrically-propelled tipping wagon as a means of saving money on team labour.

Manchester.—On Wednesday the Electricity Committee's minutes contained a report by the chairman (Councillor Dagnall) on the events of the past 15 months in regard to the electric supply undertaking.

Councillor Dagnall gave the reasons why the Committee wished to carry out a temporary scheme of extensions. War considerations were obviously paramount, and the Electricity Committee therefore unhesitatingly and unanimously recommended the Council to adopt the temporary scheme named, coming as it did with the support of the Government. The temporary scheme is to instal one of the generators of 15,000 kw. capacity, designed for Barton, at Stuart-street station, making room therein by removing a good, but obsolete, generator of 3,750 kw., some 11 or 12 years old.

Presentation.—The borough electrical engineer (Mr. T. D. Clothier), on behalf of the staff and employés of the Bootle electricity department, has presented Mr. H. J. Lamden, senior charge engineer, with a handsome marble clock on the occasion of his marriage.

Salford.—Ten 200 c.p. electric lamps are to be fixed in the Assembly Room at the Town Hall.

The electrical engineer (Mr. J. A. Robertson) has been authorised to purchase such quantities of coal as may be required from time to time at the Frederick-road station during the continuance of the war.

Stoke-on-Trent.—Ald. H. Leese and Ald. J. Schofield have been elected chairman and vice-chairman respectively of the Electricity Supply Committee.

Wirral.—The solicitors of Messrs. Johnson & Phillips have notified the Rural Council of intention to apply for a provisional electric lighting order for the supply of electricity in the parishes of Hooton, Eastham, Childer Thornton, Willaston, Great Sutton and Little Sutton. Consideration of the matter has been adjourned for a month in order to obtain information.

TRACTION NOTES.

Birmingham.—The Electro-Mechanical Brake Co. ask us to state that, in regard to the recent tramway accident, although a large number of the Corporation cars are fitted with the " Maley " electro-mechanical rail brake, the tramcar in question was fitted with a magnetic brake of another make.

Blackpool.—The Tramways Committee have decided to curtail the evening tram service.

From April 1 to Nov. 18 the receipts were £64,925, or £1,449 more than at the corresponding date last year.

Bolton.—The Tramways Committee have decided to issue free passes on the Corporation tramcars for wounded soldiers.

Light Railways.—The Urban District Councils of Wombwell, Wath-upon-Dearne, Bolton-upon-Dearne and Thurnscoe are applying for an order authorising the construction of two short lines of railway of about 1⅛ miles in length in Wath and Bolton.

Liverpool.—The City Council is recommended to place at the disposal of the Tramways Committee a sum not exceeding £200, for providing a Christmas gift for each of the Committee's employees now serving with H.M. Forces.

Luton.—The Tramways Committee has asked the lessee of the tramway to supply each tramcar with an oil lamp for use in case of failure of the electric light.

Manchester.—The Tramways Committee reported to the Corporation on Wednesday that they had decided to give the war bonus of 2s. per week to the women as well as to the men conductors, at the end of three months' satisfactory service.

The number of men in the service of the department who have joined the colours is 2,107, and the payments now being made in respect of those men are at the rate of £72,000 per annum. If all the available men of military age now with the department were to join the colours, the cost to the department of making payments to those men or their dependents, in accordance with the Council's resolutions, would be about £110,000 per annum. The general manager (Mr. J. M. McElroy) suggests, and the Committee approve the suggestion, that men in the department's service who wish to join the forces should enlist under the group system (section B, Army Reserve).

Women Tramcar Conductors and Drivers.—Females are now employed as conductors on the system of the Potteries Electric Traction Co.

Twenty-one women conductors commenced work on the Liverpool Corporation tramways on the 26th ult. It is proposed to employ about 100 as an experiment.

At Glasgow the experiment of employing women to drive the Corporation tramcars under the direction of motormen has proved so satisfactory that this week six women have commenced to drive cars without assistance.

EMPIRE NOTES.

Australasia.—The " Australian Mining Standard " says Melbourne Council has decided that in future no official or employee of the Council shall engage in any profession, trade or business other than his official duties.

Cr. Charles Atkins recently submitted to Melbourne Council a resolution that it was desirable that, in connection with the Council's electric supply undertaking, the initial cost of installing electric current in any premises within the city should be advanced by the Council (if desired by an owner), such owner to guarantee repayment in 30 monthly instalments. The resolution was, however, referred to the Electric Supply Committee for report.

Williamstown (Victoria) Council has obtained an Order in Council for electricity supply.

Messrs. McCarty, Underwood & Co. have been commissioned by Heidelberg Shire Council to report upon the cost of an electric tramway service between that suburb and Melbourne city.

The report of the Victorian Railways Commissioners states that their commitments under contracts for plant and material in connection with the electrification of the suburban railways, at the end of June, amounted to about £2,440,000, exclusive of those in respect of automatic signalling and the subsidiary schemes for the electrical operation of the plant of the various metropolitan workshops, whilst the actual expenditure incurred

amounts to £970,575. It is impossible to say when electric traction will be introduced, owing to the new conditions created by the war.

With the sale of its electrical undertaking (the Great Lake scheme) to the Tasmanian Government, the future of the Hydro-electric Power & Metallurgical Co. is restricted to its metallurgical work and such other subsidiary industries as the production of calcium carbide. A satisfactory agreement regarding the power contract for the company's works had been made with the Government. The company has asked for protection against competition and a bonus on electrolytic zinc produced from Australian ores. The Minister of Customs (Mr. Tudor) promised to submit the matter of a duty to his colleagues.

The engineer and manager of the Tasmanian Government's hydro-electric department (Mr. J. H. Butters) recently inspected the line of communication between Hobart and the Great Lake works. The wood pipe line was full of water and the steel pipe line practically ready. The power station machinery was being erected. The exciter turbines and generators, both the main turbines and one of the main turbo-alternators were in position and the other turbo-alternator would be ready in a few days. Five out of the six transformers were ready, and the other would be in place shortly. The erection of the transmission line was proceeding rapidly. The converter station in Hobart was complete except for final adjustments and testing, and there was no reason why the power should not be available in January next, provided there was no serious delay owing to non-arrival of the few small but important items.

Mr. Butters also reported on the proposed purchase by the Government of the Hobart Gas Co.'s electrical plant and undertakings. The Bill to authorise the purchase was found necessay by Mr. Butters, as it would be impossible to push the electrical side of his business if the gas company retained its present business and rights. The agreement provides that the Government should pay £8,000 in cash and £100,000 in stock. The Bill was read a first time on Sept. 22.

"Tenders" (Melbourne and Sydney) says the Sydney city electrical engineer has suggested that the City Council warn contractors by advertisement against the use of electric wire and cable believed to be of German manufacture and sold in Sydney.

Mr. W. Corin, chief electrical engineer, N.S.W. public works department, has been appointed by the Queensland Government to prepare a scheme for the establishment of an electric power station at Ipswich, to supply current in Ipswich, Brisbane and adjacent districts.

Three firms offered to report for Townsville (Queensland) Council on schemes for the electric lighting of the city. The Tramway and Lighting Committee is dealing with the matter.

Timaru (N.Z.) Council, having decided to purchase from Messrs. Scott Bros. the local electric lighting and power plant, has decided to borrow £50,000 to complete the purchase and make additions to the plant.

Blue Mountains (N.S.W.) Council propose to borrow £25,000 for electric lighting in Lawson, Blackheath, Springwood, Mt. Victoria and Medlow.

The Government of the State of Western Australia are erecting a large flour mill at Gnildford, near Perth, which will be operated by electric power obtained from the state power plant, now nearing completion

Sydney Council were recently recommended by their Electric Committee to adopt a report by the city electrical engineer, which stated that it may not be desirable that the department should operate at a loss, and to avoid risk of doing so it was desirable that great extensions of mains should be postponed until the extensions recently approved and still in hand became revenue producing, and he did not think it would do to recommend the City Council to extend its supply mains into the Illawarra suburbs for a year or two.

New Zealand.—H.M. trade commissioner for New Zealand (Mr. W. C. Wickham) notifies that the Wellington Chamber of Commerce are organising an exhibition of goods of British manufacture to be held during one week in February next.

Mr. Wickham suggests that British firms who are unable to supply the New Zealand market at present, either at all or on the same terms as previously, should endeavour to keep their names before the public, not only by participating in the exhibition, but also by carrying out a campaign in the local press, telling the public (who are inclined to be sympathetic) exactly why their goods are not obtainable or why they are higher in price. It is stated that there is a marked tendency on the part of local agents to look to foreign countries as a source of supply.

South Africa. Cape Town Corporation recently floated a loan of £75,000 for extensions of the electric supply undertaking.

The directors of the Witbank (Transvaal) Colliery Co. wish to enter into an arrangement with the township for the supply of electric current for lighting.

This can (it is stated) be done at small capital cost and on a profitable basis, but the directors are advised that there is a doubt as to whether from a strictly legal point of view they have the necessary authority under the company's articles of association. A special general meeting of shareholders has, therefore, been convened to pass a resolution to make the necessary amendment.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says the Government of the Province of Buenos Ayres have authorised Magdalena Municipality to invite tenders for the erection and equipment of electricity supply works.

Bahia Blanca Municipal Commission has been authorised by the Government of the Province of Buenos Ayres to call for tenders for the electric lighting of the suburbs of Ingeniero White, Villa Rosas, Villa Mitre, &c.

Brazil.—The United States Commercial Attaché at *Rio de Janeiro* states that there is an urgent demand for goods in the States of Santa Catharina, Parana and Rio Grande de Sul.

It is stated that amongst the articles that would probably find an immediate market are electric lighting appliances, including electroliers, lamps, lampholders, &c., iron and manufactures of iron, tools and paints.

The British Consul at *Para* says German and Austrian goods will recover their popularity after the war, as British goods do not suit the native taste and purse. Meanwhile American trade is probably profiting more than British trade by the present opportunity. A showy appearance appeals to southern races more than lasting qualities. Packing should be careful, but light, as duties are paid on gross weight. Few British travellers pass through Para, although more than one Englishman has visited Para in the interests of American houses. Orders are nearly always sent through agents in Brazil or from export houses in Europe—not direct from manufacturers. British manufacturers might do well to get into touch with the export agencies.

A report from *Maranham* says the concession granted to a British company for electric light and traction, the initial work of which was to have started before the end of 1914, has, owing to the war, &c., failed to commence, but, in view of the present conditions, the municipality have not given a decision for or against an extension of time, and it is likely that the decision will be left in suspension until the war is over at least.

Japan.—The British Consul at Nagasaki reports that extensions of the electric tramway at Nagasaki are contemplated.

In a report on the trade of Osaka for 1914 Mr. Vice-consul White says the system of electric railways radiating from Osaka is now more or less complete, and construction work in the near future is likely to be confined to connecting lines. Working results of several of these railways have not been very satisfactory. The passenger traffic has suffered from trade depression. The financing of their loans at a time when money was dear has not proved an easy task. A movement is on foot to economise working expenses by taking all the power from one source, and a tendency has lately appeared to centralise power production. The completion of the Ujigawa Hydro-electric Company's works was followed by the virtual scrapping of much of the plant of the Osaka Electric Light Co. The former company is supplying 4,000 kw. to the Osaka municipal tramways during the daytime. A number of schemes for the construction of short light railways have been held up by the dearness of the money market.

Imports at Osaka in 1912, 1913 and 1914 respectively included insulated electric wire valued at £45,300, £4,100 and nil. Electric car parts imported were valued at £8,900, nil and £400.

In a report on the trade of Shimonoseki consular district for 1914, Mr. Consul Holmes says the imports at the port were valued at £2,444,653 from January to July (decrease 5½ per cent.), and £782,782 from August to December (decrease 42½ per cent.). Imports from Germany (chiefly machinery) were £38,000 monthly prior to the war. Electric wire and cable imported during the year were valued at £4,927 (against £4,738 in previous year), and dynamos and motors, &c., £28,783 (£74,450). The principal imports into the district are, with the exception of metals and machinery, not such as can be supplied by the United Kingdom. The greater part of goods of European origin are imported through Kobe and other ports, and the opening for British exporters direct to Moji is not favourable. There should, however, be good prospects for machinery in view of the cessation of German activities. The district has undoubtedly a great industrial future, and includes many towns which even now are of considerable manufacturing importance, while the rapid extension of electrical enterprise throughout the country implies a steady demand for electrical plant and machinery. Hitherto British enterprise in this direction has shown a marked lack of the energy displayed by German manufacturers and commercial firms, a German firm with a branch office at Moji having secured the greater part of the trade in machinery, especially electrical. How far German methods of business finance appeal to British firms is open to question, but even on more conservative lines there should be an opening for British manufactures, if capably and energetically represented. It is essential that local representatives should be appointed to expend time and trouble in order to obtain business. Such representatives should be given the fullest powers as to granting discounts, &c.

Yokohama Municipality propose to purchase the undertaking of the Yokohama Electric Railway Co., and to lay down new lines.

Mexico.—A consular report from Vera Cruz says near Orizaba there has been recently installed a large hydro-electric plant (owned by a British company), which has a capacity of 30,000 H.P., and supplies Vera Cruz with electrical energy for lighting and tramways. Power is also transmitted to Orizaba and Puebla.

Spain. The Government have published an additional list of goods in which it is proposed to admit foreign competition. The list includes raw materials for naval construction workshops, diving apparatus, motor boats, gas motors of more than 30 H.P., dynamos and electric motors (of 50 H.P. or more), transformers of more than 200 kw., rails of more than 20 kilogs per lineal metre, soft steel, &c.

United States.—A Consular report from St. Louis (Mo.) for 1914 states that the electrical industry has been depressed and is still in an unsatisfactory condition.

St. Louis has been supplied since July, 1913, with 60,000 H.P. of electrical energy from the Keokuk dam, 144 miles away. To secure a larger and cheaper supply it is proposed to connect the Missouri and Meramac rivers at a point 20 miles west of St. Louis, a State Senate Commission having reported that enough fall could be secured thereby from the former river to generate all the electricity required. The cost of the proposed undertaking is estimated at over £2,000,000, and it is estimated that the damage annually sustained in different ways by the residents of St. Louis through the burning of bituminous coal aggregates about the same amount.

Roumania.—The British Consul-General at Galatz (Major J. G. Baldwin, C.B.) says imports into Roumania in 1912 were valued at £25,516,220 (increase of £2,726,420 over 1911), and the exports were £25,684,150 (decrease £1,984,650).

Amongst the chief articles of import were iron and steel and machinery. Germany supplied nearly 38 per cent. of the total imports. Austria-Hungary nearly 22 per cent., and the United Kingdom under 14 per cent. Up to 1911 the United Kingdom occupied top place as regards the quantity of goods imported. Germany and Austria-Hungary have an advantage in their geographical position, but their success is stated not to be due to that alone. German firms are more alive to the possibilities of the market, and are better represented in Roumania than their British competitors. The latter have relied mainly on the services of commission agents, who, if they have any preference at all, probably prefer German or Austro-Hungarian goods, such agents being usually German-speaking Jews or of German or Austro-Hungarian extraction. Continental firms generally send out travellers to obtain orders, which secures a better chance of doing business. A number of British firms could combine to run a branch to sell their goods. Travellers and other representatives should be able to transact business in German or French (failing Roumanian). Catalogues should be in those languages, and the metric system should be employed in quoting prices. German and Austro-Hungarian firms generally grant more liberal credit than British firms. The majority of the local banks are financed by or are branches of the large banks in Germany and Austria-Hungary, and through them manufacturers in Germany and Austria-Hungary obtain information as to the state of the market, the standing of clients, &c. British goods are generally recognised as being superior to Continental goods, but the public is apt to put smartness of finish and cheapness before quality.

Machinery imports in 1912 were valued at £2,614,443, of which Germany supplied £1,499,929, the United States £325,080, and the United Kingdom £222,649. The German share in this trade is increasing, and the British decreasing. Electrical machinery and apparatus nearly all came from Germany.

The Vice-Consul at Bucharest says the United Kingdom manufacturer usually chooses the cheapest agent. The idea of paying an agent commission only is not good when one has to deal with semi orientals. Unless the agent is very conscientious he soon puts himself in accord with the buyer to the disadvantage of the seller. The German resident agents are on a fixed salary with a commission as well.

MISCELLANEOUS NOTES.

Inquest.—An inquest was held at Skinningrove (Cleveland), on the 29th ult. on a mines electrician, named Chas. E. Markham.

It was stated that deceased had been engaged in cleaning out the electric controller and a haulage engine and started the machinery to test it. He placed his left hand on the outer casing of the motor, but almost immediately fell. When a doctor arrived, Markham was dead.

A doctor said he found a mark as of a burn on the right wrist. The condition of the body was consistent with deceased having received an electric shock.

The mines manager (Mr. W. Moore) said he thought the flesh would have been injured or burnt if deceased had had a shock.

"Death probably from electric shock" was the verdict.

Patent Licensees and Renewal Fees.—Notice has been given that in the event of the prescribed renewal fees due in connection with patents in respect of which licences have been granted by the Board of Trade under the provisions of the Patents, Designs and Trade Marks Acts (1914) not being paid by the patentees, such fees may be paid by the licensees and the amount of such fees deducted from the royalties payable to the Public Trustee under the licence. Licencees should inform themselves as to the dates upon which such fees become payable to avoid having to pay extension fees also.

Rifle Clubs.—A friendly match took place between teams representing the British Thomson-Houston and the British Electric Transformer Companies' rifle clubs on the 20th ult.

The teams consisted of eight members, the best six cards only to count. The British Thomson-Houston Club scored 562, and the British Electric Transformer Club totalled 566 on the best six targets, an average of 93·6 and 94·3 respectively. The British Electric Transformer Club (Hayes, Middlesex) is anxious to arrange friendly matches, and will be glad to hear from miniature rifle clubs in the trade who have dates vacant either for shoulder-to-shoulder or post matches.

Radiotelegraphy in Brazil.—It is announced that the working of the complete system of radiotelegraphy in the States of Pará and Amazonas, Brazil, which was opened to the public for a short time, has been suspended.

TENDERS INVITED.

Electric Cable and Wire.

The COMMISSIONERS OF H.M. WORKS, &c., invite tenders for the supply of Electric Cable and Wire for one year from Jan 1, 1916. Forms of tender from the Controller of Supplies, 18, Queen Anne's Gate, S.W., and tenders (by 11 a.m., Dec. 9) to the Secretary, H.M. Office of Works, &c., Storey's Gate, London, S.W.

WALTHAMSTOW Council invite tenders (by noon Dec. 15) for supply of l.t. cable.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of g.i. Wire (specification No. 301; schedule No. 402), and c.b. Multiple Switchboard for Adelaide telegraph exchange (specification No. 552; schedule No. 405) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-st., London, S.W.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m., Dec. 14, for 18,670 c.b. Wall-pattern Telephones (schedule 1,264) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept.

The Deputy Postmaster-General, Melbourne, invites tenders until 3 p.m. Dec. 14 for 11 sections of Lamp Signalling Trunk Line Switchboard (schedule 1,207) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Sydney, requires tenders by 2:30 p.m. Dec. 20 for 3,750 c.b. wall pattern and 300 c.b. table Telephones, 150 Magneto Wall Telephones and 50 Portable Telephones (schedule No. 454) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General, Sydney.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Brisbane.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Tramway Rails, &c.

SOUTHEND Corporation require tenders by 9 a.m. Dec. 9 for about 120 tons second-hand tram rails and 50 pairs of fishplates. Particulars from the Borough Engineer.

Electrical Fittings, &c.

WEST HAM Guardians want tenders by 10 a.m. Dec. 16 for three months' supply of Electrical Fittings, Oils, &c. Forms of tender from the Clerk.

Public Electric Lighting.

ATHY (co. Kildare) Urban Council require tenders before 11 a.m. Dec. 6 for the electric lighting of the town on a three years' contract. About 50 Lamps of 50 c.p. each will be required for public lighting, and it is estimated that 300 private consumers can be obtained.

Electric Pumps, Motors, &c.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Dec. 20 for supply of three Centrifugal Pumps and Electric Motors, each to pump 6,300 gallons per minute and one to pump 15,100 gallons per minute, with switchboards, starters, &c., and spare parts. Specification, &c., from the Board's offices, 341, Pitt-street, Sydney, N.S.W.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections (contract No. 29,491), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fish-plates (contract No. 28,685). Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

Boiler.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c, of two Water-tube Boilers and Accessories at Newcastle Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

TENDERS RECEIVED AND ACCEPTED.

WOOLWICH (LONDON).—The Electricity Committee has accepted the quotation of Babcock & Wilcox (at £127), to supply feed and blow-down pipe work in connection with two new boilers in course of erection at the electricity works. The quotation of John Hopkinson & Co., has also been accepted for the supply of special valves for £71. 0s. 3d.

GLASGOW.—The Council have accepted the tender of Pirelli (Ltd.) for the supply of rubber insulated cables. The tender of Woodward & Co. has also been accepted for the supply of carbons from December to May next for the Cleansing Committee.

LITTLEBOROUGH.—The Council have accepted the tenders of W. T. Henley's Telegraph Co. for h.t. cables, and the British Electric Transformer Co. for transformers, switchgear, &c.

LUTON.—The following tenders are recommended for acceptance by the Council :—

Davenport Engineering Co., water cooler of 180,000 gallons capacity, £1,460; Johnson & Phillips, e.h.t. switchgear, £860.

SCHOOL LIGHTING.—Three tenders have been received by the L.C.C. for wiring Thornfield-road School, Hammersmith, and that of James Whitaker & Sons has been accepted at £420. 11s. The other tenders were £429 and £483. 1s.

REIGATE.—The Council have placed an order for 12 months' supply of a.c. induction motor meters with the British Westinghouse Co.

MELBOURNE (VICTORIA).—The City Council have accepted the tenders of John Payne & Son Pty. for 12 c.i. switch pillars £237, and the Australian General Electric Co. for m.d. indicators.

HACKNEY (LONDON).—The Council are recommended to accept the tender of Ferranti Limited, at £417. 9s. 10d., for an additional panel for an e.h.t. switchboard

BUENOS AYRES.—The tender of the Cia. Industrial de Electricidad del Rio de la Plata for the installation of two Corosio lifts in the Central Police Department, at $20,250 m/n (about £1,800), has been accepted.

SYDNEY (N.S.W.).—The City Council is recommended by the Electric Lighting Committee to purchase 10 additional joint boxes, at £90. 15s., four terminal trifurcating boxes, one spare box and one set of insulators, at £214, from Noyes Bros., and to reduce the quantity of 33,000 volt cable on order from the same firm by 1,938 yds. for a reduction of £1,100 in the amount of the contract. The Committee also recommend the purchase of 140 10 ampere a.c. meters from the same firm.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Launceston Police Works Dept.—British General Electric Co., for power plant at the mental diseases hospital, New Norfolk, £2,347; A. J. Todd & Co., electric lighting and overhead equipment for same, £135. 0s. 11d.

Postmaster-General's Dept., Queensland.—Inglis, Smith & Co., for 36 B.H.P. engine, coupled to 22 kw. generator, with spare parts, for radio-telegraph station, Townsville, £742.

Postmaster-General's Dept., Sydney.—Western Electric Co., 2,500 bottles Baker's soldering solution, £83. 6s. 8d.; 3,600 bridle rings, £4. 19s.; 6,600 ditto, £16. 15s. 6d.; 6,600 ditto, £19. 16s.; 7,200 ditto, £33; 225 condensers, £25. 6s. 3d.

Victorian Railway Commissioners.—Siemens Bros. & Co., electric lighting material for Jolimont car repair shop, at rates; British Insulated & Helsby Cables, ditto, at rates; Australian General Electric Co., ditto, at rates; Gibson, Battle & Co., 5 ft. high-speed motor-driven radial drilling machine for ditto, £384; Noyes Bros. v.r. electric light wire, £15. 5s. per mile; and 13 in. centre lathe for turning and grinding commutators of traction armatures, for Jolimont car repair shop, £187; Lascelles Parrington, motor generator (9 kw.), with switchboard and accessories for battery charging at Jolimont car repair shop, £266.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Cardiff.—The accounts of the tramways department for the year ended March 31 show total capital expenditure £811,043 (increase £24,533), of which £302,242 has been repaid or provided for repayment.

Revenue was £164,683 (compared with £166,200 in previous year), working expenses were £97,300 (£99,064), gross profit on working was £67,323 (£66,638) and total gross profit £68,446 (£68,384). Interest required £23,925 (£23,941) and sinking fund £22,645 (£23,014), income tax £2,272 (£2,835), and payments to employes on war service £2,655, leaving net balance £16,949 (£18,594). Average total revenue per car mile was 12·354d. (11·650d.), and total working expenses, including power, &c., were 7·028d. (6·781d.). Average fare per mile was 0·738d. Passengers carried were 30,424,407 (31,122,962), car miles run 2,742,546 (2,966,230), and units used 4,936,582 (5,073,942).

The city electrical engineer and manager, Mr. Arthur Ellis, says in his report, as regards the effect of the war, the traffic receipts showed an increase of £3,000 at the beginning of July, 1914, but from July 25 there was a steady decrease, the total decrease at the end of the financial year being £2,846. It is desirable that a substantial reserve should be built up, out of which could be defrayed the cost of installing station plant of more modern type and increased efficiency. The parcels delivery revenue was £583, against expenditure £265. Income from sale of electrical energy to the electric lighting department increased by £1,292. Power station expenses increased £333 for an output increased by over half a million units, this improvement in cost being due to the use (for only two or three months) of the new plant installed last year. War allowances are paid to the dependents of 201 men, the cost being at the rate of £5,720 per annum. Mr. Ellis recommends the installation of a large rotary converter or motor-generator, which could be used in the summer for the tramway supply, in which case the turbine plant could take the whole load and the old plant could be shut down. The repairs department has lost nearly 50 per cent. of its men owing to the war.

The capital expenditure on the electric lighting undertaking is £298,189 (increase £7,069), of which £108,240 has been repaid or provided for redemption. Revenue was £62,345 (against £58,704), total costs were £37,563 (£35,936), interest and sinking fund required £18,858 (£18,230), and the net profit was £5,924 (£4,538). Average price obtained was 1·98d. (1·99d.) per unit. Units generated were 8,943,502 and sold 7,322,212. In his report Mr. Ellis says the past year has been one of the most successful in the history of the undertaking, and a larger gross profit was made, resulting from economies in working expenses. £982 was spent on new meters out of revenue. The reduction of the charge for heating units from 1½d. to 1d. has been justified, the consumption for domestic purposes having been almost doubled during the year. Heating installations increased from 626 kw. to 878 kw. Mr. Ellis recommends that the bulk of the net surplus be transferred to depreciation fund, and that that fund should be built up to 10 per cent. on the capital (=about £30,000). Motors connected are equal to 5,985 H.P. (5,446 H.P.), and total connections are equal to 12,584 kw. (11,500 kw.). Total maximum demand was 4,200 kw.

Exeter.—The accounts of the electricity undertaking for the year ended March 31 show total capital expenditure £121,820 (increase £6,472), of which £52,424 has been paid off or provided for paying off.

Revenue was £20,072 and working and general expenses were £11,829

leaving gross profit £8,243. Interest required £2,383 and sinking fund £4,029, and the surplus, after providing for income tax, was £1,554. Units generated for lighting and power were 1,349,759 and sold 1,100,394; and for tramways 654,699 generated and 615,956 sold. Total maximum demand was 848 kw. for lighting and power, and 300 kw. for tramways.

Capital expenditure on the tramways is £88,817, and £20,851 has been paid off or provided for. Revenue was £18,018 (=9·629d. per car-mile), expenses, including power, were £11,598 (=6·193d.), leaving gross profit £6,420 (=3·431d.). Interest required £2,240 net, income tax £120, and sinking fund £1,649, and the amount carried to reserve and renewals was £2,109. Passengers carried were 4,611,444 and car-miles run 449,103.

COMPANIES' MEETINGS AND REPORTS.

CASTNER-KELLNER ALKALI CO. (LTD.)—At the meeting last week the chairman (the Rt. Hon. G. W. Balfour) said the net profit for the year, after the customary ample allowance for repairs and maintenance, amounted to £260,804, against £174,150 in the previous 12 months. The directors recommended the appropriation of £50,000 to depreciation reserve, increasing that account to £437,500; £10,000 to general reserve, increasing it to £79,364; £90,000 in payment of a final dividend of 12 per cent. (making 20 per cent. for year), leaving £61,151 to be carried forward. Their financial position was a very strong one. The object of carrying forward £61,151, against £18,402 last year, was to provide for whatever sum might become due from them in respect of the tax on excess profits. That tax was not one he would wish to see forming part of the fiscal policy of the country, but as an emergency measure, to meet, perhaps, the greatest strain they had ever been called upon to undergo, he personally did not complain of it, but thought it was amply justified. The extra profits were due not to an increased price or to increased profits made out of contracts with the Government, but to the foresight of the directors in largely increasing the company's plant at the right time.

CONSOLIDATED SIGNAL CO. (LTD.)—At the meeting last week the chairman (Mr. S. P. Wood) said that the board must, under existing circumstances, pursue a cautious and safe course, and their first consideration must be to ensure, as far as possible, that the factories should be kept going concerns. Signalling was one of the first things on which the railway companies could and did economise in times of financial disturbance, and about the last on which they commenced expenditure, and present times were not an exception to that rule on home, colonial and foreign railways. They had turned their efforts towards the production of war materials. Only part of the subsidiary companies' plant and machinery was suitable for such work, and they had had to adapt and add to it and to adopt new methods of manufacture. The difficulty of obtaining efficient labour and additional tools had in many cases prevented their undertaking available munition work. The gross profits of the subsidiary companies for the year to June 30 were £36,329, and the net profits £7,162. After paying expenses, their company had a profit of £18,298, with £4,529 brought forward, and after placing £6,000 to reserve, and paying the preference dividend, £5,475 was carried forward.

ELECTRICAL SECURITIES TRUST (LTD.)—The report for the year to Nov. 14 states that, afrer charging all expenses and debenture interest there is a loss of £710. The directors regret that they have been unable to dispose of any of the investments during the past year.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

QUASI-ARC CO. (FRANCE) (LTD.) (142,217).—Reg. Nov. 23, capital £5,000 in £1 shares, to carry on in France or elsewhere the business of consulting, civil, chemical, electrical, mechanical and marine engineers, manufacturers of, agents for and dealers in machinery, tools, &c. Private company. Reg. office: Caxton House, Westminster, S.W.

TREDELECT ENGINEERING CO. (LTD.) (142,245).—Reg. Nov. 25, capital £3,000 in £1 shares (1,000 6 per cent. preference), to take over from H. C. H. Smyth the benefit of a certain existing invention relating to improvements in or relating to electric generators for lighting mechanically-propelled vehicles, to carry on the business of electrical and general engineers, suppliers of electricity, &c. Private company. First directors are H. C. H. Smyth, H. A. Bartlett and G. F. A. Norman. Reg. office: 11, Linden Arcade, High-road, Chiswick.

J. TRUMAN & CO. (LTD.) (142,247).—Reg. Nov. 26, capital £7,000 in £1 shares, to carry on the business of manufacturers and importers of and dealers in all kinds of metal work, electric and gas fittings, lamps, &c. Private company. M. F. Holdsworth is permanent governing director.

MORTGAGES AND CHARGES.

L. ADAMS (LTD.)—Debenture dated Nov. 18, 1915, to secure £1,000, charged on company's undertaking and property, present and future. Holder: A. E. Voss.

RENEW ELECTRIC LAMP CO. (LTD.)—Mortgage dated Nov. 17, 1915, to secure £337. 7s. 3d., and further advances up to £500, charged on benefit of a certain agreement, being a contract for the purchase of a licence to work the company's process for renewing electric lamps in Russia. Holders, Haughton, Dickson & Co.

CITY NOTES.

MEMORANDA (Dec. 1).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58⅝. Stocks and Shares Ticket Days Dec. 14 and 30. Pay Days Dec. 15 and 30. Price of silver, 26 15/16d.

BANK FUR ELEKTRISCHE UNTERNEHMUNGEN (ZURICH) — Herr Deutsch, chairman of the A.E.G., of Berlin, has been elected a director of this company.

CONSOLIDATED DIESEL ENGINE MANUFACTURERS (LTD.)—On Mr. Justice Astbury's order a meeting of shareholders was held on Wednesday to ascertain whether or no they wished (now that the creditors of the company had been paid off) that a liquidator nominated by the shareholders should be appointed to act jointly with or in lieu of Sir W. B. Peat in the liquidation. The Official Receiver in Companies Liquidation acted as chairman at the meeting.

MACKAY COMPANIES.—The regular quarterly dividend of 1 per cent. on the preferred shares and the regular quarterly dividend of 1¼ per cent. on the common shares in the Mackay Companies will be paid on Jan. 3, 1916, to shareholders of record as they appear at the close of business, on the 10th inst. The transfer books will not be closed.

POWER GAS CORPN. (LTD.)—A dividend at rate of 6 per cent. per annum (less tax) has been declared on the ordinary shares for the year ended Sept. 30.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended Sept. 30 amounted to £184,798.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Nov. 30. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Nov. 30.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9 13/32	7 8 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9 3/32	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9 19/32	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	8 3/16	5 16 9	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	90½	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3 5/16	6 11 0	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	3 5/16	5 13 5	Jan, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅛	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	88½	5 1 2	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	11	5 9 1	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9 15/16	7 0 11	Mar, Sept
10	6%	Do. 6% Pref.	10 3/16	5 17 9	Feb, Aug
St.	4½%	Do. 1st Deb.	91	4 18 11	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77 1/16	5 11 3	July
5	9%	Kensington and Knightsbridge Ord.	6 3/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 6 4	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 7/16	7 3 7	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	95½	4 14 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/16	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	0 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 5/16	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 3/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 3/16	7 10 7	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4 3/16	5 7 5	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	71	8 7 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70½	5 13 6	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅛	5 11 4	May, Nov
St.	5%	Do. Pref. 1890	80	6 5 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1⅛	4 3 4	Jan, July
St.	4%	Do. 4% Pref.	59	7 0 5	Mar, Sept
St.	4%	Do. 4% Debs.	55	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24½	4 2 11	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13 6	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 0	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	69	6 10 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	115	5 4 4	Jan, July
St	4%	Do. 4% Debs.	73	5 9 7	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	67½	5 18 0	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 1/16	..	..
1/0	..	Do. A Ord.	5/8	..	..
St.	6%	Do. 6% Inc. Debs.	105½	5 13 6	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price. Tues., Nov. 30	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	80½	7 9 6	Mar, Sept
..	4½%	Do. 4½% Bds.	99½	4 10 6	Jan, July
5	..	Yorkshire W. Riding Ord.	⅛	..	March
5	6%	Do. Pref.	4⅛	6 19 2	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅜	6 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1⅜	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	91½	5 9 2	Jan, July
1	6%	Do. 6% Pref.	⅛	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛	7 8 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅛	8 5 4	April
100	6%	Do. 6% Prior Lien Debs.	101⅜	5 18 6	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70⅜	5 13 [illegible]	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅞	7 7 3	Jan, July
5	2/6	Do. 5% Pref	4⅛	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	2⅛†	6 16 2	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅛	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅞	..	Feb, Aug
St.	4%	Do. 4% Deb.	62	6 9 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅛†	7 4 6	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
..	10%	General Electric Ord.	10⅞	9 11 7	July
10	6%	Do, 6% Pref.	9⅛	6 3 1	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	12⅜	7 16 10	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7⅛	6 7 0	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	33½	7 3 [illegible]	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅛	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	[illegible]	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	83⅝	4 15 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	102	4 [illegible] 3	Jan, Dec
		Telegraphs.			
St.	15/0	Anglo American 6% Pref. Ord.	100½	5 19 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22⅝	6 11 1	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69	5 15 11	Ja.Ap.Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅛	6 10 7	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	128	5 9 5	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80	5 0 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 [illegible]	Feb, Aug
10	7%	Do. Ord.	12	5 16 [illegible]	Ja. Ap Jly.O
10	22%	Gt. Northern Tel. Co. with Coup. 8	34½	6 8 6	Ja, My, Jly
25	13%	Indo-European	47⅛	6 15 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 6 10	April
1	7%	Do. 7% Pref.	1⅛	4 6 2	July
10	1%	West India & Panama Ord.	1⅛	9 [illegible] 3	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 11 2	May, Nov
10	7%	Western Telegh. Co.	12½	5 12 0	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	98	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135½	5 7 10	Ja,Ap, Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	75⅜	6 12 [illegible]	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅛	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101⅛	4 9 11	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79⅜	5 0 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 4 [illegible]	Jan, July
5	8%	United River Plate Ord.	5⅛	6 18 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	[illegible] 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust.	10⅛	5 13 7	Sp.Dc,Mr, Jn
10	6%	Do. 6% Pf.	10⅛	5 12 11	Sp.Dc.Mr, Jn
100	5%	Mackay Companies' Common	85½	5 17 0	Ja. Apl. Jly.O
..	4%	Do. $100 Pref	68½	5 16 4	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	91†	6 3 5	Jan, Dec
St.	4½%	Do. 4½% Debs	76	5 18 5	Jan, July
St.	4%	Do. 4% Debs.	70½	5 4 7	Jan, July
5	2/9	Do. 5½% 1st Pref.	4⅛	6 11 5	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3†	7 17 2	Jan, July
100	2%	Brazilian Traction Ord.	55	7 5 [illegible]	Fb,M,Aug,N
100	$1⅛	Do. 6% Pref.	92½	6 [illegible]	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 8 0	M..
5	2/6	Do. 5% Cum. Pref.	4½	5 11 [illegible]	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	6[illegible]	6 [illegible] 0	..
5	9½%	Calcutta Elec. Trams. Ord.	9⅛	7 11 [illegible]	Mar. Sep
..	5%	Havana Elec. Ry. 5% Bds.	69	5 1 [illegible]	Feb. Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4[illegible]	6 [illegible] 4	..
100	5%	Manaos Trams 5% Debs.	6[illegible]	7 4 11	Jan, July
..	..	Mexico Trams Common St.	42⅛	..	Fb,M,Aug,N,
..	5%	Do. 5% Bds	4[illegible]	10 8 4	M[illegible]
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	[illegible]	4 13 [illegible]	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 5) yr. Bds	72½	[illegible] 6	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4[illegible]	[illegible] 1 [illegible]	Mar, Sept
St.	5%	Do. 5% Debs.	97[illegible]	[illegible] 2 7	Jan, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10[illegible]	5 15 [illegible]	..
St.	4½%	Do. 4½% Debs.	97[illegible]	5 7 [illegible]	Jan, Jly
5	9%	Calcutta E. S. Corp. Ord	6[illegible]	7 1 [illegible]	May, Nov
5	5%	Do. 5% Pref.	4[illegible]	5 14 [illegible]	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	1[illegible]	5 13 [illegible]	Ja, Ap, Jly,O
St.	5%	Melbourn eElec. Supply 5% 1st Mt. Debs.	93	5 1 [illegible]	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	9[illegible]	5 3 [illegible]	Apl, Oct
..	..	Mexican Light & Power Ord.	29	[illegible]	Ja,Ap,Jly,O
..	..	Do. Pref	44	[illegible]	May, Nov
..	5%	Do. 5% Bds	48½	10 [illegible]	Jan, Jly
..	5%	Shawinigan Water & Power 5% Bds.	104½	4 [illegible]	Jan, July
..	6%	Do. Cap. Stock	144½	4 [illegible]	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 [illegible]	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	83½	5 [illegible]	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	⅜	[illegible]	Jan, July
..	5½%	Do. 5½% 2nd Mort Debs.	94½	5 10 3	Jan, July

* And 13⅓% bonus. Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec.. 1, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14½d.
Solid Drawn Copper Tubes	14d.
Brazed Copper Tubes	14d.
Brazed Brass Tubes	16½d.
Brass Wire	13⅞d.
Copper Wire	13d.
Rolled Brass	13⅝d.
Brass Sheets	14⅜d.

	per ton.
Copper Sheets	£112 0 0
Spelter	£100 0 0

	per ton
English Lead	£29 10 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£79 0 0
Brazlery Copper Scrap.	£70 0 0
Clean Scrap Brass	£56 10 0
Old Lead	£22 0 0
Old Zinc	£55 0 0
Hollow Pewter	£120 0 0
Black Pewter	£80 0 0
Gun Metal	£65 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark. London, S.E., quotes under date Nov. 30, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£115 0 0
Clean Mixed Brass	£58 0 0
Clean Copper	£74 0 0
Brazlery Copper	£68 0 0
Gun Metal	£68 0 0

	per ton.
Old Lead	£24 0 0
Tea Lead	£22 0 0
Old Zinc	£66 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Nov. 24	1,573	+ 108	25	45,994	+ 2,483
Anglo-Argentine	,, 25	52,407	+ 1,644	25	2,397,085	— 134,417
Ashton-under-Lyne	,, 27	396	+ 21	35	16,887	+ 1,216
Ayr Corporation	,, 27	224	+ 3	28	11,827	+ 638
Birkenhead Corporation	,, 28	1,232	+ 52	35	47,742	+ 3,809
Birmingham Corporation. Trams	,, 20	15,239	+ 3,648	34	475,038	+ 64,658
Birmingham Corporation. Buses &c.	,, 20	797	+ 178	34	28,840	+ 17,675
Blackburn Corporation	.. 24	1,004	+ 55	35	45,384	— 305
Blackpool Corporation	,, 25	588	+ 76	35	65,514	+ 1,514
Blackpool and Fleetwood	,, 29	248	— 19	47	37,542	— 274
Bolton Corporation	,, 28	2.403	+ 15	35§	93,661	+ 1,910
Bournemouth Trams	,, 24	1,553	— 19	34	73,923	+ 3,788
Bournemouth Buses	,, 24	6	+ 1	34	883	— 102
Bradford Corporation	.. ..	..	.. ..	..	..	.. ..
Brighton Corporation	,, 28	814	+ 36	35§	40,394	+ 252
Bristol Trams Trams	,, 26	4,783	+ 782	47	221,439	+ 3,765
Bristol Trams Buses,&c.	,, 26	4,851	+ 1,172	47	229,734	+ 41,884
Burmah E. Trams & Ltg.	,, 27	R3,810	+ R202	..	..	..
Burnley Corporation	,, 27	1,404	+ 168	8	12,101	+ 1,666
Burton Corporation	,, 28	244	— 23	35	9,865	— 422
Bury Corporation	.. ..	..	.. ..	..	..	.. ..
Calcutta Tramways Co.	,, 27	"R68,355	+R10.961	..	..	.. ..
Camborne-Redruth	.. ..	..	.. ..	..	..	.. ..
Cardiff Corporation	,, 20	2,392	+ 135	33	91,341	— 2,771
Cork Electric Trams Co.	,, 25	425	+ 1	47	23,639	+ 26
Coventry Corporation	.. ..	..	.. ..	..	..	.. ..
Croydon Corporation	.. ..	..	.. ..	..	..	.. ..
*Derby Corporation	,, 27	917	+ 23	34‖	36.555	+ 1,058
Dover Corporation	,, 20	248	+ 47	33	10,799	+ 1,942
Dublin & Lucan Railway	,, 26	99	— 6	21	3 275	+ 90
Dublin United	,, 26	5,351	— 13	47	287,405	+ 10,693
Dundee Corporation	,, 24	1,230	+ 44	28§	37,982	+ 2,063
East Ham Council	,, 29	1,202	+ 41	34‖	45,445	+ 5,787
Exeter Corporation	,, 26	291	+ 15	34	13,304	+ 781
Glasgow Corporation	,, 27	20,621	+ 690	26‡	560,254	+ 40,310
Glossop Trams	,, 27	119	+ 28	48	6,021	+ [illegible]
Gloucester Corpn.	,, 24	267	+ 9	34	11,538	+ 137
Halifax Corpn. Trams	,, 23	1,878	+ 24	34	77,583	+ 997
Halifax Corpn. Buses	,, 23	38	..	34	1.715	+ [illegible]
Hastings Elec. Trams Co.	,, 25	674	+ 14	47	85,965	— 166
Huddersfield Corpn.	,, 27	2,357	+ 158	34	93,465	+ 13.179
Hull Corporation	,, 27	3,088	+ 156	34	105,575	— 3,024
Ilford District Council	,, 27	565	+ 16	34	22,559	+ 2,899
Ilkeston Corporation	,, 24	121	+ 107	34	4,621	+ 149
Ipswich Corporation	,, 27	432	+ [illegible]	33	19,376	+ 3,114
Isle of Thanet Co.	,, 27	211	— 42	8¶	2,246	— 793
Kilmarnock Corporation	,, 27	143	+ 1	28	4.775	— 146
Lanarkshire Trams Co.	,, 25	1.803	— 205	47	93,194	— 5,063
Lancashire United	,, 24	1.501	+ 143	47	81,852	+ 5,145
Leeds Corporation	,, 27	8,206	+ 381	35	311,630	+ 24.585
Leicester Corporation	,, 27	2,957	+ 293	48	143,987	+ 8,448
Leith Corporation	,, 27	661	+ 37	28	21,800	+ 1,325
Lincoln Corporation	.. ..	..	.. ..	..	..	.. ..
Liverpool Corporation	,, 28	12,505	+ 802	44¶	617,811	+ [illegible]
Llandudno&Colwyn BayR	,, 26	171	+ 28	52	17,294	+ 1,787
London County Council	.. ..	..	.. ..	..	..	.. ..
Lowestoft Corporation	.. ..	..	.. ..	..	..	.. ..
Maidstone Corporation	,, 25	168	+ 19	34	7.705	+ [illegible]
Manchester Corporation	,, 27	16,006	— 393	34	620.265	+ 19,737
Nelson Corporation	,, 27	187	+ 24	34	[illegible]	+ 208
Newcastle-on-Tyne Corpn	,, 27	5.597*	..	..	218.722	..
Newport(Mon.) Corpn.	.. ..	..	.. ..	..	..	.. ..
Northampton Corporation	,, 26	[illegible]	+ 20	34¶	25,363	+ 4,637
Nottingham Corporation	,, 28	3,433	— 346	34	128.324	+ [illegible]
Oldham Corporation	,, 28	1.928	+ 37	36	82,486	+ 3,464
Portsmouth Corporation	,, 20	1.960	— 103	34	86.963	..
Preston Corporation	,, 24	906	— 112	34**	33.076	+ [illegible]
Reading	.. ..	..	.. ..	..	..	.. ..
Rotherham Corporation	,, 24	[illegible]	+ 222	34	39,853	+ 4,457
Salford Corporation	,, 24	[illegible]	— 397	36‡	181,[illegible]	— [illegible]
†Sheffield Corporation	,, 28	8,936	+ 1.425	34	317.570	+ [illegible]
Southampton Corpn.	,, 24	1,277	+ 230	34	51.948	+ [illegible]
Southport Corporation	,, 24	544	— 34	34	29.657	+ [illegible]
Stalybridge,Hyde,&c., Jt. B	.. ..	..	.. ..	..	..	.. ..
Stockport Corporation	.. 28	1,380	— 38	35	52,253	— 247
Stourbridge District	,, 24	[illegible]	+ 18	4	2.143	+ [illegible]
Swansea Corporation	,, 24	165	— 17	34	6,821	— 641
Tyneside Tram Co.	,, 17	[illegible]	— [illegible]	20	[illegible]	— [illegible]
Walsall Corporation	,, 27	[illegible]	+ 32	[illegible]	[illegible]	— [illegible]
Walsall Corporation	,, 27	[illegible]	+ 105	48	35,333	+ [illegible]
Warrington Corporation	,, 27	[illegible]	— 10	35	31,893	+ 3,300
Wednesbury Corporation	,, 25	[illegible]	+ 44	34	15.669	+ 750
West Ham Corporation	,, 28	2.7[illegible]	— 158	34	106 803	+ [illegible]
Wigan Corporation	,, 25	[illegible]	+ 38	34	[illegible]	+ 2,478
Wolverhampton Corpn.	,, 24	1,042	+ 122	8	8.641	+ 621
Yorkshire W.R. Trams	,, 28	1,420	+ 45	[illegible]	75,761	+ 6,167

(a) These comparisons are with the corresponding period last year. * Partly electrical † Includes omnibuses &c. ‡ Minus 2 days. ‖ Minus 3 days § Plus 3 days. ¶ Plus 2 days. ** Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 335
Arrangements for the Week .. 338
The Magnetic Properties of Some Iron Alloys Melted in Vacuo. By Trygve D. Yensen. Illustrated 339
Electric Heating and Schoop's Metal-Squirting Process. By Dr. Lach 342
Three-Phase Generators for the Rjukanfos Power Station. Illustrated 343
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated. *Continued* 346
Some Considerations on the Marconi High-Power Transmitting Plant. By N. Skritzky. Illustrated 348
Gas Filled Tungsten Lamps. By Dr. M. Pirani and Dr. A. R. Meyer 350
'Status" of the Engineer .. 351
THE MAGNETIC PROPERTIES OF THE IRON-SILICON GROUP .. 352
The Calculation of the Effective Resistance of Earth Plates, &c. By Prof. G. W. O. Howe, D.Sc. Illustrated 353
CORRESPONDENCE 355
Some Problems of Electromagnetic Induction (G. W. O. Howe, E. A. Biedermann and W. Tolmé Maccall).
SubmarineCableRapid Telegraphy (George O. Squier and H. H. Harrison).
"Alternating-CurrentWork" (E. Hughes).
The Institution and Alien Enemy Members (W. Ellerd-Styles).
Physical Society 359
PARLIAMENTARY INTELLIGENCE 359
LEGAL INTELLIGENCE 360
The "Electrician" Commercial and Industrial Section .. 361–368

NOTES.

Maintenance of Power Supply.

THE importance of having sufficient spare plant in order to maintain an efficient power supply was emphasised the other day by a breakdown at Wednesbury. In this case, plant is actually on order, but is already more than two months overdue, and at the moment there is no spare plant available. As a result of the breakdown Wednesbury was in darkness for one hour. The power load is an important one, and as the supply failed at a time when the works should have been running it caused some loss and inconvenience. Possibly this instance, which we believe is not altogether isolated, will serve to bring before the authorities the importance of allowing electricity authorities to place orders for new plant reasonably in advance of when it will be required. In this connection it is necessary for the Government to deal with the whole subject with a view to the future. We are glad to see that there is a tendency towards a proper appreciation of things in the attitude that is being adopted in regard to certain works. The Government is willing to lend the necessary money in certain cases for periods usually allowed for loans for similar work. Moreover, if during the period of the loan the plant is found to be in excess of what is properly required for an efficient supply of the Council's electric lighting area, the Government will either take over the plant or write off so much of the debt, in the event of the plant being retained by the Council, as will prevent any loss to the Council in respect of the plant. We think it most important that a policy of this kind should be adopted.

Gas-Filled Lamps.

GAS-FILLED tungsten lamps are now becoming better known and understood, but although a good deal of work has been done on them since the days when LANGMUIR disclosed his ideas, no very important fact has been discovered. LANGMUIR's proposal was, of course, quite a simple one, and amounted to the suggestion that the lamps should be run in an atmosphere of some inert gas instead of being run in a vacuum. The existence of an atmosphere of such a gas at a sufficiently high pressure was intended to prevent the volatilisation of the tungsten, which caused not only a blackening of the bulb, but also the breakage of the filament, if the lamp was so run that a high efficiency was obtained. In our present issue we give a summary of a Paper by Dr. PIRANI and Dr. MEYER, who discuss such developments as have been made in the process of manufacture, and in the matter of design.

BUT it does not seem that anything has been done which is of the nature of a radical change from LANGMUIR's suggestions. It is true that certain lamps are filled with argon, but the possibility of this was foreseen, though it is quite likely that the low thermal conductivity of argon did not receive much attention. Still, pure argon is not a very satisfactory atmosphere to use, largely on account of the fact that it appears to break down somewhat easily under electric stress. Such a lamp is found to be rather liable to short circuits, and a small admixture of nitrogen with the argon is found to be desirable. As for methods of winding the filament, the spiral has, of course, obvious advantages; but the spiral lends itself to different types of construction, as, for instance, the "ring" or the "zig-zag" type. The distribution of light by these different types is not at all the same, and the vexed question as to the proper method of rating lamps of this character still remains unsettled.

ORIGINALLY the gas-filled lamp, made in large candle-powers, was thought to be a suitable competitor of small arc-lamps, which had always been rated on the hemispherical candle-power. Later, when smaller sizes were made, it was found to compete with the ordinary incandescent lamp for different purposes; this had been rated on the mean horizontal candle-power. The horizontal direction was chosen because this happened to be the direction in which the illumination was a maximum. But this is not the case with some of the gas-filled lamps. There is indeed a good deal of confusion in the matter, and this has been partly caused by the use of the term "half-watt lamp," which is not justified in the case of some of the smaller nitrogen-filled lamps. It would seem a good deal better to rate the lamps by watts, and then any increase in efficiency in the future would not lead the consumer to think he could do with lamps taking less watts, and yet giving the same candle-power as before. If the watt-rating became general it would probably be necessary to add some indication to the various lamps, stating whether the maximum illumination

was in a horizontal or vertical direction; but this again depends on reflectors, and the manner of mounting.

Metal Squirting for Heating-Resistances.

It is now some years since the appearance of Schoop's metal-squirting pistol. A good deal of interest was created by this invention, as there was something new in the idea that finely divided metals could be squirted with sufficient velocity to form a coherent coating upon a surface subjected to this process. The method has so far been used for purposes akin to electro-plating; but on another page we give an account of its application to the production of resistances for electric heating. The use of metallic films for such a purpose has been known for many years. The Prometheus system, for example, depends upon the use of thin films of the noble metals on a base of mica. In the present development the films are squirted upon an earthenware base, the object being to cover the whole surface in the first instance, and then to fuse off a certain amount of metal in zigzag lines by means of a comparatively heavy electric current causing considerable heat at the point of a moving contact. By this means a zigzag conducting film is obtained which is said to be quite effective for the purpose. One advantage which is not so easily obtained by electrolysis is that alloys of any composition can be easily used. For example, constantan, nickelin, German silver, &c., can all be employed. We imagine that a possible objection to this method of producing resistances is that they cannot very well be run at a red-heat, as deterioration will set in at certain points. On the other hand, this objection does not apply to the production of electrical resistances for laboratory purposes.

Line Drawings.

There is a growing tendency to let indifferent half-tone illustrations and scanty text serve instead of working drawings (or plans, elevations and sections) and lucid notes for the purpose of describing engineering structures and works. Such tendency is to be deplored. We are well aware that half-tone illustrations serve a useful purpose in their proper place, but such place is neither in the Papers read before engineering institutions nor in the pages of technical journals when engineering drawings have to be excluded to make room for them. Prof. Thompson indirectly referred to this in his contribution to the discussion on the Paper recently read by Prof. Field before the Institution of Electrical Engineers. Information was desired concerning the structure by which the end-bends of the stator winding were held in position. Beyond question this is a subject in which many engineers are interested, and it is not unlikely that the author of the Paper had the illustrations at hand. An inspection of the pages of the "Proceedings" and "Journals" of several of the engineering institutions shows that the practice of inserting large numbers of half-tone illustrations—sometimes without figure numbers or references in the text—is rapidly extending. We think the practice is one which the Publication Committees of these institutions would do well to discourage. In certain cases it may not be expedient to publish line drawings, but we venture to think that such cases are comparatively rare.

Protection of X-Ray Operators. The Röntgen Society has recently formulated a set of recommendations for the protection of X-ray operators from the dangers attending the use of X-rays. These recommendations are to be issued in card form.

"The Times" Fund for Sick and Wounded.—The British Electrical and Allied Manufacturers' Association has made a second contribution (£200) to "The Times" Fund for the Sick and Wounded on behalf of the British Red Cross Society and the Order of St. John of Jerusalem. The total sum contributed by this Association to this fund is £1,000.

New Telautograph.—It is reported that a telautograph has been invented by two Swedish engineers which works on a new principle, making the apparatus independent of the electrical resistance of the line. It can be connected alternatively to a long or short line without any adjustment of the resistance, and can consequently be used in connection with the public telephone systems.

Calculation of Ampere-turns for Teeth.—To the "E.T.Z." Mr. J. Sumec recently contributed an article in which a graphical construction was given for determining the ampere-turns required for the teeth of an armature. A simple method of calculating the excitation was also described. The graphical method and the formula were applied to a concrete example, and were found to give close agreement.

Royal Engineers (Wireless Section).—The Wireless Section R.E. has vacancies for a number of electricians and instrument repairers with good practical knowledge. Engagement for the period of the War only. Applications for enlistment, stating qualifications, should be sent to the O.C. Wireless Training Centre, Worcester, from whom information regarding terms of service can be obtained. Men would be required to enlist as sappers in the wireless section of the Royal Engineers, but prospects of promotion for satisfactory men are very good.

Radio Stations in the United States.—According to this year's edition of the "List of Radio Stations of the United States," compiled by the United States Bureau of Navigation, the total number of stations in the United States is 5,073, an increase of 1,131 over the 1914 figures. The number of Government and commercial land stations in 1915 is 224, an increase of 35 over 1914. Government and commercial ship stations are the same in number for both 1914 and 1915, namely, 895. The increase in the number of amateur stations is 1,040.

Merchant Shipping Convention Act (1914).—The Board of Trade announce that the coming into operation of this Act has again been postponed until July 1, 1916. The Act confirms the International Convention for the safety of Life at Sea, signed by the delegates to the London Conference in January, 1914, and introduces (inter alia) important reforms in regard to the use of radio-telegraphy and signalling apparatus on board ship, &c. Originally the Act was intended to come into force on July 1, 1915, but in May last it was postponed until January 1, 1916, and now it has been again postponed.

Water Power in Norway.—The exploitation of the Saude Falls is now to be commenced. The power station here, the first of a series, will have a capacity of 27,000 H.P. The next station will be placed at the Dalwater, and will have a capacity of 10,000 H.P. to 12,000 H.P.; a little lower down, the third and largest station with a capacity of 40,000 H.P. to 45,000 H.P., will be established; and the last, of 10,000 H.P. to 12,000 H.P., will be built at Slettedal. The aggregate power will amount to 100,000 H.P., of which the first 20,000 H.P. should be available at the beginning of 1918. The first portion of the construction, 10,000 H.P., is calculated to cost from £350,000 to £400,000.

Induction Motor Under Cyclical Operation.—An informative Paper, entitled "On the Induction Motor under Cyclical Operation," was contributed recently by Mr. S. Noda to the Memoirs of the College of Engineering of the Kyoto Imperial University. The Paper deals exclusively with the class of induction motors which work under cyclically varying loads, such as rolling mills, reciprocating pumps, and hoisting machines. In the case of a cyclically varying load with a given characteristic, the author first solves some dynamical problems concerning the induction motor with rotor possessing considerable inertia, and then takes up some problems on the heating of the motor, which lead to the determination of the capacity of the motor.

Electric Ferry.—At Strassburg there is an electric ferry which receives its energy from an overhead trolley conductor.

The boat is a flat raft, 45 ft. long, with 20 ft. beam, having a deckhouse on one side in which are installed the motor, control gear and gearing. Resting on the bed of the lake is a $\frac{5}{8}$ in. galvanised-steel rope which passes around a 3 ft. hauling drum on the boat, and which also forms the return conductor. The trolley wire is of hard-drawn copper, 9 mm. in diameter, stretched between two 30 ft. lattice masts. The collector consists of a single light over-running wheel attached to the raft by a flexible insulated copper cable, the slack of which is taken up by an ingenious arrangement of hanging weights and pulleys suspended from loops in the cables.

1,000,000-Volt Transformer.—According to the "Electrical Review and Western Electrician," a big frame building 30 ft. by 90 ft. in size and three stories high, has been constructed by the Panama-Pacific International Exposition at San Francisco to house a 60-cycle 1,000,000-volt transformer. The installation of the transformer was completed at the beginning of November. The transformer was designed and built in the laboratory of C. H. Thordarson, of Chicago, at a cost of £6,000. This cost includes the specially made machinery for winding the low and high-tension coils and the insulating tube. The weight of the transformer is approximately 30,000 lb. and it is designed to develop 1,000 kw. at 60 cycles. The low-tension coils are wound to receive 2,200 volts and are made up of 122 coils arranged in multiple-series, the coils being bridged in pairs across the 2,200-volt terminals. This allows for a neutral tap which is earthed to the transformer frame. The high-tension winding is made up of 190 coils, each coil being wound for 5,000 volts, equally spaced and wound with flat aluminium, 8-mil. 0·1-ampere conductor insulated by three layers of paper. All coils are connected in series, with one end earthed.

Laboratory-Built Reactance of Large Capacity.—A 1,000 kv.-ampere reactance for use in cable testing was recently constructed in the laboratory of the Boston Edison Co. According to the "Electrical Review and Western Electrician," a transformer having the necessary core was found in stock, the calculation calling for a core of 140 sq. in. cross-section and about 56 turns of wire in the winding around the core. The transformer, which was a 200 kw. unit of the air-blast type, was dismantled and about 15,000 iron laminations taken out and reassembled on a strong hard-pine base. The laminations were built up into two slabs, each 3·5 in. thick, 2 ft. high and 4 ft. long, with a 1·25 in. space between them for ventilation. The weight of the core thus formed was about a ton, and of the assembled apparatus about 2·75 tons. The core was wound with 500 ft. of 500,000 circular-mil flexible cable in pancake coils of eight turns each, with air ducts between the coils. The whole reactance was rigidly braced to withstand structural, shipping and electromagnetic strains. The instrument was insulated for 2,300 volts and designed to carry about 700 amperes. The characteristic curve was found to be a straight line throughout its current range.

Petrol-Electric Locomotives.—"Engineering News" recently gave a description of the new petrol-electric locomotives used by the Minneapolis, St. Paul, Rochester & Dubuque Electric Traction Co., in operating what are known as the "Dan Patch Electric Lines." This line, running from Minneapolis for 107 miles to Mankato, is entirely worked with this motive power. For light traffic, use is made of a 70 ft. petrol-electric motor car seating 89 passengers, to which a trailer may be added, but for extra-heavy traffic a train is made up of trailers and a 60-ton petrol-electric locomotive. The locomotives are double-ended and carried by two two-motor, four-wheeled bogies. The cab is arranged in a single compartment and has in it two generating sets. Only one engineman is required. Each set has a 175 H.P. 550 revs. per min. 8-cylinder petrol-engine directly connected to a 600-volt compound-wound commutating-pole generator. Ignition is from low-tension magnetos. The sets are started by air pressure; but with one set running, the second set may be started electrically. Either or both of the generating units may be used to operate the locomotive in either direction. Each of the four motors is a 100 H.P. 600 volt type. The tractive effort at starting is 32,200 lb.

OBITUARY.

THOMAS PARKER.—We regret to record the death, at the age of 72 years, of Mr. Thomas Parker, F.R.S.E., he having been born on Dec. 22, 1843, which took place on Monday at his native village Ironbridge, Shropshire, after a long illness. Mr. Parker entered the service, when only 9½ years of age, of the Coalbrookdale Company, his father and other members of his family having been similarly employed. His education was received at the local school provided by the company for the workmen's children. He manifested an aptitude for mechanics, and availed himself of the good opportunities for evening study which were provided by the company. His inventive faculties were developed very early in life. At the age of 19 he moved to Birmingham, where he enjoyed better facilities for evening study at the Midland Institute and elsewhere. Later (in 1867) he went to Manchester. While at the latter place he pursued his studies and attended the science lectures at the Hulme Town Hall. He returned to Coalbrookdale, and about 1876 was promoted to the charge of the chemical department and the electro-depositing of the company, at this time building his first dynamo, which was used for depositing. About 1877 he patented a steam pump, which was then, and is still, we believe, manufactured by the Coalbrookdale Company, and for which he received a medal at the Inventions Exhibition, and in 1880 he designed the "Kyrle" grate, for which he secured a first medal at the Smoke Abatement Exhibition in London. Previous to this Mr. Parker had been promoted to the management of the engineering portion of the foundry, and in 1882 he showed Swan and Edison's incandescent lamps at a lecture by the aid of secondary batteries of his own design and make. At this time he discovered the action of nitric acid in facilitating the formation of secondary batteries, and he took out a patent (in conjunction with Mr. Elwell) in 1882 in which the action of nitric acid was claimed. The patent was divided by the Solicitor-General between M. Gaston Planté and Mr. Parker, so far as secondary batteries were concerned. In October, 1882, he joined Mr. Paul Bedford Elwell, and started the partnership of Elwell-Parker in Wolverhampton, taking over Planté's interests in the manufacture of accumulators. The business was taken over by Elwell-Parker (Ltd.) in 1884, and in the same year Mr. Parker designed and put to work the electrical machinery of the Blackpool centre slot rail tramways, remaining consulting engineer until 1892. He also designed an electric locomotive, and after experimenting with it the Birmingham-Bournbrook electric tramway was constructed. Subsequent to 1884 Mr. Parker made a number of electrical and electro-chemical inventions, both by himself and in conjunction with others, and he also made the manufacture of phosphorus by electricity a success. In 1889 Elwell-Parker (Ltd.) was taken over with other concerns and formed into the Electric Construction Corporation (Ltd.), of which he acted as engineer and manager for about five years. In 1890 the works of the Electric Construction Corporation, being found to be totally inadequate for the work in hand, Mr. Parker was instructed to lay out elaborate works at Bushbury, just outside Wolverhampton. At this time he also superintended the carrying out of several electric traction and supply undertakings, including the Liverpool Overhead Railway, the Metropolitan Railway (of which he became a director), the overhead system of electric tramways in South Staffordshire, the electric supply works at Oxford, Burnley, Wolverhampton, &c. His latest invention was Coalite, which, however, did not prove as successful as was anticipated. Mr. Parker was a Member of the Institutions of Civil, Electrical and Mechanical Engineers, an F.R.S.Edin., and in 1893 was made a Justice of the Peace for Wolverhampton. In 1894 Mr. Parker read a Paper on the Liverpool Overhead Railway before the Institution of Civil Engineers, for which he was awarded a Stephenson Medal and a Telford Premium. In April, 1894, at the end of his agreement with the Electric Construction Co., he severed his connection and formed a new company, Thomas Parker (Ltd.), Mr. Parker being appointed managing director. Subsequently he ceased to be a director of that company and engaged in consulting practice in London. He was a strong advocate of the use of the metric system and on one occasion aspired to Parliamentary honours.

PROF. F. R. BARRELL.—The death of Prof. F. R. Barrell occurred suddenly while delivering a mathematical lecture at Bristol University last week. Prof. Barrell, who had written some works on Geometry, was also the authority of a text-book on Electricity and Magnetism.

H. C. DONOVAN.—In last week's issue of THE ELECTRICIAN we announced the death of Mr. Henry Cornelius Donovan, M.I.E.E., late of the Telegraph Construction & Maintenance Co.'s electrical staff. Mr. Donovan was one of the pioneer workers in land and

submarine telegraphy, having started his electrical career with the old Electric & International Telegraph Co. in 1862. In 1864 he joined the Telegraph Construction & Maintenance Co. In 1866 he left the T.C. & M. Co. and entered the service of the Silvertown Company, but in the autumn of 1868 he re-joined the T.C. & M. Co., in whose service he remained until his retirement from active work in 1908. Mr. Donovan was one of the few surviving electricians engaged on the laying of the 1865 and 1866 Atlantic cables by the s.s. "Great Eastern." Subsequently he was associated with the manufacture and submersion of the numerous important cables undertaken by the Telegraph Construction & Maintenance Co., and as early as 1873 was in electrical charge of an expedition which laid the Jamaica-Porto Rico cable. Although of a retiring disposition, Mr. Donovan had many amiable qualities, including a love of children and sympathy for the helpless, and many unrecorded acts of kindness can be laid to his count. He also possessed a fund of quiet humour. The end took place painlessly at his residence in Blackheath.

KILLED IN ACTION.—Second Lieut. Owen Hughes, Royal Engineers, who was recently killed in action, was in his 26th year, and at the outbreak of war he was an assistant to his father (Mr. G. H. Hughes), who is a civil engineer in Queen Victoria-street, London.

PERSONAL.

At the meeting of London County Council on Tuesday it was reported that Dr. Wm. Garnett, the educational adviser, would, on Dec. 30, attain the age of 65 years, and would consequently retire, in accordance with the provisions of standing orders. The Education Committee felt themselves under a deep debt of gratitude to him for his services to the cause of education in London. The Finance Committee would deal with the question of the retiring allowance (£503. 15s. a year) payable to Dr. Garnett.

The Board of Trade have appointed Mr. W. G. Wickham, at present Trade Commissioner in New Zealand, to be Trade Commissioner in South Africa, in succession to Sir R. Sothern Holland, at present engaged in the Ministry of Munitions. Mr. Wickham will be succeeded by Mr. R. W. Dalton, of the Commercial Intelligence Branch of the Board of Trade.

Mr. H. Marriott, chief goods manager of Lancashire & Yorkshire Railway Co., has been re-elected chairman of the Irish and English Goods Traffic Conference for 1916.

Mr. E. S. Riley, station superintendent at Walthamstow, has resigned in order to join H.M. Forces.

APPOINTMENTS VACANT.

A resident mechanical and electrical engineer (married) is required for the Royal Holloway College, Englefield Green, Surrey. Particulars from the Secretary.

Oldham Corporation Electricity Committee invite applications for the position of shift engineer. Wages £2 per week. Applicants must have had good mechanical and electrical training and have had previous experience in generating station giving l.t. and e.h.t. supplies. Applications to Mr. Fred. L. Ogden, joint electrical engineer and manager, Greenhill electricity offices, Oldham, by Dec. 13.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—Among the lectures to be given after Christmas are three lectures on "Utilisation of Energy from Coal," by Prof. W. A. Bone; a lecture on "Measurement of the Brightness of Stars," by Sir F. W. Dyson; six lectures on "Radiation from Atoms and Electrons," by Sir J. J. Thomson. The Friday evening meetings will commence on January 21st, when Prof. Sir James Dewar will deliver a discourse on "Problems in Capillarity." Succeeding discourses will be given by Leonard Hill, Prof. William Bateson, Prof. Gilbert Murray, Prof. Ernest G. Coker, Prof. Sir Arthur Quiller-Couch, Prof. Silvanus P. Thompson, Sir Napier Shaw, Dr. Aubrey Strahan, Prof. W. M. Bayliss, Prof. A. Fowler, Wilfrid Ward and Sir J. J. Thomson.

Yorkshire Association of Mining Electrical Engineers.—Mr. A. R. Claytor presided at the monthly meeting of the Yorkshire Branch of the Association of Mining Electrical Engineers, held at Sheffield. The meeting considered a Paper by Mr. Andrew Gibson of Glasgow, on "Bearings of Electrical Machinery," in which it was pointed out that bearings give the most anxiety when running the plant for the first time. After giving general practical advice, based upon experience, Mr. Gibson dealt with anti-friction metals, lining bearings, jigs, plummer blocks, lubricating oils and ball bearings. Illustrations were given of a bearing suitable for light duty, and of an improved type of bearing for cases where the shaft and bearing box could not align with one another.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, Dec. 11th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7.0 p.m. Annual Meeting at the Swan Hotel, New-street, Birmingham.

MONDAY, Dec. 13th.

ROYAL SOCIETY OF ARTS.

4:30 p.m. Meeting at John-street, Adelphi, London, W.C. "Cantor Lecture" by Dr. W. Rosenhain, F.R.S., on "Optical Glass" (Lecture III.).

WESTERN SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

5 p.m. Meeting at the South Wales Institute of Engineers, Park-place, Cardiff. Paper by Mr. J. R. Beard on "Design of High-pressure Distribution Systems."

TUESDAY, Dec. 14th.

INSTITUTION OF CIVIL ENGINEERS.

5:30 p.m. Meeting at Great George-street, Westminster, S.W. The "James Forrest" Lecture, by Mr. H. M. Hobart, on "Electric Railways," to be delivered by Mr. J. A. F. Aspinall.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

7:15 p.m. Meeting at St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Electric Lifts," by Mr. H. Marryat.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the Engineers' Club, 17, Albert-square, Manchester. Paper on "Design of High-pressure Distribution Systems," by Mr. J. R. Beard.

SCOTTISH SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

8:0 p.m. Meeting at Princes-street Station Hotel. Paper on "Electric Heating: Its Present Position and Future Development," by Mr. G. Wilkinson.

ILLUMINATING ENGINEERING SOCIETY.

8:0 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi, W.C. Discussion on "Recent Developments in Electric Incandescent Lamps in relation to Illuminating Engineering." Opened by Prof. J. T. Morris.

WEDNESDAY, Dec. 15th.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:0 p.m. Meeting at the University, Edmund-street, Birmingham. Paper by Mr. J. D. Morgan, entitled "Notes on the Ignition of Explosive Gas Mixtures by Electric Sparks."

NOTTINGHAM SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Welbeck Hotel, Nottingham. Paper on "Evolution of High-speed Steel," by Mr. A. W. Shepherd.

THURSDAY, Dec. 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8:0 p.m. Meeting at Victoria Embankment, W.C. Paper on "The Design of High-pressure Distribution Systems," by Mr. J. R. Beard.

ROYAL SOCIETY OF ARTS.

4:30 p.m. Meeting at John-street, Adelphi, W.C. Paper on "The Indian Jute Industry," by Mr. C. C. McLeod.

FRIDAY, Dec. 17th.

INSTITUTION OF MECHANICAL ENGINEERS.

6.0 p.m. Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Paper on "Engineering Colleges and the War," by Dr. Walmsley and Mr. C. E. Larard.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. CLAY.

The following orders have been issued for the week commencing Dec. 13, 1915:

Drills, 6.25 to 7.25, 7.25 to 8.25 p.m.

Monday, Dec. 13.—Sections 1 and 2, technical; Sections 3 and 4 squad. Signalling sections and recruits.

Tuesday, Dec. 14.—School of arms with Architects' Corps, 6 to 8 p.m.

Thursday, Dec. 16.—Sections 3 and 4, shooting.

Friday, Dec. 17.—Sections 3 and 4, technical; Sections 1 and 2, squad. Signalling sections and recruits.

Saturday, Dec. 18.—Ceremonial parade. Time and place to be posted at Headquarters later.

Sunday, Dec. 19.—Trench digging for Sections 1 and 2. Parade at Victoria Station, time to be announced later.

Sections for technical parade at Headquarters, London Electrical Engineers, 46, Berners-street, S.W. Sections for shooting parade at immediate ranges. Unless otherwise ordered, all parades at Chester House. Members who have not yet been measured for uniforms, must call at Samuel Brothers, Ludgate hill, as soon as possible. Payment for uniforms to be made to the Adjutant.

THE MAGNETIC PROPERTIES OF SOME IRON ALLOYS MELTED IN VACUO.*

BY TRYGVE D. YENSEN.

Summary.—This Paper deals briefly with the iron-boron and iron-carbon alloys, and presents the results obtained with the iron-cobalt alloy, Fe_2Co, but the main part deals with the iron-silicon alloys, as these appear to be of more than usual interest.

Material, Apparatus and Methods.†—The iron used as the basis of the investigation consisted of electrolytically refined iron, containing less than 0·01 per cent. carbon and about 0·01 per cent. silicon. Before being used, the iron was crushed, made chemically clean, and then dried in vacuo. This cleaned iron was then placed in a fused magnesia crucible together with the desired portion of the alloying element, covered with a magnesia cover and placed in an Arsem type vacuum furnace, where it was melted under a finishing pressure of 0·5 mm. of mercury. The ingots, after being allowed to cool in the furnace, were heated and forged into rods about ½ in. by 20 in. From these rods the test pieces were prepared; one rod for the magnetic and electrical tests; two test pieces with threaded ends for the mechanical tests; and one small specimen for the metallographic investigation. Tests were made after the following heat treatments: (1) As forged. (2) Annealed at 900°C. Cooled at a rate of 30°C. per hour. (3) Annealed at 1,100°C. Cooled at a rate of 30°C. per hour.

The iron-cobalt and iron-silicon alloys were annealed in vacuo, so as to preclude any possible contamination by gases.

The Magnetic Testing.—The Burrows compensated double bar and yoke method (Fig. 1) has been used for the magnetic testing, as this is the method now generally adopted whenever accurate testing is desired. The author investigates the errors, and deals in considerable detail with the error due to mechanical strain caused by clamping the rods in the yokes.

The apparatus was calibrated from time to time by means of an air-coil, and also by means of rods submitted to the Bureau of Standards for standardisation. While the rods submitted to the Bureau did not include any of the high permeability rods, the certificate received serves as a general check upon the apparatus. The results obtained check very well with those obtained by the Bureau and others.

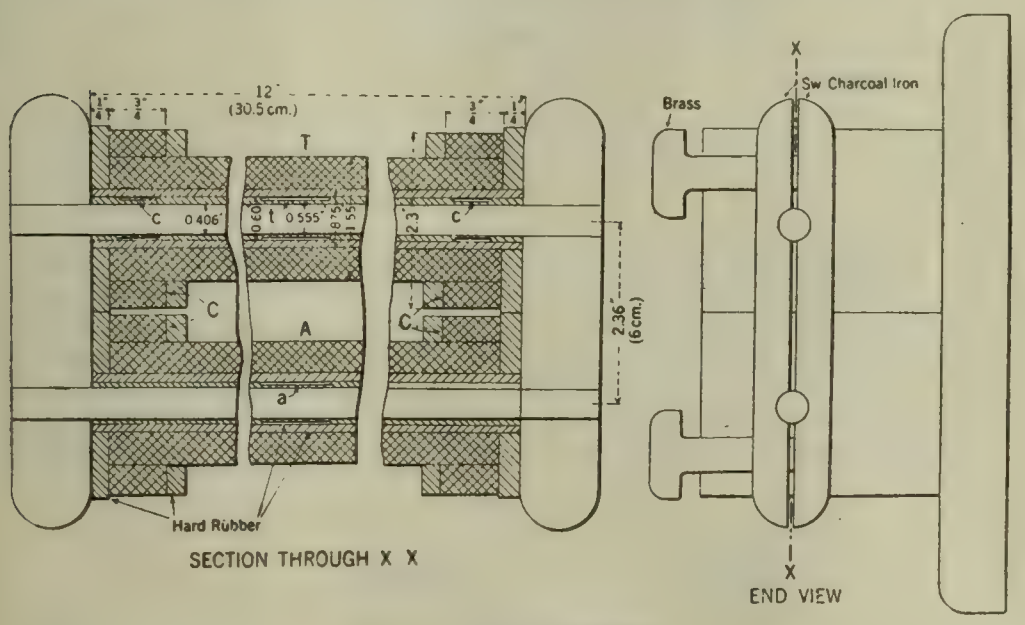


FIG. 1.—PERMEAMETER.

Coil data.

T, *A* and *C* coils—10 layers No. 18 B. & S. enamelled copper wire, 20 turns per inch per layer (7·875 turns per centimetre) *t* and *a* coils—64 turns each of No. 30 B. & S. d.s.c. copper wire; *C* and *c* coils 32 turns each of No. 30 B. & S. d.s.c. copper wire—connected in series.

IRON-BORON AND IRON-CARBON ALLOYS.

These two series of alloys will be discussed together, as boron and carbon seem to behave very similarly in their effect upon the magnetic properties of iron. The properties of the iron-carbon series, prepared under ordinary conditions, have been investigated very extensively in times past, and are consequently very well known.

Iron-boron alloys have thus far received only slight attention, and, as far as can be found, practically nothing has been done to determine their magnetic properties. On that account it may be of interest to summarise the results obtained by the author, in spite of the fact that they offer no promise that any valuable alloy will be found in this series.* Thirty iron-boron alloys were prepared, the maximum boron content being 0·45 per cent.

The results may be summarised as follows:—

1. Small percentages of boron added to pure iron and melted in vacuo have a double effect upon the iron, since part of it reduces the iron oxide present and the remainder combines with the iron. In this respect boron differs from carbon.
2. Small additions of boron to iron have a slightly beneficial effect upon the magnetic properties, probably on account of the reduction of iron oxide, which more than offsets the effect of the combined boron. The beneficial effect in the present case reached a maximum with the addition of 0·05 per cent. boron, and ceased as soon as the amount of combined boron became measurable.
3. Boron added in a sufficient amount to leave a measurable quantity combined with the iron has a decidedly detrimental effect upon the magnetic properties of the iron.
4. Boron increases the specific electrical resistance of iron by 0·62 microhms per 0·1 per cent. boron combined with iron.
5. The effect of boron upon the mechanical properties of iron is in general similar to that of carbon.

THE IRON-COBALT ALLOY, Fe_2Co.

On account of the remarkable magnetic properties obtained for pure iron by melting it in vacuo, it was suggested to the author that the iron-cobalt alloy, Fe_2Co, might show some interesting properties when prepared under such conditions. An investigation was consequently undertaken, and the results fully met the expectations. The magnetic properties in low and medium fields were measured by the Burrows method, while the saturation values were obtained by means of the isthmus method. (The results of the research on the iron-cobalt alloy were given in THE ELECTRICIAN, Vol. LXXVI., p. 52.)

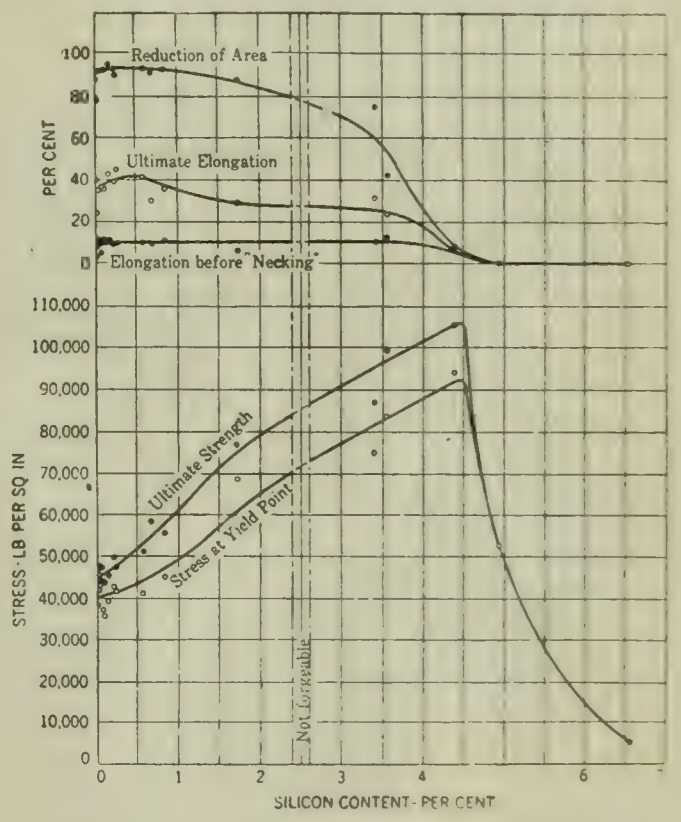


FIG. 2.—MECHANICAL PROPERTIES OF IRON-SILICON ALLOYS—MELTED IN VACUO. AS FORGED.

IRON-SILICON ALLOYS.†

Probably no series of iron alloys, outside the iron-carbon series, has received more attention in recent years than has the iron-silicon series. This is largely due to the fact that some of the alloys belonging to this series have proved their superiority over pure iron and other iron-alloys, for certain very important purposes in the electrical industry. The iron-silicon alloys have been thoroughly investigated from a chemical, metallurgical and physical point of view, so that their properties are generally very well known.

RESULTS.

Chemical Properties.—A list is given of all the alloys made, together with the chemical analyses of the silicon alloys. The only elements present in the alloys as impurities in a measurable quantity are carbon, amounting to about 0·01 per cent., and oxygen.

* Abstract of a Paper read before the Am. Inst. E.E.

† Details with regard to material, apparatus and methods used are given in "Bulletins" No. 72 and No. 77 of the Eng. Exp. Sta. of the Univ. of Illinois.

* For a full report of the results, *see* "Bulletin" No. 77, Eng. Exp. Sta. Univ. of Illinois, 1915.

† For a more detailed report, *see* "Bulletin" of the Eng. Exp. Sta., Univ. of Illinois, 1915.

Mechanical Properties.—The results of the mechanical tests are shown graphically in Figs. 2 and 3, and a comparison between these results and those obtained by previous investigators is given in the Paper. From the curves it may be stated in general that silicon increases the elastic limit and ultimate strength of iron in direct proportion to the amount added, reaching a maximum at about 4·5 per cent. From this point on, the elastic limit coincides with the ultimate strength, and both decrease very rapidly. The values for the forged condition are considerably higher than for the annealed condition, the difference varying between 10,000 lb. and 20,000 lb. per square inch. For the 4·5 per cent. alloy "as forged" the ultimate strength is 105,000 lb. per square inch. The practical absence of carbon in the vacuum iron causes the low silicon alloys to be weaker than the corresponding alloys tested by previous investigators, but this same absence of carbon evidently is a cause for added strength in the 4·5 per cent. alloy, in which the carbon exists in the form of graphite.

With regard to the elongation and reduction of area, the results in general agree with those obtained by Hadfield and others. However, the vacuum alloys again show the effect of the lack of carbon in being much tougher in the region of low silicon as well as in the region between 3 and 5 per cent. The latter is particularly significant, as it is in this region that the maximum strength occurs. While the strength maxima for alloys containing small amounts of carbon correspond to zero elongation and reduction of area, the strongest vacuum alloy in the forged condition has a reduction of area of 8 per cent., and an elongation of 7 per cent. In the annealed state the corresponding figures for the same alloy are 24 and 22 per cent.

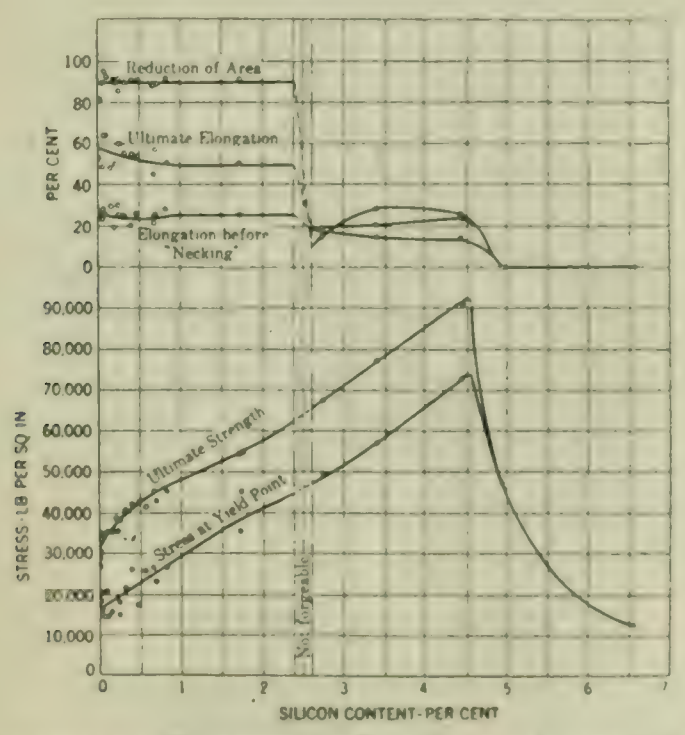


Fig. 3.—Mechanical Properties of Iron-Silicon Alloys—Melted in Vacuo. Annealed at 970°C.

Two of the alloys, containing 2·55 and 2·57 per cent. silicon, respectively, could not be forged, but fell into a mass of crystals that apparently had no adhesive strength. That this occurrence was no accident is shown by the fact that the two alloys were made at different times, and they were subjected to forging on different days, in company with other alloys that forged perfectly. The structure of the two alloys is identical, consisting of large allotrimorphic crystals $\frac{1}{8}$ in. to $\frac{1}{4}$ in. across, and about twice these dimensions in length. The author has as yet been unable to find any satisfactory explanation of this phenomenon, neither has he been able to find a similar occurrence reported by anybody else. It would appear that the region of non-forgeability is restricted to within a few tenths of 1 per cent., unless the small amount of impurities present in the alloys used by other investigators, chiefly carbon, may have changed the physical properties sufficiently to make them forgeable, whereas their absence might have made them non forgeable.

Magnetic and Electrical Properties.—The results of the magnetic and electrical tests are shown in Figs. 4 and 5. These show at a glance the magnetic and electrical properties of the series. The properties in the forged state have not been thus plotted for the reason that they are of less interest on account of their inferiority. However, in order to have them included in the Paper the author gives the flux densities for various magnetising forces for the alloys as forged, and the corresponding values after annealing at 900°C. and 1,100°C., respectively, thus affording means for comparison as to the effect of the various heat treatments.

From Figs. 4 and 5 it will be noticed that two maxima appear very distinctly in the curves for maximum permeability, corresponding to two minima in the curves for hysteresis loss and coercive force. The first of these points occurs at a silicon content of about 0·15 per cent., the second at a silicon content of about 3·5 per cent. for the permeability and about 4·0 per cent. for the hysteresis loss and coercive force. The reason that the second maximum for permeability and minimum for hysteresis loss do not occur at the same silicon content

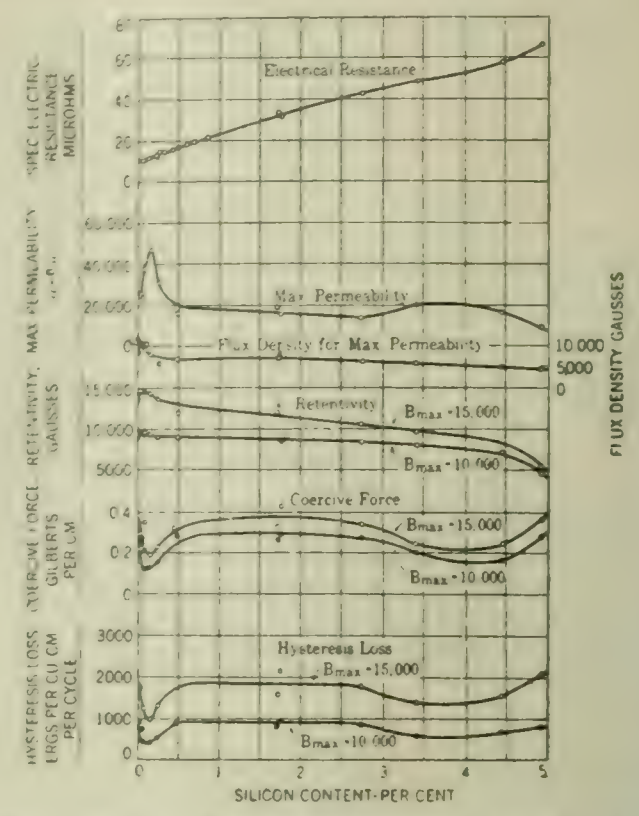


Fig. 4.—Magnetic and Electrical Properties of Iron-Silicon Alloys Annealed at 900°C.

appears very clearly from the retentivity and coercive force curves, when it is remembered that the hysteresis loss primarily depends upon the coercive force and the retentivity, and only to a less extent upon the maximum permeability. That a maximum—or minimum—should occur for a low silicon content was not surprising in view of the results previously obtained with pure iron, iron-carbon and iron-boron alloys. In the latter case a maximum was obtained with a

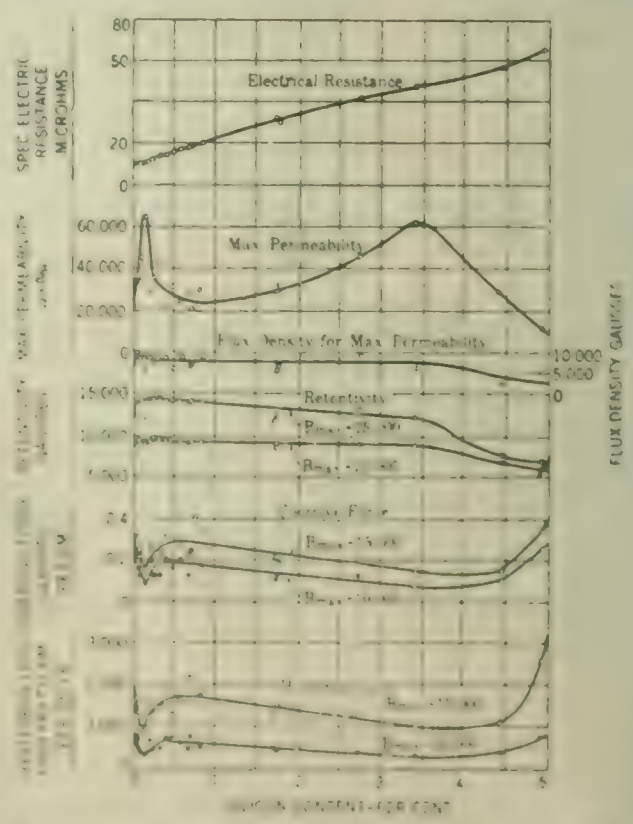


Fig. 5.—Magnetic and Electrical Properties of Iron-Silicon Alloys Annealed at 1,100°C.

trace of boron, evidently on account of a slight purification of the iron, but as soon as the boron content became measurable the magnetic properties immediately deteriorated. The first maximum in the present case, no doubt, is accounted for in the same way, and consequently this point may be regarded as characteristic of the purest iron obtainable under the present conditions, containing 0·15

per cent. silicon and a small amount of oxygen in the form of iron oxide. The slight uncertainty existing for silicon contents below 1·0 per cent. as shown by the distribution of the points, is probably due to the varying amounts of oxide left in the iron. This reasoning would consequently also account for the uniform results obtained for the high silicon contents.

The second maximum—or minimum—was wholly unexpected, as strength and brittleness are not generally associated with high magnetic quality. It seems probable that the improvements are due partly to the conversion of combined carbon into graphite, and partly to the complete reduction of iron oxide. If this second maximum should be due entirely to the conversion of combined carbon into graphite, the current ideas regarding the influence of carbon upon the magnetic properties of iron will certainly have to be changed, and it will become desirable to remove from the iron the last trace of carbon. According to these hypotheses, the first maximum is due to pure iron in spite of small amounts of iron oxide and combined carbon, while the second maximum is due to pure iron in spite of a relatively large amount of dissolved silicon. The author shows there is no reason why the low saturation value and the high permeability at low densities of the 3·40 per cent. iron-silicon alloy cannot both be due directly to silicon. More experimental evidence is needed, however, before it is safe to make a definite statement in this respect.

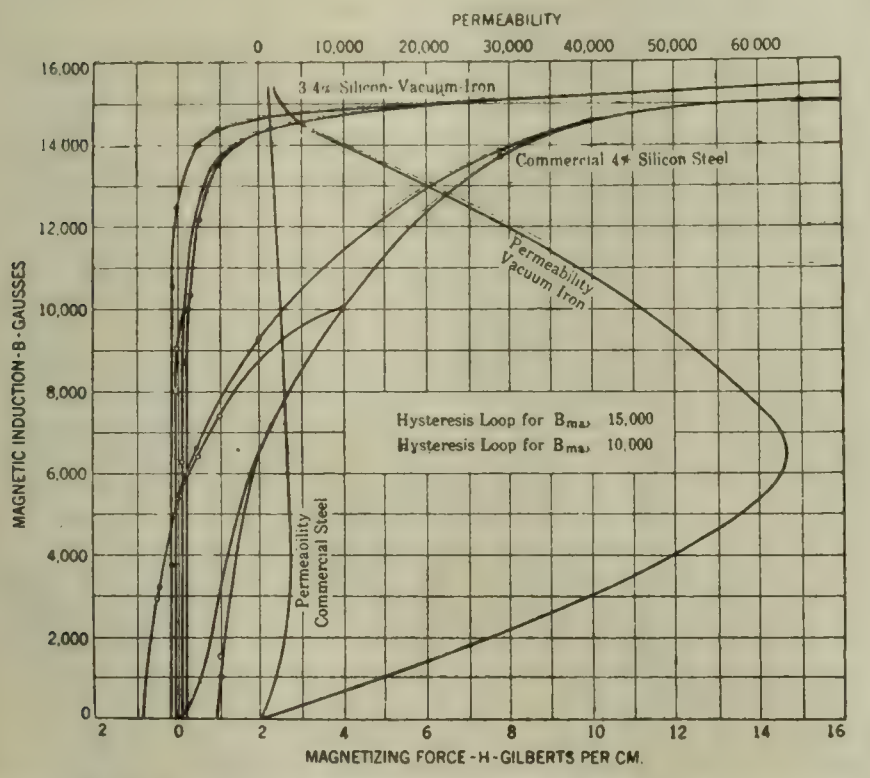


FIG. 6.—A COMPARISON BETWEEN VACUUM IRON AND COMMERCIAL STEEL, BOTH CONTAINING BETWEEN 3 AND 4 PER CENT. SILICON—THOROUGHLY ANNEALED.

	Vacuum iron.		Commercial steel.
Hysteresis loss for $B_{max.}$=10,000 ergs per c. c. per cycle	280	..	2,260
,, ,, $B_{max.}$=15,000 ,, ,, ,, ,,	1,025	..	3,030
Specific electrical resistance, microhms	48·50	..	51·15

While silicon is thus, directly or indirectly, engaged in improving the magnetic properties of iron, it serves a very useful purpose by increasing the electrical resistance of the iron enormously, giving the iron the exact characteristics desired for electromagnetic machinery

The iron-silicon series thus offers two important alloys for electrical purposes, both having high permeability and low hysteresis loss, but differing in that one has a very low, while the other has a very high electrical resistance.

The values obtained are, undoubtedly, without precedent in the annals of the magnetic properties of iron and iron alloys, and it is only after a careful analysis of the apparatus used and the methods employed in testing that the author feels reasonably safe in publishing them. Even if the maximum error in the results as given should amount to 20 per cent., their significance would not be altered appreciably. Whether the true maximum permeability obtained is 66,500 or 53,200 is of little consequence at the present time, as long as it is reasonably certain that it lies in this neighbourhood.

It was only a few years ago that a permeability of 6,000 was regarded as exceptionally high. This was gradually raised to 8,000, and then Gumlich, in 1912, obtained a value of 11,000 for a high-grade low-silicon alloy in the form of sheets. Last year the author published 19,000 as the maximum found for pure iron melted in vacuo, and this value was regarded as remarkable. The step from 19,000 to 66,500 indeed seems a long one, but intermediate steps have been taken in the meantime in the laboratory, and the values for the hysteresis loss have followed in a similar path.

Fig. 6 illustrates the difference in magnetic quality between a silicon-vacuum-iron and a commercial silicon steel, both containing approximately the same amount of silicon. The maximum permeability is as 20 to 1, the hysteresis loss, for $B_{max.}$=10,000, as 10 to 1, and $B_{max.}$=15,000, as 3 to 1, in favour of the vacuum alloy. For $B_{max.}$=15,000 the permeability of the latter is twice the permeability of the commercial iron. The electrical resistance is nearly the same for both alloys, or about five times that of pure iron.

Fig. 7 shows to a large scale the difference between a high-silicon and a low-silicon vacuum-iron, both having about the same hysteresis loss. The characteristics of the low-silicon alloy are seen to be very high retentivity and high permeability for medium and high densities, while the high-silicon alloys have a low retentivity, with the maximum permeability occurring at a low density. The chief advantage of the high-silicon alloy lies in the high electrical resistance, amounting to more than five times that of the low-silicon alloy.

Photomicrographs.—From the photomicrographs given in the Paper it is seen very clearly that the iron-silicon alloys, in the range here investigated, consist of only one kind of crystals, thus confirming the results obtained by previous investigators,

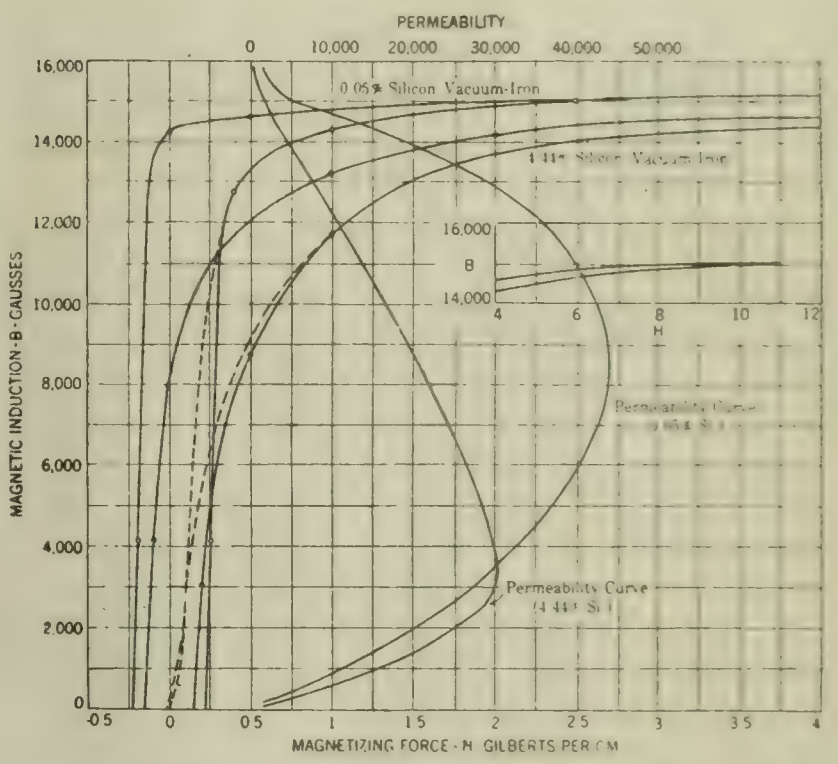


FIG. 7.—A COMPARISON BETWEEN A HIGH AND LOW SILICON VACUUM IRON—ANNEALED AT 1,100° C.

	0·048 p.c. Si		4·44 p.c. Si.
Hysteretic loss for $B_{max.}$=10,000 ergs per c. c. per cycle	407	..	[illegible]
,, ,, $B_{max.}$=15,000 ,, ,, ,, ,,	1,214·5	..	1,171
Specific electrical resistance, microhms	10·78	..	57·40

that iron and silicon, for silicon contents below about 15 per cent., form a solid solution everywhere between the freezing point and ordinary temperature.

Below 1 per cent., silicon appears to have no marked effect upon the structure of the iron, either as forged or annealed. Annealing at 900°C. does not seem to change the structure of the alloys in this range, but annealing at 1,100°C. breaks the large crystals up into smaller ones, giving an appearance of a very fine structure. There is no sign of foreign substances in these structures, other than those arising from imperfect polishing. After passing the 1 per cent. mark, silicon begins to show its effect. The crystals are generally larger than for pure iron, and are readily polished in relief, showing that they are not of uniform hardness. There is no breaking up of the crystals by the 1,100°C. annealing as in the case of the low alloys. The 1·71 per cent. alloy shows a very irregular structure as forged, and after the 900°C. annealing, but this gives way to a structure of more regularity as a result of the 1,100°C. annealing.

The principal difference between these photomicrographs and the ones published by previous investigators is the absence of foreign matter in the structure of the vacuum alloys.

Summary and Conclusions.—The results recorded in the previous pages regarding iron-silicon alloys may be summarised as follows :—

1. By means of the vacuum method of melting it is possible to obtain a decidedly purer product than has thus far been obtained in

any other manner. Consequently, more definite conclusions can be drawn with regard to the effect of silicon upon iron than have hitherto been possible.

2. Silicon, like boron, has a double effect upon iron. Part of it combines with the iron and remains in solid solution throughout the cooling of the alloy, while a smaller part reduces the iron oxide present.

3. The tensile strength of the vacuum product follows in general the same law as alloys made under ordinary conditions, but the ductility of the former is much greater, particularly below 2 per cent. and above 3 per cent., probably due to the absence of carbon. The maximum tensile strength of 105,000 lb. per square inch occurs with a silicon content of 4·5 per cent.

4. The limit of forgeability lies between 7 and 8 per cent. silicon. A critical range occurs between 2·50 per cent. and 2·60 per cent., in which the alloys are not forgeable.

5. With regard to the magnetic properties the vacuum alloys exhibit most remarkable characteristics. The best alloys are obtained with about 0·15 per cent. and 3·40 per cent. silicon, after annealing at 1,100°C. The values of maximum permeability for both of these alloys are above 50,000, and the values of hysteresis loss for $B_{max.}$=10,000 and 15,000 are about 300 and 1,000 ergs per cubic centimetre per cycle respectively. This hysteresis loss is one-eighth and one-third of the corresponding loss for commercial silicon steel. The most favourable annealing temperature is in every case 1,100°C.

6. The specific electrical resistance increases about 13 microhms for the first 1 per cent. of silicon added. For each additional per cent. added the increase is about 11 microhms. Consequently, the 3·40 per cent. alloy mentioned under (5) has a resistance nearly five times that of the 0·15 per cent. alloy, and yet both have similar magnetic properties.

Table I.—*Properties of the Two Best Iron-Silicon Vacuum Alloys.*

Silicon content per cent.	Stress at yield point lb. per sq. in.	Ultimate strength lb. per cent.	Elongation per cent.	Reduction of area per cent.	Maximum permeability.	Density for maximum permeability, gausses.	Hysteresis loss ergs per cubic cm. per cycle for $B_{max.}$ = 10,000	Hysteresis loss ergs per cubic cm. per cycle for $B_{max.}$ = 15,000	Spec. elec. resistance microhms.
0·15	18,500	37,000	56	90	66,500	6,500	286	916	11·80
3·40	58,000	76,500	21	28·5	63,300	6,500	280	1,025	48·50

By the vacuum process two silicon alloys have thus been produced that have very valuable characteristics; one, low in silicon, not very strong, but extremely ductile, of high permeability, low hysteresis loss, and of low electrical resistance; the other, high in silicon, very strong, moderately tough, of high permeability, low hysteresis loss and of high electrical resistance. The properties of these two alloys are summarised in Table I. The first is evidently suitable for use in places where high permeability and low hysteresis loss are the chief requirements, while the second alloy is suitable for electromagnetic machinery, principally where a low eddy-current loss is an additional requirement.

ELECTRIC HEATING AND SCHOOP'S METAL-SQUIRTING PROCESS.*

BY DR. LACH.

The original idea of electric heating was developed on the lines of employing spirals of wire, through which the current passed. They were generally made of alloys of copper, nickel and manganese, and were usually wound on the surface of some fireproof body. Sometimes enamelled wires were used, and a metallic cylinder was used as a kind of core. The well-known heaters, made by Helberger, of Munich, were made in this way, the insulation consisting of small beads of glass or porcelain, painted over with a cement of clay. The wire is thus to some extent protected from oxidation, and the dissipation of heat is such that the wire does not become red hot. The inner cylindrical metallic core gives up its heat to the air, which is thus caused to circulate through the room. A totally different system is that of the Prometheus Co., in which the heating body consists of extremely thin sheets of metal and only the more expensive metals can be used. They are brought into some kind of solution and painted on some substratum; a reducing process follows and the metal is then burnt in so as to form a solid and adhering layer. The substratum usually consists of plates of mica, and the thickness of the metallic covering is about 0·01 mm. A number of these elements are so assembled as to form a complete heater. Another kind, very inefficient, consists in using large glow lamps of the frosted kind; but these are only used by those who care nothing about the amount of the bill. The Helberger system probably costs more in repairs and maintenance than the Prometheus system; the mica plates can be removed and replaced, if necessary, while the other type needs a good deal of work.

The Schoop metal-squirting process is probably an advance on either of these methods. By it the workman is in a position to produce thick or thin layers of metal, which firmly adhere to the substratum. The works at Zurich turn out a product which seems essentially to combine the two principles, first described, and to have the advantages of both. The foundation consists of a plate or hollow cylinder, made of clay, earthenware, slate or some similar substance, on which the metal is squirted either in zig-zag form or in the shape of a spiral. Some sort of a lathe is generally used to effect the necessary displacement with respect to the squirting nozzle. The substratum, being rough, adheres to the layer of metal perfectly; the thickness of the squirted coating, and, therefore, its resistance, can be adjusted to suit any requirements, depending, as it does, on the speed with which the displacement is effected with regard to the nozzles, and on the distance of the nozzle from the surface of the cylinder. For large heating elements, this distance might be about 50 cm., and the breadth of the metallic layer would in that case be between 18 cm. and 20 cm. The adhesion of the surface layer can be increased by heating or by roughening the surface of the substratum. A drawing shows a simple form of heater, consisting of a firebrick plate, covered on both sides with a kind of spiral winding. But the difficulty is to cover the surface as completely as possible without any contact between adjacent turns. This can be done by covering the surface with a stencil plate, and squirting at it indiscriminately. Thus a kind of grid can be produced, as shown in another drawing. But this does not cover the entire surface, as it is necessary to secure rigidity to the stencil plate at the expense of fairly solid strips, which are naturally represented on the finished heater by an absence of metallic layer. It was, therefore, a good idea to cover the whole of the surface with a uniform layer of metallic covering, and then to use fine emery wheels for grinding away the non-conductive areas. Thus a kind of zig-zag track can be constructed over the whole surface. For removing the non-conductive zones, the most satisfactory method has been found to be the following: The entire surface being covered with a metallic layer, a pressure of 10 or 15 volts is applied. One of the poles consists of a metal fork, which carries a small carbon disc, mounted in such a way that it can rotate. If this carbon disc is moved over the surface at a moderate speed, it causes a certain local fusion of the metallic layer, resulting in a sharp cut. This has advantages over the grinding process: there are no jags on the edges of the cut, which are sharply defined by a fused line; thus any contact between neighbouring turns is avoided with certainty. Resistances of this kind can be made in the shape of plates or hollow cylinders. This method seems to embody the advantages of both the Helberger and the Prometheus systems. The hollow cylindrical form certainly favours the circulation of the air. By making the walls thick, a kind of heat-accumulator can be constructed; this might be an advantage in places where the current is supplied at a low rate in the daytime, as the apparatus could be disconnected from the network at times when the price was high, with the result that the accumulated heat would gradually discharge itself into the room. Or, alternatively, the cylinder could be filled with sand, but obviously this plan is not without its disadvantages. The length, breadth and thickness of the metallic covering are entirely independent variables, except in so far as the voltage and temperature are concerned, and can, therefore, be adjusted to meet the circumstances of any particular case.

For ordinary purposes, the metal would not be required to withstand a red heat. Constantan has been found to be a suitable alloy, and good results have been given by an alloy of chromium and nickel, which fuses at 1,800° C. Nickelin and German silver, containing up to 30 per cent. zinc, lose somewhat in conductivity owing to the gradual volatilisation of zinc; in one case, for instance, it was found that after three days' continuous use, the resistance had increased from 21 to 21·5 ohms. Schoop's wire-squirting pistol can be used for metals like platinum and iridium, and in this way resistances for laboratory purposes can be constructed.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 22, 1915.

THREE-PHASE GENERATORS FOR THE RJUKANFOS POWER STATION.

Recently the Allmanna Svenska Elektriska Aktiebolaget (the Swedish General Electric, Ltd.) supplied six generators to the Rjukanfos Company's second power station at Saaheim, Telemarken, Norway, which probably are the largest three-phase generators yet built for direct coupling to water-turbines. The power is used for the production of nitrate of soda in Birkeland-Eyde furnaces, and having regard to the capacity and arrangement of the furnaces, the output of each generator was fixed at 19,800 k.v.a., 9,500 volts, 50 periods, power-factor 0·65 as the maximum continuous rating. The speed of the sets is 250 revs. per min.

As compared with the sets previously supplied for Rjukanfos, the new machines differ in so far as the total output is obtained from one single machine. The considerable dimensions and heavy weight of this large machine necessitated the sub-division of the stator as well as of the rotor. The routes available for transport did not permit the handling of weights exceeding 25 tons, and the outside dimensions had to be kept within the limits given by the railway company's loading gauge.

The exciter armature is fixed to the extended shaft, leaving sufficient distance between the exciter and the bearing for the application of a hydraulic jack under the shaft between them to facilitate removal and inspection of the bearing liners. The field of the exciter is mounted on a separate sole plate.

The stator frame of the generator, Fig. 3, is made entirely of cast iron in four sections bolted together, forming at the same time the air-duct into which the ventilating air, after passing through the machine, is collected and discharged through openings in the bottom half into the discharge air-duct of the ventilating system. Similar openings are also provided above the floor line, which generally remain covered, but can be opened if it is desired to let the hot air into the engine room for the purpose of regulating the temperature.

Cast-iron covers, enclosing the end connections of the coils, are bolted to the stator frame. Cast-iron has been selected for this purpose in spite of the increase in the total weight of the machine, on account of its damping influence on the noise produced in the interior of the machine. It is, moreover, easier to give to these cast-iron end covers a form suitable for the control of the air ventilation. The covers are provided with hand holes for the inspection of the winding. Circular end shields, also made of cast-iron, form the enclosure between the end covers and the shaft. On one side of the machine the end shields are provided with suitably formed openings for connection to the inlet air-duct.

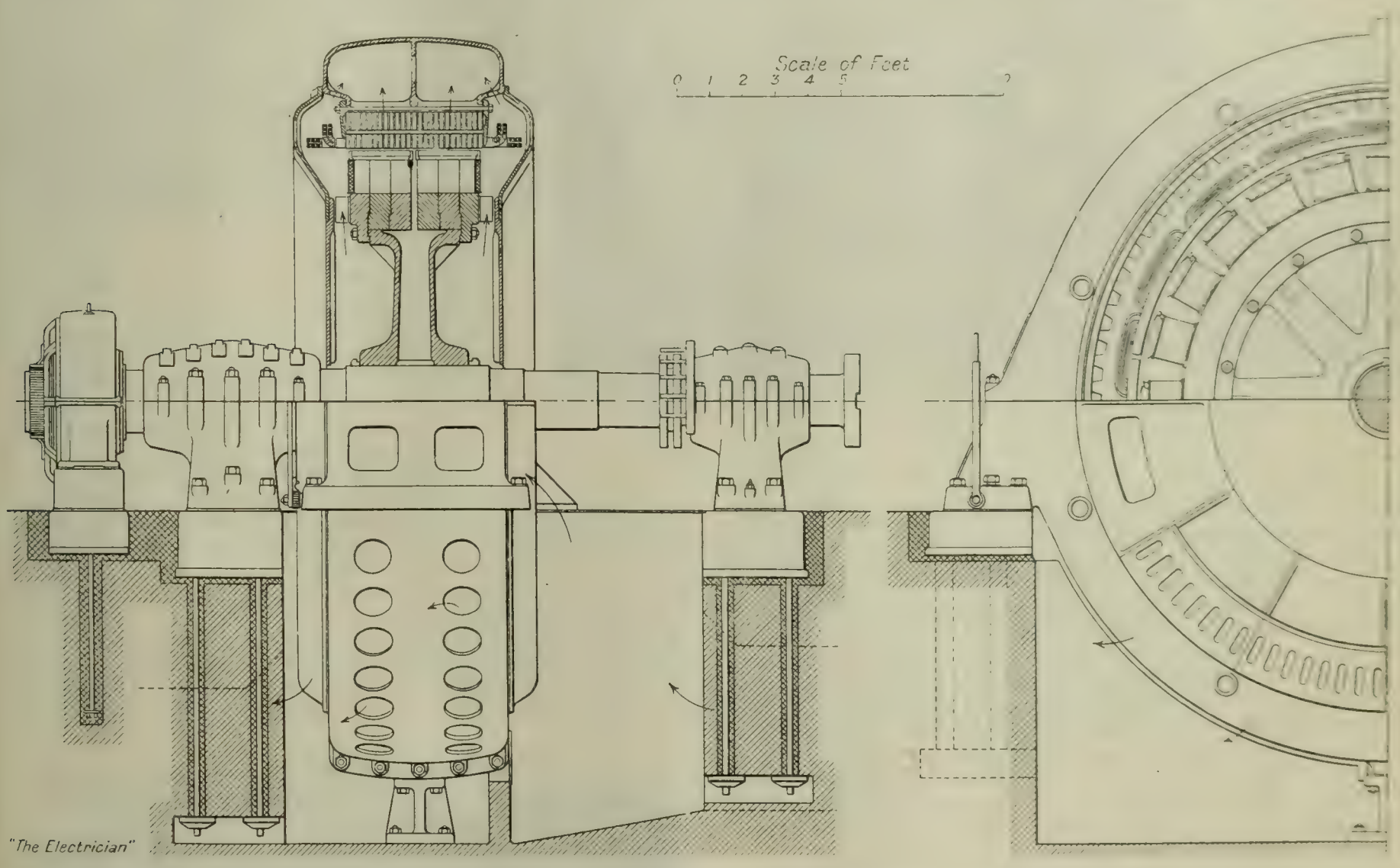


FIG. 1.—ARRANGEMENT OF 19,800 K.V.A., 9,500-VOLT, 50-CYCLE, 250 R.P.M. ALTERNATOR.

Partly to obtain satisfactory ventilation and partly to reduce the noise in the power station, the machines were completely enclosed. Each machine requires about 700 cubic ft. of air per second. The dimensions of the engine rooms are 195 ft. by 65 ft. by 40 ft., and consequently open-type generators would have required the renewal of the air in the generating station every third minute, even if the temperature in the engine room was allowed to rise by 20°C. Hence the advantages resulting from totally enclosing the machines.

The generators, Figs. 1 and 2, are erected with a centre height over the finished floor of 3 ft. 3 in., and the foundations are so designed that the stators, after removing the end plates, can be shifted in an axial direction, leaving the rotor fully accessible for inspection or repair. Special gear is provided for moving the stator, with guides controlling the movement parallel to the original position.

To make the stator winding equally accessible, the stator has been arranged so that, after removing the supporting feet, it can be turned on rollers specially arranged for the purpose. Otherwise the arrangement is the usual one with separate sole plates for the stator and the bearings. To avoid bearing currents, one bearing is electrically insulated from its sole plate and from all oil and cooling water piping attached to it.

The stator core laminations are made of alloyed sheet-steel insulated with paper. These are fixed to the stator frame in the usual way by means of dovetailed keys in a radial direction, and are pressed together in an axial direction by means of cast-iron press rings and insulated bolts. The press rings are specially formed to facilitate the fixing of the coil supports. On account of its unusual length the core is provided with a large number of ventilating ducts. The total weight of the laminations amounts to approximately 40 tons per machine, and it was therefore found desirable to make special punching arrangements by means of which a whole segment could be made complete in a single operation. 34,000 such segments are contained in each complete core.

The armature is provided with a coil winding distributed in three slots per pole per phase. The slots are of the open type, and each slot contains two conductors. The end connections are arranged in two planes. Each armature bar is further sub-divided into a number of parallel conductors, of which those nearest the pole face are stranded, pressed to proper dimensions. The additional load losses have in consequence been so far reduced that the losses ascertained

on short-circuit test exceed those calculated from resistance by only 35 per cent.

For the insulation of the winding, micanite has been used wherever possible. The parallel conductors forming the complete armature bar are each cotton-covered and impregnated, and inserted in the mica tube by a special compound, applied in a manner to exclude all possibility of the formation of ozone and nitric acid in the interior of the slot. The two conductors contained in the same slot are insulated from each other by means of micanite.

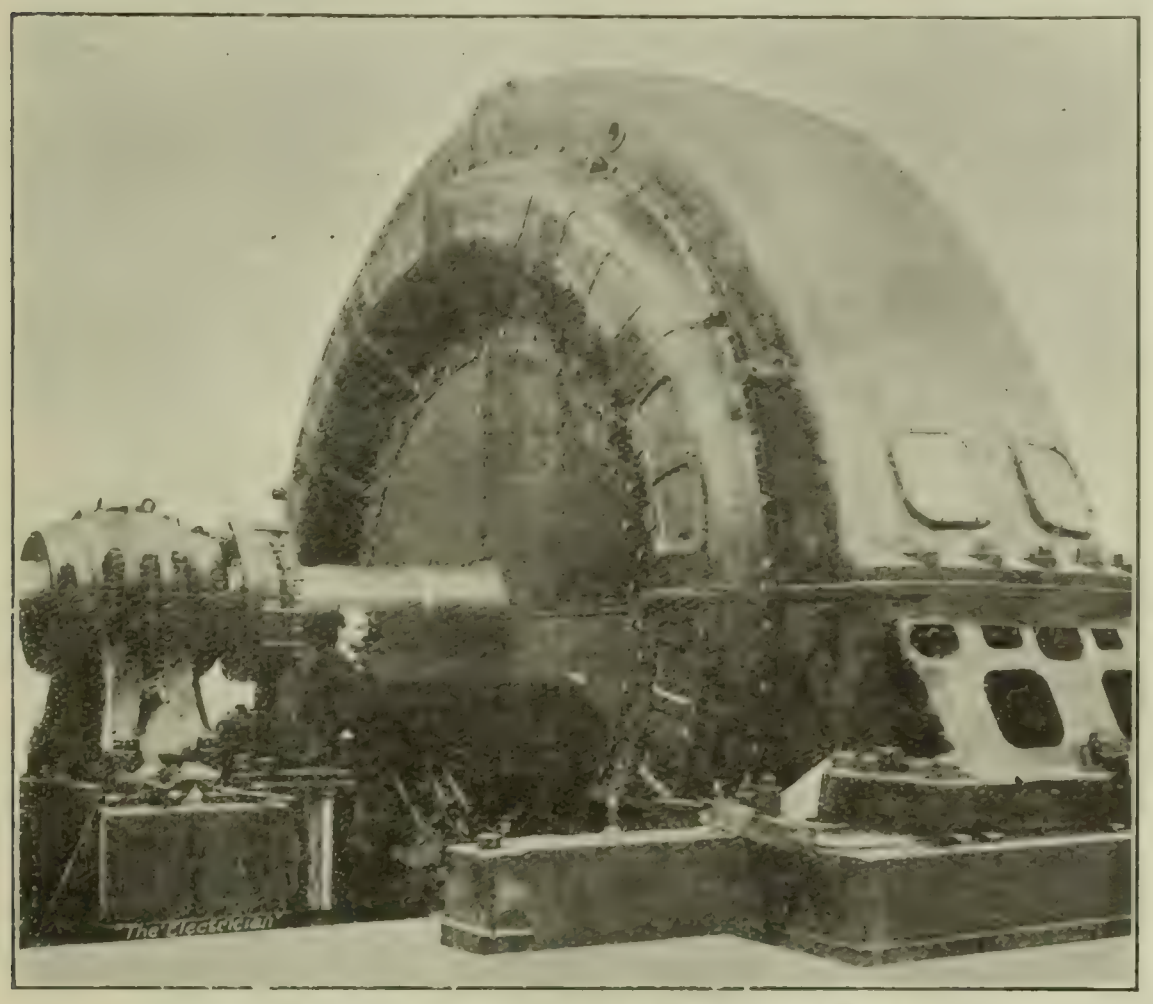


Fig. 2.—General View of one of the Alternators.

Apart from the stringent conditions relating to ozone formation, the specified insulation tests were unusually severe. The insulation between two conductors in the same slot was tested for 10 seconds with 12,000 volts, when cold, and the whole winding between phases to earth with 30,000 volts for 60 seconds, all with alternating current 50 periods of a wave-form corresponding to the sine curve. The machines passed these tests satisfactorily, but some difficulty was experienced at the commencement with the 30,000-volt tests due to creeping discharges across the coil supports, and their insulating collars. After some alterations to the form and distribution of the insulation of these coil supports, the test pressure could be increased considerably above 30,000 volts without any noticeable surface leakage.

Outside the slot the two conductors are insulated separately with a view to increasing the cooling surface. The insulating material used for the purpose is of the usual Sterling linen class. Each coil is provided with two supports, which (on the coupling side of the generator) in addition carry the connections from coil to coil.

The rotor, Fig. 4, is divided perpendicularly to the shaft into rings bolted together. These rings and the corresponding parts of the poles are made in one piece of Siemens-Martin steel. This design was selected to facilitate the manufacture and transport, and also to permit of closer control of the material. Test pieces were cut from each ring, which were tested in respect of mechanical and magnetic properties. The rings are shrunk on to a separate centre piece, Fig. 5, made of Siemens-Martin steel. The weight of the ring and poles alone is about 50 tons.

To reduce the losses due to the open slots, laminated pole-pieces are screwed on to the poles. The high peripheral speed (197 ft. per second) and the resulting high stress due to the centrifugal force demanded the greatest care in the fixing of these pole-pieces. As it is carried out, the stress in the bolts does not under the most unfavourable circumstances exceed the usual permissible limits.

The field coils are made of flat copper wound on edge and insulated with paper between layers and presspan against the core. The insulation between turns was tested with 50 times the normal voltage and against the core with 2,000 volts for one minute. The normal field voltage is 220 volts.

The arrangement previously described for moving the stator in an axial direction demanded an increased distance between the bearings, and in consequence the shaft had to be made particularly strong to obtain a sufficiently small deflection. The shaft is pierced throughout its length, and the piece thus cut out was used for testing the quality of the material. It is provided with a solid forged half-coupling for direct coupling to the turbine.

The slip-rings are made of cast-iron, and are placed near the turbine bearing. Each ring is provided with 10 brushes arranged in pairs. The brushgear is supported from the bearing. To avoid the insulating defects which sometimes occur when the slip-ring connections are taken through the centre of the pierced shaft, separate grooves have been provided along the surface of the shaft in which these connections are carried, and which are covered and protected by wedges inserted in the grooves.

The bearings are of the spherical self-aligning type, with white-metal liners arranged for water cooling with both ring and pressure oil lubrication.

As previously stated, each machine requires about 700 cubic ft. of air per second. This air is drawn into the machine by means of fans attached to both sides of the rotor, which are of sufficient capacity to drive the air not only through the machine, but also through the inlet and outlet ducts of the ventilating system. The fresh air enters under the shaft on one side of the machine, and is driven by the fans through the laminations of the stator and past the coil heads. In addition, part of the air passes direct through a ventilating duct of ample dimensions in the middle of the rotor, which effectively cools the interior parts of the stator and rotor. Although the air is admitted only on one side, no difference in temperature rise between the two sides of the machine has been observed.

The speed regulation required a flywheel effect of 17,800,000 lb./ft.^{2}. Considerations relating to the mechanical design led, however, to an increase of this flywheel effect, which in the completed design amounts to about 24,000,000 lb. ft.^{2}.

The weight of each machine complete is about 200 tons, of which the stator accounts for 90 tons, and the rotor with shaft for 80 tons.

For the testing of the machines a special two-speed induction motor was made for an output of 1,500/650 H.P. at 500/250 revs. per min. 50 periods 380 volts for direct coupling to the generator. The tests all gave good results proving that the guaranteed conditions were well covered. Fig. 6 shows the no-load and short-circuit characteristics taken during official tests. The regulation at 8,600 volts 1,050 amperes power-factor 0·65 was guaranteed at 25 per cent. The figure calculated from the tests is 21 per cent. The pressure drop on switching in this load was guaranteed at 45 per cent., which figure was also fully obtained. The losses were measured at the same time. On account of special fans used in connection with these tests, the losses due to air friction were comparatively large, and



Fig. 3. Section of Stator.

expressed in kilowatts amounted to 1 per cent. of the kilovolt-ampere output of the generator, whereas for machines of similar design and speed the corresponding figure would be 0·75 per cent. to 0·8 per cent. The short-circuit copper losses were guaranteed not to exceed 1·6 times the calculated resistance loss. As already mentioned, the figure 1·35 was obtained instead of 1·6. The no-load losses consisted for the greater part of friction losses, the iron losses being comparatively small, due to the use of alloyed core plates, which were adopted mainly to obtain the best possible efficiency. Fig. 7 gives the value of the efficiency at full voltage and different loads calculated from the above tests without making any allowance for reduced air friction, after exchanging the temporary larger fans for the permanent smaller ones. The calculated losses also include the resistance losses in the field circuits. It will be seen that on full-load and unity power-factor the high value of 96·7 per cent. was

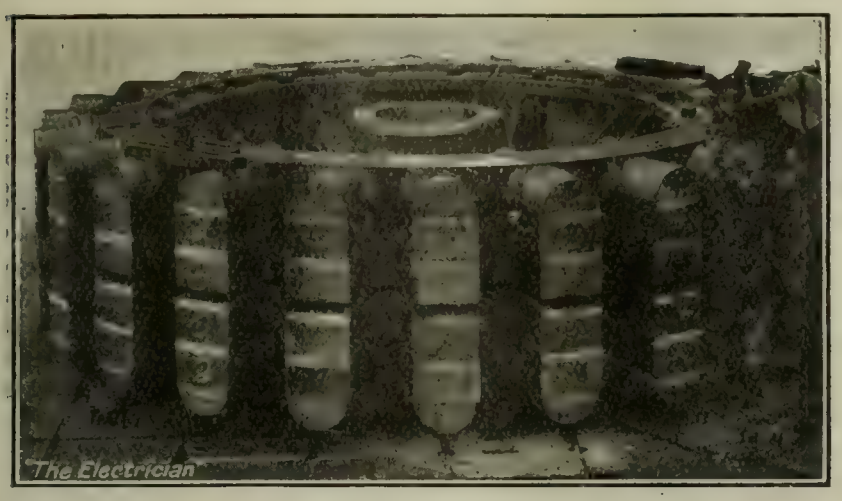


Fig. 4.—Revolving Field.

reached. The guaranteed figures, which were all reached on test, are as follows :—

96 per cent. at	8,600 volts	1,050 amperes,	power-factor	0·7
95·5 ,,	,, 9,500 ,,	1,050 ,,	,,	0·7
95·75 ,,	,, 9,500 ,,	1,150 ,,	,,	0·7

The temperature tests also gave very satisfactory results.

On continuous full load, power-factor 0·65, the temperature rise in the hottest part of the machine was specified not to exceed 45°C. after reaching permanent conditions, on the assumption that the air temperature, which is measured at the inlet of the machine, does not exceed 25°C. Under the same circumstances but with a load of 1,150 amperes at 9,500 volts, power-factor 0·65, the temperature rise did not exceed 55°C.

Special guarantees were given in respect of (*a*) unbalanced loads, and (*b*) maximum temperature rise as measured by means of thermo-elements inserted in the interior of the machine.

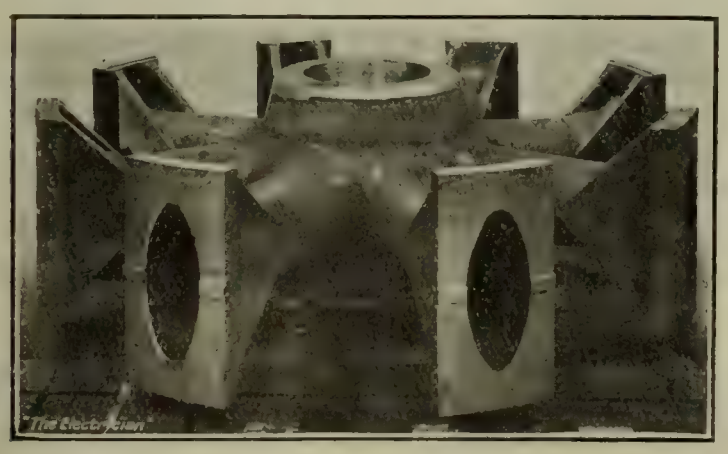


Fig. 5.—Cast-steel Spider for Revolving Field.

For the bearings, the highest permissible temperature rise, regardless of the temperature of the engine-room, was 50°C. with a cooling water temperature of 20°C.

In addition to the insulation tests previously mentioned, the machines were also run light at a voltage 50 per cent. in excess of the normal for a period of three minutes. A short-circuit test was also carried out at full speed and with excitation corresponding to the maximum load of the machine. No detrimental effects were noticeable, and the vibrations of the windings which usually accompany such tests were so insignificant that other methods had to be employed to demonstrate that a complete short-circuit had taken place.

After all other tests were completed a run-away test was made. For different reasons it was extended over a longer period than the 30 minutes stipulated in the contract with 80 per cent. overspeed. In reality the machine was running for over an hour with speeds varying from 150 to 180 per cent. of full speed, the latter value

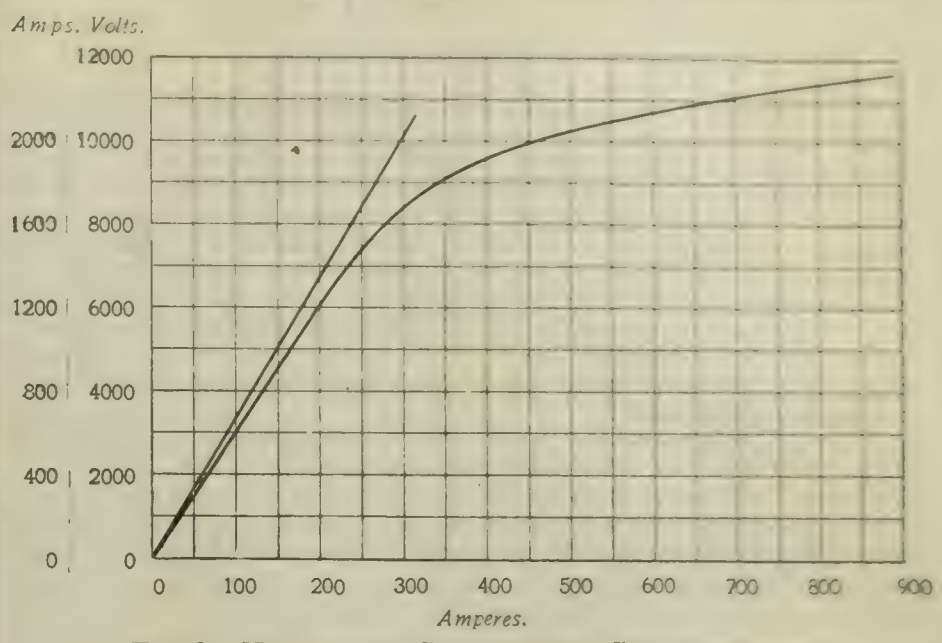


Fig. 6.—No-load and Short-circuit Characteristics.

during the last 30 minutes of the test. As the rotors during this test had to be in the same condition as when erected on site, the fans could not be removed. In consequence, the power consumption even with closed inlets was considerable, and at 80 per cent. overspeed measured 830 kw. transmitted to the generator shaft. Allowing for

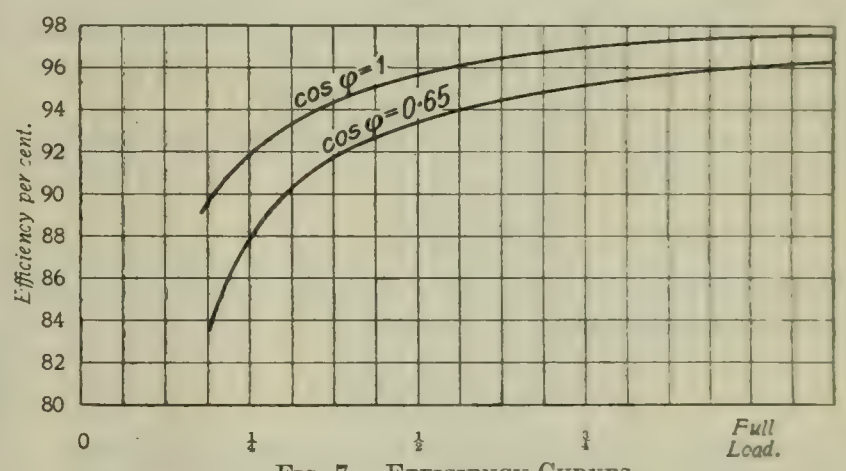


Fig. 7.—Efficiency Curves.

the motor and other losses in connection with the test, the total energy required amounted to from 100 kw. to 1,000 kw. The losses of the machine are mainly due to air friction, and in consequence a considerable temperature rise of the air was to be expected. A temperature rise of 30°C. was actually measured where the air escaped through various openings.

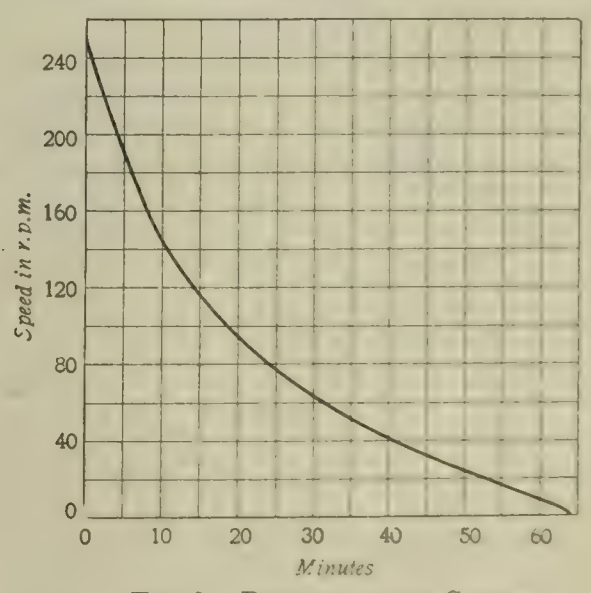


Fig. 8.—Running-down Curve.

Fig. 8 shows the gradual decrease in speed which takes place when the machine, running at full speed, is left to run out. It will be seen from this curve that the machine comes to a standstill after approximately 65 minutes.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Continued from page* 278.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

Calculation of Peripheral Dispersion with Semi-enclosed Slots.—We have

$$\sigma_2=(l_2+l'_2)/\mathrm{L},$$

where l_2 is that part of $(\mathrm{L}_s-\mathrm{M})$ which is due to stator slot leakage, and l'_2 that part of $(\mathrm{L}_r-\mathrm{M})$ due to rotor slot leakage. The axial length of stator and rotor and the number of poles being factors of both $(l_2+l'_2)$ and L we shall only calculate these quantities per unit axial length of stator and rotor and per pair of poles.

We have seen that the effective permeance of the leakage paths per slot is

$$\mathrm{P}=\left(\frac{e}{v}+\frac{1}{3}\frac{h}{b}\right).$$

The linkage per cm. axial length with all the coils of one phase per pair of poles, occupying 2S/3 slots is

$$\frac{4\pi}{10}n\mathrm{P}\times 2\frac{n\mathrm{S}}{3}=\frac{4\pi}{15}\frac{\mathrm{P}}{\mathrm{S}}(n\mathrm{S})^2.$$

Now, nS is the number of conductors per pole, and this number, as has been shown, is to be assumed the same for both stator and rotor.

$$\therefore\ {}^{2}=\frac{4\pi}{15}\frac{\mathrm{P}_1}{\mathrm{S}_1}(n\mathrm{S})^2,$$

and

$$l'_2=\frac{4\pi}{15}\frac{\mathrm{P}_2}{\mathrm{S}_2}(n\mathrm{S})^2,$$

where P_1, P_2 denote respectively the stator slot and rotor slot permeances.

Again, neglecting the peripheral and flank leakages in comparison with the main flux—

L_s (per pair of poles per centimetre axial length).
= Magnetomotive force per unit current per phase.
× Permeance of main circuit (per centimetre axial length).
× Turns per pair of poles per phase.
× Linkage coefficient β_s.

$$=\frac{4\pi}{10}\frac{n\mathrm{S}}{3}\times\frac{\tau_i}{2{\cdot}4\delta}\cdot\frac{n\mathrm{S}}{3}\cdot\beta_s$$

$$=\frac{4\pi}{216}\frac{\tau_i}{\delta}\beta_s(n\mathrm{S})^2.$$

Similarly,

$$\mathrm{L}_r=\frac{4\pi}{216}\frac{\tau_i}{\delta}\beta_r(n\mathrm{S})^2.$$

$$\therefore\ \mathrm{L}=\frac{\mathrm{L}_s+\mathrm{L}_r}{2}=\frac{4\pi}{432}\frac{\tau_i}{\delta}(\beta_s+\beta_r)(n\mathrm{S})^2$$

$$\therefore\ \sigma_2=\frac{l_2+l'_2}{\mathrm{L}}=\frac{28{\cdot}8\left(\frac{\mathrm{P}_1}{\mathrm{S}_1}+\frac{\mathrm{P}_2}{\mathrm{S}_2}\right)\delta}{(\beta_s+\beta_r)\tau_i}.$$

Also $(\beta_s+\beta_r)=\frac{20}{9}+\frac{2}{\mathrm{S}_1{}^2}+\frac{2}{\mathrm{S}_2{}^2}$.

Taking a mean value of $\frac{1}{2}\,1/9^2$ for $1/\mathrm{S}_1{}^2$ and $1/\mathrm{S}_2{}^2$ we have

$$(\beta_s+\beta_r)=\frac{20}{9}+\frac{1}{81}+\frac{1}{81}=\frac{182}{81}.$$

Also $\mathrm{P}_1/\mathrm{S}_1$ and $\mathrm{P}_2/\mathrm{S}_2$ are in general nearly equal quantities, so that we may put $(\mathrm{P}_1/\mathrm{S}_1+\mathrm{P}_2/\mathrm{S}_2)=2\mathrm{P}/\mathrm{S}$, where P is the mean of P_1 and P_2, and S of S_1 and S_2.

$$\therefore\ \sigma_2=28{\cdot}8\times 81\times 2\mathrm{P}\delta/182\mathrm{S}\tau_i. \qquad =26\mathrm{P}\delta/\mathrm{S}\tau_i.$$

Calculation of Peripheral Dispersion with Totally-enclosed Slots.—So far as the leakage from side to side of the slot is concerned, there is no difference between a totally enclosed and a semi-enclosed slot, and the dispersion due to this part of the slot leakage is given by

$$26\left(\frac{1}{3}\frac{h}{b}\right)\delta/\mathrm{S}\tau_i.$$

Again, if e, v denote now the thickness and width of the thinnest portion of the iron bridge enclosing the slot, then, *provided the permeability μ were constant*, the permeance for this part of the leakage would be $e\mu/v$ giving a dispersion

$$=26\left(\frac{e\mu}{v}\right)\delta/\mathrm{S}\tau_i.$$

But the permeability varies greatly throughout a current cycle, in consequence of the high degree of saturation which exists in these enclosing iron bridges. That this is so may easily be shown.

Variation of Permeability.—If q denote the number of ampere conductors per centimetre of stator periphery at normal full load, then $q/\sqrt{v}$ is generally approximately equal to the number of ampere conductors at short-circuit on full voltage. The number of ampere-conductors per slot at short-circuit is therefore $qw/\sqrt{\sigma}$. Take as an example a case most *un*favourable to high saturation—*i.e.*, assume q, w to have very low values, and σ a high one, say $q=150$, $w=1$, $\sigma=0{\cdot}09$. Then the number of ampere conductors per slot $=\frac{150}{0{\cdot}3}=500$.

If we take 0·2 cm. for v, which is a fairly high value for so small a slot pitch, then the number of ampere-turns per centimetre (peripheral) length of the iron bridge is 2,500. This is the root-mean-square value, the maximum value being more than 3,500. At such a high intensity of magnetisation the iron is completely saturated, the flux-density being about 25,000 lines per square centimetre, and the permeability about 6. These values are, of course, independent of the thickness e of the iron bridge. Not only is the iron completely saturated when the current reaches its maximum value, but throughout about nine-tenths of the cycle there exists a very high degree of saturation. The permeability varies from about 5,000 when the current is nearly zero down to 6 or less when the current reaches its maximum value.

Values of Permeability to be used in Calculating Slot Bridge Leakage.—The question at once presents itself, if we use the formula $26\left(\frac{e\mu}{v}\right)\delta/\mathrm{S}\tau_i$ for the dispersion due to this part of the magnetic leakage, what value is to be given to μ?

Suppose for the moment that this source of leakage could be eliminated, all other sources, including that due to the sides of the slots, remaining unaltered. Let I'_s denote the short-circuit current which would theoretically be obtained under these circumstances, I_s the actual short-circuit current.

Then $\sigma=\mathrm{I}_m/\mathrm{I}_s=\mathrm{I}'_s/\mathrm{I}_s\times\mathrm{I}_m/\mathrm{I}'_s$.

In Fig. 17 the curve ABC represents the resultant stator flux linkage curve, which must remain unaltered under all conditions, if we neglect the effect of the stator resistance and assume the applied E.M.F. wave does not vary. It therefore applies equally to the hypothetical case with short-circuit current I'_s and to the actual case with short-circuit current I_s. We shall suppose the applied E.M.F. to have a sine-wave form so that ABC is also sinusoidal.

In the hypothetical case, since there are no iron parts in a saturated condition, the curve ABC also represents the stator

current curve, but in the actual case the current curve has a slightly different form and is of rather less amplitude. It is represented in Fig. 17 by the curve A*b*C. The reason for the reduced *amplitude* is, of course, the fact that with the leakage paths across the iron bridges the same current, in addition to causing the same resultant stator flux linkage as before, would also cause a leakage flux across these bridges, and as the total flux linkage cannot be increased the current must be reduced. The reason for the different *shape* of the curve is that for very small values of the current the bridge leakage flux is relatively very large, owing to the high permeability of the iron, and so the current at first increases but slowly relatively to the sine-wave current. The curve A*b*C represents not only the current, but also the resultant stator flux linkage *exclusive of that due to the leakage across the iron bridges.*

Let A denote the amplitude of the sine wave of current I'_s, a the reduction in this amplitude caused by the iron bridge leakage. We have to determine the ratio of the root mean square values of I'_s, I_s—that is, of the curves ABC, A*b*C.

No great error will be introduced if for the curve A*b*C we substitute the curve *abc*, such that its ordinates are all less than those of ABC by the amount a, because the difference of the ordinates of the curves ABC, A*b*C is proportional to the bridge leakage flux, which, owing to the high degree of saturation existing during nine-tenths or more of the cycle varies but little

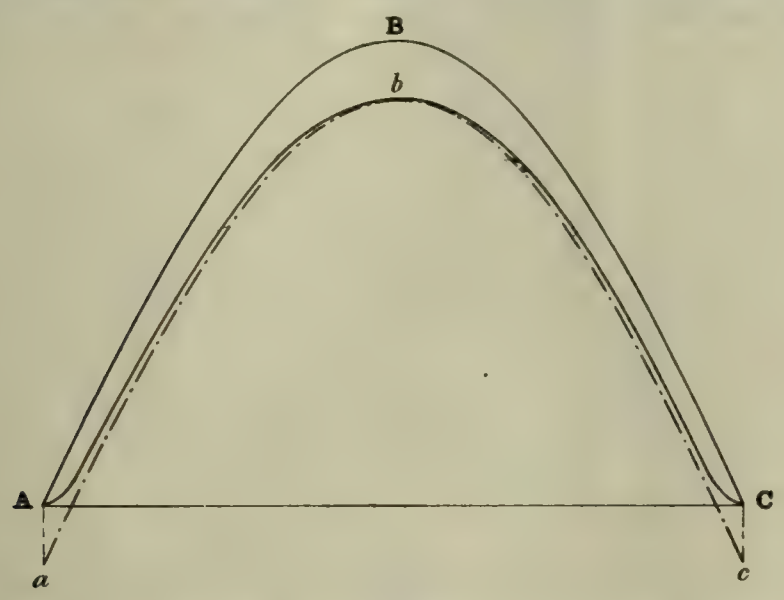


FIG. 17.—CALCULATION OF SLOT BRIDGE LEAKAGE FOR TOTALLY-ENCLOSED SLOTS.

compared to the variation of current. Whatever error is caused by this approximation will be such as to cause our estimate of I_s to be a little low, and therefore that of σ slightly too high.

Root mean square value of curve *abc*—

$$=\sqrt{\frac{1}{\pi}\int_0^{\pi}(A\sin\theta-a)^2d\theta}$$

$$=\sqrt{\tfrac{1}{2}A^2-\frac{4aA}{\pi}+a^2}$$

$$=\frac{A}{\sqrt{2}}\sqrt{1-\frac{8a}{\pi A}}$$

neglecting $(a/A)^2$

which is very small compared with unity.

$$\therefore\quad \frac{I'_s}{I_s}=\frac{A/\sqrt{2}}{A/\sqrt{2}\sqrt{1-\frac{8a}{\pi A}}}=(1-8a/\pi A)^{-\frac{1}{2}}$$

$$=(1+4a/\pi A)$$

neglecting higher powers of a/A.

$$\therefore\quad \sigma=\frac{I'_s}{I_s}\times\frac{I_m}{I'_s}=\frac{I_m}{I'_s}\left(1+\frac{4a}{\pi A}\right)$$

$$=\frac{I_m}{I'_s}+\frac{4a}{\pi A}\frac{I_m}{I'_s}=\frac{I_m}{I'_s}+\frac{4}{3}\frac{a}{A}\frac{I_m}{I'_s}$$ approximately.

Now, $$\frac{a}{A}=\frac{i_s{}'_{\max.}-i_{s\max.}}{i_s{}'_{\max.}},$$

where accented letters refer to the hypothetical, and unaccented to the actual case.

Under ideal short-circuit conditions the resultant stator flux linkage is equal to the sum of stator and rotor leakage flux linkages $=i_{s\max.}(l_s+l_r)$.

Similarly, in the hypothetical case it is equal to $i'_{s\max.}(l_s'+l_r')$, so that, as this resultant linkage must remain unaltered,

$$i_{s\max.}(l_s+l_r)=i'_{s\max.}(l_s'+l_r'),$$

or
$$i_{s\max.}/i'_{s\max.}=(l_s'+l_r')/(l_s+l_r).$$

$$\therefore\quad \frac{a}{A}=\frac{(l_s+l_r)-(l_s'+l_r')}{(l_s+l_r)}=\frac{(l_s-l_s')+(l_r-l_r')}{(l_s+l_r)}$$

$$\therefore\quad \frac{a}{A}\frac{I_m}{I_s}=\frac{a}{A}\frac{(l_s+l_r)}{L}=\frac{(l_s-l_s')+(l-'r')}{L}.$$

$$=\frac{\text{Maximum linkage of bridge leakage fluxes per unit current}}{\text{Maximum linkage of main flux per unit current}}$$

$$=\frac{26P'\delta}{S\tau_i}$$

by exactly the same argument as was used for semi-enclosed slots; but P′ now denotes the permeance of the bridge leakage paths *when the leakage flux is at its maximum short-circuit value—i.e.*, $P'=e\mu v$, where μ is the permeability at *maximum* flux density.

$$\therefore\quad \sigma=\frac{I_m}{I'_s}+\frac{4}{3}\frac{a}{A}\frac{I_m}{I}$$

$$=\frac{I_m}{I'_s}+\frac{4}{3}\frac{23P'\delta}{S\tau_i}$$

$$=\sigma_1+\sigma_3+\frac{26\left(\frac{1h}{3b}\right)\delta}{S\tau_i}+\frac{26(^4P')\delta}{S\tau_i}.$$

$$\therefore\quad \sigma_2=\frac{26\left(\frac{4e\mu}{3v}\right)\delta}{S\tau_i}+\frac{26\left(\frac{1h}{3b}\right)\delta}{S\tau_i}$$

$$=\frac{26P\delta}{S\tau_i}$$

where
$$P=\left(\frac{4e\mu}{3v}+\frac{1h}{3b}\right)$$

and μ is the *minimum* value of the permeability

The permeability of wrought iron completely saturated may be expressed approximately as

$$\mu=1+\frac{16{,}300}{\text{amp. turns per cm.}}=1+\frac{11{,}500}{qw/v\sqrt{\sigma}}.$$

The value of μ will usually be between 1·5 and 6.

Effective Gap Area.—It should be noticed that τ_i has been retained in the above formula. At first sight it would appear that it should be replaced by τ, since the periphery is no longer interrupted by slot openings, but with the very thin iron bridges employed to keep down the slot leakage they are so easily saturated, even at no-load, that the resulting permeance of the gap is expressed far more nearly by τ'/δ than by τ/δ, where τ_i here means the pole-pitch reduced by the total length (mean of stator and rotor) of the *thin portions* of the iron slot bridges per pole pitch.

Reasons why I_s/I'_s is not Equal to I_m/I'_m.—For the same reason the difference between I_m and I'_m is relatively negligible, where I'_m refers to the hypothetical case discussed above (*i.e.*, no slot bridge leakage).

It may be objected that if the difference between I_m and I'_m is relatively negligible so also should be the difference between I_s and I'_s: but it must be remembered that whereas at no load the magnetomotive forces acting both across the slot bridge and across the air-gap are due to the same magnetising current, at short-circuit the slot bridge is exposed to the full magnetomotive force due to the stator (or rotor) short-circuit current, while the air-gap is only acted on by that due to the *difference* of stator and rotor currents—or about half the magnetising current. In consequence the slot bridge

magnetomotive force is, at short-circuit, much larger than the resultant air-gap magnetomotive force.

Leakage with Totally-enclosed Slots not necessarily Greater than with Semi-enclosed Slots.—While the thickness e of the overhanging tooth edge of a semi-enclosed slot is generally of the order 0·1 cm., the thickness of the iron bridge of a totally-enclosed slot can easily be made, and *is* made, considerably less than this. There should, therefore, be no difficulty in designing a totally-enclosed slot with as little leakage as one with a slit in it of normal dimensions.

(*To be continued.*)

SOME CONSIDERATIONS ON THE MARCONI HIGH-POWER TRANSMITTING PLANT.*

BY N. SKRITZKY.

The process by which the excitation of oscillations in a wireless antenna is effected is generally well understood. As to the system, invented in 1902, consisting of a feebly-damped closed oscillation circuit, containing a long stationary spark-gap, and coupled to the aerial, the principal peculiarities of its working are explained in the theory of coupled oscillation circuits, given by Bjerkness, Drude, Wien and others. With the introduction into wireless practice of the method of excitation of oscillations by shock there have arisen new problems for the wireless investigator. These problems have been studied by Wien, Riegger, Rohman, Skritzky and others, and are actually fairly well explained. As an essential advantage of the method of excitation by shock is pointed out its high efficiency, due to the tight coupling permissible by special peculiarities of the discharger, quenching the spark being generated after few beats, thus avoiding the two frequencies in the aerial. It should be mentioned that as a rule in a plant excited by shock the closed circuit has a high damping—about 0·3 to 0·4.

The greater number of actual wireless plants are evidently based upon the principle of excitation by shock. But there remains one class of stations, not marked by the number of its representatives, but exceedingly important by the range and power of them—namely, the Marconi high-power stations. As to the processes in its transmitting plant there is not yet any clear evidence; at least not in available technical literature.

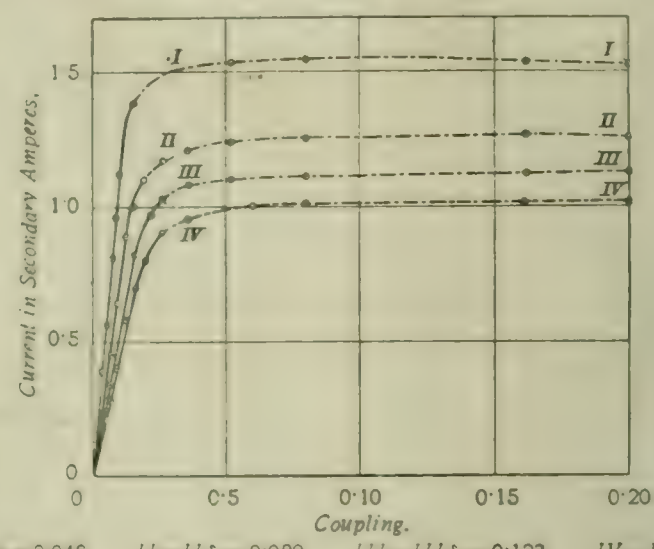
In regard to the Marconi high-power transmitter it is known that the coupling of the closed circuit and the aerial is rather loose; according to the communication of Mr. Marconi,† the damping of the closed circuit is as low as 0·015—0·030 for a half period; still, on account of the size of the aerial its damping cannot be low; probably it is not less than 0·1, and thus the damping of the secondary system is greater than that of the primary. All the stated facts do not agree with the conditions necessary for excitation by shock. There arises, therefore, the principal question: Should not the Marconi high-power transmitting plant be considered as two coupled common oscillation circuits, where the prohibition of two waves is avoided by suitably diminishing the coupling, and how should we explain in this case the efficiency, which is stated not to be very low?

The essential qualities of the Marconi high-power rotary discharger may be considered to be (1) low resistance of the spark gap, causing feeble damping, (2) an abrupt breaking off of the spark long before the amplitude of oscillations has reached zero. The last-mentioned quality is not to be ascribed to mechanical separating of the stationary electrode and the stud on the revolving disc, but rather to their electric and thermal properties, and to the state of the surrounding medium. As can be seen from photographs showing the oscillatory discharge, the premature breaking off occurs also with sparks between stationary electrodes. The photographs, taken by Roshansky with the Braun cathode ray tube, show that this effect is very marked when the discharging surfaces are of magnesium. On the other hand, as shown by Wien, the spark between magnesium electrodes causes feeble damping.

The two principal qualities of the Marconi high-power revolving discharger can thus be imitated by a magnesium spark-gap: therefore, it is not inevitably necessary to investigate a rotary gap, the conditions of work of which in a laboratory, it may be mentioned, can in no way attain sufficient identity with those of actual practice (especially with regard to the current).

The experiments here described deal with two coupled circuits, the primary containing a magnesium spark-gap, and having less damping than the secondary. As the experimental investigations of two coupled oscillation circuits were carried out in order to verify theoretical predictions by Fischer, Wien, Kaiser, Bierlein, Skritzky and others, they deal especially with the case of tight coupling. The following results may be interesting also from the theoretical point of view:—

After a series of preliminary tests the principal experiments were carried out with a gap consisting of two magnesium rods ($\delta = 5{\cdot}6$ cm.), the opposite ends of which were turned to a sphere. The primary circuit was formed of a plate condenser (plates 33 cm. × 45 cm. immersed in paraffin oil), the capacity measured at high frequency being 4,540 cm., and of a flat spiral, containing 11 turns of copper wire $d = 5$ mm., fixed by silk cords in a wooden frame. All connections were soldered. The wave-length was 718 m. Damping, as measured by the resonance method with a measuring circuit as described below, was $\delta_1 = 0{\cdot}043$; the constancy of this value, except a slight decrease of about 2 per cent. at the end of the experiments, evidently due to slight increase of the length of the spark-gap, was proved by repeated measurements. The secondary circuit contained three Leyden jars, connected in series, having the resulting capacity at high frequency of 2,890 cm.; further a flat spiral, similar to that in the primary circuit (10 turns), an inductance for accurate tuning (some turns of soft copper wire, wound on a glass cylinder), and a single loop for coupling with the measuring circuit. Damping, measured by the Bjerknes's resonance method, the circuit being excited by shock, was $\delta_2 = 0{\cdot}048$. In order to increase it, when needed, there were provided three pieces of manganin wire, arranged parallel to the connecting copper wires. By means of mercury contacts a certain length of the copper wire could be replaced by an equal length of this manganin wire. In this way the secondary damping could attain the values $\delta_2 = 0{\cdot}089$, $\delta_2 = 0{\cdot}123$ and $\delta_2 = 0{\cdot}167$;



I—*I* $\delta_2 = 0{\cdot}048$. *II*—*II* $\delta_2 = 0{\cdot}089$. *III*—*III* $\delta_2 = 0{\cdot}123$. *IV*—*IV* $\delta_2 = 0{\cdot}167$.

FIG. 1.—VARIATION OF SECONDARY CURRENT WITH COUPLING.

the wave-length was not affected by it in any observable degree. The two circuits were tuned with all possible accuracy. They were inductively coupled by means of the two flat spirals, fixed in parallel wooden frames. The degree of coupling was varied by changing the distance between them; its value was determined by the formula $K = M \sqrt{L_1 L_2}$.

The measuring circuit consisted of a Dönitz wave-meter, fitted with a Siemens thermoelement (resistance 11 ohms) and galvanometer (sensibility 250×10^{-11}A). The damping of the measuring circuit, as determined by the method of introducing known additional resistance, was 0·020.

For charging the condenser of the primary circuit there was provided an independent battery of accumulators (110-volt, capacity 320 ampere-hours) in association with an A.E.G. turbine interrupter and Boas transformer. The speed of the interrupter was maintained strictly constant. Every resonance between the number of interruptions and the proper period of the secondary of the transformer with the condenser to be charged was avoided in order to secure better constancy of the discharge frequency.

As a preliminary characteristic of the oscillation process the current flowing in the secondary circuit was measured at various degrees of coupling. The values obtained with an Hartmann & Braun hot-wire ammeter are plotted in Fig. 1. The curves show rapid increase of current up to $K = 0{\cdot}05$. Further increase of the coupling does not affect the R.M.S. value measured by the thermal instrument very much, causing only slight increase, or even decrease, according to the damping of the secondary circuit. Repeated surges and falling of the secondary current when increasing the coupling, which, according to Riegger, Rohman and Skritzky, always arise when there is excitation by shock, could not be observed.

* Abstract of a Paper in the "Proceedings" of the Electrotechnical Institute, Petrograd, Vol. XII., 1915.

† Lecture on Radiotelegraphy, delivered at the Royal Institution, 1911

As predicted by the theory of coupled circuits, when the degree of coupling is less than $\delta_1-\delta_2/2\pi$ (δ_1 and δ_2 being the decrement of the primary and secondary respectively), there are oscillations of a single frequency; when $K>\frac{\delta_1-\delta_2}{2\pi}$, there are two frequencies. The coupling when the two frequencies can just be observed are shown in the following table:—

Table I.

δ_2.....	0·078	0·089	0·123	0·167
K observed.....	0·015	0·019	0·022	0·026
K calculated	0·005	0·009	0·015	0·022

In the curves in Fig. 1 the parts corresponding to the two frequencies are marked dotted. A more evident proof that there is no excitation by shock is given in Fig. 2, representing the current in a very loose coupled tertiary system (wave-meter) as a function of the

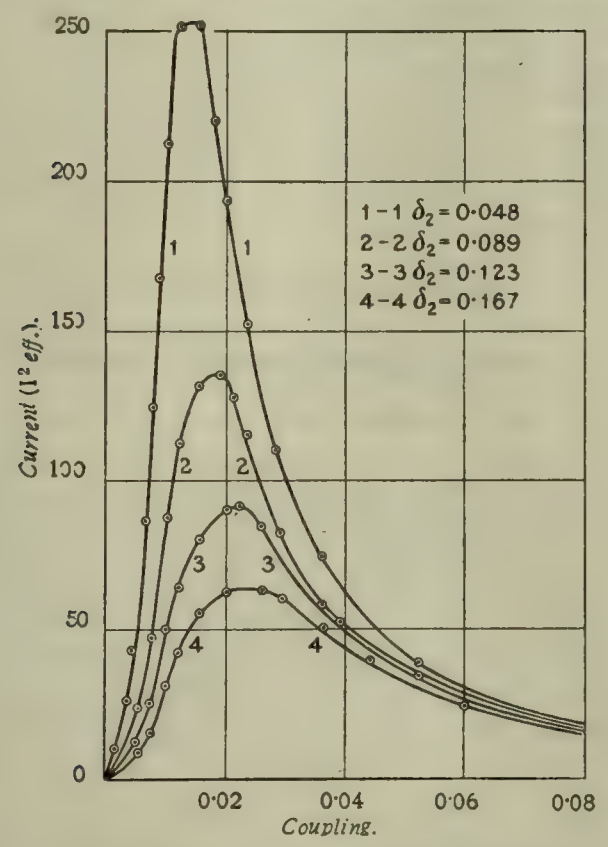


FIG. 2.—VARIATION OF TERTIARY CURRENT WITH COUPLING.

degree of coupling between the primary and secondary circuits. The tertiary is, of course, tuned to the secondary.

Although the investigation of the damping of the oscillations arising in the secondary presented some serious difficulties, it was carried out with all possible care, and the results obtained can be regarded as fairly reliable. They are shown in the following table, and in the curves of Fig. 3.

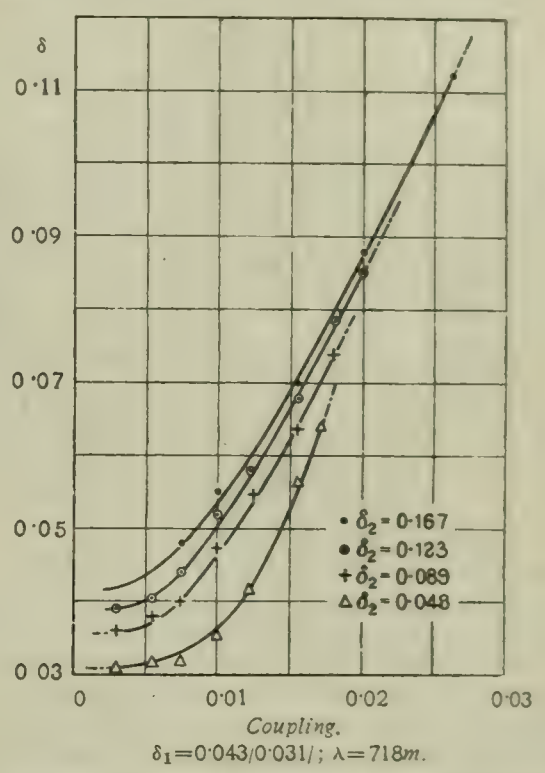
Table II.

λ=718 m., δ_1=0·043, ν=8·1 (spark-frequency).

K.	δ_2.			
	0·048	0·089	0·123	0·167
0·004	0·031	0·036	0·040	0·042
0·006	0·032	0·038	0·042	0·045
0·008	0·034	0·042	0·045	0·049
0·010	0·036	0·047	0·051	0·054
0·012	0·042	0·053	0·057	0·060
0·014	0·049	0·060	0·064	0·066
0·016	0·062	0·067	0·070	0·073
0·018	0·069	0·075	0·078	0·080
0·020	2 frequencies	Two frequencies	0·085	0·088
0·022	...	...	Two frequencies	0·096
0·024	...	...	...	Two frequencies

The striking fact may be pointed out that the damping of the oscillations arising in the secondary circuit is less than the proper damping of each of the coupled circuits, when measured separately; for instance, at K=0·004 and the proper damping of the secondary being δ_2=0·167, the damping observed in the secondary is δ=0·042; when δ_2=0·123, at the same coupling, δ=0·040; when δ_2=0·089, δ=0·036; when δ_2=0·048, δ=0·031. In the last case the difference b tween the observed damping δ=0·031 and the damping of the primary circuit δ_1=0·043 attains 40 per cent.

According to theoretical predictions, with very loose coupling, the last value was to be expected, namely δ=0·043, as it is the proper damping of the less damped coupled circuit. There arises therefore the question how to explain the observed discrepancy. The author ascribes it to the prematurate extinction of the spark. Indeed, as shown by Macku, the values of the damping, obtained by the resonance method with a feebly damped measuring circuit, do not correspond to the real damping, but are increased, the amount of the increase being proportional to the amplitude of the oscillation when the spark breaks off, expressed in per cent. of the initial amplitude; the correct value can be obtained when the damping of the measuring circuit is equal to that to be measured. In view of this statement there was introduced in the measuring circuit a non-inductive resistance R=1·051Ω. The additional damping thus obtained was 0·025, and the total damping of the measuring circuit, δ_m=0·020+0·025=0·045. Repeated determinations gave for the sum of the damping to be measured and the damping of the measuring circuit the mean value 0·077; thus the damping of the primary circuit is 0·077—0·045=0·032. We can draw, therefore, the conclusion, that the damping of the primary circuit containing the spark, as determined by the ordinary method with a feebly damped wave-



δ_1=0·043/0·031/; λ=718m.

FIG. 3.—VARIATION OF THE DAMPING OF THE SECONDARY WITH THE COUPLING.

meter, is but an appar nt value, increased on account of the premature extinction of the spark. In the experiments here described, the spark has broken off, as calculated according to the formula given by Macku, when the amplitude decreased to 9 per cent. of its initial value.

The further increase of the observed damping with the increase of the coupling can be explained in a fairly plausible manner by the formulæ given by M. Wien; according to these formulæ the damping of the less damped circuit is increased, and that of the more damped decreased, the actual values being

$$\delta^1=\delta_1+\frac{\pi^2K^2}{\delta_2-\delta_1} \text{ and } \delta''=\delta_2-\frac{\pi^2K^2}{\delta_2-\delta_1}.$$

The values obtained experimentally and calculated from the above formulæ are shown in Table III.

Table III.

λ=718 m., δ_1=0·043, ν=8·1.

K.	δ_2=0·089.		δ_2=0·123.		δ_2=0·167.	
	Observed.	Calculated.	Observed	Calculated	Observed	Calculated
0·004	0·031	0·038	0·040	0·037	0·042	0·036
0·006	0·038	0·041	0·042	0·039	0·045	0·038
0·008	0·042	0·046	0·045	0·042	0·049	0·040
0·010	0·047	0·052	0·051	0·046	0·054	0·042
0·012	0·053	0·059	0·057	0·050	0·060	0·045
0·014	0·060	0·068	0·064	0·056	0·066	0·049
0·016	0·067	0·079	0·070	0·063	0·073	0·054
0·018	0·075	0·089	0·078	0·070	0·080	0·059
0·020	...	...	0·085	0·078	0·088	0·064
0·022	. .	...	...	...	0·096	0·071

Turning now to the problem of excitation of a wireless plant, we can draw the conclusion, that in regard to the damping of the emitted

waves, the method of a feebly coupled primary circuit can give better results than the method of excitation by shock. With the latter we obtain the proper damping of the secondary system (aerial), while with the former we can reduce it. The experiments cited above have shown that when the proper damping of the secondary was $\delta_2=0{\cdot}089$, $\delta_2=0{\cdot}123$, $\delta_2=0{\cdot}167$, the damping of oscillations, obtained with the degree of coupling just before its critical value when there arise two frequencies, was respectively $\delta=0{\cdot}078$, $\delta=0{\cdot}091$, $\delta=0{\cdot}112$; thus the decrease is 13 per cent., 26 per cent. and 33 per cent. respectively. As to the current in the secondary circuit, it had reached at this coupling almost its maximum value.

There remains the question of the efficiency. With regard to the method of excitation of oscillations by shock, the efficiency is claimed to be high; that means about 60 per cent. The efficiency of the transfer of energy to the secondary circuit in the conditions of the experiments described is shown in Table IV. The energy in the primary circuit was calculated from the formula $W=\frac{1}{2}\nu C_1 V_0^2$ 2 (V_0—the initial pressure, was determined from the curves of Heidweller, ν=spark frequency); the energy in the secondary circuit was calculated from the formula $W_2=RI^2_{eff.}$, where

$$R = 150 \cdot \delta \cdot \lambda \text{ (metres)}/C_2\text{(cm.)}$$

Table IV.

$\delta_1=0{\cdot}031$, $\lambda=718$ m., $C_1=4{,}540$ cm., $C_2=2{,}890$ cm., $V_0=17{\cdot}7\times10^3$ Volts. $\nu=8{\cdot}1$ per sec.

Damping of the secondary circuit.	W_1 Watts.	δ_2 damping observed.	R_2 Ohms.	I_2 Amperes.	W_2 Watts.	η.
0·048	6·44	0·058	2·17	1·39	4·19	65·0%
0·089	6·44	0·078	2·91	1·10	3·52	54·6%
0·123	6·44	0·092	3·43	0·99	3·36	52·1%
0·167	6·44	0·112	4·17	0·90	3·38	52·5%

In view of the experiments described with two coupled circuits, the primary being less damped than the secondary, and according to the little that is known of the Marconi high-power transmitters, the author draws the following conclusions.

1. The Marconi high power transmitting plant may be considered as based on the same principle as the transmitters with long and stationary spark, employed by Braun, Marconi and others.

2. The most advantageous coupling of the closed circuit and aerial in the above named stations is comprised within the limits K=1 per cent. to 2·5 per cent.; there is no excitation by shock.

3. The damping of the oscillations in the secondary system (aerial) can be considerably less than that of the two coupled circuits, when measured separately. This diminution of damping is *apparent*, and it can be explained by the peculiarities of the primary circuit (premature extinction of the spark).

4. The relation between the observed damping in the secondary and the damping of the primary circuit is in fair accordance with the theory of feebly coupled circuits.

5. The efficiency of the transfer of energy to the secondary circuit can attain as high values as in the plants, excited by shock, that is 55 per cent.—65 per cent.

In addition, attention may be drawn to the following consideration. Suppose we have a wireless plant working with a revolving discharger, but having the damping of the primary circuit about 0·2. Of course, when worked with loose coupling the increase of the primary damping is harmful, but as it is now larger than the secondary damping, there can be chosen a different manner of working. The coupling can be made closer in order to produce beats, which can be broken off in one of the minima of the current amplitude in the primary circuit; in other words, there can be obtained excitation som what similar to that by shock. Nevertheless, the principal advantages of this method of excitation of oscillations cannot be ascribed to it. Indeed, as shown by experimental investigations on two coupled circuits, the primary containing a de-ionising spark-gap and being more damped than the secondary, the spark does break off after a certain number of beats, and the proper oscillations of the secondary circuit are always produced; on the other hand, the oscillating process begins always with beats, and, therefore, for a certain time there are always two frequencies. Now, the moment when the beats stop and the proper oscillations of the secondary begin is determined by the damping of the primary circuit, due to the resistance of its spark-gap. The higher this is the sooner the beats are stopped, and thus the higher is the efficiency of the plant and the purer the emitted wave. Every decrease of the resistance of the spark increases inevitably the first part of the process, allowing the beats longer to persist; the total losses in the primary circuit are thus increased and the two frequencies become more pronounced.

In practice there is a further inconvenience of low resistance (low de-ionising effect) of the spark-gap—namely, the limits of dissonance between the primary and secondary circuits, in which excitation by shock can occur are reduced. As the wave-length of the aerial is affected by the meteorological changes in the air, in large plants, where the adjusting of the wave-length of the aerial is not a simple matter, this consideration must also be taken into account.

Turning to the shock excited wireless plants now in use we meet with primary damping comprised within the limits 0·3 (Telefunken system) to 0·4 (Marconi system and the system of the Russian Company). With such a damping high efficiency of the plant is assured, and practically a single emitted wave allowing sharp tuning of the receiving plant. It can happen, however, that there arise difficulties in maintaining the resistance of the spark at the mentioned high figure; with the high-power plants, for instance, in view of the heavy current this seems to be the case. Then it seems unwise to attempt in spite of this to increase the primary damping, satisfying oneself with some middle value. It may be preferable to avoid the excitation by shock altogether to reduce the primary damping as much as possible, and to work with loose coupling. According to the experiments described above, in this way there can be attained very satisfactory results. In every case, for medium values of primary damping, that means about 0·2, there cannot be found any justification. The plant cannot be satisfactory whether the coupling is tight and the aerial is excited by shock, or whether it is loose and the aerial is excited by continual induction.

GAS-FILLED TUNGSTEN LAMPS.*

BY DR. M. PIRANI AND DR. A. R. MEYER.

Nitrogen-filled lamps were originally called "half-watt" lamps, owing to the fact that the first to be put on the market gave a light of 600 c.p., and more, and the arc-lamp method was used for determining the output of light. This was done by ascertaining the candle-power over the lower hemisphere, and the figures that were obtained by this method justified the rating as half-watt lamps. Further developments produced lamps of lower candle-power which could be used on high pressures; theoretical investigations had, however, shown that there was likely to be a larger loss owing to the convection currents, and this proved to be the case. The newer types had, therefore, a higher consumption per candle-power, and the old designation was, therefore, no longer free from objection. The name of "half-watt" lamps has thus to some extent had to be abandoned, lest the consumer should have reason to think he was being misled; in place of this, there grew up many trade names, such as "Azo," "Nitra," and "Wotan" lamps.

A good many points of constructive interest have now been settled. The diameter of the spiral into which the filament is wound has had to be made small, owing to the fact that the wire becomes soft and with a large diameter of spiral, the greater sag might cause trouble. Also in taking the filament through the hooks a short, straight or bent length is introduced at this point in place of the spiral, in order to avoid an excess of heat, and a loss by conduction through the hook. With large lamps, a plate of mica is largely used to close the neck from the bulb. It serves the double purpose of catching some of the volatilised tungsten and of shielding the point at which the leading-in wires pass through the glass from the action of the hot gases. Nitrogen is used as the gas in the larger sizes, and argon in the smaller. A very small diameter of spiral had to be used in the smaller sizes of lamp, and it was found necessary to have a gas with low thermal conductivity. Therefore, argon was used in preference to nitrogen. But it was found to be desirable to add a small admixture of nitrogen, since argon had no great power of resisting electric discharge, and lamps filled with argon were found to be liable to short-circuits. This arrangement proved very convenient, since commercial argon contains a considerable amount of nitrogen.

The gas pressure, when the lamp is cold, is about one-half or two-thirds of an atmosphere. Even when hot, there is no great excess of pressure, and, therefore, no fear of an explosion. The temperatures of the bulbs are, of course, higher than with vacuum lamps: in the largest sizes, the temperature ought not to exceed 150° C. to 200° C. at the hottest spot. The authors give curves showing the physical properties of the lamps, such as the relation between the watts per candle-power (or the percentage of the full candle-power) and the

* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 38 and 39, 1915.

voltage, taking a lamp which runs at 0·6 watt per Hefner candle-power; also showing the relation between current, resistance and voltage. These curves show that the resistance of the lamp, when cold, is one-fifteenth of that when hot. Thus, at the moment of switching on, there will be a momentary current 15 times as great as the final current. An oscillographic record shows how quickly this momentary current falls off. It appears that with a 1,000 c.p. lamp the current has twice its normal value at the end of 0·05 second, and reaches the ormal value in 0·3 second. With a 2,000 c.p. lamp, these figures are 0·09 and 0·4 respectively. These figures are very similar in order of magnitude to those obtained with the usual vacuum lamp, in which the resistance, when hot, is about 12 or 13 times as great as it is when cold.

The filament must be wound in the form of a spiral, and is sometimes arranged in the shape of a ring, and sometimes in a zig-zag. The ds tribution of the light is rather different in the two cases. The authors give curves showing the spherical distribution of the light from a "zig-zag" lamp, taking 1,000 watts; the mounting and the globe make certain differences, and the curves show the light-distribution with variations of these conditions—*e.g.*, with clear and opal globes. Another set of curves shows the distribution of light with the "ring" shape. The method of mounting, and the use of reflectors are matters which affect the distribution of light very much; it is therefore not easy to generalise. The specific efficiency is also another point about which there are differences, depending on the thickness of the filament, for instance; neither, of course, is the thickness of the filament an independent variable. It is not quite free from question what the plan should be on which the specific efficiency should be measured, or, rather, it is open to doubt as to the rating to be adopted. In the first instance these lamps used to be rated on the lower-hemispherical candle-power, seeing that they competed only with small arc lamps, which had always been rated in this way. This was in itself an abandonment of the mean-horizontal candle-power method of the carbon-filament lamp. But when gas-filled lamps of smaller size were made, which competed with the old type of tungsten lamp, as used for internal illumination, it was a question what should be done, more especially seeing that with the "ring" system of spiral the maximum illumination was in an axial direction, whereas with the "zig-zag" type it was in a horizontal direction. Another suggestion was to determine the spherical candle-power, and at the same time to state the direction in which there was the maximum illumination. Further, there is the very important fact that the efficiency depends on the size of the lamp, taken in conjunction with the pressure on which it burns. The authors give some interesting curves, showing how the efficiencies for the gas-filled lamps compare with those for flame-arcs and for ordinary tungsten lamps, taking into account the variations in the size of the lamp. There are two sets of these curves, one for 110 volts, and the other for 220 volts. Naturally the curve for ordinary tungsten lamps is practically a straight line, seeing that its efficiency does not depend on the candle-power, but is uniform; the line is, therefore, parallel to one of the axes of co-ordinates. Similarly with flame-arcs; the line, though straight, falls slightly, which means that the efficiency increases slightly with a larger size. With gas-filled lamps, the curve starts with a decided bend, both at 110 and 220 volts, and then becomes nearly straight. The bent portion or knee corresponds to the lamps of low candle-power, for which the efficiency is very different from that of those of higher candle-power. The curves indeed show that with the high candle-powers, the term "half-watt" lamps is justified; they take about half the current required for the vacuum type, and even with the smaller candle-powers there is a saving of 30 or 40 per cent. The gas-filled lamps, too, are smaller in diameter and length of globe than those of the old vacuum type, and this is appreciated by the consumer. A table is given showing the sizes of one particular make, which is said to be very similar to others. Thus, for a lamp giving 100 c.p. (on an unstated voltage), the diameter and length of bulb of a gas-filled lamp are 75 mm. and 150 mm.; for the vacuum type, these figures would be 100 and 160. For a gas-filled lamp of 1,000 c.p., the diameter and length are 150 and 300; for the vacuum type, 240 and 350. These figures are typical of others included in the table. The life of large gas-filled lamps varies from 800 to 1,000 hours. For lamps of lower candle-powers, the life is supposed to be from 600 to 800 hours; but they have not yet been largely used, and it is impossible to do more than state the results of tests, which are as yet unconfirmed by consumers. Another matter is the falling-off in light with age, and curves deal with this point. It may be said generally that the results are very similar to those with the vacuum type. The curves show the falling-off of candle-power for a 1,000-watt lamp, burning on 220 volts; for a 200-watt lamp, burning on 220 volts; and for a 60-watt lamp, burning on 110 volts. There is naturally a slight difference in the three cases.

The lamps are also made in special types, suitable for projection purposes or for lighting motor cars. It was originally thought that a low pressure, such as 14 volts, might be desirable for such purposes; it was proposed to make small separate transformers for use with them, or to join them up in series on direct current; but these plans are now no longer urged. The temperatures of the filament are several hundred degrees higher than for the vacuum type, but they have not been exactly determined except in the larger sizes. From this it appears that for lamps, taking 0·55 watt per spherical candle-power, which is a usual rate of consumption, the temperature of the filament is about 2,500°C. This is about 450°C. higher than with the normal vacuum lamp, and 90°C. more than in a vacuum lamp, loaded to the same extent. The filament gives about 8 Hefner candle-power per square millimetre of radiating surface, which is about five times the value of that found with the old tungsten lamp. The concentration of light is also greater. If the light is projected in the direction of the maximum illumination, and the quotient is formed showing the ratio of the light to the surface on which it falls, we get a figure varying from 20 c.p. to 400 c.p. per square centimetre, as compared with from 2 c.p. to 12 c.p. per square centimetre for a normal tungsten lamp. This causes a certain glare, if the proper precautions and arrangements are not adopted. With half-watt lamps for projection purposes, an illumination of more than 600 c.p. per square centimetre can be obtained. The light is naturally noticeably whiter than that of ordinary incandescent lamps, and it constitutes a much nearer approach to the colour of daylight. Siemens make a so-called Verico lamp, which is provided with a globe of such a character that the light differs so slightly from the appearance of daylight that for most purposes no difference may be said to exist. The Paper concludes with a table, showing the efficiencies of the different kinds of electric lamp. The first column gives the watts per horizontal candle-power, and the second the watts per spherical candle-power, and the last gives the lumens per watt. This gives an idea of the value of the improvements that have been gradually introduced since the days when the carbon filament was displaced by the Nernst lamp, which was in its turn succeeded by the osmium, tantalum and tungsten filaments.

"STATUS" OF THE ENGINEER.

In his presidential address before the American Electrochemical Society, Mr. F. A. Lidbury made the following comments on the status of the engineer:—

"Perhaps as good an illustration as any of the direction in which our duties and our interests lie can be found by considering our relations to current tendencies in government. The extension of legislative and bureaucratic activities which the last few years have seen has been too widely regarded by intelligent persons as a manifestation which would play itself out, on the principle that 'if the fool would persist in his folly, he would become wise.' Not only has this optimistic expectation not borne fruit, but reliance on it has to a large extent prevented the offer of information and guidance from those in a position to give it. There are signs that men of business are realising their mistake in the matter, and it is time that the man of science and the engineer also realised theirs. What cannot be averted can at least be guided into intelligent channels.

"The engineer—take the word in its widest sense—has been worrying about these matters for a long time; and occasionally he comes to the conclusion that what is needed is representation of himself in legislative bodies. He had better remember that legislation is really lawyers' business. If the scientific and engineering professions would worry less about their 'status' and pay more attention to making their opinions heard and their recommendations respected, they would cease to be bothered about the undue proportion of lawyers in legislative bodies. For, on the whole, these lawyer-legislators are not so scornful of information and advice as we are inclined to believe. They try to get both whenever they can, and, when the practical business man, the technical man, the engineer held aloof, they went to the university professor and, when he was not available, to the charlatan and the agitator. They have shown their power of discrimination by preferring the professor; they instinctively felt that he knew more. If his guidance has led them into difficulties, it is because his truths are too often coloured by his theoretical idiosyncrasies, and not founded on a pragmatic basis. Until we have given the legislator all the assistance in our power, we are obviously not in any position to accuse him of spurning it. Nor does it particularly matter if he does; for the power of an intelligent minority, however small, is tremendous, and there is no man more sensitive to well-informed criticism of sufficient publicity than your legislator, unless it be your bureaucrat."

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THE MAGNETIC PROPERTIES OF THE IRON-SILICON GROUP.

The influence of research on the development of industry is well shown in the metallurgy of iron. Many of the alloys, built up by the metallurgist, have had a profound effect in engineering. The iron alloys used for the construction of the magnetic circuits of electrical machinery and apparatus are typical examples. Machinery users look at the matter from the point of view of the business man. The latter argues that if the efficiency of a 5,000 kw. transformer can be improved by 0·5 per cent. by decreasing the all-year loss, the saving will be 25 kw., which, at 0·5d. per kilowatt-hour, means a cash saving of £456 per year, and simple arithmetic enables him to determine the capital expenditure which may, profitably, be incurred. Although many problems are interesting for their own sake, not the least interesting are those which bear the simple arithmetic test of the business man.

At one time it was customary for electrical engineers to use Swedish charcoal-iron, but experience showed that this expensive material was little, if any, better as regards core-loss than the common grades of sheet steel. Probably the first serious attempt to investigate in a systematic manner the physical properties of an extensive series of alloys of iron was that made about 1900 by Sir R. A. HADFIELD and Prof. W. F. BARRETT. In this research 110 specimens were available. Of these, 59 were alloys of iron containing varying proportions of one other element; 44 were iron alloys containing two other elements in varying proportions; and the remaining seven specimens contained three or more elements alloyed with the iron. The authors dealt with the electric conductivity and magnetic properties of the alloys, and described a series of practically non-magnetic alloys of iron. Furthermore, the results were given of tests on alloys containing nearly 3 per cent. of non-magnetic

elements, which were, within certain wide limits of induction, of higher permeability than the purest commercial iron obtainable, all being in the same physical state as regards annealing.

Some years later the magnetic properties in intense fields of the same specimens were investigated by Sir R. A. HADFIELD and Prof. B. HOPKINSON. Certain of these alloys showed great mechanical strength and excellent magnetic properties, and at the same time were of high specific resistance. The outcome of the research was the discovery of an iron alloy which showed a loss of about 0·82 watts per pound for a maximum induction of 10,000 lines per square centimetre at a frequency of 50 cycles per second. Up to this time the best iron obtainable commercially, when tested under similar conditions, gave a loss of 1·45 watts per pound, and common iron a loss of 2·10 watts per pound. According to Mr. MORDEY, the discovery yielded in a few years an economical result represented by the yearly saving of many thousands of tons of coal.

It is now generally known that silicon enters into the composition of the low-loss iron alloys. The iron-silicon group has engaged the attention of many metallurgists and physicists, and the most recent work on the subject is that presented by Mr. TRYGVE D. YENSEN in a Paper read before the American Institute of Electrical Engineers. For some years Mr. YENSEN has been experimenting with electrolytically-deposited iron melted in a vacuum furnace, and the material so prepared is said to approach very nearly to chemically pure iron. From the abstract of Mr. YENSEN'S Paper, given elsewhere, it will be seen that alloys showing properties of a remarkable character are described. Data in regard to the iron-silicon group are given in considerable detail, and two silicon alloys have been produced that have very valuable characteristics. One of these, low in silicon, is not very strong, but extremely ductile; it has a high permeability, low hysteresis loss and low specific resistance. The other, high in silicon, has great mechanical strength and is moderately tough, a high permeability, low hysteresis loss and very high specific resistance.

Not the least important section of the Paper is that devoted to the description of two non-forgeable alloys in the iron-silicon group. Up to the present it has been thought that the limit of forgeability is reached with about 7 per cent. of silicon. The two alloys in question, containing 2·55 and 2·57 per cent. of silicon, fell into a mass of crystals that apparently had no adhesive strength. That this occurrence was not accidental is shown by the fact that the alloys were made at different times and were subjected to forging on different days, in company with other alloys that forged perfectly. As no other investigator has observed this, it would appear either that the region of non-forgeability is restricted to a very narrow range, or that the small amount of impurities present in the alloys used by other investigators may have altered the physical properties sufficiently to make them forgeable, whereas their absence might have made them non-forgeable.

The question as to whether advantage can be taken of the new alloys in the construction of electrical machinery depends upon cost of production. Given a reasonable demand it is not unlikely that the materials will be produced on a commercial scale. Experience shows that mechanical treatment has an important effect on the physical properties of iron alloys. The specimens tested were made by forging the cast ingots into rods, and no data were given of the magnetic properties of the alloys in sheet form, but we understand that further work on the subject is in progress. From the discussion on the Paper it appears that the specimens of highest permeability depart most widely from an application of the STEINMETZ law. This indicates either some error or else the possession of remarkable properties in the material examined. Further tests will clear up the point, and in the meantime it is interesting to note that a sample tested at Schenectady also gave extremely high values for the permeability.

THE CALCULATION OF THE EFFECTIVE RESISTANCE OF EARTH PLATES, &c.

BY PROF. G. W. O. HOWE, D.SC.

Summary.—The author refers to a Paper read recently by Prof. E. W. Marchant before the British Association, in which it is suggested that the resistance of earth plates should be expressed in terms of an equivalent length. In the present Paper it is pointed out that this equivalent can be calculated without resorting to measurements of specific resistance.

A Paper was recently read by Prof. E. W. Marchant * before the Engineering Section of the British Association at Manchester, entitled "A Note on Earth Resistance," in which it was suggested that the effectiveness of any arrangement of earthing plates or wires should be expressed by the "equivalent length" of the "earth." This length was defined as the length of a column of the earthy material which, with a cross-section equal to the surface of the earth-plate, would have a resistance equal to that of the actual arrangement. The method described in the Paper for determining this equivalent length was as follows: The actual resistance of the arrangement was measured by means of two other "earths" in the neighbourhood, the specific resistance of the earthy material was determined by excavating and measuring the resistance of a sample of the excavated material, and from the known surface of the buried conductors, the "equivalent length" was calculated by means of the usual formula—

$$R = \rho l / A.$$

The object of this communication is to point out that this equivalent length, which is a very useful conception, depends merely on the geometrical arrangement of the conductors with regard to the surface of the earth, and can be calculated directly to a sufficient degree of accuracy without any experiments involving such an unsatisfactory procedure as the determination of the specific resistance of excavated and recompressed soil.

The writer would suggest that the whole procedure be reversed, and the specific resistance of the soil in situ be determined from the calculated "equivalent length."

When a conductor is buried in the earth, the current which enters or leaves the earth follows stream lines identical with the electrostatic lines of force which would be present were the earth replaced by air or any other dielectric. Hence the calculation of the ratio of the total current to the P.D. is strictly analogous to that of the ratio of the total electrical displacement or quantity to the P.D., or, in other words, having calculated the capacity in one case, the result can be applied to the resistance in the other case.

The exact relationship can best be seen from a consideration of two parallel plates. The capacity of a plate condenser with air as the dielectric is given by the formula,

$$C = A / 4\pi l,$$

where the distance l between the plates is assumed to be very small compared with the dimensions of the plates. If immersed in a semi-conducting medium of specific resistance ρ the resistance between the plates is given by the formula

$$R = \rho l / A.$$

Hence, $$R = \rho\, 4\pi C,$$

and the "equivalent length" $l = A / 4\pi C$.

It can easily be shown that the same relationship must hold, whatever the shape and distribution of the conductors.

* THE ELECTRICIAN, Vol. LXXV., p. 882, Sept. 17, 1915.

It is obvious that the considerations which would guide us in arranging the wires, &c., so as to obtain the greatest capacity are the same as would lead to the smallest earth resistance.

A method has recently been devised by the writer by which the capacity of any arrangement of conductors can be approximately calculated.* With any simple arrangement of wires, such as a T or umbrella type of antenna, a high degree of accuracy is easily attainable, and even with complex combinations of plates and wires of various shapes and sizes an accuracy quite sufficient for all practical purposes can be obtained with a little trouble.

Before proceeding to apply the method to the actual cases described by Prof. Marchant, it might be mentioned that the reverse process has been employed by Kennelly and Whiting, who determined the capacity of a vertical wire near the earth by immersing a small model of copper wire in a vessel of conducting liquid and measuring the resistance.†

The effect of the proximity of the earth's surface on the distribution of the stream lines of current flow, and thus on the effective resistance, can be represented exactly by the method of images. If an exact replica of the buried conductors were placed at the same distance above the earth's surface as the actual conductors are below it, and charged to the same potential with electricity of the same sign, then, if the whole were embedded in the same uniform earthy material, no current

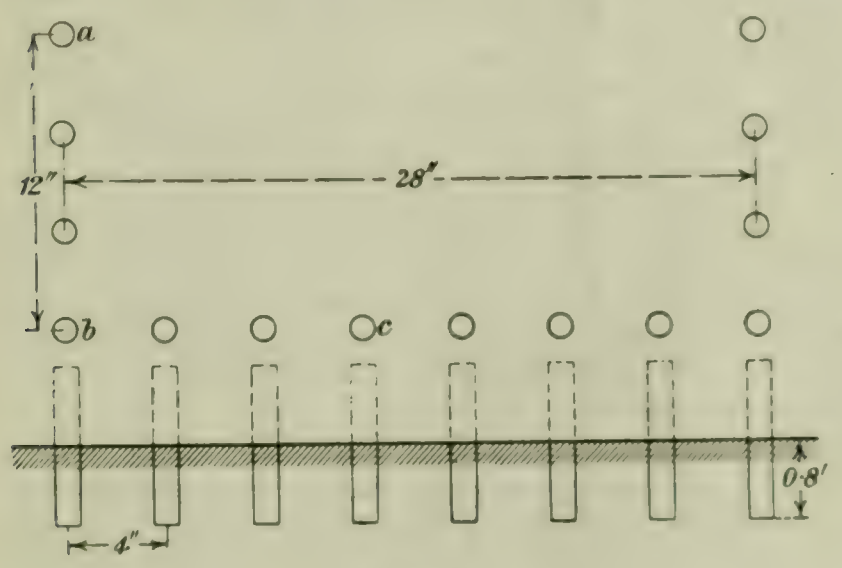


Fig 1.

would cross the boundary which formerly marked the earth's surface. The distribution below the earth's surface would be unaltered and the effective resistance would be exactly halved. The problem is greatly simplified by adding this image of the conductors and assuming that the whole is embedded in a uniform medium.

The simplest form of "earth" from a mathematical point of view is a conducting hemisphere embedded with its plane surface level with the ground. Adding its image, we have a sphere, the capacity of which is equal to its radius.

Hence, $R=\rho/4\pi C=\rho/4\pi r$ for the whole sphere, and $R=\rho/2\pi r$ for the hemisphere; for the equivalent length we have

$$l=A/4\pi C=4\pi r^2/4\pi r=r,$$

which can, of course, be calculated directly, as stated by Prof. Marchant.

It is assumed in this and in the further examples that the earthy material surrounding the conductor is uniform and has a constant specific resistance, ρ. If the conductor is embedded in some material, such as coke, with a specific resistance between that of the conductor and of the soil, the problem is much more complicated, but can still be calculated approximately, if the data are known.

Of the two earthing arrangements described by Prof. Marchant the first consists of 14 iron pipes 2 in. diameter driven into the earth to a depth of about 0·8 ft., giving a total surface of 5·8 sq. ft. The arrangement is shown in Fig. 1. The spacing of the pipes is given as 4 in., and the dimensions are approximately those shown in the figure. By adding the image above the surface, as shown dotted, we get 14 parallel conductors, each 1·6 ft. long, the capacity of which can be calculated by means of the formulæ and curves given in the Papers referred to (loc. cit.).

For each rod we have $l/r=19{\cdot}2$, for two adjacent rods $l/d=4{\cdot}8$, for any two rods 8 in. apart $l/d=2{\cdot}4$, and so on.

It is assumed that all the rods are uniformly charged with 1 unit per centimetre of length, and the average potential of any rod due to its own charge and to the charges on all the other rods is then found by means of the formulæ,

$$V_{av}=2\left(\sinh^{-1}\frac{l}{d}+\frac{d}{l}-\sqrt{1+\frac{d^2}{l^2}}\right),$$

due to a parallel rod at distance d, and

$$V_{av}=2\left(\sinh^{-1}\frac{l}{r}+\frac{r}{l}-\sqrt{1+\frac{r^2}{l^2}}\right),$$

due to its own charge.

In this way the potential of rod a is found to be 20·09, that of rod b 23·06, and that of rod c 25·46, while the average potential of all the rods is about 23 units.

It is assumed that if the total charge, while remaining unchanged in quantity, be allowed to take up its natural distribution on each rod and between the various rods, the uniform potential which the whole will assume will be approximately equal to this calculated average potential. In the present case, where the calculated potentials differ but little from one another the error due to this assumption is very small indeed.

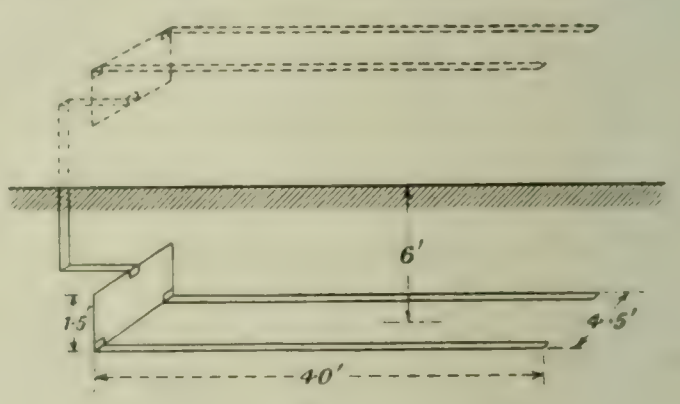


Fig 2.

The total charge on the lower half of the rods is $0{\cdot}8\times30{\cdot}5\times14$ units, and

$$C=(0{\cdot}8\times30{\cdot}5\times14)\div23=14{\cdot}86 \text{ cm.}$$

Hence, $R=\rho/4\pi C=\rho/186{\cdot}5$,

$A/l=186{\cdot}5$ cm. and $l=A/186{\cdot}5=28{\cdot}9$ cm.,

that is, the "equivalent length" is 28·9 cm., or 0·95 ft. From his measurements Prof. Marchant derives an equivalent length of 0·63 ft., which is too low a value to be explained by any error in the approximate dimensions and spacing of the pipes. The source of the error is almost certainly to be found in the specific resistance which is given as 375 ohms per foot-cube for an excavated sample pressed into a box and containing 10 per cent. moisture. From the calculated value of the "equivalent length" the specific resistance of the soil in situ was 250 ohms per foot cube. This could easily have been determined experimentally by measuring the resistance between two adjacent pipes.

The resistance of any arrangement of earth wires can be determined without the use of any other "earth," by splitting the wires into two sections and measuring the resistance between them; from the calculated "equivalent length" of this split arrangement the specific resistance of the soil can be calculated and used to determine the resistance of the two sections in parallel. By employing the method devised by the writer for calculating the "equivalent lengths" of the two arrangements, the resistance can be determined very easily to within 1 or 2 per cent.

The other arrangement described by Prof. Marchant consists of a copper plate buried vertically, and two antennæ

* *See* The Electrician, Vol. LXXIII., p. 829, also Vol. LXXV., p. 870, Sept. 17, 1915.

† "Electrical World," New York, 1906, p. 1240.

running from it, as shown in Fig. 2. The plate is 4 ft. 6 in. wide and 1 ft. 6 in. high, and its lower edge is 6 ft. deep. The strips are 1 in. wide and each 40 ft. long. In this case the assumption of a uniform density of charge on strips and plates would be very far removed from the actual distribution and would cause the potential of the plate to be about three times that of the strips. In such a case it is necessary to assume different surface densities for the plate and strips—*e.g.*, 1 unit per square centimetre on the plate and q units per square centimetre on the strips, where q is such that the average potential of the strips is equal to that of the plate. This sub-division can be carried still further if great accuracy is required.

The calculation of the average potential in the present case can be summarised as follows :—

Average potential of the plate—	
Due to its own charge	$=435$
„ „ „ „ image	$=39$
„ „ the charge on the strips	$=41q$
„ „ „ image of the strips	$=22q$
Total	$=474+63q$
Average potential of a strip—	
Due to its own charge	$=76{\cdot}2q$
„ the other strip	$=23{\cdot}1q$
„ „ image of the strips	$=24{\cdot}2q$
„ „ charge on the plate	$=41$
„ „ image of the plate	$=18$
Total	$=59+123{\cdot}5q$

Since the plate and strips must have the same potential

$$474+63q=59+123{\cdot}5q$$

and $q=6{\cdot}86$.

That is to say, the surface density of the charge (or of the current) is nearly seven times as great on the strips as on the plate.

The charge on the plate $=(4{\cdot}5\times1{\cdot}5)\times30{\cdot}5\times30{\cdot}5\times2$,
$=12{,}550$ units.

The charge on the strips $=80\times30{\cdot}5\times5{\cdot}4\times6{\cdot}86$,
$=90{,}300$ units,

assuming the strip to have a periphery of 5·4 cm.

Hence the total charge is 102,850 units, and the average potential $474+63q=474+432{\cdot}5=906{\cdot}5$.

For the capacity we have

$$C=\frac{Q}{V}=\frac{102{,}850}{906{\cdot}5}=113{\cdot}5 \text{ cm.},$$

and

$$R=\frac{\rho}{4\pi C}=\frac{\rho}{4\pi\times113{\cdot}5}=\frac{\rho}{1{,}425.}$$

For the " equivalent length " we have

$A/l=1{,}425$; $l=A/1{,}425=25{,}750/1{,}425=18{\cdot}1$ cm.$=0{\cdot}59$ ft.

Prof. Marchant's measurements gave 0·51 ft. for this arrangement. The sudden change where the strips meet the plate will cause the above method of calculation to give a larger error than one would get with a more uniform arrangement of conductors. The true capacity would be greater than the calculated, and a further increase would be caused by the leading-out conductor which we have neglected, although it could easily be allowed for if its dimensions were known. This increase in capacity is equivalent to a decrease in resistance, and, to some extent, in the equivalent length, so that the calculated value would probably agree very well with the measured value in this case, if the data were all accurately known and the calculation carried out in greater detail than has been here attempted. It appears therefore that the excavated sample of soil was tested under conditions similar to those obtaining around the buried conductors.

The calculation of the capacity has not been given in detail, since it merely involves an extended application of the formulæ and curves given in the writer's original Paper read before the British Association at Sydney (loc. cit.). The only items which are likely to give trouble are the first in each set. It can be shown that the capacity of a rectangular strip with a width of about 17 times its thickness, is about 0·9 of that of a round conductor of the same periphery. A rectangular plate is merely a large number of parallel strips, and the average potential along any strip can be found by integrating the expression already given, viz :—

$$V=2\left(\sinh^{-1}\frac{l}{d}+\frac{d}{l}-\sqrt{1+\frac{d^2}{l^2}}\right),$$

where d is the distance between any two strips. The writer hopes to go into the application of his methods to the determination of the capacity of plates and strips in greater detail on another occasion.

A word of warning should, perhaps, be given with regard to the difference which may exist between the resistances of any arrangement of earth-wires to continuous or slowly alternating current, and to currents of radio-frequencies, owing to the action of the E.M.F.s induced in the earth in the latter case, in confining the current to the upper layers. The problem is very complicated owing to the great variation of current in the immediate neighbourhood of the aerial where the ground forms the lower plate of a huge air condenser. A large proportion of the current entering the earth connection does not flow through the earth to a great distance, but charges up the surface in the immediate neighbourhood of the aerial.

CORRESPONDENCE.

SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS : Mr. Wilson's letter in your current issue falls naturally into three parts. In the first he says that the question as to whether a magnetic field does or does not rotate with the solenoid or magnet producing it can easily be settled experimentally. I wonder, then, what is Mr. Wilson's estimate of the intelligence of the many scientists who have tried in vain to devise some *experimentum crucis* to settle this vexed question. He suggests some variation of Poincaré's arrangement, but I have considered every modification which I can think of without discovering any which, whatever the result, could not be explained equally well on either hypothesis. When the bar magnet is rotated and the ring stationary, an electric force is induced in the latter ; if the field rotates with the magnet, whatever that may mean, it cuts the ring and induces the electric force ; if the field does not rotate, the electric force is induced in the magnet, causing charges to collect upon it (Fig. 6, page 170). On the first supposition the charges on the ring will induce charges on the magnet, while on the second supposition the charges on the magnet induce charges on the ring. The result is the same in either case. The same misunderstanding underlies Mr. Maccall's suggestion that if the field rotates with the magnet, the latter will not become charged ; it will do so, owing to the electric forces induced in the surrounding medium.

The second part of Mr. Wilson's letter deals with the improbability of an electric force being induced in the earth due to its rotation in its own field. If it is not, then it is induced in the medium surrounding the earth and all Mr. Wilson's journeys backwards and forwards between Land's End and John o' Groats with insulated charges, would, so far as I can see, do nothing to decide which of the two is the correct hypothesis. He has obviously failed entirely to appreciate that the results—including the 12,000 volts between Land's End and John o' Groats—are identical in both cases, however " incredible " and " easily " disproved they may appear to him.

Mr. Wilson's assumption that a perfect insulator has zero specific inductive capacity, and consequently allows no electrical displacement, is hardly the sort of thing one expects to find in the correspondence columns of THE ELECTRICIAN, and one must not be surprised at any conclusion arrived at by assuming the earth to consist of this wonderful material.

Mr. Wilson's third objection is based on Rowland's experiment, in which he showed that a charged annular ring rotated

at a high speed produced a magnetic field. Mr. Wilson ascribes the magnetic field to the rotation of the electric field, and says that it is " at right angles to the motion and to the electrical force." It would be rather difficult to explain the magnetic field at the centre of the ring on this basis ; what is the direction of the motion or of the electrical force at this point ?

A more striking illustration of the weakness of this explanation is obtained by considering two similar rings side by side, equally but oppositely charged. Placed face to face with a small air-gap they will produce practically no external electric field, but if rotated in opposite directions their magnetic effects will be added. Here we have the magnetic field produced without an electric field, and although it may be quite legitimate from a mathematical point of view to split nothing into two equal and opposite components and assume these to rotate in opposite directions, it is not a procedure which appeals very strongly to one striving after some physical conception of the nature of the phenomenon. In view of the production of the magnetic field without any electric field, I fail to see any justification for assuming that the magnetic field in the ordinary Rowland arrangement is due to the rotation of the electric field. As I have already said, in connection with the bar magnet, " The peculiar condition of the ether which we call the magnetic field is absolutely constant in direction and magnitude at every point and it seems impossible to attach any definite meaning to the question as to whether this peculiar condition of the ether is rotating or not," and I quite agree with Mr. Wilson that " the same argument in the same words might be applied to the electrical field in the neighbourhood of a charged annular conductor."

In my opinion, a modification analogous to that suggested here for Rowland's experiment could be applied to a rotating bar magnet, by rotating around it in the opposite direction a hollow cylindrical bar magnet of equal but opposite polarity, the solid magnet fitting inside the hollow one with a narrow annular air-gap. There would be no external magnetic field, but the electrical field would be twice as strong, assuming that the speed of rotation of the outer magnet were equal to that of the inner. I see the cause of this external electric field in the charges accumulated on the magnets due to their movement through their own fields, whereas on the other hypothesis it is due to the opposite rotation of the two equal and opposite fictitious magnetic fields, which may be supposed to exist simultaneously in this or in any other non-magnetised space.

I must apologise for the length of this and of my preceding letter, but I hope that I have thereby made it clear that the examples brought forward by your correspondents have only served to confirm my view that we are only justified in applying the idea of motion to a want of uniformity in magnetic and electric fields and not to the fields themselves.—I am, &c.,

South Kensington, Nov. 30. G. W. O. HOWE.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS : I am sorry to find that my criticism of Prof. Howe's article does not appear to him to carry much weight. Let me say in the first place that Prof. Howe has misunderstood my objection to " the two entirely different physical conceptions of one and the same phenomenon." He apparently thinks I was referring to his conception and mine. This was not so. What I was objecting to was his own two entirely different conceptions of the cause of the phenomenon, in the one case when the conductor moves, and in the other when the magnetic field changes. I was maintaining, and still maintain, that there is one and the same cause in both cases—namely, the relative motion between the conductor and the magnetic field.

Prof. Howe rejects entirely the idea of the motion of a magnetic field as a whole, and maintains that it is only the " want of uniformity " which moves ; this, of course, is quite a different matter. Prof. Howe is very emphatic in rejecting this idea, and even suggests that Mr. Maccall and myself " wish to endow the field with a new characteristic—viz., velocity." On this point let me call Prof. Howe's attention to the following passage, which occurs in Art. 276 of the fourth edition of Sir J. J. Thomson's " Elements of Electricity and Magnetism," published in 1909. Referring to the motion of a charged sphere, Sir J. J. Thomson says : " As the sphere moves the magnetic force at P changes, so that, in addition to the electrostatic forces, there will be forces due to electromagnetic induction ; these will be proportional to the intensity of the magnetic induction multiplied *by the velocity of the lines of magnetic induction.*" (The italics are mine.) Apparently, then, an authority like Sir J. J. Thomson was using this *new* characteristic of a magnetic field for purposes of calculation some six years ago !

Prof. Howe still further emphasises his inability to form a conception of the motion of a magnetic field when he says, " What do they mean by saying that it is rotating ? To me it has no meaning, unless the field be not uniform, but consists of discrete lines of force with gaps in between, so that any line may be earmarked and its movements traced. In our present ignorance of the fundamental nature of the phenomenon, this seems to be an unnecessary and undesirable complication to introduce." May I ask Prof. Howe if a statement that water is rotating in a bucket has a meaning for him only because he knows that water is composed of *discrete molecules with gaps in between* ?

Although our ignorance of the nature of an electric field is no less than that of a magnetic field, Prof. Howe proceeds in the very next paragraph to *earmark* loops of electric force, and to *trace their movements* from what he conceives to be their place of origin—namely, certain more or less indefinite lines round the pole-tips—up to their arrival at the coil, where they constitute, he contends, the induced E.M.F. Again, if the coil, instead of being at rest in the air-gap, be supposed to move with the poles, Prof. Howe's loops of electric force would still act on it, thus producing an E.M.F. ! Needless to say this is contrary to all experience, so that Prof. Howe's interpretation of Maxwell's theory cannot be a correct one. But whoever heard of closed loops of electric force ? I have always understood that the lines or tubes of an electric field must have their origin on positive charges and their ends on negative ones. Prof. Howe is certainly endowing the *electric* field with a *new characteristic !* A force which can act on electric charges is not necessarily an electric one in the sense of being an electric field—witness the mechanical force on a conductor carrying current in a steady magnetic field where, even from Prof. Howe's point of view, there can be no electric field. Even were Prof. Howe's explanation open to no other objection, there would still be this one : that if the coil and not the poles be supposed to move, he then has to move the seat of the induced electric force to the conductor itself. His physical conception of the induced electric force is in this case quite different from that when the poles move. I certainly object to introducing what seems to me to be *quite an unnecessary and undesirable complication.* Prof. Howe would possibly invoke still a third explanation of the mechanical force brought into play by the interaction of the magnetic field and the induced current.

On my view, we have one and the same conception for the induction of electric force both with moving coil or moving poles, and also for the cause of the mechanical force produced. This cause, I maintain, is the *relative* motion of the magnetic field and the electricity in the coil, whether it be the coil that moves, or the field that moves, or only the electricity in the coil.

If the coil move to the left, the relative motion of the field to coil is to the right, and the induced force on the electricity in the coil is perpendicular to the plane of the paper—*i.e.*, along the conductor—and the motion of this electricity relatively to the magnetic field induces, according to the same fundamental law, another force which acts on it in the plane of the paper at right angles both to the magnetic field and the direction of the current. Since the charged particles constituting the current are, however, confined to the conductor by internal forces this force shows itself, not as an E.M.F., but as a mechanical force on the conductor. If now the coil is at rest and the poles move to the right, the magnetic field does, I contend, move

with them, thus producing the same relative motion as before with exactly the same effects.

Want of space alone prevents me from showing that the results obtained from this point of view are not only qualitatively, but also quantitatively, in accordance with observation.

Prof. Howe makes some sarcastic remarks *re* the closing paragraph of my last letter. As a result of doing something for which he sees no justification, I am, according to Prof. Howe, able to agree substantially with his point of view. What a comment on Prof. Howe's point of view! Prof. Howe does not trouble to enlighten me as to how and why my description of what constituted the circuit was incorrect. In default of such enlightenment, I am afraid I am still of the opinion that the case described was one in which there was cutting of lines by a circuit, but no change of flux through it.—I am, &c.,

E. A. BIEDERMANN.

Bedford, Dec. 6.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Prof. Howe in his letter on the above subject published on the 3rd inst. has unintentionally misrepresented my position.

My letter published on the 12th ult. did not attempt to prove that the field of a magnet rotates with it, nor even to discuss whether any physical meaning can be given to the phrase "the rotation of a symmetrical field." What my letter did was, firstly, to point out that all the experiments could be explained equally well on the suppositions that the field does rotate with the magnet (or solenoid) and that the E.M.F. is due to the cutting of lines of force. Prof. Howe agrees with this statement in his letter, but I do not think that this was apparent in his original article.

Secondly, I expressed the opinion that it is difficult (if not impossible) to devise a test to differentiate between the two points of view. Here again Prof. Howe agrees with me. I will not now attempt to discuss Mr. Wilson's arguments (published on the 26th ult.), as no doubt Prof. Howe is about to do so.

My main object in writing to you again is not, however, to state my own views, but to make a suggestion—viz., that if, as appears to be the case, there is general agreement that either point of view leads to correct results, both be retained. Then whichever happens to be more convenient for any particular problem can be applied. In difficult cases both should be used, and if they appear to lead to different results further consideration should show that the discrepancy is not a real one. If a real discrepancy is found the case can be tried experimentally, and the faulty theory rejected. But till this has been done it appears to me advisable as well as convenient to keep both possibilities in mind.—I am, &c.,

Sunderland, Dec. 6. W. TOLMÉ MACCALL.

SUBMARINE CABLE RAPID TELEGRAPHY.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: In your issue of December 3, 1915, in the abstract of the Paper on "Cable Telegraphy, &c.," presented at the recent Panama Pacific Convention of the American Institute of Electrical Engineers, Mr. Béla Gáti refers to a Paper* by the writer as advocating the use of high-frequency electric waves for rapid cable telegraphy and ocean telephony.

On page 306, Mr. Gáti says: "Mr. George O. Squier, on the ground of actual experiments on telephone cables, believed that with electric waves (high-frequency currents) long-distance telephony, and a more rapid cable telegraphy and ocean telephony will be possible."

I fear that Mr. Gáti has extended the arguments and data given in my Paper to include the case of ocean cables, whereas the Paper in question is confined to the subject of unloaded and preferably open land lines as now used for telephone and telegraph services.

I did not, and do not, advocate the application of so called "high-frequency" electric waves for the case of ocean cables, either for telegraphy or telephony. The lowest frequency employed in the experiments described in my Paper were 23,000 cycles per second, which frequency at present on an ocean cable would deliver waves at the receiving end of the cable of imperceptible magnitude when using any form of receiver yet developed.

The time has come when a more definite meaning should be applied to the words "high frequency" and "low frequency," as applied to alternating currents. On an ocean cable, for instance, a frequency of $n=10$ is at present a very high frequency and corresponds to 300 standard cable letters per minute.

There is no doubt, as Mr. Gáti says in his Paper, that a properly loaded cable would offer many advantages, and will probably be constructed and laid in due course, but in the meantime, are we getting from the existing cables as constructed anything like the capacity they are capable of?

The immediate problem, therefore, seems to be to take things as we find them, and set to work in earnest seeking aid from any quarter, to improve cable engineering practice, and indeed, to add extra circuits to the duplex. In the judgment of the writer these extra circuits will be realised from what might be called "high frequency" alternating currents from the cable view point, but "high frequency" in this case would mean frequencies, say, from two to five times the fundamental letter "*a*" frequency now employed, or, from 20 to 50 cycles per second. In present practice the letter "*h*" is sent with exactly double the frequency used in sending the letter "*a*."

It has been shown recently that by considering the cable as a power line through which we seek to deliver the maximum number of watts, we can, by employing an unbroken single-phase alternating current, completely isolate the cable circuit proper, and permanently connect each end to earth, and impress the signals upon the cable inductively, and receive them in a like manner inductively from the cable.

This fact opens the way directly for inducing other messages on the same cable in similar fashion, separating them at the transmitting end by wide differences of voltage and frequency, and at the receiving end by selective receivers on the same general principles as are now used in wireless telegraphy and telephony.

We are at liberty for the first time, to receive cable messages through that most useful piece of apparatus, the power transformer, with all of its flexibility and resourcefulness. In present practice on long cables, a letter like "*h*" for instance, arrives totally unresolved into its elements, and a letter of this kind, therefore, completely collapses in passing through a transformer.

With an alternating current, however, variable coupling and an adjustable ratio of transformation offers the means to largely control the disturbing impulses which every cable experiences, which correspond to "atmospherics" or "strays" in wireless practice; to correct for shifting zero line, and also to transform the received energy for operating either voltage or current types of instruments. The receiving transformer, it is believed, will be, *inter alia*, universally used in the future development.

On the other hand, we have only to turn to the wireless art to find available for possible adaptation several types of receivers, which respond to a range of energy of a different order of magnitude from those now employed in cable practice.

The moment a *single* frequency can be used for signalling, we are permitted to develop to a high degree in the receiving instruments both the principle of mechanical and of electrical tuning, and of automatic magnification as well, which have contributed so much to the advancements of wireless telegraphy and telephony. The artificial line of the future promises to become a comparatively simple and inexpensive piece of apparatus.

Holding these views, my present object, therefore, is to correct the impression made by Mr. Gáti that I have advocated wireless frequencies for an ocean cable as now constructed. To repeat, I do advocate the use of "cable high frequencies" as defined above, for the creation of extra circuits.

If, for example, the existing Cable Companies should combine to offer a substantial prize to be put into the hands of, say,

* "Multiplex Telephony and Telegraphy by means of Electric Waves Guided by Wires," "Trans." Amer. Inst. Elec. Eng., May, 1911.

the Institution of Electrical Engineers, or the Physical Society of London, to be granted to any person who would add an extra circuit to the cable duplex, I should not be surprised to see it accomplished within six months, due principally to the vast experience gained in developing wireless telegraphy and telephony.—I am, &c.,

London, Dec. 4. GEORGE O. SQUIER.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Your telegraph and telephone readers are indebted to you for the very full abstract of Gáti's Paper on the above subject in the current number and your editorial note on the same. The Paper, though speculative in character, is stimulating and well deserves the space given to it in your columns.

There are one or two points both in your editorial note and in the Paper itself which call for some attention. The disadvantages of shunt loading with respect to earth currents and testing disappear if condensers are inserted between the cable and the shunts, a suggestion previously made by Gáti himself. The introduction of such condensers, however, gives rise to another objection which will be found to be serious or not, according to the method of using the cable. The presence of the inductive shunt with series condenser increases the admittance of the cable from $g+jwc$ (g=leakage conductance, 1/ohms; c=capacity, both for unit length) to $g+jwc+1/R+j(Lw-1/wC)$, where R is the resistance and L the inductance of the shunt, C being the capacity of the series condenser. It is easy to see that for the resonant frequency g is increased very considerably, and the attenuation constant also as a consequence. For frequencies of the order of $5{,}000/2\pi$, R is about 10 ohms and L=1 henry, very nearly.

If it is proposed to telephone in the standard manner, very serious distortion will result in employing inductive shunts; but if a permanent high-frequency current having a frequency of, say, $100{,}000\ 2\pi$ is used as a carrier for superposed speech waves, then it is easy to avoid the resonance frequency. In connection with this last method, Gáti seems to credit Weinberg with its conception, but the method was very definitely proposed by Cornelius Ehret in 1905 (American patent specifications 789,124 and 789,087). It has also been suggested by M. M. Hutin and Le Blanc, 1892-1895.

You say in your note on Gáti that it would be difficult to multiplex a system loaded by inductive shunts. There are two means of multiplexing a two-wire cable: (1) By superposition; (2) by the adoption of two or more "carrier" frequencies. If single-wire cables only are considered, the second is the one possible means of accomplishing the desired result. Such a cable with inductive shunts will have minimum attenuation for one frequency only, but the curve connecting frequency and attenuation shows that there are several frequencies well away from the frequency for maximum g, for which the attenuations are almost equal and not greatly in excess of the minimum. It appears, therefore, that it would be possible to use two "carrier" frequencies sufficiently wide apart to secure good selectivity and yet without either being subject to impracticable attenuation.

Returning to Gáti's Paper, the order of difficulty in modifying the construction of submarine cables submerged to profound depths would seem to be: (1) Pupin coils; (2) Thompson shunts; and (3) the so-called Krarup cable. As Gáti has himself shown, the Krarup cable is not suitable for ocean telephony, but it appears to possess great possibilities for ocean telegraphy. Employing an unbroken series of sine currents and superposing signals on them, as suggested by Squier, or using the detached trains of Gáti, multiple printing telegraphy on Krarup cables of trans-oceanic length is quite within the bounds of possibility. Depending on the precise method of using the alternating current, 180 words per minute—calculated on the five unit or Baudot code—should be possible with a frequency of the order of $750\ 2\pi$. With such a loaded cable, and adopting a carrier frequency, the duplex balance would be a comparatively easy matter, and, indeed, could be dispensed with by using different frequencies at the two ends of the cable.

It must be particularly gratifying to Dr. Thompson to find that, 23 years after his Paper on ocean telephony, the inductive shunt is seriously put forward as the only practicable method by an authoritative writer.—I am, &c.,

London, Dec. 6. H. H. HARRISON.

"ALTERNATING-CURRENT WORK."

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Mr. Maycock has drawn my attention to the review of the above in your issue of 26th ult., and as I had a good deal to do in connection with the book, I may be permitted to make a few remarks.

It would be interesting to know what the reviewer means when he states that the book does not convey "real knowledge." Since the absence of much mathematics has apparently irritated him, it may be presumed that he considers that a person has "real knowledge" only when he can prove mathematically such expressions as $i=E_{max.}(\theta+90°)$ for a capacity circuit, irrespective of whether he understands their physical significance. Now, in Mr. Maycock's book it has been endeavoured to give the reader some more concrete conceptions of alternating-current phenomena, partly by the aid of mechanical and hydraulic analogies, and partly by vector diagrams. In addition there are—though not mentioned by the reviewer—chapters, containing numerous worked examples, devoted to the calculation of current, power-factor, power, &c., in alternating-current circuits, and to the construction and operation of modern alternators, transformers, and motors. Is all this not "real knowledge"?

As regards the reviewer's remarks about the "indispensable commercial engineer," may I refer him to Mr. Sparks' presidential address wherein he states: "It is sometimes suggested that commercial matters should not be dealt with by engineers. . . . I disagree with this view, and believe that the commercial engineer is just as much a recognised member of our profession as a pure scientist." Surely this does not mean that the commercial engineer is necessarily a specialist in either the "theory or the practice" of engineering.

With reference to the comments upon the standard of the A.M.I.E.E. examination, it would be interesting to know whether the answers given were as full as or even expected to be fuller than the treatment in Mr. Maycock's book when we consider some typical examples of the questions set, such as: (*a*) Describe what is meant by an auto-transformer and indicate the currents in the windings of a 100 kw. three-phase star-connected auto-transformer having a ratio of 1,000 to 400 volts. (*b*) Describe the relative advantages and disadvantages of squirrel-cage and slip-ring induction motors.

In conclusion, it may be mentioned that the extensive adoption of Mr. Maycock's books is sufficient evidence that useful text-books, containing only a "little trigonometry," find appreciative readers.—I am, &c.,

Edinburgh, Dec. 4. E. HUGHES.

[Mr. Hughes is mistaken in assuming that absence of mathematics irritated the reviewer. In common with many other books, Mr. Maycock's book contains numerous worked examples as well as chapters on the construction and operation of modern alternators, transformers and motors. Such being the case, the reviewer did not think it necessary to mention this in the review.—EDS. *E.*]

THE INSTITUTION AND ALIEN ENEMY MEMBERS.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Many members of the Institution of Electrical Engineers consider that the Council should be approached with a view to removal from the list of membership those individuals who are alien enemies.

My own opinion is that the members of the Institution should prepare their protest outside the Institution, and if they feel justified present it to the Council. I should be pleased to hear from any members sharing my views, with the object of taking speedy action.—I am, &c.,

London, Dec. 7. W. ELLERD-STYLES.

[We feel that it is preferable to leave a matter of this kind in the hands of the Council.—EDS. *E.*]

PHYSICAL SOCIETY.

At a meeting held on November 26, 1915, at the Imperial College of Science, Dr. A. RUSSELL, M.A., Vice-President, in the Chair, a Paper on

"Obtaining and Maintaining a Bright Hydrogen Spectrum, with Special Reference to the 4,341 Line,"

was read by Mr. J. GUILD, F.R.A.S.

The Paper treats of the conditions of pressure, discharge, &c., most suitable for the production of a bright hydrogen spectrum, such as is required for refractometry and similar purposes. The rapid deterioration of the tubes with use is shown to be caused by a rise of pressure due to the evolution of hydrogen by the electrodes. The trouble may be obviated by sealing an auxiliary bulb of 1½ or 2 litres capacity to the discharge tube. This reduces the rate of pressure variation and prolongs the useful life of the tube nearly a hundredfold. The use of capacity and inductance is shown to be very helpful with partially deteriorated tubes.

Mr. F. E. SMITH asked if the hydrogen could not be expelled from the electrodes before sealing off.

Mr. S. D. CHALMERS said he had had a similar experience with the deterioration of hydrogen tubes. He was surprised that the author found all the lines to be most satisfactory at the same pressure. He had sometimes found it convenient to use different tubes for the C and G′ lines.

Mr. G. H. GARDINER mentioned that when taking some photographs of vacuum tube spectra he had been struck with the rapid deterioration of some of the ultra-violet lines. This had been traced to the formation of a scarcely perceptible deposit on the quartz window due to the scattering of the electrodes, and he thought a similar cause might be sufficient to account for the decay of the violet hydrogen line.

Prof. J. W. NICHOLSON thought the Paper, although written from another point of view, formed a useful contribution to the knowledge of the conditions under which different spectra of the same gas were produced. The hydrogen spectrum was a difficult one to deal with and anything which threw additional light on it was welcome.

Mr. D. OWEN referred to the rapid rise in the heating of the glass near the electrodes at pressures under 1 mm. What happened at still lower pressures? Presumably the rise could not go on indefinitely as, under the conditions of the experiment, the current decreased as the exhaustion progressed.

The AUTHOR, in reply, said he had tried to get rid of the hydrogen occluded in the electrodes before detaching the tube from the pump but without success. His experience that all the lines attained their maximum brightness at the same pressure was borne out by all other observers who had made quantitative observations. A tube which does not show any G′ may still have plenty of C and F on account both of the greater energy of these lines and of their greater visibility, but he could not conceive of a tube having a usuable G′ being deficient in either C or F. It was shown conclusively in the Paper that the deterioration was due to pressure changes. No "imperceptible" deposit could affect lines in the visible spectrum, however effective it might be in the case of those in the ultra-violet. Moreover, no deterioration due to deposits on the glass or to the condition of the capillary would be retarded in the least by the addition of an auxiliary volume.

A Paper on

"The Determination of the Coefficient of Diffusion of Potassium Chloride by an Analytical Method,"

by A. GRIFFITHS, J. M. DICKSON and C. H. GRIFFITHS, was read by Dr. GRIFFITHS.

This Paper represents an attempt to develop an analytical method of determining the coefficient of diffusion of a salt in water capable of giving consistent and accurate results. The lower ends of a number of vertical and parallel diffusion tubes end in a reservoir of large capacity containing a solution of potassium chloride. The greater part of the reservoir is above the lower ends of the tubes, and by gravity the solution at the lower ends is kept at an approximately constant concentration. The upper ends of the tubes are covered with a cap provided with an outlet and an inlet tube. Water enters the cap by the inlet tube, and a weak solution containing the diffused salt leaves the cap by the outlet tube. Time, which may be as long as a fortnight, is allowed for the attainment of the steady state, and an individual experiment may last six weeks. The quantity diffused is obtained by chemical analysis. In the case of a solution containing 0·2237 gramme of potassium chloride to the cubic centimetre (a 3N solution) the "mean diffusivity" with respect to water is $1{\cdot}703 \times 10^{-5}$ (C.G.S. units) at a temperature of 18·5°C.

Mr. B. W. CLACK said that the difference of 10 per cent. between the Author's results and those obtained by him was not nearly so great as the discrepancies between the results of other workers on similar solutions. He showed slides containing the tabulated results of other observers for solutions of KCl and NaCl. These differed from one another by 20 to 30 per cent. He believed Dr. Griffiths had had some difficulty at first in the analysis of the dilute solutions. The method by which he had overcome this was, he thought, noteworthy.

Dr. S. W. J. SMITH said he was interested in diffusion from the point of view of electrolytic phenomena. The way in which the diffusion depends on the concentration for different salts had an important bearing on the electrolytic behaviour of dilute solutions.

Dr. T. BARRATT asked if variations of temperature might not account for the discrepancy between the authors' results and those of Mr. Clack. The temperature coefficient appeared to be about 7 per cent. for 1°C. Was it certain that in both methods the temperature was maintained constant to within this amount for the periods of six weeks or so mentioned for an enperiment? There was another effect of temperature variations. Any expansion of the solution in the reservoir had to take place through the diffusion tubes and this would affect the results very seriously.

Dr. GRIFFITHS, replying for the authors, said that the temperature had been kept constant to within 0·5°C. He had gone into all the possible errors due to temperature variations and they were not comparable with the 10 per cent. question. His convective method gave results about 4 per cent. lower than the analytical method.

An Apparatus for Evaluting Elliptic Integrals

was exhibited by Mr. A. F. RAVENSHEAR.

The apparatus produces by mechanical means a graph of the integral in rectangular co-ordinates. The graph is made by a hatchet scriber which is controlled as regards direction, but is otherwise free to move anywhere over the surface of the paper. Taking the third integral as an example

$$y = \int \frac{1}{(1+a\sin^2\theta)\sqrt{1-c^2\sin^2\theta}}\, d\theta.$$

The apparatus comprises (1) the scribing appliance; (2) a mechanism which evaluates $\sqrt{1-c^2\sin^2\theta}$, where θ is the value of the abscissa of the middle point of the hatchet; (3) a mechanism which determines a length equal to the product $(1+a\sin^2\theta)\sqrt{1-c^2\sin^2\theta}$; and (5), a director which is variably inclined to the axis of X so that the tangent of its inclination is negative and equal to the above-mentioned product. By a parallel linkage, a line in the hatchet plate at right angles to the hatchet is kept parallel to the director, so that the hatchet has an inclination φ to the axis of X such that

$$\tan\varphi = \frac{1}{(1+a\sin^2\theta)\sqrt{1-c^2\sin^2\theta}}.$$

Since the hatchet is always tangent to the graph which it describes, $dy/dx = \tan\varphi$, whence

$$y = \int \frac{1}{(1+a\sin^2\theta)\sqrt{1-c^2\sin^2\theta}}\, d\theta.$$

By suitable adjustments the apparatus deals in a similar way with the first and second integrals.

Dr. A. RUSSELL thought the instrument was very ingenious and likely to be of the greatest utility. The third elliptic integral was of frequent occurrence in electrical engineering and in hydrodynamics and an apparatus for its easy evaluation would be welcomed by many.

PARLIAMENTARY INTELLIGENCE.

FINANCE (No. 3) BILL.

The consideration of this Bill on the Report stage was concluded by the House of Commons on Tuesday, when certain additional amendments were adopted.

On the motion of the CHANCELLOR OF THE EXCHEQUER, an amended form of the sub-section to Clause 29 (provisions with respect to the charge of income tax on non-residents) was agreed to. The effect of the sub-section is to exclude all agency transactions, except such as come within the existing law. He said the Government had no desire to press the law in a way which would be injurious to British trade, and equally they had no desire that any person should escape taxation who the House thought should be liable under sub-sec. 3 of clause 29 of the Bill.

On clause 33 (relating to the computation of profits and gains in relation to excess profits duty), Mr. MONTAGU stated that under no circumstances whatever could income tax be chargeable in this year, and under this Finance Act, on the profits of a munition-controlled establishment. The Government would take steps to prevent controlled firms having to pay income tax on the excess profits taken by the Exchequer.

Sir A. MOND moved an amendment to enable the postponement or suspension of expenditure on advertisements as a consequence of the war to be taken into account by the Commissioners of Inland Revenue as a special circumstance calling for consideration in the computation of profits. He urged that in the case of firms which were in the habit of advertising largely, the suspension of that expenditure during the war should be regarded as analogous to suspension of expenditure upon the renewal or repair of plant, to which consideration was given in the clause.

Mr. MONTAGU said he imagined that when a firm suspended its expenditure on advertisements that suspension was reflected in its profits, and therefore that was not a good case in which to claim special treatment. When such a firm began advertising again after the war he assumed that the effect of its advertisements upon its business would very soon be

seen. The case, therefore, did not seem comparable with the other cases dealt with, and the amendment was negatived.

The House agreed to an amendment treating as a "special circumstance" under clause 38 "the necessity in connection with the present war of providing plant which will not be wanted for the purposes of the trade or business after the termination of the war."

Mr. MONTAGU then announced the names of the Board of Referees to hear appeals against the excess profits tax, as follows :—

Mr. Duke, K.C., M.P. (Chairman), Lord Faber, Mr. Albert Illingworth, M.P., Sir Clarendon Hyde, Sir C. B. Renshaw, Messrs. A. F. Pease, J. H. Tritton, Leif Jones, M.P., F. W. Gibbons, J. E. Fottrell and Alex. Cooke; with the following accountants: Sir Wm. B. Peat, and Messrs. H. W. Kirby, A. O. Miles, R. H. March, W. H. Cook, J. G. Fowler, C. Hewetson Nelson and W. T. Walton. The following merchants and traders were added: Sir Jeremiah Colman; Messrs. C. D. Morton, Howard Williams, W. Penrose-Green, L. F. Massey, Walter Tyzack, J. A. Jones and A. W. Faire.

He thought those names would give confidence to those engaged in the trade and commerce of the country. The list was not necessarily complete, and there was nothing in the Bill to prevent additions on the suggestion either of the Chancellor of the Exchequer or the Board of Referees themselves when they got to work.

On the fourth schedule dealing with the computation of profits the House accepted an amendment providing that where account is taking of any income received from investments any variation in value of any investment which appeared to the Commissioners of Inland Revenue not to be due to variation of profits should also be taken into account.

LEGAL INTELLIGENCE.

Prize Court Cases.

On the 2nd inst. Sir Samuel Evans had before him a suit by the Crown, brought under the Reprisals Order in Council of March 11, 1915, in connection with a quantity of merchandise, including some electrical goods, seized on board the Danish steamship "Cathay."

Mr. D. STEPHENS (for the Crown), in moving for an order for the sale of the goods and payment of the proceeds into Court, or for an order for their detention, said that the "Cathay," having loaded a cargo left Copenhagen on March 26, 1915, proceeded to Gothenburg and Christiana, where she completed her loading, and she arrived at North Shields for timber on April 13. As she had on board goods of German origin, these were seized as coming within Article 4 of the Reprisals Order. He urged that it was not sufficient merely to show by certificate that goods of German origin arrived in a neutral country before March 1, but that proof was required from claimants that the goods were the subject of a bona fide contract, and were either paid for by the neutral before March 1, or contracted for upon such terms that the neutral purchaser was liable for payment, and that such payment in the enemy country could be legally enforced, whether the goods were delivered to the neutral in his own country or not. It was desirable that the goods should be cleared and sold as soon as possible, as the port was very congested.

Mr. C. R. DUNLOP (for the Peking Electric Co. (Ltd.), amongst other claimants) said that that company claimed to be the owners of goods comprising 37 cases of machinery and 21 cases of insulating material, which were intended for the public works of the company. The claim was supported by a statutory declaration, dated May 8, 1915, from which it appeared that the goods were ordered before the outbreak of war on May 9, 1914. The cost was £3,300, and payments on account, amounting to a total of about half that amount, were made on July 4 and 18, 1915, by claimants. The Procurator-General had had a copy of that declaration.

Mr. STEPHENS: We have not had a copy, and it has not been filed.

Mr. DUNLOP said the declaration was made by Mr. Edgar P. Allen, an American subject, who described himself as chairman of the claimant company. He stated that the goods were ordered by the company, the board of directors of which consisted of three Germans, one Chinaman, one Swiss (under French protection) and himself.

The PRESIDENT: Mr. Allen does not give his address. Where is he to be found supposing I made an order for costs against him?

Mr. DUNLOP: I don't know, my lord. The declaration is signed on May 8, 1915, before the British Consul-General at Tientsin, and I suppose he lives somewhere in that neighbourhood. The document goes on to say that the goods were ordered through the company's agents (Messrs. Arnhold, Karberg & Co., of Tientsin), and the order went forward in May, 1914, payments being made to the amount of nearly half the total cost in July last. The declaration stated that the Peking Electric Co. operated the sole electric lighting plant in the Legation quarter of Peking, and the machinery so ordered was ordered for an extension of premises, and were urgently needed in order to ensure a full and efficient service during the coming winter. The company was limited by shares registered under the Companies' Ordinances, Hong Kong. Of the shares issued, 464 were held by Chinese, 525 by Swiss (under French protection), 60 by British, 60 by Americans and 763 by Germans. Other documents included the bill of lading, and showed that the goods were shipped at Copenhagen on board the "Cathay," bound for Shanghai via the Suez Canal, the goods to be delivered to Shu Hung Chien, to be forwarded by him. The documents also included detailed specifications.

The PRESIDENT: The payments were made after the seizure?

Mr. DUNLOP: Yes, my lord. Prima facie, the property passes. I contend, when the goods are made and appropriated to contract. The goods had to be manufactured, and then they were sent by lighter to Copenhagen, where they arrived before the date of the Order in Council, as he believed. The documents were submitted to the Procurator-General, who on Nov. 13 asked for further documents, correspondence, &c., but these had not yet been obtained from China. If those documents were considered material to the case he would have to ask for an adjournment. The goods ought not to be sold at this stage for two reasons. The first was that there had been no defiance of the Order in Council, the goods having been actually ordered before the war. Secondly, claimants ought to be given an opportunity of proving their title to the goods. To order a sale now would be to destroy the value of the goods, because they were manufactured for a particular purpose for which they were required in Peking. The goods were not perishable, and to order their sale without giving the neutral claimants an opportunity of proving their case would be to deprive them of their right of having the goods released to them. Therefore, he asked that the goods should be detained until the claimants had had a further opportunity of affording the necessary proof.

The PRESIDENT: Is there any objection to that?

Mr. STEPHENS: That is what the Procurator-General asked for.

The PRESIDENT: Then there is no difference between you. I order the goods to be detained only.

Another consignment dealt with was one from the Siemens-Schuckert Co. in Berlin to the Siemens firm in China. Mr. Dunlop said the goods consisted of 10 cases of electrical lighting apparatus, and declarations had been made that the articles were shipped at Copenhagen for a neutral firm—the San Kien Lighting Co.

The President made an order for sale.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

20,319 SHEPHARD & MCKECHNIE. Line or wireless telegraph systems.
Selecting apparatus for use in line or wireless telegraph systems, wherein means are provided whereby the relatively long spaces between the characters representing the letters or words of the code are differentiated from the short spaces between the dots and dashes constituting the characters of the code.

21,792 LINCOLN. Electric meters of the thermal type. (5/11/13.)

22,004 W. R. SYKES' INTERLOCKING SIGNAL CO. & SYKES. Means for automatically arresting railway trains provided with automatic brakes.

22,554 BRITISH INSULATED & HELSBY CABLES (LTD.), FULLER & HARRISON. Art of duplex telephony.
Consists in simultaneously loading the physical and phantom circuits by means of a single coil without the production of a stray field.

22,887 GREENWOOD. Telephone receivers.

23,071 HOLDEN. Electric measuring instruments of the moving-coil type.

23,357 MIDGLEY & VANDERVELL. Electric starters, more particularly for use on motor cars and the like.

23,544 B.T.-H. Co. (G.E. Co.) Electromagnetic switches.

24,697 SUNDERLAND FORGE & ENGINEERING CO. & REED. Electric connection boxes.

1915 SPECIFICATIONS.

757 PARKER. Wire joiner, for the purpose of connecting or joining telegraph or other wires.

937 BOOTH & MILLER. Electric light prepayment apparatus.

1,689 RICCI & RICCI. Portable electric head lamps.

1,818 FRANCIS BARKER & SON (LTD.) & BARKER. Magnetic compasses.

4,079 ROUTIN. Means for collectively actuating and controlling alternating-current motors. (Patent of addition not granted.)
Consists in the combination of a plurality of alternating-current commutator motors, the rotor of each having a plurality of slip-rings severally connected to different points of its winding, and the slip-rings of the several rotors being connected to each other in pairs, and the stator of each motor having two coils, one arranged so as to neutralise self-induction of the armature, and the other not in series with the rotor winding, fed at constant pressure and with a suitable phase difference with respect to the voltage supplied to the rotor.

5,865 ROBERT BOSCH (Firm of). Means for starting internal-combustion engines, (17/5/14.)

9,682 OESTERREICHISCHE DAIMLER-MOTOREN AKT.-GES. Electrically-operated change-speed gear. (14/7/14.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 5, 1915.

15,595 MANSELL & WALKER. Construction of dynamos and electro-motors.

15,633 B.T.-H. Co. (G.E. Co., U.S.) Protective devices for electric circuits.

15,635 W. & T. AVERY & GIBBS. Instrument for ascertaining the tensional stress of flexible members.

15,642 FARMER. Screening or deflecting rays of light emanating from lamps of various kinds.

15,652 [illegible] Switchboards.

15,663 LEWIS. [illegible]-photometers.

November 6, 1915.

15,681 RAILWAY & GARAGE [illegible] Operating rotary converters and other alternating-current [illegible] (Application to 1/11/13.)

15,685 LANDIS & GYR AKT.-GES. Electric heating device. (9/11/14, Switzerland.)*

15,695 B.T.-H. Co. (G.E. Co., U.S.) Method of making vitreous bodies.

15,697 FAIRWEATHER. (Singer Mfg. Co., U.S.) Power transmitters.

15,713 ROBERTS. Relays.

15,715 KIMBALL. Systems of power transmission.

November 8, 1915.

15,737 HARRIS & SMITH. Semi-obscured reflecting electric incandescent lamp.

15,740 CARTER. [illegible] overhead tram trolley.

15,750 IMRAY. [illegible] of Chemical Industry in Basle, Switzerland.) Process for electrolytically reducing or oxidising organic substances.*

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	361	Zepp Proof Motors. Illus.	72
Imports and Exports of Electrical Manufactures	362	New Lists	72
Educational Notes	362	Telegraph and Telephone Notes	365
Business Notices	362	Empire Notes	365
Liquidations, &c.	362	Miscellaneous Notes	365
Electricity Supply	362	Tenders Invited	366
Lighting and Power Notes	364	Tenders Received & Accepted	367
Traction Notes	364	Companies' Meetings and Reports	367
The Round Table	65	City Notes	367
Park Royal Engineering Works. Illustrated	66	Electrical Companies' Share List	367
The "Migas" Detector. Illus.	70		

COMMERCIAL TOPICS.

The Coal Supply. The Board of Trade have issued an important notice in regard to the supply of coal. The Board call attention to the probability that, owing to the increasing consumption of coal in the industrial areas, and the reduced output from the mines due to the enlistment of miners, it will become necessry for many industrial consumers to draw their supplies to some extent from districts other than those on which they have been accustomed to rely. In order to obtain a regular and uninterrupted flow of coal, it is recommended that industrial consumers should, wherever possible, contract for their requirements, and not trust to the open market. Colliery owners on their part will, it is hoped, assist by making contracts for as much of their output as they can feel reasonably sure of maintaining. In view of the situation it may be necessary for the Coal Exports Committee from time to time to restrict further the recommendation of licences in the case of coals in general demand for home consumption.

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New Parliamentary Schemes. The restrictions upon the issue of new loans has had the effect of reducing the number of new schemes for public works to quite modest dimensions, for the total number of plans of bills deposited is only 15, compared with 158 for the past session. There are two railway bills, against four last year; tramways none, against 10; miscellaneous five, against 35; provisional orders nine, against 109. Though there is no new tramway scheme, the Metropolitan Electric Tramways (Ltd.) is seeking an extension of time for the exercise of powers acquired in 1911, 1913 and 1915. Private promoters also seek to construct light railways in Lostock, Manchester, having junctions with the Trafford Park lines and with West Manchester light railway at Davyhulme. Modifications of the authorised Dearne District (W. Riding) Light Railways are also sought, including the construction of about 1⅝ miles of new tramway at Wath-upon-Dearne and Bolton-upon-Dearne, but two short lines sanctioned in 1915 are to be abandoned. Only one electric lighting order has been applied for—viz., by the Church Stretton Electric Supply Co. for Church Stretton. Though there is little new work proposed, it must be remembered that the acts and provisional orders of the past two or three years were sufficiently numerous to keep manufacturers and contractors busy for a long time after the declaration of peace. It might, perhaps, be mentioned that this year there are a number of gas bills, in which financial and other powers are asked for. In many of these bills authority is sought to prescribe a minimum charge for gas laid on to premises having a supply of electricity. If such a power be conferred upon gas companies, there can be no reason why it should not be extended to electric supply undertakers, though it is not likely to be asked for except in small towns and isolated places incapable of maintaining rival lighting companies. Attempts to check progress and to avoid the effects of economic laws are not successful for long, and our gas friends will find out in due course that their desire to establish a species of preferential charging will not stop the progress of electricity supply or stave off the evil day.

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Allowances to Employes Serving with the Colours. On more than one occasion recently we have called attention to the risk of surcharge run by local authorities who make excessive allowances to employés who have joined H.M. Forces. It is now reported that the L.G. Board district auditor has surcharged the members of Camberwell (London) Borough Council £900 in respect of payments to workmen and officials who are serving with the colours. The auditor states that in most of the cases the money paid by the Council, when added to the Government payments, doubled the sums available for the maintenance of the men's families.

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Canadian Hydro-Electrics. Some interesting facts relating to the uses of electrical energy, as supplied by the Hydro-Electric Power Commission of Canada are given in another column. The details, such as they are, have been given to the "Electrical World" by Sir Adam Beck, the chairman of the Commission. In particular they show how rapid has been the progress in the use of the electrical energy generated by the original plant of the Ontario Power Company at Niagara Falls. With this company the Commission entered into a 30-years contract for the supply of 100,000 H.P., but it has been found necessary, owing to the growth of the demand, to make provision in the shape of additional plant for a prospective peak load of 300,000 H.P. It is significant that the Commission has found it necessary to arrange for other sources of supply than that of the plant at Niagara, and has itself a number of smaller stations in service and connected up with the system.

We have always pointed out that it is difficult to compare the methods and progress of electrical undertakings "on the other side" with those which obtain in this country; at the same time there is a tendency to centralise generating plant and distribute energy to small townships on the grand scale which is worthy of note in this country. We hear, at times, from visitors on their return from Canada and the United States, that the standard of reliability of supply in those countries is not as high as it is in Europe, nor is it aimed at by the supply authorities. On the other hand, schemes of this nature are of value, in that they are able to prove that wide areas of industrial and commercial territory can be furnished with electrical energy at low rates, and on a basis which will yield a profitable return to the undertakers. The Commission set out with the plan of public ownership in mind, and prides itself upon the fact that it has succeeded in its ideal. No less than 130 municipalities are at present "authorised distributors" of its hydro-electric energy, and they are enabled to charge rates which encourage practically every class of consumer to use the service for lighting, heating, cooking and power purposes. The work being done in the supply of power in the farming districts is of great interest, and might well be made the subject of a special report on the part of our own Minister of Agriculture. Failing that, the Commission itself might be persuaded to issue a complete account of the progress made in this direction, together with technical data regarding the class of motors used, the kind of machinery driven, and the results obtained with certain energy consumption over a period of 12 months. Information is also needed upon the plan resorted to for the supply of motors and installation material to farmers and agriculturists generally, who cannot lay out capital upon purchase outright. There must be in vogue some method of hire-purchase, or other deferred payment arrangement, whereby the smaller men are enabled to become consumers; because, although the charges for energy are low, considerable financial outlay is required before a consumer can take advantage of them. We do not know to what extent the work of the Commission has been influenced by the war, but we hope that its efforts on behalf of cheap domestic and industrial electricity supply over vast areas of country will not be seriously hampered. We need experience in this region of power service, and the future will prove that the detached position of the Canadian Dominion from the European War will furnish results which we ourselves shall take advantage of in times of peace.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Nov. 29, 1915, *to* Dec. 4, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. carbons, 13 pkgs.; unenumerated, 12 pkgs.
LIVERPOOL. *France:* Electrodes, 31 pkgs.
LONDON.—*U.S.A.;* Elec. machinery, £2,167; carbon candles, £70; elec. lamps, £1,973; telephone materials, £187; lamp parts, £81; wire and cable, £10; unenumerated, £2,902—13 pkgs. *Holland:* Elec. lamps, £3,514—302 pkgs.; carbon candles, £90; wire and cable, £924; lamp parts, £346; unenumerated, £265. *France:* carbon candles, £115; unenumerated, £43. *Denmark:* Elec. machinery, £120. *Sweden:* Elec. lamps, £310. *Norway:* Elec. machinery, £16; telephone materials, £54. *Spain:* Elec. carbons, 50 pkgs. *Canada:* Elec. meters, 13 pkgs. *Switzerland:* Carbon candles, £500; unenumerated, £60.
SOUTHAMPTON.—*France:* Unenumerated, 31 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £318. *Melbourne:* Elec. machinery, £761; wire and cable, £3,326; unenumerated, £87. *Sydney:* Elec. machinery, £238; wire and cable, £23; telegraph material, £43; unenumerated, £33. *Wellington:* Elec. machinery, £487; wire and cable, £1,622; unenumerated, £263. *Brisbane:* Wire and cable, £45; telegraph material, £38; unenumerated, £1,858. *Dunedin:* Unenumerated, £107. *Lyttelton:* Wire and cable, £43; unenumerated, £187. *Adelaide:* Unenumerated, £147. *Freemantle:* Unenumerated, £17. *Perth:* Elec. machinery, £256; unenumerated, £36. *Christchurch:* Unenumerated, £76. *Townsville:* Wire and cable, £113. *Invercargill:* Unenumerated, £10.
AFRICA.—*Durban:* Elec. machinery, £594; wire and cable, £622; unenumerated, £376. *Port Elizabeth:* Wire and cable, £716; unenumerated, £76. *Cape Town:* Elec. machinery, £430; wire and cable, £55; telegraph material, £33; unenumerated, £257. *East London:* Elec. machinery, £173; unenumerated, £58. *Beira:* Unenumerated, £10. *Moji:* Unenumerated, £39. *Zanzibar:* Unenumerated, £12.
EGYPT.—*Aden:* Unenumerated, £16.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £184; unenumerated, £56. *Santos:* Unenumerated, £52. *Colvy:* Unenumerated, £201. *Rio de Janeiro:* Unenumerated, £88. *Panamas:* Unenumerated, £290.
U.S.A.—*New York:* Unenumerated, £57. *Boston:* Unenumerated, £17.
CANADA.—*Montreal:* Unenumerated, £42. *St. John's:* Unenumerated, £96.
HOLLAND.—*Amsterdam:* Wire and cable, £1,217; unenumerated, £2,891. *Rotterdam:* Wire and cable, £861.
PORTUGAL.—*Lisbon:* Unenumerated, £11.
SPAIN.—*Barcelona:* Elec. wire, £80; unenumerated, £161.
NORWAY.—*Christiana:* Unenumerated, £407.
DENMARK.—*Copenhagen:* Unenumerated, £100.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Unenumerated, £247. *Calcutta:* Wire and cable, £2,232; unenumerated, £307. *Madras:* Wire and cable, £515; unenumerated, £100. *Singapore:* Unenumerated, £117. *Penang:* Unenumerated, £300. *Karachi:* Wire and cable, £14; elec. machinery, £47; unenumerated, £15. *Ceylon:* Unenumerated, £170. *Kilindini:* Elec. machinery, £53; unenumerated, £15.
CHINA.—*Shanghai:* Unenumerated, £414. *Hongkong:* Elec. machinery, £433; unenumerated, £10.
JAPAN.—*Yokohama:* Unenumerated, £141.
JAVA.—*Sourabaya:* Unenumerated, £280.
WEST INDIES.—*Jamaica:* Unenumerated, £21.
MAURITIUS.—Telegraph material, £58; unenumerated, £31.
GIBRALTAR.—Elec. machinery, 14 tons; telegraph material, £130.
FRANCE.—*Dieppe:* Unenumerated, £135. *Paris:* Unenumerated, £17. *Dunkirk:* Unenumerated, £280. *Calais:* Unenumerated, £200. *Havre:* Unenumerated, £97. *Rouen:* Unenumerated, £670. *Boulogne:* Unenumerated, £301.

FOREIGN GOODS (duty paid and free).

Durban: Unenumerated, £370. *New York:* Unenumerated, £20. *Port Elizabeth:* Unenumerated, £115. *Harve:* Elec. motor, £67. *East London:* Unenumerated, £104. *Rotterdam:* Unenumerated, £487. *Brisbane:* Unenumerated, £58. *Calais:* Unenumerated, £30. *Cape Town:* Unenumerated, £132. *Ceylon:* Unenumerated, £29. *Nantes:* Unenumerated £18. *Wellington:* Unenumerated £315.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL NOTES.

University of Oxford.—It has been decided to suspend all university scholarships and prizes which would be opened to competition after May 1 next. The income and scholarships and prizes will be transferred to the general fund during the emergency period, by which the university will gain £1,841 in 1916 and £3,717 in 1917.

Imperial College of Science and Technology.—A list of students (past and present) and staff who have joined H.M. Forces has been issued.

The list is incomplete, and the Registrar will be pleased to receive information to enable him to correct and amplify it. Up to May 27 1,185 had joined, including 715 officers and 470 men. 23 have been killed and 17 wounded.

BUSINESS NOTICES.

The head office of the Etandem Company is now situated at Fallings Park Works, Wolverhampton.

Mr. W. J. Fahn has (we are informed) now ceased to take an active part in the conduct of the business of the Company, and Mr. Walter Howcroft has resigned his offices of managing director and secretary. All orders given on behalf of the Company will be signed by the Secretary, Mr. Peter Smith.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at Holy Trinity Schools, Beresford-street, near the Royal Arsenal, Woolwich, on Thursday, 16th inst. (by order of the Secretary of State for War), at 11 a.m. some unserviceable and obsolete stores, including quantities of iron and steel scrap, capro-nickel, lead, antimony and tin alloy, electric cable, &c. Lots may be viewed on Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues from Armament-buildings, Whitehall-place and Imperial House, Tothill-street, Westminster, S.W., Ordnance Office, Tower, and Ordnance Office, Royal Arsenal, Woolwich. *See an advertisement.*

Business for Sale.—The patents and stock of Checkogram (1908), Ltd., are advertised for sale in another column. Particulars from the liquidator, 150, Oxford-street, London, W.

Patent Development.—The proprietor of patent No. 29,240/1909, relating to an "Improved storage battery for portable lamps," is prepared to sell the patent or to grant licences thereunder. Applications to Messrs. Boult, Wade & Tennant, patent agents, 111 and 112, Hatton-garden, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of the Felgate Installation Co. (Ltd.) will be held at 51, Market-place, Reading, on Jan. 8.

A supplementary dividend (1¾d.) will be payable on Dec. 17 at 27, Brazennose-street, Manchester, to creditors of Joseph Swainson, electrical contractor, 22, Booth-street, Manchester.

Winding-up Petition.—A petition for winding up Maxim Lamp Works (Ltd.) has been presented by A. Hurst & Co., and will be heard by Mr. Justice Astbury on Dec. 14.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Electricity Committee recommend the Corporation to approve a scheme prepared by the city electrical engineer (Mr. J. A. Bell) for the extension of the electric supply works at an estimated cost of £21,175.

In his report Mr. Bell states that the installation of further modern plant, even at its present enhanced price, could be shown to be a very paying proposition from a costs point of view, especially with coal and material at their present prices. He recognises that capital expenditure must at present be reduced to a minimum, and the reduction of costs has had no influence upon him in making his recommendations. In his judgment, the continuity of supply would be endangered unless plant were installed. Each month since the opening of war the output of the department had risen, notwithstanding the curtailment of public and private lighting, amounting to about half a million units per annum. Since the city has been made a centre for the manufacture of munitions the increase had taken a further upward turn. Already over 5,000 H.P. of motors coupled to the mains were employed in factories or works wholly or partly engaged on munition and Government work, and to that 870 H.P. would be added in the near future. The total horse-power of motors coupled on July 31 last was 10,082. Including the 200 kw. set dismantled for sale, they had a total of 8,380 kw. of generating plant, consisting of 4,000 kw. a.c. plant in two units of 3,000 kw. and 1,000 kw., and 4,380 kw. of d.c. plant in seven units. The maximum load for 1913 was 4,733 kw., and for 1914 4,560 kw.—a reduction of 173 kw., due to restriction of lighting. In the latter year, however, there was an additional 250 k.w. known to be running over the peak, which would have increased the difference to 423 kw. The normal maximum load for 1914 ought, therefore, to have been at least 4,733 kw. plus 423 kw., or a total of 5,156 kw. In the last 10 years the maximum increase in maximum load was 911 kw., the minimum increase 25 kw., and the average 286 kw. Taking the average increase as a basis, they should reach a maximum load of 5,442 kw. this winter and 5,728 kw. for the winter of 1916. Last year, however, was anything but an average year, and the present one is also abnormal. The lighting load coupled for the year ending July, 1914, was the largest since the advent of the metal filament lamp. The financial year ending July, 1915, showed that the lighting load connected was above the previous five years' average (excluding 1914). Further, the maximum increase per annum in motors coupled in the above 10 years equals 1,726 H.P., the minimum increase 270 H.P., and the average increase per annum 806 H.P. The year ending July 31 last showed an increase of 1,641 H.P. In the first 11 weeks of the present year they had coupled up 679 H.P., and they had applications for a further 870 H.P. to be installed in the near future. The average for a period of years was, therefore, no gauge for the requirements of 1916. The monthly returns already show over 800 kw. in excess of previous corresponding maxima. In view of all the circumstances, therefore, the maximum load for 1916, though it may be considerably more, cannot, in Mr. Bell's opinion, be taken as less than 5,870 kw. They were then left with an apparent stand-by of plant of 2,510 kw., reduced to 2,410 kw., due to traction having to be run separately. In the event of the 3,000 kw. set being rendered inoperative for any time in the winter months, supply could not

be fully maintained, even supposing that the a.c. plant and the d.c. plant were interchangeable and equal. The additional loads in the various areas were being met by means of supply from a.c. plant and sub-stations, and in the event of failure of the a.c. generating plant the d.c. cables were insufficient to cope with the load, even if the requisite generating plant were available. There were other engineering difficulties due to conversion from d.c. to a.c., and there was also the question of boiler capacity even if d.c. plant could be utilised as the stand-by. Common prudence, therefore, made it necessary to provide new a.c. plant before the winter of 1916. He estimated the a.c. load in 1916 would be 2,420 kw., exclusive of the docks sub-station (held over last year), and at least 2,670 kw. with this addition. The 3,000 kw. set had, up to the 7th ult., generated 19,000,000 units, and would be continuously called upon to do more work from day to day. The set had already in 20 months saved, after all capital charges were paid, £2,490, and would at the present price of coal pay for itself in another 18 months. The policy adopted by the Council of delaying the doubling of the Ferryhill generating station buildings until such time as the older plant was replaced by large and more efficient units had proved itself correct. It had, however, the disadvantage that it was only during the period April to July that the necessary alterations could be made and the foundations prepared. With the present shortage and class of labour available, it was expected that, on this occasion, the full four months would be required for that work. As regards delivery, he understood that if plant be put on a "munition" basis, delivery could be obtained in from eight to nine months. He recommended that he be authorised to proceed with the preparation of specification and drawings forthwith, so that offers could be obtained at as early a date as possible. He estimated the cost of these extensions to be as follows: One 5,000 kw. turbo-alternator, with condensing plant, switchboard gear and foundations, £16,500; one 1,000 kw. Lá Cour converter, with switchgear and foundations, £2,750, plus 10 per cent. for contingencies (£1,925), or a total of £21,175.

Bath.—The Electric Lighting Committee recommend the Council to lay a new feeder at a cost of £1,400, in order to provide Messrs. Stothert & Pitt with an additional supply of power for their Newark works.

Belfast.—At the meeting of the City Council last week it was reported that, in view of the small margin of reserve available at the power station, a circular had been sent to consumers of electricity asking them to help the Tramways and Electricity Committee by reducing their lighting as far as possible between 4 p.m. and 5:30 p.m.

Ald. TYRRELL, in moving the adoption of the Committee's minutes, said that the claim against the insurance companies in connection with the fire at the power house had been settled for £3,808. The original claim was £4,504, and the consequential loss had yet to be settled.

As the Treasury had refused the application of the Corporation for sanction to capital expenditure of £6,700 on electric supply mains, an important part of the public service would be held up for the time being.

It was also stated that the late superintendent of the power house (Mr. A. B. Farrell), who had been dismissed by the city electrical engineer (Mr. T. W. Bloxam), had served a writ upon the latter for libel and slander. The Committee decided to take no action in connection with those proceedings. It was also stated that Mr. J. A. M'Kee, distributing assistant, had resigned his position.

Councillor Dr. WILLIAMSON, in moving the adoption of the minutes of the Police Committee, called attention to the fact that the public electric lamps were being put out of commission and replaced by gas, the object being to relieve the pressure on the power house.

Councillor CURLEY felt sorry that the electric lamps were being taken down and scrapped. They had cost £1,582, and would be worth very little if laid aside for a period. The lamps were suggestive of progress in Belfast, and if they were taken down it would seem to imply that they were progressing the wrong way.

Councillor Dr. WILLIAMSON said (in reply) the action of the Police Committee was taken solely with the object of relieving the electric supply station, and was taken at the instance of the electricity department. With regard to the general lighting of the city, it had been reduced originally at the request of the authorities responsible for the defence of the realm, and could not be restored without their consent.

Burton-on-Trent.—Owing to the increasingly heavy demands for electrical energy, it is proposed to apply to the L.G. Board for sanction to borrow £3,500 for laying additional cables.

Darlington.—The Corporation have received the sanction to borrow £15,600 for extensions at the electricity works.

Of the loan, £12,800 is required for a turbo-generator, condensing plant, &c., switchboard and cables, and £2,800 for coal handling plant.

Hornsey.—The L.G. Board have sanctioned a loan of £500 for laying electric supply mains.

London County Council.—On Tuesday a capital estimate of £5,000 for the construction of foundations for an additional turbo-generator at Greenwich generating station was passed.

Nuneaton.—About a year ago the British Thomson-Houston Co., of Rugby, supplied to the Corporation a 750 kw. geared Curtis turbo-generator, and this set has operated so satisfactorily since its installation that the Corporation have placed an order for a duplicate set to be delivered in the near future.

Stoke-on-Trent.—The borough electrical engineer (Mr. C. H. Yeaman) is preparing specifications for additional generating plant.

Worksop.—Messrs. Oates (Ltd.) are putting down additional machinery at their works, and they have asked for a further supply of electrical energy from the municipal electricity department.

GENERAL.

Accrington.—An appeal is to be made against the assessment for income tax purposes of the municipal electricity undertaking.

During the absence of the Borough Electrical Engineer (Mr. Harold Gray), who is serving with H.M. Forces, the Acting Engineer is to be paid an extra remuneration of £100 per annum from the date of Mr. Gray's enlistment.

Bungay.—The Urban Council have appointed a committee of four to meet Mr C. H. Best, in order to consider and report upon his electric supply scheme.

Burnley.—The Electricity Department have connected with the mains up to 500 H.P. of motors for power supply to engineering works.

The electricity department holds an excellent record in connection with the war. Already a large number of men have enlisted, and on Dec. 3, 25 out of 26 eligibles were attested under Lord Derby's scheme, including the electrical engineer, Mr. J. E. Starkie. The department is now working at higher pressure than ever before, the electrical energy supplied being now over 30 per cent. more than at the same period last year.

Derby.—Ald. Wilkins, chairman of the Electric Lighting Committee reported at the last meeting of the Council that they were endeavouring to manage with a very small staff, only two-thirds of that of pre-war conditions. A rearrangement of duties, which would not involve extra expenditure, had been made.

Eastbourne.—It was reported to the Corporation last week that the London Electric Firm of Croydon, manufacturers of arc lamp lowering gear, searchlights, &c., were considering moving their works to Eastbourne, and wished to know if they could have a supply for power and lighting at a special and uniform flat rate.

For power the company would require about 50 H.P.; they estimated they would use a total of 24,000 units per annum and they asked for a flat rate of 1d. per unit. Their annual account would, therefore, amount to £100. The hours of working were from 7 a.m. to 5:30 p.m. They also wished to know if they could have the supply as direct current.

The electrical engineer (Mr. J. K. Brydges) pointed out that the ordinary charge would amount to £125 per annum and he did not think they would be justified in quoting the lower charge. The Electricity Committee approved this and also decided that the company should provide their own converting machinery.

The Electricity Committee also reported that there were several men on the staff of military age who had expressed their desire to join the Army, but as Mr. Brydges considered them essential to the business of the electricity undertaking, he could not give them a written statement to the effect that their services could be dispensed with. The men wished to know what their position would be with regard to the difference between their civil and military pay being made up by the Corporation, supposing later on they were compelled to join the Army, although at present they were willing to go but could not. The question has been referred to the Establishments Committee.

Hampstead (London).—Mr. F. Geere Howard has been elected chairman of the Electric Lighting Committee.

Newquay.—A Board of Trade inquiry was held here last week into the application of the Newquay Electric Supply Co. for power to increase the maximum price of electricity from 6d. to 8d. per unit.

Mr. H. GREENWAY (for the company) said his clients commenced business in 1906, and had expended over £20,000. A guarantee was given to the shareholders that a dividend of 4 per cent. should be paid for the first three years. More than 4 per cent. had not been earned, and on one, if not more occasions, the dividend had to be paid by additional share capital, because of the demand for extra mains, &c. The long, straggling nature of the town, with something like 11 miles of mains, meant a very large expenditure, and the revenue return was small. The application was for permission to increase the maximum charge from 6d. (fixed in the provisional order) to 8d. per unit, but there was no intention to immediately increase the charge to 8d., but only to 7d. If the application was successful, and the company found that owing to the war and the charges they could not do with 7d., they desired to have the power to increase the maximum to 8d., because the matter could not be reopened for five years, but they were prepared to enter into a reasonable agreement that for a period they would not raise the price more than 1d. Newquay had no manufactures, and there was practically no consumption of current for power. The effect of the war had been to increase the cost of producing electric light and to decrease the income. The Defence of the Realm Act had been vigorously applied to Newquay, and had resulted in the revenue being practically halved for street lighting and public purposes, whilst private lighting had been reduced to practically a minimum. The increased cost of production was about 2½d. per unit.

Mr. CARPMAEL (for the Urban Council and private consumers) pointed out that in an agreement between the promoters of the company and the Council before the provisional order was granted, it was stipulated that the charge should never be more than 6d.

Mr. GREENWAY replied that that was a statutory company, and the

agreement entered into was rendered null and void as far as the company was concerned, and the application that day was under the statute.

The Inspector (Mr. G. Roper) said it appeared to him the Board of Trade were not concerned with the agreement, as it was not in the order.

Mr. Greenway said he was not aware of the agreement, and he could not until now understand why the maximum was 6d. and not 8d., as in so many other orders.

Mr. L. Milne, one of the original promoters and a director of the company, said the maximum of 8d. was actually in the original draft of the order, and they believed it was in the order until the Clerk to the Council sent them the agreement. The actual increased cost of generating electricity at Newquay was 2·4d. per unit, as compared with the Midsummer and Michaelmas quarters in 1913. The additional cost of fuel had been 0·67d. per unit. For the 1913 Midsummer and Michaelmas quarters wages were 0·59d. per unit sold, the units being 49,249. For the two quarters of the present year the wages were 1·28d. per unit, the units sold being 28,778. The fixed charges were 2·16d. per unit in 1913, and in 1915 they were 3·18d. Of municipalities, he had found that 81 out of 200 had increased their prices since the war. The units sold for the whole of 1913 were 106,774, and for the whole of 1914, 104,620.

In cross-examination he said he had not looked for cases of an increase over 6d. per unit; Ilfracombe had raised the price by 10 per cent. over 6d. since the war. The reason of the present troubles was the war. During the past month of the fuel used one-tenth had been coal and nine-tenths oil. The cost of oil was lower than coal, and they hoped to make quite an appreciable saving by its uee.

At this point the Inspector said the Board of Trade could not alter prices for the period of the war. They could only revise them at intervals of five years, but there could be an agreement with the company outside the order the Board might make, either by the Council or a body of consumers.

Mr. Greenway said in the event of opposition being withdrawn, the company would undertake for a period not to charge more than 7d. But he did not think they ought to be asked to enter into an agreement and still meet opposition.

Mr. Milne added that immediately conditions returned to those of ante-war time they would go back to the old price. It was impossible to say what the conditions would be at the termination of the war.

Sir Robert Edgcumbe (chairman of the Urban Council) said five years seemed an unreasonable time to go without a revision of price under the circumstances. They were hampered by pre-war legislation which was not suitable to the present time. Could not the Board of Trade get Parliament to give them power to make orders for three years instead of five years?

Mr. Milne suggested an arrangement whereby without the approval of the Board of Trade, or an official of the Board of Trade, any increase should not hold good beyond six months after the war.

The Inspector said the Board of Trade might fix a minimum above 6d., and then the company could independently make an agreement with the Council and probably a representative body of consumers, that the price should be whatever was agreed upon within the maximum for a certain period—the period of the war and six months after.

Mr. Milne: Could we make it such that it could be referred to the Board of Trade, or an official or to arbitration?

The Inspector: I should not object to that. I will undertake that the Board of Trade shall hold their hands while any negotiations are going on between the Council and the Company.

Mr. Carpmael for the Council and consumers, suggested that the Board should not allow the limit of 6d. to be increased. The company had calculated on the use of coal, but they were not using coal. It seemed the company had applied too soon for the increase of the maximum.

Evidence was then given by consumers, and at the conclusion of the inquiry the Inspector said the impression made on his mind was that the company's case was not quite so strong as they maintained, but he thought they had made out something of a case for consideration owing to war conditions. The company might have made rather rosy estimates in the early days which had not quite come up to expectations, but, as far as he could gather, there was never any idea in their minds of getting their maximum modified but for the extraordinary conditions now ruling. Nearly every application made to Parliament this session for a provisional order asked for 8d. per unit, war conditions being no doubt partly responsible for that. If the company had gone to the Board of Trade to-day for any powers they would have asked for 8d., and though it would have no doubt been opposed, he was inclined to think Parliament would have given them 8d., because of the conditions. In the present application there was pretty strong and pretty general opposition, but he thought the case was one for compromise.

At the suggestion of the Inspector the parties concerned had a private conference, and eventually an agreement was arrived at. It was that the maximum price for private consumption should be 7d. per unit, and that the price per unit should not exceed 6d. after the expiration of one year of the conclusion of peace, with liberty to the company, at the expiration of that date, to refer to the arbitration of the Board of Trade the question of any price higher than 6d.

Sheffield.—At the meeting of the City Council on Wednesday it was decided to apply for a provisional order to authorise the transfer of the Kelham Island electric power station from the tramways undertaking to the electric supply undertaking.

The Electric Supply Committee's estimates for the year ending March 25, 1916, show that originally the income was fixed at £190,240, but this had since been increased to £277,450, and for the year ending March 25, 1917, the estimated income is £337,650. The working expenditure for the current year originally estimated at £87,308 has been increased to £165,889, and the expenditure for next year is estimated at £217,103. The increase is due to the advance in prices of coal and materials, the allowances to dependents and other matters. The gross profit for the current year estimated originally at £111,932 is now estimated at £101,561, and for next year at £120,547. After allowing for interest and sinking fund the surplus for this year, originally estimated at £4,252, has been increased to £12,421, and for next year £6,351. The latter figure is based on the possibility of coal being purchased at its present figure, but if the price goes up there may be an adverse balance on the year's working.

South Shields.—Out of a regular staff of about 56 of the electric supply department 11 are now with H.M. Forces, one has returned unfit for service and one was drowned when H.M.S. "Hawke" was sunk during the early part of the War. The present staff numbers 44, and is considered to be an irreducible minimum if the work of the department is to be carried on.

Of the present staff 18 males are of recruitable age, but seven of these have been certified unfit for military service. Including the borough electrical engineer (Mr. Harry S. Ellis, M.I.E.E.), the remainder have enlisted under Lord Derby's scheme (Class B), although the majority of this number are already starred men. All men of recruitable age still wear the Admiralty badge which was obtained for them several months ago, and all men above the recruitable age now wear the Ministry of Munitions badges. It will now be left to the Local Tribunal to decide as to which of the remaining men will be called up for military service.

The borough electrical engineer has recently been able to persuade the Military Authorities to allow a certain amount of very much reduced lighting in the streets. This consists of two 20 c.p. lamps on each arc lamp standard, and one 20 c.p. lamp on each ordinary standard, the lamps being dipped in green paint, and the surrounding globes coloured black in such a way as to leave only one-third of the bottom part of the lantern transparent. Owing to the military restrictions as to lighting, the output of the electric supply department for lighting purposes is down very considerably, and owing to shortage of labour the output for traction purposes shows a fall of 10 per cent. for November as against October. The power output, however, has increased by about 20 per cent. for the year up to date, which to some extent compensates for the serious loss in revenue from lighting.

Wednesbury.—For about an hour on the 30th ult. there was a failure of the supply of electricity.

It is stated that the failure proved very inconvenient, as many of the local works take current for power purposes from the Municipal generating station. Of late there has been an increasing demand for current and the delay in the delivery of a rotary converter, which was ordered some time ago by the Council, has increased the difficulties of the situation.

Woodford.—The County of London Electric Supply Co. have decided, in consequence of the decision of the Board of Trade not to grant provisional orders during the war, not to proceed with their application for an order for Woodford district.

TRACTION NOTES.

Blackburn.—At the Council meeting last week the vice-chairman of the Electricity Committee (Councillor Higham) said the difficulty in obtaining the delivery of coal and other commodities might slightly curtail their powers of production, and might render necessary a curtailment in the tramcar service.

Doncaster.—The Council have decided to reconstruct the tramway track in Nether Hall-road from Christ Church-road to Sunny Bar, at an estimated coat of £500.

The Council have undertaken to bear the actual cost (£2,730) of the necessary alteration of the telegraphs along the Brodsworth tramway route.

Leith.—The Tramways Committee recommend the Council to grant, in addition to the war bonus already given, an increase of ½d. per hour in the wages of the employees who are paid by the hour, and an increase of 2s. in the wages of those paid a fixed wage.

London County Council.—The Highways Committee reported on Tuesday that the present services of all-night tramcars entails a loss of about £1,000 a year.

There are 16 all night cars in service, and the number of passengers carried was approximately 2,000 a night. The revenue during October was only 5·69d. per car mile. Hitherto workmen's fares had been charged on the cars, but as from Jan. 1 the committee recommended that ordinary fares be charged.

After a debate the recommendation was carried, with the addition of words to make it clear that the increased charge would only apply during the period of the war.

Newcastle-on-Tyne. The Tramways Committee has been instructed to reconsider the question of the night service of tramcars. At present the cars stop at 9:30 p.m., and it is suggested that a service should be given until 10:30 p.m.

Last week the Corporation were recommended by the Finance Committee to continue the war bonuses on the same scale as at present. The

Council was paying £37,215 to dependents of men on active service and £13,919 in war bonuses.

It was moved that the bonus be increased by 1s. per week for youths and 2s. a week for other employees, but Mr. Johnstone Wallace pointed out that this would cost a further £10,000 or £11,000 per annum if the tramwaymen were included, £4,163 without them, and the amendment was defeated.

Mr. Matthewson then moved that there be increases of 6d. and 1s. per week respectively, and this amendment was agreed to.

Women Tramcar Conductors, &c.—Women conductors have commenced work on some of the London County Council's single-deck cars, and others are to be employed shortly on double-deck cars on outlying routes.

Women conductors are also employed on Derby and Doncaster Corporation tramcars.

Forty women are now performing the work of cleaning cars at one of the Glasgow Corporation tramway depots, the male staff thus displaced being transferred to another depot. This week women have started as cleaners at a second depot.

TELEGRAPH & TELEPHONE NOTES.

Radiotelegraph Notes.—In our issue of Oct. 1 last we referred to the opening of the new Marconi stations at Hawaii and gave a brief description of the equipment which was not quite correct.

We are informed that the stations at Hawaii are two-way stations, capable of sending and receiving simultaneously in two directions. The receiving station at Koko Head has two aerials, one to receive messages from San Francisco, is 4,500 ft. long, supported by five masts each 300 ft. high; the other is to receive messages from Japan and is 5,000 ft. long, supported by two masts 450 ft. high and one tower, 1,200 ft. above sea level, on top of Koko Crater. The transmitting station at Kahuku is also equipped with two aerials, one to send to San Francisco is 4,500 ft. long and supported on 12 masts, each 325 ft. high; the other to send to Japan is 5,000 ft. long, supported on 12 masts each 450 ft. high.

According to reports from Holland the German army possesses both fixed and mobile wireless stations. Fixed stations are established in fortresses, and they have a radius of 1,000 kilometres (about 620 miles). They are in communication with Nauen station, and they also keep in touch with all cruising airships. In regard to the mobile stations, heavy stations are at the disposition of the General Headquarters, the higher command of the army, and the cavalry divisions. These stations have a radius of 200 kilometres (over 120 miles), move on wagons and possess in most cases two installations, which work alternately and can be got ready for use in 15 minutes. The light stations, which are attached to the reconnaissance squadrons of the cavalry divisions receive the communications of patrols and redespatch them immediately. The radius is 70 kilometres (over 40 miles).

EMPIRE NOTES.

Australasia.—The report of the Gawler (S. Australia) municipal electric supply for the half-year ended May 31 shows net profit £124 (against a loss of £247 in previous half-year). Receipts from sale of current were £802. The plant is not yet working to its full capacity.

Kyneton (Victoria) Council has applied for an Order in Council to establish electricity works at Trentham. Mr. V. J. Crowley is consulting engineer.

In view of the possibilities of the development of the Waikaremoana (N.Z.) water-power scheme, opposition has been raised in Napier to a proposal of the Wairoa residents to harness the Te Reinga Falls if the latter interferes with the former undertaking.

Colombo (Ceylon).—"Indian Engineering" states that the Colombo Electric Tramways & Lighting Co. have recently installed two four-cylinder Diesel engines (500 H.P. each), making seven Diesel engines in all. The other engines are of 225 (two), 400 (two) and 525 H.P. The steam-driven plant will in future be used only as a stand-by.

Hydro-Electric Development in Canada.—In a recent interview with a representative of the "Electrical World" the chairman of the Hydro-Electric Power Commission of Canada (Sir Adam Beck) gave some interesting particulars of the growth and development of the business of the Commission.

At present a cheap supply of electrical energy was being given to over 130 municipalities. The latest improvement was the new plant at Eugenie Falls, which would supply a peak load of 10,000 H.P., and operations were begun on Nov. 18 by supplying energy to 10 or 15 municipalities. The turbines used had a rating of 2,250 H.P. each; they were of the reaction type with spiral wheel cases and [illegible] and of Swiss manufacture. The storage basin of the development was about 1,650 acres in area and was created by two dams. The maximum load in the Niagara district, which was bounded by Niagara Falls, Toronto and Windsor, was over 100,000 H.P. and was reached the first week in November for the first time. During December the peak load in that district would reach a maximum of 110,000 H.P. The commission received most of its supply from the Ontario Power Company, at Niagara Falls, with which it had a 30-year contract to supply 100,000 H.P. at a minimum of $9 per horse-power-year. In addition, the commission had three power developments of its own, but of a much smaller size. The limit of the present supply of available power was now practically reached, and the peak threatened to exceed their contracts. With a full realisation of this situation and wishing to effect a suitable remedy, the provincial government requested the commission to lay before it plans for the further development of Ontario's hydroelectric resources. The commission recommended a scheme of new development at Niagara Falls in which the initial installation of 150,000 H.P. would, with the present sources of supply, take care of a peak of 370,000 H.P. The ultimate rating of this development as recommended amounts to 600,000 H.P. The entire development would be used only to supply the Niagara district, the remaining districts being fed from other sources. Many of the municipalities which were taking supplies from them were formerly supplied from local central stations, but when it was found that there were large possibilities for supplying energy both in the cities and in the rural districts for farm work, the municipalities took over the privately owned enterprises. They had succeeded in their plan of public ownership because the entire system had been conducted on a business basis to the exclusion of politics and personal privilege. Each year they were able to show a large surplus after paying all expenses including interest, a 5 per cent. depreciation charge, a sinking-fund reserve, and a large sum to pay off the debentures which were a liability of the system when they acquired it. The system was not run for a profit but for the benefit of the consumers. While it was controlled by the Province of Ontario, the government in no way shared in its revenue except to collect the interest due to it on its loans to the system, and the principal of the loan, which must be liquidated in 40 years. Any surplus after the payment of all charges was put back into the system's property to pay for improvements. Their low rates had been instrumental in increasing their rural and domestic load. First, they charged a service charge of 30 cents per 1,000 sq. ft. floor area for domestic service, with a minimum of 30 cents. To small consumers the rate was 2 cents per kilowatt-hour for the first 30 kw.-hour and 1 cent per kilowatt-hour for all over that. A large householder, however, paid 2 cents per unit for the first 100 kw.-hour and 1 cent for all over that. With such rates most of their customers were now using electricity for heating and cooking as well as for lighting. An average of fifty families, averaging six to a family, showed a monthly bill of $1·67 for cooking, while the average household bill, including service charge, was 98 cents. With those rates the Commission was able to show last year a net surplus of more than $21,000. To take his own home as an instance. His bill for September was $7.11, as follows: Service charge, 90 cents; first 100 kw.-hour, $2; second 500 kw.-hour, $5. That totalled $7·90, or, less 10 per cent. for prompt payment, $7·11. He used energy for lighting, cooking, bathroom heating, around the stables and for all of the miscellaneous household heating devices. That was not unusual for a family with a large place and many servants. In the rural districts the use of energy was becoming quite common. There were so many uses for electricity on the farm that its use was becoming almost universal in the districts served by their lines. Most of the farms used a 5-H.P. motor, which they employed in pumping, sawing, food grinding, silo loading and a multitude of other ways. The average monthly bill for those farms was about $8 or $9. He had in mind a sanitarium farm on their lines which had about 50 patients. The farm used energy for cooking, laundry work, farm work and lighting, and its monthly bill was about $23. The Commission had placed in the hands of the householder electrical energy at such rates that gas competition became impossible, and within a few years he expected to see all households in their districts using electricity universally for lighting, cooking and heating.

South African Exhibition.—An industrial exhibition will be held at Durban (Natal) from March to August next inclusive.

The organisers hope that the exhibition will afford an opportunity for manufacturers and exporters to obtain a good footing in the South African markets and capture trade hitherto in the hands of Germany. Communications as to terms of exhibiting, &c., to the manager.

MISCELLANEOUS NOTES.

British Empire Industrial Exhibition.—An agreement has been concluded between the Institute of Industry and the British Dominions Exhibition (Ltd.) whereby the Institute takes over the whole of the latter undertaking and the management of the British Empire

Industrial Exhibition, which the latter company was formed to promote.

In accordance with the terms of the agreement a joint advisory committee for the exhibition has been constituted, and appears to be a representative one. The committee state that their exhibition scheme is the only one which is likely to be considered by the Dominion Governments and important British interests. They have placed proposals before the various Dominion Governments which provide for the erection of permanent exhibition buildings within 15 minutes walk of the Strand and covering an area of about 10 acres, which are likely to be favourably considered. It is intended to hold in these buildings a comprehensive exhibition of British industries within 12 months of the conclusion of peace, and also one of the natural resources of the Empire. The exhibitions will be continued at frequent intervals thereafter.

Controlled Establishments.—The Ministry of Munitions announces that 333 additional establishments have been declared as controlled establishments under the Munitions of War Act as from Dec. 6. In all, 2,026 establishments have now been declared as controlled.

Customs Duties.—According to recent decisions the duty upon electrodes each 3 kilogs. or more upon importation into Finland is 1m. 20p. per 100 kilogs. (5¼d. per cwt.), and on electrodes each less than 3 kilogs., 12m per 100 kilogs. (4s. 4½d. per cwt.); on "fastening arrangements for electrical machines not being integral parts of such machines," 14m. 70p. per 100 kilogs. (6s. per cwt.); and on generators and transformers (dutiable separately), 47m. 10p per 100 kilogs. (19s. 3d. per cwt.).

Exports to China.—In one of the lists recently published of firms to whom goods exported to China may be consigned, the Chinese Electric Light & Power Co. should be the Chinese Light & Power Co., Peking.

Exports to Holland.—The Board of Trade notify that the provision in the Order of Council of Oct. 7, which permits of the consignment of goods to British consular officers in Holland is only intended to enable such officers to import goods into Holland for their personal use without the necessity of consignment to the Netherlands Oversea Trust.

Exports to Switzerland.—With reference to the recent announcement relative to the commencement of operations of the Société Suisse de Surveillance Economique, it is now announced that, in order to lessen the pressure of work upon the Society in its initial stages, it has been decided that the requirement that certain goods must be consigned to the Society shall not come into force until Dec. 15 (not Nov. 16, as previously arranged).

Fatality.—An employee named Price was killed at the Penallta Colliery on Wednesday of last week. The man hung his lamp on a live wire in order to attend a tram that had left the rails, and he received a fatal electric shock.

German Trade Methods.—The Board of Trade announce that 300 catalogues of German origin, illustrating various industries, may be inspected at the Foreign Samples Section of the Commercial Intelligence Branch, 32, Cheapside, London, E.C., where the index to the catalogues may be obtained. Arrangements have been made to lend such catalogues to United Kingdom firms established in the provinces, and the number of days for which the loan of the catalogues is required should be stated in the application to the director.

Last week a Board of Trade exhibition of samples of German and Austrian goods was held in the M'Lellan Galleries, Sauchiehall-street, Glasgow, and attracted a good deal of attention from merchants and traders. During the week there were about 1,500 visitors, and there were numerous inquiries regarding the marketing of the commodities represented by the samples, the sources from which British-made competitive goods could be obtained, &c.

Parliamentary Notices.—The following notices of intention to apply for powers for electric supply and electric traction have been given :—

Electric Traction Bill.—Metropolitan Electric Tramways (Ltd.) are promoting a Bill seeking further powers to extend the powers conferred by their Acts of 1911 and 1913.

Miscellaneous Bill.—Burnley Corporation seek powers to borrow money temporarily for defraying their current expenses or the expenses of any of their undertakings by temporary loan or overdraft from any bank or on temporary loan or deposit receipt or otherwise.

Provisional Orders.—The Church Stretton Electric Supply Co. (Ltd.) notifies its intention of applying for an electric lighting order for Church Stretton Urban district and the parishes of All Stretton and Little Stretton in Church Stretton Rural District, and for the revocation of the Church Stretton Electric Lighting Order, 1912.

Lancaster Corporation is applying for a provisional order to enable it to run omnibuses within the borough.

Ryde Corporation is applying for a provisional order for the transference to the Corporation of the Victoria Pier, with its electric tramway.

TENDERS INVITED.

Electric Cable, Fittings, &c.

WALTHAMSTOW Council invite tenders (by noon Dec. 15) for supply of l.t. cable

WEST HAM Guardians want tenders by 10 a.m. Dec. 16 for three months' supply of Electrical Fittings, Oils, &c. Forms of tender from the Clerk.

BRIGHTON Guardians require tenders by 10 a.m. Dec. 14 for supply of Electrical Fittings. Forms of tender, &c., from the Clerk, Princes street, Brighton.

Lubricating Oil.

REIGATE Corporation require tenders by noon Dec. 15 for the supply of Lubricating Oil for 6 or 12 months to the electricity works. Particulars from the Electrical Engineer.

Telegraph and Telephone Material, &c.

In reference to the invitation of tenders by DURBAN Corporation for (1) Telephone Apparatus and Materials; (2) Underground Cables (paper insulated, armoured, silk and cotton covered, &c.); and (3) 540 Cast-iron Pipes, 9 ft. in length, for the cables, it has been arranged that firms who tendered by the date originally announced (Dec. 1 inst.), in consequence of the fluctuations in the cost of material, amend their figures and send them to Messrs. Webster, Steel & Co., 5, East India Avenue, London, E.C., by Dec. 31.

The Deputy Postmaster-General, Sydney, requires tenders by 2:30 p.m. Dec. 20 for 3,750 c.b. wall pattern and 300 c.b. table Telephones, 150 Magneto Wall Telephones and 50 Portable Telephones (schedule No. 454) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications from the Deputy Postmaster-General, Sydney.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Brisbane.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. Jan. 4, for the supply of Detectors, Galvanometer Shunt, Keys, Megohm and Milliameter (Schedule 1,216); Telephone Cords, Earpieces, Receivers and Lamps (Schedule 1,275); and 500 Automatic C.B. Telephones (Schedule 1,276) for the AUSTRALIAN COMMONWEALTH, Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General, Melbourne.

Overhead Line.

NUNEATON Electricity Committee require tenders by Dec. 24 for the supply and erection of an Overhead Line. Specifications from the Acting Borough Electrical Engineer.

Electric Pumps and Motors.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Dec. 20 for supply of three Centrifugal Pumps and Electric Motors, each to pump 6,300 gallons per minute and one to pump 15,100 gallons per minute, with switchboards, starters, &c., and spare parts. Specification, &c., from the Board's offices, 341, Pitt street, Sydney, N.S.W.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections (contract No. 29,491), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fishplates (contract No. 28,685). Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

TENDERS RECEIVED AND ACCEPTED.

NUNEATON.—The Corporation have placed an order with the British Thomson-Houston Co. for another 750 kw. geared Curtis turbo-alternator.

LUTON.—The following tenders have been accepted by the Corporation :—

Johnson & Phillips, e.h.t. switchgear, £860 ; Davenport Engineering Co., water cooler of 1,800 gallons capacity, £1,460.

MANCHESTER.—The following tenders have been accepted by the Corporation :—

F. Smith & Co., copper trolly wire ; Edgar Allen & Co., special track work, tongues and crossings ; Western Electric Co., Ltd., cable ; Howard Asphalt Troughing Co., asphalt troughing, &c. ; British Westinghouse Electric and Mfg. Co., 5,000/6,000-kw. turbo-alternator ; J. Howden & Co., 5,000-kw. high-pressure turbine ; National Boiler and General Insurance Co., supervision during construction of two boilers.

Monometer Furnaces.—The Monometer Mfg. Co. have recently been favoured with a war contract for a battery of 18 Monometer patent crucible furnaces of the tilting type for a newly-erected works.

The need for accurate control of temperature in gas-fired furnaces is shown by the fact that many noteworthy firms have lately placed orders for Monometer patent self-acting heat controllers to be fitted to their existing gas-fired furnaces, examples being the Daimler Co. and Messrs. Chance Bros. & Co. The latest tinning furnace for coating wire and cables without oxidation has fulfilled a long felt want, numerous orders having come in for these lines. The company's standard furnace for melting aluminium without crucibles is still making great headway, the Wolseley Motors (Ltd.), Messrs. Jos Lucas (Ltd.), and Crompton & Co., amongst many others, having placed orders for this class of furnace. The Monometer oven and muffle furnaces, fitted with Monometer heat controller, are specially suitable for the accurate temperatures required in engineering works. Telephone manufacturers are also recognising the value of melting their metals without oxidation, the Peel-Conner Telephone Works having recently acquired a Monometer soft metal furnace.

COMPANIES' MEETINGS AND REPORTS.

AGAR, CROSS & CO. (LTD.)—For the year ended June 30, 1915, after making provision for debenture interest, &c., there was a loss of £2,446. Deducting the credit balance of £134 brought forward, the debit is £2,312. To meet this the directors have transferred from general reserve £2,500, leaving £188 to be carried forward.

BULLERS (LTD.)—The directors report that the general trade of the company has materially suffered during the past year owing to the war, and the great number of employés who have joined the army has much increased the difficulties of management. The company has now been declared a controlled establishment. After paying directors' fees and salaries, and £800 (to be ratified at the meeting) for special expenses and exertions entailed on the senior directors, Messrs. A. K. Tharp and E. J. Chambers, during the last two years, there is a profit of £27,859. 13s. 7d. for the year. With £7,676. 4s. 8d. brought forward, the available total is £35,535. 18s. 3d. Depreciation has been allowed and the preference dividend has been paid. The directors recommend that a further dividend of 5 per cent., making 7½ per cent. for the year, be paid on the ordinary shares, and that £7,000 be placed to reserve, the balance (£9,785. 18s. 3d.) being carried forward.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.).—The accounts for the year ended Sept. 30 show profit of £19,035, making with £26,320 brought forward a total of £45,356. In future the preference dividend period will correspond with the financial year of the company. A dividend at rate of 6 per cent. (less tax) has already been paid on the preference shares for the half-year to Jan. 31, 1915. To give effect to the alteration in the dividend period the directors now recommend payment of a dividend at rate of 6 per cent. per annum (less tax) on the preference shares for the eight months to Sept. 30, 1915, leaving to be carried forward £26,581.

MANX ELECTRIC RAILWAY CO. (LTD.)—The accounts for the year to Sept. 30 show a loss of £9,436. The debenture interest (£9,000 per annum) was paid in cash for the first half-year and funded by the issue of second debentures for the second half.

CITY NOTES.

MEMORANDA (Dec. 8).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58¾. Consols Pay Day, Jan. 5. Stocks and Shares Ticket Days Dec. 14 and 29. Pay Days Dec. 15 and 30. Price of silver, 26¾d.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The preference share and transfer books of the company will be closed from the 17th to 24th inst. inclusive, for preparing the dividend warrants on the 6 per cent. preference shares for the half year ending 31st inst., on which date the warrants will be posted.

BRAZILIAN TRACTION, LIGHT & POWER CO. LTD.—A quarterly dividend of 1½ per cent. has been declared on the preference shares.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. LTD.—The directors have declared an interim dividend for the quarter ended Sept. 30 last of 2s. 6d. per share (tax free), payable on the 15th prox. The share register will be closed from Jan. 7 to 14 inclusive.

ELECTRIC LIGHT & POWER CO. OF COCHABAMBA.—It is announced that Messrs. Emile Erlanger & Co. will pay the half-yearly interest due 15th inst. on the 6 per cent. Government guaranteed loan for £400,000.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The directors have declared a quarterly interim dividend of 3s. per share on the preference shares, less tax, and of 2s. per share on the ordinary shares, income tax having been already deducted.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have decided to pay on the 1st prox. the interim dividend of 2½ per cent. in the ordinary shares postponed in July last.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the first quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1916, being at rate of 6 per cent. per annum. The transfer books of the company will be closed from Dec. 13 to 18 inclusive, and the dividend will be payable on the 20th inst.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 7. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased

SHRS.	LAST DIVIDEND	NAME.	Price, Tues. Dec. 7.	RATE PER CENT YIELDED. £ s. d.	DIVIDEND DUE.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 8 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅛	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	90½†	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3½	6 18 6	..
5	5%	Do. Ord.	3⅞	7 5 0	Aug, Feb
5	4½%	Do. City Pref.	3½	5 13 5	Jan, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅝	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb Aug
10	6/0	Do. 6% Pref.	10⅛	5 11 0	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9⅛	7 0 11	Mar, Sept
10	6%	Do. 6% Pref.	10⅛	5 19 9	Feb, Aug
St.	4½%	Do. 1st Deb.	90½	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	May, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77⅛	5 11 3	July
5	9%	Kensington and Knightsbridge Ord.	6⅛	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4⅛	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 6 4	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2⅛	7 3 7	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 0	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
..	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7⅝	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6⅛	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 0	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅛	7 10 7	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4½	5 4 5	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	72½	8 5 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	71½	5 12 3	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 6	..
St.	4½%	Do. 4½% Pref.	90½	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93½	4 5 3	Jan, July
St.	4%	City & S. London Deb.	71⅛	5 11 4	May, Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	8%	London Electric Ry. Ord.	1⅛	4 5 1	Jan, July
St.	4%	Do. 4% Pref.	59	7 0 5	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24½	4 2 1	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	80½	4 4 0	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15½	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	90½	6 15 4	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	113½	5 5 9	Jan, July
St	4%	Do. 4% Debs.	72	5 11 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	73	5 9 7	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅛	..	..
1/0	..	Do. A Ord.	½	..	..
St.	6%	Do. 6% Inc. Debs.	105	5 14 3	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Tues., Dec. 7.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	77	7 15 10	Mar, Sept
..	4½%	Do. 4½% Bds.	100½	4 9 6	Jan, July
5	..	Yorkshire W. Riding Ord.	⅛	..	March
5	6%	Do. Pref.	4⅛	6 19 2	Jan, Jly
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅛	6 1 1	Apl, Oct
1	6%	Do. 6% Pref.	1⅛	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 4 3	Mar
100	5%	Do. Prior Lien Debs.	92	5 8 8	Jan, July
1	6%	Do. 6% Pref.	⅞	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 8 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅞	8 0 0	April
100	6%	Do. 6% Prior Lien Debs.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	70	5 14 3	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅞	7 7 3	Jan, July
5	2/6	Do. 5% Pref	4⅛	5 12 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	2½†	6 14 9	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	62	6 9 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅛†	7 4 6	Jan, July
St.	4%	Do. 4% Debs	69½	5 15 6	Jan, July
10	10%	General Electric Ord.	10⅛	9 8 3	July
10	6%	Do. 6% Pref.	9⅛	6 2 4	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	7⅛	6 7 0	Feb, Aug
10	5%	Do. Pref.	8⅛	5 16 6	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34½	7 0 2	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, Jly
1	7½%	Vickers Ord.	1⅛	4 12 4	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	83½	4 15 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½†	4 18 9	Jun, Dec
		Telegraphs.			
5	30/0	Anglo American 6% Pref. Ord.	100⅛	5 19 7	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23	6 10 5	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69½	5 15 6	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅝	6 7 4	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½	5 9 7	Ja,My,Jly,O
St	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80	5 0 0	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 8	Feb, Aug
10	7%	Do. Ord.	12½	5 14 3	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8	33½	6 10 4	Ja, My, Jly
25	13%	Indo-European	47½	6 15 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 6 10	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅛	9 8 3	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 11 2	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 11 5	Mr, Jly,O,Dec
St	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135½	5 18 4	Ja,Ap, Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 0	Jan, Jly
1	7½d.	Monte Video Telephn. Ord	⅜	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	99½	4 10 3	May, Nov
1	10%	*Oriental Telephone Ord.	1½	5 14 3	Apl, Oct
St	4%	Do. Db. St.	79⅜	5 0 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 5 11	Jan, July
5	8%	United River Plate Ord.	6	6 13 4	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10⅛	5 14 3	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10⅜	5 13 7	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	86⅜	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68½	5 17 3	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	81†	6 3 5	Jun, Dec
St.	4½%	Do. 4½% Debs	76	5 18 5	Jan, July
St.	4%	Do. 4% Debs.	75	5 5 3	Jan, July
5	2/9	Do. 5½% 1st Pref.	4⅜	6 15 5	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3½	7 17 2	Jan, July
100	2%	Brazilian Traction Ord.	53½	7 3 6	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	92½	6 9 6	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62½	6 16 0	..
5	9½%	Calcutta Elec. Trams. Ord.	6½	7 15 1	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	89	5 12 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅞	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	43½	..	Fb,M,Aug,N
..	5%	Do. 5% Bds	49	10 8 4	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	95	4 13 10	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 5) yr. Bds	78½	6 7 2	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 8	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	97†	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	15½	5 15 8	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	J— Jly
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4½	5 17 8	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	124	5 12 10	Ja,Apl, Jly,O
St	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	93	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29½	..	Ja,Apl,Jly,O
..	..	Do. Pref.	44	..	May, Nov
..	5%	Do. 5% Bds.	47½	11 1 1	Jan, Jly
..	5%	Shawinigan Water & Power 5% Bds	103½	4 16 3	Jan, July
..	6%	Do. Cap Stock	143½	4 3 9	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	83½	5 8 1	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	⅛	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	94½	6 1 0	Jan, July

* And 13½% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 8, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14½d.
Solid Drawn Copper Tubes	14d.
Brazed Copper Tubes	14d.
Brazed Brass Tubes	16½d.
Brass Wire	13½d.
Copper Wire	13d.
Rolled Brass	13½d.
Brass Sheets	14½d.

	per ton.
Copper Sheets	£112 0 0
Spelter	£100 0 0

	per ton
English Lead	£29 10 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£79 0 0
Brazziery Copper Scrap	£70 0 0
Clean Scrap Brass	£56 10 0
Old Lead	£22 0 0
Old Zinc	£55 0 0
Hollow Pewter	£120 0 0
Black Pewter	£80 0 0
Gun Metal	£65 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec 7, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£115 0 0
Clean Mixed Brass	£58 0 0
Clean Copper	£74 0 0
Brazziery Copper	£68 0 0
Gun Metal	£68 0 0

	per ton.
Old Lead	£23 10 0
Tea Lead	£21 10 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £93; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 1	714	+ 163	26	47,708	+ 2,646
Anglo-Argentine	,, 2	51,954	— 762	26	2,449,039	— 135,179
Ashton-under-Lyne	,, 4	411	+ 31	36	17,298	+ 1,248
Ayr Corporation	,, 4	230	+ 3	29	12,058	+ 642
Birkenhead Corporation	,, 5	1,284	+ 33	36	49 026	+ 3,842
Birmingham Corporation. Trams	Nov. 27	14,750	+ 3,046	35	489,818	+ 67,704
Birmingham Corporation. Buses&c.	,, 27	768	+ 150	35	29,608	+ 17,825
Blackburn Corporation	Dec. 1	1,012	— 35	36	46,397	— 339
Blackpool Corporation	,, 2	593	— 68	36	66,113	+ 1,458
Blackpool and Fleetwood	,, 4	267	— 47	48	37,809	— 320
Bolton Corporation	,, 5	2 426	+ 29	36§	96,087	— 1,881
Bournemouth.... Trams	,, 1	1,580	— 67	35	75,503	+ 3,720
Bournemouth.... Buses	,, 1	7	..	35	890	— 102
Bradford Corporation	Nov. 27	5,739	+ 124	34	227,315	+ 9,618
Brighton Corporation	Dec. 5	837	+ 4	36§	41,231	+ 256
Bristol Trams Trams	,, 3	4,808	+ 563	48	226,247	+ 4,338
Bristol Trams Buses,&c.	,, 3	4,963	+ 753	48	234,702	+ 42,637
Burmah E. Trams & Ltg.	,, 4	R3,611	+ R16	..	..	..
Burnley Corporation	,, 4	1,438	+ 102	9	24,539	+ 1,768
Burton Corporation	,, 5	269	— 16	36	10,134	— 438
Bury Corporation	,, 5	1.144	+ 17	35§	48,805	+ 554
Calcutta Tramways Co.	,, 4	R67,400	+ R4,343	..	..	..
Camborne-Redruth	.. ..	..	..	..	..	..
Cardiff Corporation	Nov. 27	2,383	+ 46	34	93,729	— 2,726
Cork Electric Trams Co.	Dec. 2	439	— 11	48	24,078	+ 15
Coventry Corporation	.. ..	..	..	..	..	..
Croydon Corporation	.. ..	..	..	..	..	..
*Derby Corporation	,, 4	950	+ 39	35|	37.485	+ 1,098
Dover Corporation	Nov. 27	252	+ 55	34	11,052	+ 1,998
Dublin & Lucan Railway	Dec. 4	114	— 7	22	3 383	+ 82
Dublin United	,, 3	5,624	— 93	48	293,030	+ 10,646
Dundee Corporation	,, 1	1,280	+ 55	29⅔	39,262	+ 2,123
East Ham Council	,, 4	1,232	+ 17	35|	46,677	+ 5,187
Exeter Corporation	,, 3	306	+ 12	35	13,610	+ 769
Glasgow Corporation	,, 4	20.997	+ 1,093	27‡	581.251	+ 41,434
Glossop Trams	,, 4	118	+ 24	49	6,139	+ 255
Gloucester Corpn.	,, 1	268	— 25	35	11,805	+ 112
Halifax Corpn. Trams	Nov. 30	1,895	— 47	35	79,478	+ 950
Halifax Corpn. Buses	,, 30	38	— 5	35	1.753	+ 1
Hastings Elec. Trams Co.	Dec. 2	667	— 16	48	86,632	— 182
Huddersfield Corpn.	,, 4	2,317	+ 23	35	95.782	+ 12,202
Hull Corporation	,, 4	3.121	+ 119	35	103,695	— 2,904
Ilford District Council	,, 4	577	— 10	35	23.136	+ 2,900
Ilkeston Corporation	,, 1	117	+ 3	35	4,739	+ 153
Ipswich Corporation	,, 4	441	+ 53	34	19,817	+ 3,179
Isle of Thanet Co.	,, 4	202	— 60	9¶	2,448	— 853
Kilmarnock Corporation	,, 4	148	+ 1	29	4.925	— 148
Lanarkshire Trams Co.	,, 2	1,901	+ 250	48	95,094	+ 5.312
Lancashire United	,, 1	1,451	— 18	48	83,311	+ 5.143
Leeds Corporation	,, 4	8,202	+ 283	36	319,834	+ 24,673
Leicester Corporation	,, 4	3,037	+ 251	49	147,023	+ 8,709
Leith Corporation	,, 4	695	+ 48	29	22,495	+ 1,372
Lincoln Corporation	.. ..	..	..	..	..	..
Liverpool Corporation	Nov. 27	12,383	+ 270	47¶	630,194	+ 9,063
Llandudno&Colwyn BayR	.. ..	..	..	..	..	..
London County Council	.. ..	..	..	..	..	..
Lowestoft Corporation	.. ..	..	..	..	..	..
Maidstone Corporation	Dec. 2	170	+ 10	35	7.875	+ 212
Manchester Corporation	,, 4	16 559	+ 208	35	636,824	+ 19,709
Nelson Corporation	,, 4	168	+ 18	35|	6,984	+ 225
Newcastle-on-Tyne Corpn.	,, 4	5,610	— 205	36|	224.332	+ 28.282
Newport (Mon.) Corpn.	,, 4	793	+ 49	36	29.913	+ 417
Northampton Corporation	,, 3	591	— 18	35¶	25,955	+ 4,620
Nottingham Corporation	,, 2	3,397	+ 180	35	131.931	+ 9 099
Oldham Corporation	,, 5	2,022	+ 107	37	84,508	+ 3,572
Portsmouth Corporation	Nov. 27	1,908	+ 117	35	88.871	..
Preston Corporation	Dec. 1	910	+ 58	35••	34,019	+ 1,053
Rochdale	.. ..	..	..	..	..	..
Rotherham Corporation	,, 1	1.138	+ 183	35	40.992	+ 4.646
Salford Corporation	,, 6	4.759	+ 174	36‡	180 538	+ 6.131
†Sheffield Corporation	,, 5	9 029	+ 1,353	35|	326,600	+ 44.797
Southampton Corpn.	,, 1	1,334	+ 124	35	53,283	+ 5.750
Southend Corporation	,, 1	532	— 96	35	30,190	+ 7.809
South Shields	Nov. 27	702	+ 57	34|	27,811	+ 1.102
Stirling&c. Joint Bd	.. ..	..	..	..	..	..
Sunderland Corporation	Dec. 5	1,460	+ 103	36	53.713	+ 350
Sunderland District	,, 1	535	+ 16	5	2,678	+ 124
Swindon Corporation	,, 1	160	— 11	35	6,982	+ 631
Tynemouth Tram Co.	Nov. 24	494	+ 8	21	3,001	— 532
Wallasey Corporation	Dec. 4	1,084	+ 11	35|	46,264	+ 463
Walsall Corporation	,, 4	725	+ 52	49	36.053	+ 5.352
Walthamstow	,, 4	704	— 20	36	32 601	+ 3,289
Warrington Corporation	.. ..	..	..	..	..	..
West Ham Corporation	,, 2	2 808	+ 88	35	109.611	+ 9.653
Wigan Corporation	,, 2	1,422	+ 19	35	54,083	+ 2,497
Wolverhampton Corpn.	,, 1	1,021	+ 5	9	9.662	+ 826
Yorkshire W.R. Trams	,, 5	1,372	+ 56	49	77,133	+ 6.223

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 2 days. ‖ Plus 3 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 369
Arrangements for the Week .. 372
Standard Marine Electrical Installations. By H. A. Hornor 373
The Design of High-Pressure Distribution Systems. By J. R. Beard, M.Sc. Illustrated 375
The New York Municipal Car. Illustrated 379
Temperature Limits for Mica Insulation 381
The Erection Plant for the Quebec Bridge. Illustrated 381
St. Marylebone Electricity Supply, 1914-15 385
HIGH-PRESSURE TESTING 386
REVIEWS 387
An Introduction to Applied Mechanics [Andrews].
Handbook of Patent Law [Thompson].
Alignment Charts [Andrews].
An Abac for the Calculation of Wave-Lengths. By W. Eccles. Illustrated 388
Variations in the Wave-Shape in High-Tension Testing Installations. By Dr. Gustav Benischke. Illustrated .. 389
A New High Efficiency Incandescent Lamp. By E. A. Gimingham and S. R. Mullard. Illustrated 390
Electrical Machinery at the Meadowside Granary 392
Trolley Wire on Double-Leaf Bascule Bridge. By S. L. Foster. Illustrated 393
Recent Developments in Electric Lamps in Relation to Illuminating Engineering .. 394
CORRESPONDENCE 394
Earth Resistance (E. W. Marchant).
LEGAL INTELLIGENCE 395
PARLIAMENTARY INTELLIGENCE 396
The "Electrician" Commercial and Industrial Section .. 397–408

NOTES.

Coal Supplies for Electricity Works.

REPORTS from various parts of the country show that there is considerable difficulty in getting the coal supplies through to electric generating stations. In some cases to keep the supply going it has been necessary to draw heavily upon the coal reserve. We believe that in at least one instance wagons have had to be purchased by the electricity works at a cost of several hundred pounds in order to secure coal. Very disturbing news to the effect that in one of our largest manufacturing towns the coal reserve, which originally stood at 20,000 tons, is being used up at the rate of 1,000 tons per week was recently reported. At the present time the coal consumption at the generating station referred to amounts to about 4,500 tons per week, but towards this quantity delivery of only 3,500 to 4,000 tons can be obtained The railway companies are more to blame in the matter than are the collieries, and the present position is sufficiently serious to demand the immediate action promised by the Board of Trade. It is quite certain that those who are responsible for the delivery of coal to the electricity supply stations do not fully realise the extent of their responsibilities or there would not be the present shortage. The wise man of business in booking large contracts sees to it that raw materials shall be forthcoming, and electricity supply is one of the most important of the raw materials used in the manufacture of munitions.

The New Ediswan Lamp.

AT the meeting of the Illuminating Engineering Society, held last Tuesday evening, we had an opportunity of seeing the new Ediswan lamp in operation. We think that all who witnessed the demonstration by Mr. S. R. MULLARD, to whose work the lamp is largely due, must have been very much struck by the simplicity of the arrangement and the brilliancy of the light obtained. Some details of the lamp will be found in another column, and, therefore, here we may content ourselves with saying that it consists essentially of an arc in vacuo between a tungsten anode and a carbon cathode. The tungsten takes the form of a small sphere, and the carbon, which is combined to some extent with rare earths in order to give it a greater ionising power, is in the form of a thick filament. We are glad to see that by this invention a new principle is brought into play. The arc is started simply by ionising; no contact between the poles is necessary. The warming up of the carbon filament gives the necessary ions to render the space between the two electrodes sufficiently conducting to carry the current. Those who saw the demonstration were struck, on the one hand, by the intense brilliancy of the tungsten sphere, and on the other by the very small amount of heating that occurs where the arc passes into the carbon filament. The latter is barely at a dull red heat over a proportion of its length, and as the arc itself does not give any appreciable light the glowing tungsten is the only luminous source which is noticeable. In looking over the sequence of events in the history of the incandescent lamp, it is interesting to notice that this history began with the Ediswan lamp, and it is only fitting that the latest advance should be made by the same company after a lapse of many years.

Advanced Students of Science and Technology.

TIMES without number we have directed attention to the folly of allowing advanced students of science and technology to sacrifice their careers by joining the Army, since it is to these we look, not so much for help in the present, as in the near future in the organising and developing of industry. Were it otherwise, higher technical education would be fraudulent and base. The man in the street is endowed with sufficient intelligence to realise that if senior medical students are called upon to enlist, his position, in case of some petty ailment, would be jeopardised. He also realises that in case of serious illness, without skilled attention, he would probably die. This is not the place to argue that the former would be detrimental to the State, or that the man's demise would be an irreparable loss to the country. After due consideration, and, incidentally, after the medical schools were nearly emptied, it was decided that the budding doctor should be allowed to pursue the even tenor of his way, and, in consequence, the man in the street feels easier in his mind. The case in favour of keeping the student of science or technology in the laboratory or lecture room has been disregarded, and, after 16 months of war, our universities and colleges are nearly empty. Inquiry shows that these institutions, with the consent of the governing bodies, have either been converted into miniature arsenals or else given up to the

training of munition workers. With such absurd misuse of higher educational establishments we may have occasion to deal in a subsequent issue.

Now that Lord DERBY's Scheme has closed there is no objection to giving publicity to a circular issued to local education authorities, university institutions and technical institutions by the Board of Education on November 26th. The only comment we propose to make on this extraordinary circular is that it is addressed to those whose services ceased to be of value to the country on the day when the Board allowed —nay, encouraged—senior students to enlist, and that it was sent out 12 months after practically every eligible man had left college. The text of the circular is as follows :—

SPECIAL PROVISION RESPECTING ADVANCED STUDENTS OF SCIENCE AND TECHNOLOGY.

The Board of Education are authorised by Lord Derby to make the following statement :—

An advanced full-time Student of Physical Science or Technology who is (*a*) in the last year of his course for a Degree or Diploma, or is engaged in post-graduate work, and (*b*) working in an institution of University rank or in a Technical School doing advanced work, may, if a request for his retention is made on grounds of public interest by the Governing Body of the institution or school and endorsed by the Board of Education, be retained to complete his studies.

No request will be entertained unless the Student has been attested under Lord Derby's Scheme. Lists and particulars of such Students, who have been attested and passed to Army Reserve B and who concur in a request for their retention, should be sent by Governing Bodies, on the enclosed Forms A and B, to the Board of Education, who will submit them (after scrutiny) to the Director-General of Recruiting. If the Director-General of Recruiting approves of the request, he will give the necessary instructions to the Recruiting Officers, but he reserves to himself a discretion to limit the total number of Students retained under this arrangement.

It will, of course, be understood that, so far as any individual Student is concerned, no guarantee can be given to him personally that if he is attested he will not be called up either with his age-group or at some future date. These arrangements are based on the assumption that the Student is willing and ready to serve in the Forces if he is wanted.

The New Lamps and Their Effect.

AT the meeting of the Illuminating Engineering Society the discussion, which was introduced by Prof. J. T. MORRIS, turned largely upon the modified conditions introduced by the new forms of incandescent lamp. Some interesting remarks were made in this connection by Mr. F. W. WILLCOX, who pointed out that we must deal with the more efficient sources of light along new lines if they are to be thoroughly satisfactory. The effect of passing from, say, 1¼ watts per candle to half a watt per candle, or thereabouts, has been an inevitable increase in the standard of illumination. The general public desires high illumination, provided it can be obtained at a reasonable cost. Therefore, in the near future, the standard of illumination will certainly increase. Moreover, owing to the higher power in a single lamp the lamps will be placed at a higher level above the working plane. At the same time there will be a departure from the use of clusters of lamps, as these will become unnecessary, though it is unlikely that people will care to depend upon a single lamp for lighting any considerable area, as the failure of the one lamp would then lead to considerable inconvenience. The fact that the light source in the half-watt lamp covers a much smaller area than in the less efficient lamps necessitates a much more careful placing of the lamp in a reflector, and, therefore, it becomes necessary somewhat to focus the lamp and to have suitable adjustments for so doing. Moreover, for the same reason, an "extensive" distribution curve is not so easily obtained, and deflectors become necessary. In fact, the whole question of fittings requires reconsideration on account of the high intrinsic brilliancy of the source. Further, there is the question of candle power. Obviously, the meaning of candle power may differ considerably when it is applied to the old cage form of metal filament lamp and then to the newer form where the filament forms merely part of a horizontal circle. It will become necessary for makers and users of lamps to come to some argeement as to what is meant by candle power in the near future.

A Chance for Electrical Engineers.

As will be seen by a notice in this column, the Corps of London Electrical Engineers (Territorial Force) is once again open to recruiting. Men belonging to the trades detailed are specially desired, and they will find in this corps a field for the exercise of their peculiar abilities. It is fashionable at the present time to hold out a sop to those eligible for the service of their country in military guise, and if we follow the prevailing fashion we can make out a good case why men of fair technical ability should join this unit. The work performed is most interesting. Our word must, however, be taken on this point, as further details are not available for publication. Further, the pay is good and depends to a large extent on a man's own ability, and promotion for those who join at once will be rapid. A skilled mechanic who joins this corps is enabled to serve his country in a most direct way, and at the same time to keep in touch with the latest developments in mechanical and electrical engineering. Our advice to all eligible men is to pay an early visit to 46, Regency-street, Westminster.

Drying of Telephone Cables.—The current issue of the "Telephone Engineer" contains a translation of an article devoted to the question of the use of compressed air for cleaning and drying telephone cables and gives results taken from several years of practice.

Telephones in New York.—According to the "Telephone Engineer," the last New York city telephone directory contains 350,000 names for 566,000 telephones in the city. The first telephone directory, issued in 1878, consisted of a card containing the names of 252 subscribers.

Preparation of Tungsten for Lamp Filaments.—A patent has been taken out by Gottlieb Gmür-Zehnder, of Switzerland. By means of a resistance furnace the tungsten is fused to a perfectly liquid condition and then rapidly cooled by air blast. This process makes the tungsten exceedingly malleable and ductile.

The Telephone in Latin America.—According to statistics published by the Pan-American Union, there were on Jan. 1, 1914, 232,816 telephones in Latin America, as compared with 9,542,000 in the United States. Argentina stood first among the Latin American countries, with 74,296, but Uruguay led in the proportion of telephones to population, with 1·05 per 100.

Zirconium-Iron Alloy for Lamp Filaments.—According to a patent granted to Mr. J. L. Brown, of Baltimore, satisfactory alloys of these metals have been produced by reducing mixtures of compounds. They are tough, malleable and ductile. They also possess the property of selective radiation, and have a high degree of luminosity at relatively low filament temperatures.

London Electrical Engineers, R.E. (Territorial Force).—The Corps of London Electrical Engineers is again open to recruiting. Men of the following professions and trades are specially required: Mechanical and electrical engineers, electricians, engine drivers, engine erectors, instrument repairers, metal turners, fitters, telephonists and telegraphists and tinsmiths. There are a limited number of vacancies for carpenters, cabinet makers, pattern makers, draughtsmen, joiners and wood turners. Forms of particulars can be obtained from the Officer Commanding at 46, Regency-street, Westminster, S.W.

Illumination Tests with a Camera.—The Fort Madison Co., U.S.A., has been conducting a series of tests on comparative illumination by means of photography, the duration of exposure of the plates being the same in each case. In this way the contrast between different types of illumination was obtained.

How to Sell to Latin America.—To the current issue of the "Engineering Magazine" Mr. Alex. Del Mar contributes an informative article on "How to Sell to Latin America." The fact that Mr. Del Mar is writing for American readers adds to the interest of the article, and amongst the subjects discussed may be mentioned the following: How not to get the trade, commissionaires, decline of German influence, concessions, customs regulations, labour, steamship facilities and capital.

Trolley Omnibuses *versus* **Motor Omnibuses.**—To the current issue of the "Tramway and Railway World" Mr. H. Webber contributes an article in which a comparison is made of the results obtained by the Keighley Corporation with electrically-driven trolley and petrol-driven motor omnibuses. An interesting feature of the article is that all the data and figures have been obtained in connection with both undertakings on exactly the same routes, and deal with the same population and class of traffic, so that the comparison could not be more equitable.

Large Power Project Sold.—According to "Engineering News" the uncompleted hydro-electric development and aluminium works of the Southern Aluminium Co., near Whitney, U.S.A., have been taken over by the Aluminium Co. of America. The Southern Aluminium Co. is a French concern, and on the outbreak of war stopped its work on this project. There were under construction a gravity-section concrete dam, 1,350 ft. long and 200 ft. high, a power house with five 5,200 kw. direct-current generating units (ultimately 16), as well as a manufacturing plant and town. It is reported that the new owners will assume the old contracts and complete the entire development, with only such changes from original plans as are necessary to fit in with the company's processes.

Projected 350-Kw. Arc-Generator for Radiotelegraphy.—We are informed that the U.S. Naval Authorities are calling for bids for a 350 kw. arc-generator to give a current of 250 R.M.S. amperes in the antenna. The capacity of the latter is to be 0·012 mfd., and the wave-length is to be variable from 4,000 to 18,000 metres without extinguishing the arc. The set is to be installed at Pearl Harbour, Sandwich Islands, and it is hoped to get into direct communication with Cavité in the Phillipine Islands, 4,600 miles distant. This projected station is a big advance on the largest existing station, namely, that at Darien, where a 150 kw. to 200 kw. arc-generator is installed. Of the 100 kw. arc-generator stations, it is interesting to note that one has recently been set to work "somewhere in France."

Research.—In the "Journal" of the Institution of Electrical Engineers for December 1st it is announced that the Council have made application in the name of the Institution for a grant under the Government scheme for the organisation and development of industrial research.

On the 7th September last, Sir John Snell and Dr. S. P. Thompson, F.R.S., on behalf of the Research Committee, had an interview with Sir William McCormick, Chairman of the Research Advisory Council, which has been appointed by the Board of Education to deal with this matter. The views of the Research Committee were given at the interview, together with a statement of the researches in hand or decided upon; and a summary of the points discussed was afterwards sent to Sir William McCormick. A letter has since been received from the Research Advisory Council asking for particulars of the above-mentioned researches, together with notes of the grants desired for each by the Institution, and various other details, and a reply containing the desired information has been sent to the Advisory Council.

Electrochemistry and Lighting.—An interesting Paper on "Unstable States in Arc and Glow" was read by Prof. W. E. Cady at the first meeting of the New York Section of the American Electrochemical Society. An elaborate Paper by Mr. D. McFarlan Moore, of the Edison Lamp Works, was also read on "Moore Tube Lamps." One form of the lamp is a straight tube provided with a screw base. The tube is filled with CO_2 gas, which is generated automatically within the tube. At each electrode there is a small bulb about 1 in. diameter which contains calcium-carbonate with a resistance wire embedded in it. This resistance wire on becoming heated causes carbon dioxide to be generated by the calcium carbonate, and fills the tube. This tube appears to be filled with light of intense whiteness. For matching various materials dyers require a good light from the north with a clear sky. It appears that the spectra of this lamp is particularly suitable for matching materials, and it has been suggested to use it as a colour standard.

The Consumption of Carbon in the Electric Arc.—A Paper on this subject was read before the Royal Society in November by Prof. W. G. Duffield, who described experiments to determine the amount of material lost by the poles of a direct-current carbon arc under different conditions of current and arc length. For a given current the carbon consumption of both the anode and the cathode increases with the arc length until a constant value is reached. Using long arcs the consumption per coulomb decreases with increasing current; the ratio of anode to cathode consumption is about 1·5, increasing slightly with the current. The author also concluded that the loss of an atom of carbon from the cathode of a very short carbon arc is accompanied by the transfer between the poles of a quantity of electricity equivalent to four electronic charges, and that in long arcs the loss is due to this essential carbon disappearance plus a quantity due to combustion. Though the phenomenon is describable on the basis of electrolytic action in which carbon is quadrivalent, the electronic emission has to be accounted for. The chief supply of cathodic material comes from behind the small growth which forms upon its extremity, but if the necessary quantity of carbon cannot be derived from this source the growth itself is consumed. The mean spherical candle-power increases with current strength and arc length in much the same way as the total consumption of carbon does. In a typical experiment the energy of combustion was approximately 11 per cent. of the electrical energy supplied to the arc.

OBITUARY.

Frank Iago.—We regret to have to record the death, which took place on the 8th inst., of Mr. Frank Iago, late secretary of the Westminster Electric Supply Corpn. (Ltd.). Mr. Iago was educated privately, and, owing to the state of his health, he went for a voyage round the world when 16. On his return, in greatly improved health, he went into the office of a firm of accountants in the City. In 1880 he accepted the assistant secretaryship of the London Hospital. After six years of strenuous work there he was appointed secretary to the Westminster Trust, and from there he went to the Westminster Electric Supply Corpn. on its incorporation in 1888 as secretary, and it was a matter of great pride to him to watch its growth to its present dimensions. The interests of the company and its staff were always his first concern. Ill-health compelled him to resign his appointment of secretary of the Westminster Electric Supply Corpn. at the end of August last. He belonged to the old Naval Volunteers, whose headquarters were on the ship "Buzzard," which then used to lie off Somerset House, and it was a great disappointment to him when the corps was disbanded. He was a great swimmer, and in his younger days never missed a morning when in town (summer or winter) without having a swim in Hampstead ponds.

Wm. Shea.—The death is announced of Mr. Wm. Shea, former telephone manager for Blackpool district, aged 52 years. Deceased was first connected with the National Telephone Co. 32 years ago, and was engaged in the construction department. Afterwards he was promoted to Burnley, and thence to Blackburn, later being appointed manager of Fylde district, with Blackpool as centre.

Lane.—The death is also announced of Mr. Jas. Horsburgh Lane, formerly a director of the Indian Telegraph Dept. Mr. Lane, who was 76 years of age, died at Eastbourne on the 11th inst.

KILLED IN ACTION.—Second Lieut. H. Lionel Harris, who died of wounds on Dec. 2, was the second son of the late Henry Graham Harris, of the late firm of Bramwell & Harris, consulting engineers, Westminster, and Mrs. Graham Harris, Raynes Park, Surrey. Lieut. Harris was born in 1882 and in 1901 he went to King's College, and later studied engineering at Rugby for nine months. He entered the firm of Bramwell & Harris in England and afterwards went abroad for them. In March, 1910, he visited the Argentine and was employed by W. T. Henley's Telegraph Works Co. in laying a new submarine cable for the Western Telegraph Co. Later he started on his own account as contracting engineer in Buenos Ayres. He left the Argentine in November, 1914, and in January last he joined the University of London Officers' Training Corps, obtaining a commission in the Royal Engineers on March 4, and left for the front on Sept. 27. He leaves a widow, two daughters and a son.

PERSONAL.

Mr. S. B. Cox, electrical engineer, of the Sydney office of the Australian General Electric Co., has enlisted for active service, and has been granted a commission in the Australian Engineers.

Monsieur Maurice Leblanc has been elected an Honorary Member of the Institution of Electrical Engineers.

Mr. P. M. Lincoln, Past President of the American Inst.E.E., who for many years has been connected with the engineering department of the American Westinghouse Co., has resigned his position in order to devote his time to the manufacture of a maximum demand meter which he has recently invented.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

Tyne Electrical Engineers : C. B. Williamson to be Second Lieutenant.

East Riding (Fortress) Engineers, Electrical and Mechanical Company : Major A. E. Levin, A.M.I.E.E. (from London Electrical Engineers), to be Major (temporary). Capt. G. L. L. Russell, A.M.I.E.E. (from Tyne Electrical Engineers), to be Captain (temporary). H. C. C. Tufnell, A.M.I.E.E. (from London Electrical Engineers) and F. H. Bowers (from Tyne Electrical Engineers) to be Lieutenants (temporary).

North Midland Divisional Engineers : Sapper P. H. Crawshaw (from London Electrical Engineers) to be Second Lieutenant.

APPOINTMENTS VACANT AND FILLED.

An electrician is required for Gold Coast Government waterworks. Salary £300, rising to £350 by annual increments of £10, with free quarters. Applications to Messrs. Hunter, Duff & Middleton, 17, Victoria-street, London, S.W. *See advertisement.*

Mr. Chas. O. Silvers has been appointed general manager and engineer of Wolverhampton Corporation tramways, at a commencing salary of £350 per annum. During the late Mr. W. A. Luntley's illness Mr. Silvers acted as manager of the undertaking.

Mr. H. D. T. Waldram has been appointed electric station supervisor at H.M. Dockyards and Naval Establishments, and Mr. Wm. McClelland and Jas. McCaffery have been appointed electrical engineers in H.M. Naval Establishments.

Mr. E. J. Foster has been appointed draughtsman at West Bromwich electric supply works.

Mr. C. G. Calman, of Messrs. Siemens Bros. Dynamo Works, Melbourne, has been appointed engineer in the Sydney office of Messrs. W. Adams & Co.

Mr. V. L. Molloy has been appointed sub-station engineer by Sydney City Council at a commencing salary of £375 per annum.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—From the Roll of Honour of the Institution it appears that up to Nov. 20, 1915, 30 members have lost their lives in the service of the country. Of these, three were members, 13 were associate members, one was an associate, one a graduate and 12 were students.

Institution of Electrical Engineers (Students' Section).—On Thursday evening last Mr. J. E. Kingsbury delivered an address to the students of the Institution of Electrical Engineers. In opening the proceedings Mr. E. L. M. Emtage, the chairman of the Students' Section, thanked the members for electing him to the office of chairman for a second year in succession. He hoped that the students would concentrate around the Institution, so that when those of their members who were away in the fighting line returned they would find things in good order. Mr. Kingsbury took as the subject of his address "The Institution," which was founded in 1871.

He stated that scientific societies dated from a considerably earlier period. A club of scientific men which was formed in 1645 met weekly, and ultimately became the Royal Society. The object of that club was to interest its members in various investigations. In 1754 the Society for the encouragement of Arts, Manufactures and Industries was formed. Later on an interest sprang up in engineering, and thus the Institution of Civil Engineers was formed in 1818. In due time a tendency towards specialisation became evident, and one result of this was the formation of the Society of Telegraph Engineers, which soon became the Society of Telegraph Engineers and Electricians, and finally the Institution of Electrical Engineers. The formation of this body was not looked upon unfavourably by the older institution, which put their meeting room at its disposal. At that date over £10,000,000 was invested in submarine cables, and probably about £7,000,000 in home telegraphs, and, therefore, it was not inappropriate that a society should be formed to deal with this class of work. During the first year the membership numbered 110, and included Ronalds, Wheatstone, Cooke, Latimer Clark, and many other well-known men. Of these 24 were still among us, including Prof. Carey Foster, Sir John Gavey, Mr. Alexander Siemens, Mr. A. W. Heaviside, Mr. P. V. Luke and Mr. Rymer-Jones. There was also one student. As compared with these figures the last report of the Institution showed a membership of 6,811. Students' meetings were started in 1887. In 1899 Local Sections were formed, which had been extremely beneficial to the Institution, the members having thereby become more active than in any other society. The present home of the Institution was near the Savoy Theatre, which was the first theatre to be lighted electrically. This was effected by means of a portable engine of 60 H.P. driving four dynamos. There were 200 lamps which cost 25s. each.

Mr. Kingsbury called particular attention to the library of the Institution, on which a great deal of money had been spent during the last few years. It included the library of Ronalds, who, although a telegraph man, took a wide interest in scientific matters, and prepared a catalogue of all works relating to electricity. The library now contained not merely a number of rare books, but also a very valuable collection which would enable the students to gain information in any direction they desired. Mr. Kingsbury also emphasised the importance of "Science Abstracts." Turning to other matters, Mr. Kingsbury stated that the past had been bound up largely with individual inventions. Future advance, however, would depend more upon collective effort. It would, therefore, be well for the student not to cultivate what might be termed "the inventor's vanity." There was a great difficulty in arriving at the true value of one's own patents until they were submitted to some independent expert. In some cases it was more important to facilitate the inventions of other people than to prosecute one's own inventive ideas.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Dec. 17th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6:0 *p.m.* Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Paper on "Engineering Colleges and the War," by Dr. Walmsley and Mr. C. E. Larard.

ELECTRO-HARMONIC SOCIETY.

8:0 *p.m.* Smoking Concert at the Holborn Restaurant.

MONDAY, Dec. 20th.

JUNIOR INSTITUTION OF ENGINEERS.

7:30 *p.m.* Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper by Mr. W. A. Tookey, M.I.M.E., M.I.A.E., on "Modernisation of Power Plant in Factories."

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding : Lieut.-Col. C. B. Clay, V.D.

The following orders have been issued for the fortnight commencing December 20, 1915 :—

Drills : 6:25 to 7:25, 7:25 to 8:25 p.m.

Monday, December 20th.—Sections 1 and 2, technical ; sections 3 and 4, squad. Signalling Section and Recruits.

Tuesday, December 21st.—School of Arms with Architects, 6 p.m. to 7 p.m.

Thursday, December 23rd, to Thursday, December 30th, inclusive.—Headquarters closed.

Friday, December 31st.—Social evening, 6:15 to 8:15.

Saturday, January 1st. Uniform Parade.

Officer of the week : Monday, December 20th, to Saturday, January 1st, Mr. Corbett.

Platoon on Duty : Monday, December 20th, to Saturday, January 1st, No. 2 Platoon. Platoon on duty has to provide a piquet for H.Q. of one N.C.O. and three men, and also one N.C.O. for instructing recruits.

Sections for technical parade at Headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for Shooting Parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call at Samuel Brothers, Ludgate-hill, as soon as possible.

Payment for uniforms to be made to the Adjutant.

STANDARD MARINE ELECTRICAL INSTALLATIONS.*

BY H. A. HORNOR.

Summary.—The requirements of merchant and naval installations are cited in brief. Then follows the specific applications to a number of different types of ships, including both merchant and naval vessels.

The Committee on the "Use of Electricity in Marine Work," appointed by the American Institute of Electrical Engineers, has collected data on all the important points connected with marine electrical installations from as many different sources as possible, and in this Paper presents a monograph recording the best practice at this time in the United States. The rules and requirement for merchant vessels will be first treated; next will follow the general considerations for government vessels; and then a brief consideration of the applications to a number of different types of vessels.

General Requirements for Merchant Practice.

Merchant vessels are usually constructed in accordance with the requirements of some classification society, which establishes also the rules for the electrical equipment. Besides the rules of underwriting societies, the electrical installation must conform to the rules of the Steamboat Inspection Service, under the cognisance of the Department of Commerce. There are also requirements of the owners, which are usually specific, and serve to standardise for them the various equipments so as to reduce upkeep and maintain a similarity of spare parts.

The most important requirements of the American Bureau of Shipping for the electric plant are as follows: The voltage shall be about 125 volts, preferably direct current. If alternating currents are used there must be an increase of 50 per cent. in the insulation resistance of the wires. Generators and motors must be insulated by mounting them on dry wood or other equivalent insulation. No single wire larger than No. 12 A.W.G. is allowed, and no single solid wire smaller than No. 14 A.W.G., except in fixture wiring. Both conduit and wooden moulding for the protection of the conductors are allowed, but conduit is preferred throughout. Slate or marble switchboards are required, equipped with necessary instruments, cut-outs, knife switches, &c. Stuffing tubes are required wherever the conduit passes through a deck or watertight bulkhead. All joints and splices are protected by watertight junction boxes. Where exposed to moisture, lamps must be provided with a vapour-proof globe and for mechanical protection a guard. Lights must not be suspended with flexible conductors. Signal lights must be on a separate circuit and controlled in the pilot house from a tell-tale board which indicates a defect in the lamp or circuit. All leads to searchlights must run directly from the switchboard to a switch near the searchlight. To prevent the effect of electric currents on the adjustment of the magnetic compasses, both polarities must be carried in the circuit. The American Bureau of Shipping stipulate that on oil tank vessels electric lighting only is to be used, and that generating sets must be in duplicate, besides other special requirements.

The rules of Lloyd's Register differ slightly from the American Bureau. No preference is stated as to kind of current or the amount of voltage. "Double-pole" fuses are not permitted when the voltage exceeds 125 volts. Permission is granted, in addition to the use of wooden mouldings and conduit, for the employment of steel-armoured conductors secured by screwed clips. The switches on main switchboard must be of the quick-break design. The signal lights must be controlled from a point accessible to the officer of the watch, but a tell-tale indicator is not required. Single-wire system is not permitted on oil tank vessels. Compasses should be adjusted with and without the generators running. It is to be noted that the classification societies make no rules governing the installation of interior or exterior signalling systems.

The rules of the Steamboat Inspection Service relate more to the provision of appliances for protection to the vessel, her passengers, cargo and crew. Vessels which do not keep watchmen on guard day and night in the sleeping accommodations must equip such quarters with alarm bells which can be energised at will from the bridge or pilot house. Passenger-carrying steamers lighted by electricity, and whose dynamos are located below the deep-load line, must carry an auxiliary lighting system above the deep-load line, which must be sufficient to allow the passengers and crew readily to find their way to the exits. Vessels are permitted to carry gasoline to the amount necessary for providing such auxiliary lighting and wireless system.

From the foregoing it will be seen that the owner, for general methods of installation, needs only to state that the electrical installation must conform to the rules of the classification society. The owner then specifies what the requirements of his service are (*e.g.*, the number and size of the generating sets and the number of lights and motors).

* Abstract of a Paper read at the Panama-Pacific Convention of the American Institute of Electrical Engineers.

Merchant Marine Practice.

In general, the commercial installations in the United States combine wooden mouldings and iron conduit. The manufacture of steel-armoured lead-covered wires was started about four or five years ago, and was recently adopted by the Navy. Now the use of steel-armoured conductors in merchant practice is increasing. For vessels designed with the propelling machinery aft, requiring long leads to the amidships and forward compartments, it is necessary to provide a sliding connection for the conduit and a loop box for pulling in the wire. This is necessitated by the expansion and contraction or working of the structural parts of the vessel.

Except for very close work all conduits are bent cold, and with the exception of the termination of a lead elbows are not permitted. The restriction of fittings of all kinds is deemed advisable. For the purpose of overhauling and to facilitate the safe installation of the cables it is necessary to use, especially at bends, couplings, but these must not be right and left threaded. It is recommended that splicing of wires larger than No. 12 B. & S. be not permitted, and that even such small joints be made with a soldered sleeve. On the other hand, care must be exercised in the use of mechanical joints, as the working of the vessel may cause the connection to loosen, allowing "grounds," "opens" or "short-circuits."

The distribution of energy as above noted is made on a two-wire metallic system. Feeders are led from the main switchboard to centres of distribution, and from thence branch leads, not carrying, except in special cases, more than 660 watts. When conditions of the ship's structure or arrangement will not facilitate this method of distribution the feeders are broken by special feeder boxes of watertight construction, mains taken off and branches in turn taken directly from the mains. For the lighting system an allowable voltage drop of 3 per cent. from the main switchboard to the farthest light, and for power 5 to 8 per cent., is considered good practice. A potential of 110 volts is generally adopted in accordance with the standard incandescent lamp.

Generating sets are designed so that the prime mover and generator are direct connected and mounted on a common bedplate. In small vessels and freight steamers where the sets are of small capacity—say from 2 kw. to 20 kw.—the prime mover is a reciprocating engine. This unit possesses distinct advantages of operation from the practical side, as such ships cannot carry an engineer expressly for the care of the generating plant, and the chief engineer of such vessels is well skilled as regards reciprocating engines, as these are his means of propulsion. The manufacturers to-day have designed sets with forced lubrication and a combination of both forced lubrication and gravity feed, so that these sets operate ordinarily without much attention. There are three points of importance from a mechanical standpoint regarding generating sets. Firstly there must be ample reinforcement of the ship structure to form a foundation for the set. The builders' designers do not all agree as to the proper foundation, and in some cases the generators are bolted directly to the deck or platform, in other cases a wooden base is provided on top of the deck and again still others believe in building up a steel structural foundation on top of the deck and not bolting down the set until the vessel is nearly completed. Next, these sets must be able to operate either condensing or non-condensing with approximately 8 lb. to 10 lb. back pressure. They must exhaust either into the feed water heater, or the main or auxiliary condenser, or to the atmosphere. It is probable, because they are usually exhausted into the feed water heater for steam economy, that greater stress is not laid upon the efficiency of the prime mover. The third point is that for installation on shipboard the steam connections must be flanged so as to reduce the number of joints in the pipings, and because of the vibrations set up in the vessel when the main engines are working.

Small direct-connected turbine generating sets have been employed on shipboard and in certain installations have given satisfaction; but many marine engineers object to the high rotative speeds for direct-current generators and the lack of economy unless a high vacuum can be provided. On the other hand, some engineers prefer the turbine drive because of the reduction of upkeep and ease of operation. The use of reduction gears between the turbine and generator is now being suggested. Some of these sets, however, have shown, as expected, a great reduction in weight and water rate.

The material for switchboards has up to the present time been slate and in rare cases marble, but, as will be seen later, naval practice has turned to a special composition. This may shortly change the merchant practice. Ordinarily the circuits are arranged

for the parallel operation of the generators if there be more than one. Certain owners prefer separate operation, however, and then double 'bus bars are provided with throw-over switches. Marine switchboards must be built as compactly as possible, so that they may be mounted near a bulkhead. The 'bus bars, though mounted on insulation, are bare copper strips, and opinions do not concur as to the advisability of insulating the entire 'bus bar. Although it is a matter of expense, on switchboards handling 200 amperes or over from the main leads of the generating set, double-arm circuit breakers are provided instead of fused lever knife switches. The re-fillable fuse of proper design is now being introduced, but proper precaution must be observed to prevent unauthorised metals replacing the original.

On vessels of 4,000 tons burden or over the searchlight should not be less than 18 in. in diameter. The searchlight feeder is run direct from the main switchboard to a fused knife switch located usually in the pilot house near the controller of the searchlight. A variable external resistance is placed in series with the arc for proper adjustment. Up to the present time the lamp mechanism has been that of magnets operating through a ratchet on a screw, permitting both hand and automatic operation; but the naval projector lamp is now operated by a small motor, and it may be assumed that such will shortly come into merchant practice. For adjusting the arc voltage arrangements are provided on the main switchboard. To ensure against inductive disturbances from the wireless telegraph, the exposed leads of the searchlight must be carefully encased in an iron shield or wrapped with iron wire. This protective covering must be well grounded to the hull of the vessel.

The use of iron branch junction boxes and iron steam-tight globe fixtures meets with general approval, and the use of brass or bronze is looked upon as an expensive refinement. Foreign passenger vessels have for some time been using majolica or beleek fixtures, which add to cleanliness, are substantial, are more readily insulated and do not require re-finishing. The employment of indirect or semi-indirect units is very small. This is attributed to the low deck height and the usual exposure of the deck beams. Tungsten filament incandescent lamps are largely used outside of the machinery spaces, where the vibration is generally such as to require the carbon filament lamp. Cargo reflectors containing four small lamps are still used as portable units for lighting such spaces, as well as for gangway lighting. The tendency is toward great lightness for hand portable units, and a reduction in the number required to be watertight. The navy standard switch and switch and receptacle are generally used on merchant vessels. There has been but one good receptacle and plug designed for watertight work outside of the navy design, and this device is very expensive. The practice in the United States still adheres to the Edison screw socket, but a design on the lines of the Ediswan or bayonet type should prove more satisfactory.

Ordinary land motors are installed, but it would be unwise to continue this practice if the use of motors increases, as the upkeep to the owner would be such that the application would soon be discouraged. Motors should be designed so as to prevent oil from creeping along the armature shaft, a tendency when the ship rolls or pitches. Easy means for overhauling and the use of non-corrosive parts are essential. It seems that the owners of vessels in America are overlooking the advantages of economy in the lack of a more extended use of electric power. The question of first cost is easily counterbalanced by the reduction in upkeep, ease and readiness of service provided by the electric motor. The controlling devices for motors are similar to those of land practice, except that where exposed to the weather and located in the machinery spaces, water tight protecting boxes are supplied. To prevent unauthorised handling, non-water-tight sheet metal inclosing cases with padlock are provided in all cases.

Besides those systems of communication which are required by law the owner finds many adapted to the convenience of passengers and crew. Such systems should be energised preferably by a low voltage (20 volts) if used by passengers. The general opinion is that only direct current should be used. Many attempts have been made to utilise ordinary land telephones on shipboard but they do not seem to give the service desired. Special marine telephones are now being installed and carefully watched. A combined system of loud speaking telephones between the bridge and engine room and flat speaking for inter-communicating purposes appears to have some merit. The telephones for the bridge and engine room are made entirely water-tight and provided with double receivers of the watch-case pattern. All the telephones are made portable and of the hand microphone type, as experience has shown that the human body performs the function of a cushion to the ship's vibration better than any other device. Electric telegraphs for transmitting orders, from the bridge to the engine room, for sending docking orders, and so forth, are often installed on merchant vessels, but it is recommended that such instruments when needed should preferably be of the lamp type. The electrically-operated valve for the main steam whistle in addition to the mechanical hand pull is now frequently installed, even on freight vessels, and the clock mechanism is arranged with two contact discs so that the vessel may comply with the law when towing or being towed. In all such applications the object most sought after is simplicity and reliability.

Fire alarm systems are very rarely installed on freight vessels, but passenger vessels are always so equipped. The older systems have not proved of great value, but two systems are now on the market; one applicable to cargo carrying vessels by means of which not only is the location indicated by smoke coming from the compartment, but live steam is also admitted to the seat of the fire. This requires an expensive system of piping which is not always satisfactory. The other system operates on the principle of the expansion of air due to a rise in temperature. A pipe of very small inside and outside diameter is installed in all the compartments. The indications are given by the lighting of a small battery lamp, and the sounding of an alarm.

An increasing number of coastwise vessels now carry a submarine receiving set. This consists of two tanks filled with brine located in a lower forward hold of the vessel. Transmitters similar to telephone transmitters connect with double receivers located in the pilot-house —one receiver connecting to the port tank and the other to the starboard. The submarine bells located on the lightships or buoys along the coast may be heard through the water by this means, and the direction in case of for or thick weather detected by noting the equality or inequality of the strength of the signal on each tank.

Although wireless equipments are required by law on passenger vessels many freight vessels carry such equipment. The advances in this field are exceedingly rapid. A typical installation for freight vessels is as follows: A motor generator, running at 2,400 revs. per min., is supplied with energy from the 110-volt direct-current system. The alternator has 12 poles, and it generates a voltage of 500 at 240 cycles. On the same shaft is a disc discharger giving 480 sparks per second. The transformer steps up the 500 alternating volts to 12,000, and charges a condenser made of high quality glass plates coated with copper or tinfoil and immersed in oil. The primary of the oscillation transformer is connected in series with the gap and condenser. One end of the secondary coil is connected to the earth, and the other to the aerial through a variable inductance coil and condenser. The aerial consists of seven strands of No. 18 silicon bronze hard-drawn wire used to prevent sagging or stretching. The receiver consists of the tuner for tuning to resonance all incoming waves by variable inductances and capacities. The detector is generally of the carborundum crystal type mounted on the tuner. This set establishes reliable communication under favourable conditions over a considerable distance.*

Naval Practice.

Each bureau of the navy department of the United States compiles the requirements for the work under its cognisance, and in this manner provides for its inspection both at the works of the manufacturer, and at the plant of the contractor. All type plans issued by the Bureaus, whether of apparatus or for the construction work, are simply guides or schedules from which elaborated drawings must be made embodying correct designs and full details. These drawings must receive formal approval before work may proceed.

The use of iron conduit and open wiring supported on insulators has now given place to armoured conductors. There are conditions which require different types of wire so that the specifications permit of three general types, namely, plain conductors, armoured, and lead-covered armoured. The practice at the present time is to use lead-covered armoured cables for all permanent leads throughout all spaces in the vessel. Cables are, where possible, clipped rigidly to the structural parts of the vessel by strap hangers. These cables are sufficiently flexible to allow of close fitting or "nesting." In addition to these advantages is the reduction of upkeep over conduit due to a decrease in the deterioration of the insulation by its protection from condensed moisture. Stuffing tubes as in merchant practice but of special design are required when passing through decks or watertight bulkheads. In the vicinity of the magnetic compasses the steel braid is removed. No splices are permitted and mechanical joints are all made in specially-designed watertight brass boxes. All feeders for every purpose must be continuous throughout their length except in especially long leads of the larger size cables. The distribution of energy is on the two-wire system. The lighting, and small power feeders are run from the main switchboard to centres of distribution and mains led from thence to the terminal apparatus. Twin

* According to the author, 3,000 to 4,000 miles.—Eds.

conductors up to 60,000 circular mils. are permitted, and branch leads for lighting must not be less than 4,000 circular mils. The permissible drop on the lighting system from the main switchboard to the farthest outlet is 2½ per cent. and for power 5 per cent. The carrying capacity of all conductors is based on 1,000 circular mils. per ampere for continuous loads, and 500 circular mils. for intermittent loads. The permissible drop on the signalling systems is 2½ per cent. when lamp instruments are used, and not over 5 per cent. on circuits containing bells, buzzers, push-buttons, contact-makers, or similar apparatus.

Generators for naval service are generally direct-driven by steam turbines, mounted on a common bedplate. The turbines are of the horizontal type and designed for both condensing and non-condensing operation. They must be capable of operating the generator indefinitely at one-third overload. They are required to operate automatically with load varying from zero to 1⅓ load. They must function with the most economical water rate possible when supplied with dry saturated steam at 200 lb. pressure and 25 in. vacuum. Forced lubrication is specified for all sizes, and the largest sets have their bearings water-cooled. The generators are direct-current compound-wound, and in the larger sizes are supplied with commutating poles. At the present time the U.S. navy requires its generators on battleships wound for 240 volts, but for smaller craft retain a potential of 125 volts. In order to obtain increase in economy, reduction gears with high-speed turbines are now being installed and have received formal sanction. The change in voltage to 240 on the larger vessels has brought about the necessity for a neutral 'bus to supply the lighting and searchlight systems. This may be accomplished either by a three-wire generator wound for operation with a compensator; or an auxiliary independent rotary balancer set.

Until recently the switchboard panels were made of carefully selected slate. Now the requirements call for a special composition material having a high insulation resistance and unaffected by steam, or moisture, or shrinkage, when subjected to differences in temperature or hygroscopic changes and capable of a certain deflection without breaking. Enclosed fuses are approved if they conform to the general requirements of the national electric code. Renewable enclosed fuses are allowed under the requirement of a special specification for fuses.

For the larger vessels the U.S.A. Government furnish 36-in. distance control searchlights and 12-in. signal searchlights. The larger projectors are arranged so that some of them may be placed on trucks and transported about the decks. On the smaller vessels 30-in. and 24-in. searchlights, with mechanical distant control, are installed. All lamp mechanisms are of the motor type and both venetian blind and iris shutters are provided. The plain glass front frame is supported on springs so as to take up the shock of gun fire. A finder similar to that used on a camera is fitted so that it will show on a ground glass screen the arc, and by means of cross hairs enable the arc to be placed in the proper focal position and the carbons correctly adjusted.

Lighting fixtures and appliances are all made of brass composition and are heavier in every sense than the merchant marine type. However, the navy has now discarded the spring type of socket and adopted that used in commercial practice, with the difference that a special insulation material is provided for the base instead of porcelain. Prismatic glass globes are fitted in all steam-tight fixtures, and special shades are employed to direct and diffuse the light. Tungsten incandescent lamps are in general use, but locations greatly affected by vibration are lighted with carbon filament lamps. The high wattage tungsten lamp is used for the illumination of large spaces.

Motors are wound for either 120 volts on smaller vessels or 230 volts on the larger. For spaces and conditions where water or moisture cannot damage the apparatus open or semi-enclosed motors are permitted; on the other hand where exposed to the weather or moisture they are totally enclosed and of water-tight design. Non-corrosive parts and interchangeability are of great importance. Three types of control are now required in order to cover the various power equipments; namely, panel type controllers, drum-type controllers, contactor type controllers. Contactor panels usually being of large size are located below decks where they can be mounted like switchboards. They are operated automatically by a master controller which would be of the water-tight pattern if located on the weather deck.

Energy for the signalling systems is taken from the lighting 'bus bars, and transformed by means of small motor generators, or dynamotors, to a low potential (20 volts direct current). A special cable is designed for the general systems and one composed of like materials, but with the wires twisted and paired for the telephone system. The direct-current motor-operated instruments have superseded the lamp instruments almost entirely, and they seem to be providing very satisfactory service. Communication systems play an important part in the navigating of the vessel, in the transmission of general orders, and in the signals for gun firing.

(*To be concluded*)

THE DESIGN OF HIGH-PRESSURE DISTRIBUTION SYSTEMS.*

BY J. R. BEARD, M.SC.

Summary.—The author gives figures showing the cost of various systems of high pressure distribution to sub-stations, and shows that the interconnected system gives the lowest total cost, notwithstanding the higher cost of the protective devices.

The author first makes reference to the growing tendency to supply large power consumers with energy at high voltages, transformation taking place at the consumer's sub-station. Similarly, there is a tendency to split up low-tension networks into several sections, each fed by a separate sub-station. As the use of electricity increases, these sections will gradually decrease in area, thus approximating to the supply of consumers at high pressure. The utilisation of high-tension distribution is likely to increase, but the growth of such systems should be in size, not in number, so as to benefit by improved diversity factor. In the present Paper the discussion is concerned with the cable system for conveying electrical energy from the power station to the sub-stations and with three-phase systems.

The following are the items which make up the annual cost:—

1. Interest on capital expenditure. One method of reducing this is to obtain a low rate of interest, which can be secured by a permanent and steady business.
2. Repairs and provision for depreciation.
3. Switchgear attendance. This may be reduced by the close localisation of breakdowns, apparatus being employed of such a character as to prevent automatically any serious mistakes in operation.
4. Energy losses in the mains. Apart from capital expenditure these can be reduced by linking up the various parts of the system.

The present Paper is divided into the following sections:—

I. The important points in the choice of individual apparatus: (*a*) Mains, (*b*) switchgear.

II. The methods by which such apparatus may be most economically utilised, the consideration of which naturally falls into three successive stages. The basis of the investigations is:—(*a*) The determination of the economical section of mains; that is to say, the correct balance between losses and capital expenditure.

From this it is possible to consider progressively: (*b*) The lay-out of the distribution system to give the maximum economy. (*c*) The most suitable distribution voltage.

Mains.

Underground mains are preferable from the point of view of security, but it is found in practice that the average number of serious breakdowns per mile of overhead mains is only about double that of underground mains. Overhead mains are far more liable to cause temporary interruptions of supply by being automatically disconnected. The advantage of lower capital cost tells in favour of overhead mains when the transmission voltage is high and the size of main is large, but for low voltages and small sizes there is not much to choose between the two systems. Overhead mains have also the following disadvantages:—

(*a*) *The Necessity of Wayleaves.*—The objection here is not so much the cost, as the trouble and delay in obtaining them and the fact that they cannot simply be bought outright.

(*b*) *Inductive Drop.*—This is much greater than that of an equivalent cable, since the inductance varies as the logarithm of the distance between the conductors. With a lagging power-factor the drop may become serious, particularly in the case of heavy section lines. To some extent this disadvantage is minimised by the fact that for economy overhead mains should be run at a lower current density than cables.

(*c*) *Running in Parallel with Cables.*—The difficulty here is that if a cable and an overhead line of an equal section are connected in parallel, the higher inductance of the overhead line causes the total current to divide unequally between the two circuits. This not only prevents the two circuits being run at their most economical current density, but makes the losses greater.

* Abstract of a Paper read before the Institution of Electrical Engineers.

(*d*) *Power-factor.*—Overhead mains tend to lower the power-factor of the system as a whole.

Switchgear.

The primary function of switchgear is to isolate faulty apparatus, and consequently to interrupt or prevent heavy short-circuit currents. Owing to the difficulty of carrying out experiments on a large scale, switch design is a gradual process of feeling one's way. At one time it was held that the explosion of oil switches was due to the ignition of explosive gases rising to the surface of the oil. It has been proved, however, that a switch designed to withstand the maximum explosive pressure of the gases may be unable to withstand a short-circuit with unlimited power behind it. It seems that the rapid generation of gas beneath the surface of the oil causes such a shock that the pressure cannot be relieved and is transmitted before the oil has an opportunity to move at its free surface. It is, therefore, necessary either to reduce the intensity of the explosion or to build a switch strong enough to withstand it. The former is the less expensive method, and consequently recent practice has tended towards quickening the break by decreasing the inertia of the moving parts and by means of powerful springs. Attempts have also been made to use the magnetic forces of the current. One of the most interesting suggestions is the idea of having two arcs, electrically in series, but arranged parallel and close to each other, the currents flowing in opposite directions, so that there is a repulsive effect between them proportional to the square of the current.*

Reactance coils for the purpose of cutting down a short-circuit current do not seem to be a correct method, as they are only in the

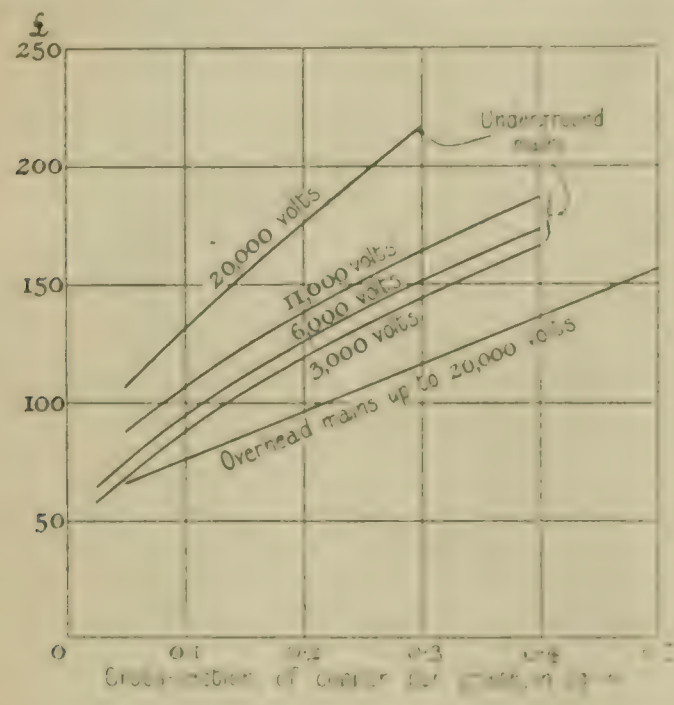


Fig. 1.—Annual Cost of Interest and Depreciation for Various Types of Three-phase Mains (per Mile).

nature of a palliative. Switchgear is the most vital part of the system, and it is imperative that it should be a sound job, any saving in capital expenditure being dearly bought if it in any way increases the risk of breakdown. One common error is to save money by proportioning switchgear according to the capacity of the apparatus which it controls, forgetting that short circuits may be as great on small apparatus as on large.

Faults of switchgear fall into three categories—namely, (1) faults under short circuit conditions, (2) failure under normal conditions, (3) failure due to mistakes. Even though a switch should explode it will often interrupt a circuit, and should, therefore, be isolated, so that other short-circuits will not be produced by the products of the explosion. The large mechanical forces brought into play must also be remembered, and the fusing of connections, more particularly in current transformer windings. Failures under normal conditions can generally be guarded against. A frequent cause of trouble is the potential transformer, which should not be connected to the bus bars without an oil switch. With regard to mistakes in operation, foolproof arrangements should be provided, also interlocks between oil switches, and corresponding isolating switches and arrangements should be made to facilitate the routine earthing of feeders.

The Economical Section of Mains.

Although it is generally known that the economical cross-section of a main is that at which the sum of the annual charges and the value of the energy lost is a minimum, it is seldom that any practical use is made of the formula. This is partly owing to the difficulty of calculating the losses and of placing the correct value upon them when calculated, and also partly because there is an impression that the resulting cross-section would work out to a figure inconsistent with that required by considerations of carrying capacity and voltage drop. In the following investigation an attempt is made to apply the formula to the special case of high-pressure distribution systems, and this seems to show that, for this case at any rate, the results are commercially useful.

The annual charges which have been taken for underground and overhead mains at various voltages are shown in Fig. 1. These are based on average commercial prices, allowing interest at the rate of 5 per cent. per annum,* and depreciation at 2 per cent. for underground mains and 3 per cent. for overhead mains, suitable allowance being made for trench work in the former case and for wayleave charges in the latter. With compound interest at 5 per cent., the rates allowed for depreciation are sufficient to enable the underground mains to be replaced after 22½ years and the overhead mains after 17½ years, allowing a scrap value of 20 per cent. in each case. It is probable that these figures considerably under-estimate the life of mains, but conservative values have been taken so that there may be no question of the importance of capital charges being minimised.† It will be noticed that in the case of overhead mains only one curve is given, as up to 20,000 volts the difference is in the insulators, and this is so small that it is usually worth while to make the line suitable for 20,000 volts, although it may only be intended to operate it at a lower voltage. Higher voltages than 20,000 will not be considered, as the design and manufacture of apparatus for such

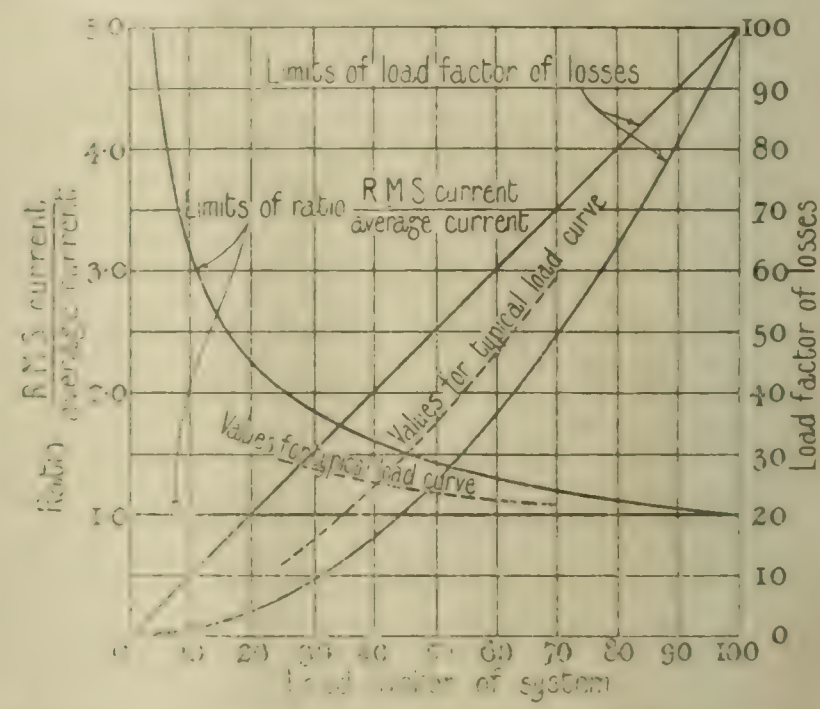


Fig. 2.—Effect of Shape of Load Curve on R.M.S. Current and Load Factor of Losses.

higher voltages is not sufficiently standardised to enable definite annual charges to be assumed.

The only losses which are important enough to be taken into account in this investigation are the resistance losses in the copper conductors; and in estimating their value it is necessary, as in all estimates of the cost of producing electricity, to take account of the effect of the addition of the load considered to the normal load of the system.

In order to obtain definite figures as to the value of the energy lost, certain fundamental data must be assumed, and accordingly a system has been taken having a maximum load of not less than 50,000 kw. and an average load factor of 50 per cent., figures which fairly closely correspond to what may be expected if the system deals with the general demand over a reasonably extended area.

From an analysis of the fixed and running charges the cost per unit of generating the losses at the power stations can be calculated, and to this must be added the fixed charges on the increased capacity of the distribution system necessary to transmit these losses. Since the power stations can seldom be located at the exact electrical centre of gravity of the load, the losses have to be transmitted, on the average, over, say, two-thirds of the distribution system, and should, therefore, bear two-thirds of the fixed charges of the latter. Taking

* Hunter and Shand, British Patent 11,586, 1912.

* This is assumed to be a reasonable figure for a sound industrial concern operating on a fairly large scale; municipalities and similar bodies would usually be able to obtain their capital at a somewhat less rate of interest.

† No allowance is made for repairs, as these consist almost entirely of jointing and labour, which are independent of the cross-section of the main.

the cost of the distribution system as two-thirds that of the power stations, the value of resistance losses on the typical system considered is about 0·25d. per unit.

Since the resistance losses over a given time are proportional to the mean square of the current, it is very necessary in calculating them to take account of the shape of the current load curve. The ratio of the R.M.S. current to the average current must be taken into account. The full lines in Fig. 2 show the extreme values of this ratio for different load factors, and the dotted line the approximate values for the usual type of load curve ; corresponding extreme and usual values for the load factor of the losses are also indicated.

On the system which we are considering, the load factor of the mains nearest the power stations will not be much less than the system load factor—viz., 50 per cent.—but for mains on the outskirts it will be much less, probably as low as 30 per cent. Over the whole network the average would probably be about 40 per cent., and it will be seen from Fig. 2 that the corresponding R.M.S. current would be 1·25 times the average current. Calculating the losses on this basis, and taking their value as 0·25d. per unit, the annual value of the losses per mile of three-phase main is £0·000296 I^2/A, where I is the maximum current in amperes and A is the cross-sectional area of the conductor of each phase in square inches. The value is expressed for convenience in terms of the maximum current, since mains are usually laid to suit a given maximum current.

By adding the curves of annual charges and value of losses for mains of various sizes for any particular maximum current a curve is obtained of the type shown in Fig. 3, which refers to a 6,000-volt underground cable required to deal with a maximum current of 100 amperes. The most interesting feature of this curve is that the most economical section is not very definite ; it is actually 0·09 sq. in.,

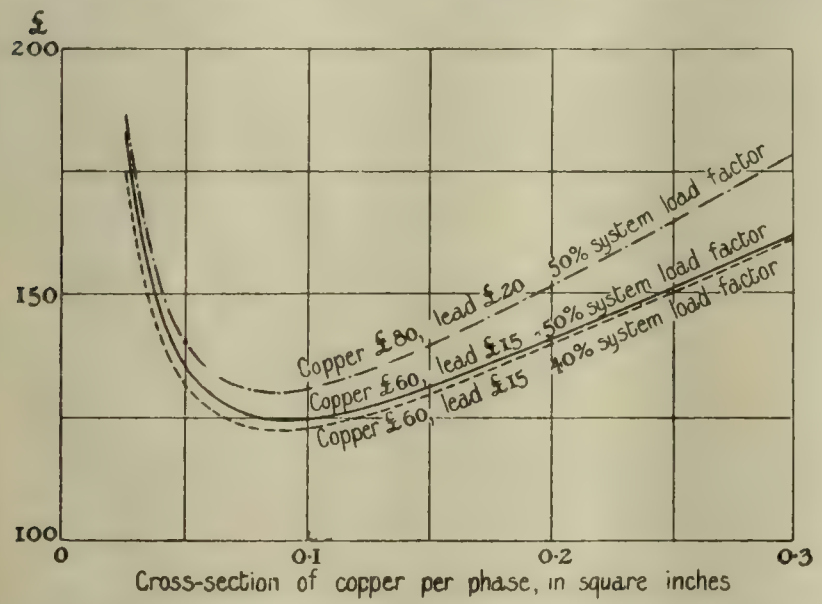


Fig. 3.—Combined Annual Cost of Interest, Depreciation and Energy Losses per Mile of 6,000-volt Underground Main carrying a Maximum Load of 100 amperes.

but for 2½ per cent. increase in the total annual costs the section can be increased 44·5 per cent., or decreased 27·2 per cent., the corresponding figures for 5 per cent. increase in annual costs being 65·5 per cent. and 36·1 per cent. respectively. It follows that it is not sound practice to cut the section of mains too fine, more especially since it is a most expensive matter after a main is once laid to increase its carrying capacity if this should prove too small. Curves are included to show the effect of a different load factor and of the prices of copper and lead.

Curves are given in the original Paper showing the maximum currents for a given section of copper. Except for 20,000 volt cables the economical section gives an overload margin of as much as 100 per cent. in nearly all cases, and even for 20,000 volt cables a considerable margin exists, so that it is quite permissible to settle the cross-section of mains on the basis of maximum economy. That it does not pay normally to operate cables at the maximum current density allowed by heating limits is of interest, since it means reduced voltage-drop per mile and consequently an increased radius of distribution for a given voltage.

From the series of curves used in determining the economical sections it is also readily possible to find the minimum annual costs of interest charges, depreciation and losses per mile of main for given maximum currents, on the assumption that the economical sections which correspond to those currents are used. If an allowance for repairs is added, the resulting figures will give the total minimum annual cost per mile of main, thus providing a definite basis on which the relative economy of alternative arrangements of mains can be determined. The curves in Fig. 4 have been obtained in this manner, the allowance for repairs being taken as a certain percentage of the cost of a 0·15 sq. in. main, since repairs consist almost entirely of jointing and labour and their cost is, therefore, independent of the cross-section. The percentages which have been taken are 1 per cent. for underground mains and 2 per cent. for overhead mains, but these must only be looked upon as approximations, since the cost of repairs depends on so many conditions.

The Lay-out of the Distribution System.

For the protection of sub-stations some form of discriminating protective device must be installed in each feeder, and a fault on one feeder must not interfere with the supply through a sound feeder. The balanced current protective system with pilot wires and the split conductor protective system are the only forms of protection which meet these conditions. They increase the cost per mile of main of a given section, but this is counter-balanced by the possibility of using an interconnected system, allowing of (*a*) reduction in cost of mains due to the saving in spare feeders, (*b*) reduction in cost by using a few large feeders instead of many small ones, (*c*) reduction in amount of switchgear, and (*d*) reduction in the total annual cost of mains, owing to the effect of diversity factor.

In the case of high-pressure distribution system on the North-East coast no less than 350 sub-stations are interconnected in this way and fed by 15 power stations. For a period of time selected at random, faults occurred on 23 feeders equipped with automatic protection, and in 22 cases the faulty feeder was instantaneously isolated without causing an interruption of supply to a single sub-station, except in one case where the sub-station was given a non-

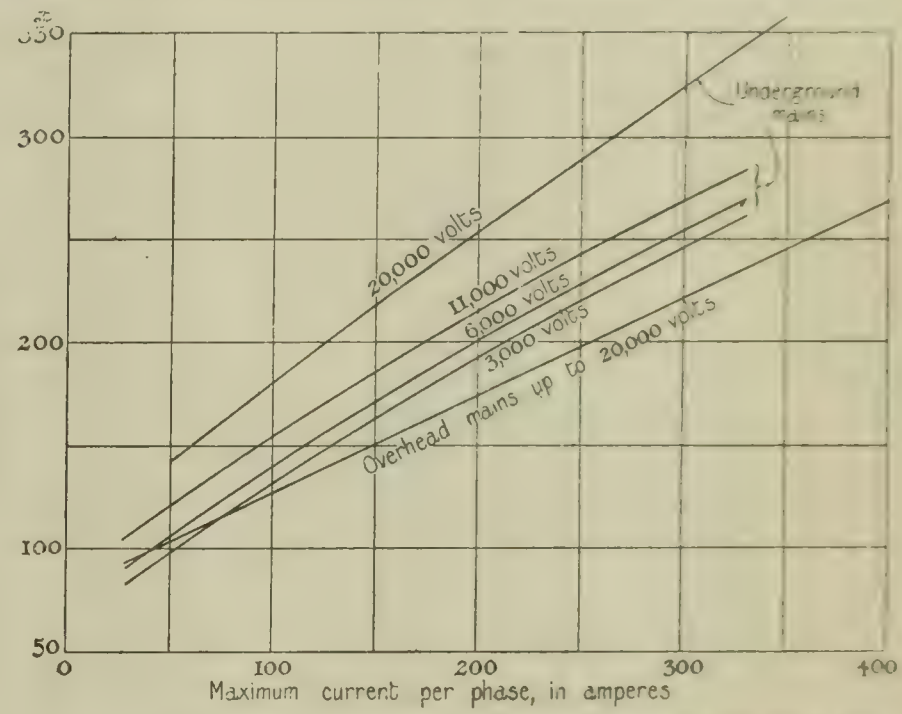


Fig. 4.—Minimum Total Annual Cost per Mile of 3-phase Mains for various Maximum Currents.

duplicate supply through the faulty feeder. In another case one of the feeder switches failed to open due to a mechanical fault.

The author gives an investigation showing the saving to be effected by interconnection. In order that the results may be on the conservative side the extra cost of the special protective devices has been taken at 10 per cent. on the switchgear, including building accommodation, and at 2s. per yard on the mains, which is sufficient to cover the cost of balanced current protection and decidedly more than sufficient to cover the cost of split-conductor protection. In the first place a comparison is made between the three following types :—

1. An interconnected system equipped with balanced current or split-conductor protection of a fault on a feeder.

2. A simple radial system with duplicate feeders direct from the power station to each sub-station, equipped with time-limit overloads at the power station end and reverse power relays at the sub-station end.

3. A series radial system with duplicate feeders to each sub-station protected as in 2, but with direct feeders from the power station to only half the sub-stations, each of these in turn feeding one of the remaining sub-stations.

For the purpose of the comparison a typical case is assumed of an area of 25 square miles with the power station at the centre and a sub-station with a maximum load of 500 kw. at 0·8 power factor and a load factor of 30 per cent. situated at the centre of each square mile, the distribution being effected by underground mains at 6,000 volts. It is assumed that owing to the diversity between the various sub-station loads the power station load-factor will be 50 per cent., and the average feeder load-factor on an interconnected system 40 per

cent. The average maximum feeder currents are, therefore, deduced by assuming the sub-station maximum demand to be reduced in the ratio of the sub-station load-factor to the average feeder load-factor. This only holds for the interconnected system, but in the first instance the same reduced sub-station demands will be taken for other types of system, *i.e.*, the advantage which an interconnected system gains from its utilisation of diversity is neglected.

The annual cost per switch panel is taken from Fig. 6, and the annual cost of the mains from Fig. 4, the proper deductions being made in the case of types 2 and 3 for the omission of the special protective devices. Table I gives the comparison.

Table I.

Type of system.	Reference to Figs.	No. of switches	Mileage of mains	Annual costs.	Percentage increased cost over interconnected system.
Interconnected	9 (*a*)	64	32·0	£4,752	—
Simple radial ...	9 (*b*)	96	93·7	7,664	61·3
Series radial ...	9 (*c*)	96	61·2	6,075	27·8

In certain cases where momentary interruption of supply is not of great importance a " tee " system has been used. This also is more costly. The cheapest system for comparison giving reasonable

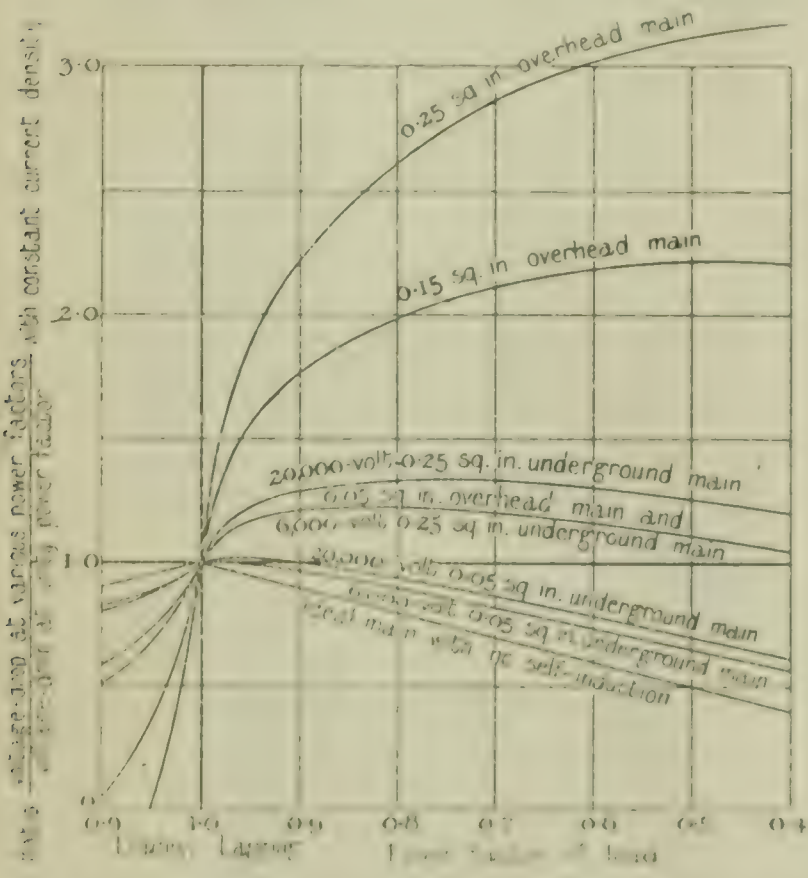


Fig. 5.—Effect of Inductive Drop at Different Power Factors for Various Mains.

security is the series radial system under various conditions. This shows that this is always considerably more costly than the interconnected system.

The outstanding features of this comparison are :—

(*a*) The economy of the interconnected system is generally maintained.

(*b*) The saving effected by an interconnected system rapidly increases as the area of supply is enlarged. This is important as only relatively restricted areas have been considered.

(*c*) The saving is greatest for lightly loaded sub-stations and decreases as the sub-station loading increases. In the case of the most heavily loaded sub-station it would appear at a first glance that while the interconnected system may have other advantages its direct economy is very small. This is only apparent, for in the first case the saving due to diversity has been ignored, and, secondly, the voltage should be higher.

The possible further savings which may be effected if diversity is taken into account have been considered, and without going into details of the calculation it may be taken as adding something of the order of 4½ per cent. to the cost of a simple radial system, and rather less to the cost of a series radial system.

When comparing an interconnected system with other types, two further points must also be borne in mind. (1) It is a very difficult matter exactly to forecast sub station maximum loads or, as in the case of railways, definitely to fix the allocation between the various sub-stations. (2) The greater part of the saving effected by an interconnected system is in the trunk feeders, and in consequence it is more marked the farther the power stations are removed from the centres of load.

So far the investigation has been limited to the comparatively low voltage of 6,000; but, speaking generally, the higher the system voltage the greater is the economy to be obtained by interconnection. This is obvious if it is remembered that—

(*a*) The higher the voltage the less is the proportionate cost of the protective devices, which is practically independent of the voltage.

(*b*) The higher the voltage the smaller is the section of the mains for given loads, and consequently the greater the advantages offered by intercommunication in reducing the total length of main sand increasing their average capacity.

The Most Suitable Distribution Voltage.

In settling the distribution voltage the primary consideration is that it shall be sufficiently high to ensure that the voltage variation at the boundaries of the supply area can be kept within a reasonable amount without putting an excessive amount of copper in the feeders. It is usually desirable that the voltage variation should not exceed 5 per cent. either side of the normal, *i.e.*, a total of 10 per cent., and from this about 2½ per cent. should be deducted for transformer voltage drop, leaving a permissible maximum drop of 7½ per cent. in the high-pressure mains.

As the power factor of most distribution systems is less than unity it is also necessary to take account of the inductive voltage drop. Fig. 5 shows, for several typical sizes of both underground and overhead mains at various voltages, the relative amount by which the inductive drop increases the total voltage drop at various power factors. The calculations are based on a frequency of 50 cycles per second and on a constant current density, since the economical value for the latter is independent of the power factor. They also assume the use of ordinary three conductor mains; if arranged for split-conductor protection the inductive drop would be appreciably reduced.

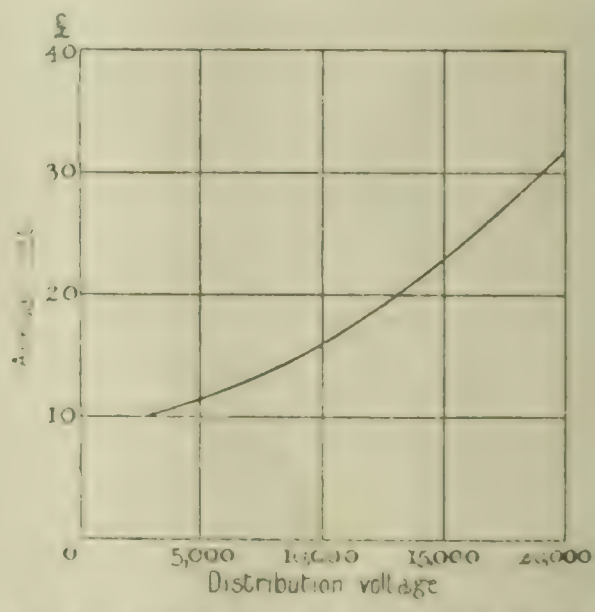


Fig. 6.—Annual Cost of Switchgear per Panel.

It is evident that the maximum radius of distribution and area of supply at a given voltage will vary according to the power factor of the system and to the various factors which determine the inductive drop. It is, however, not sufficient to settle the distribution voltage on the basis of permissible voltage drop alone. It is also important to choose that voltage which gives the cheapest distribution system, and from this point of view it may often pay to use a voltage much higher than that which is required by the conditions of voltage drop. Generally speaking, the higher the loads which have to be dealt with the higher is the economical voltage; but it is also necessary to take into consideration the proportion between the total number of switches required and the total mileage of mains, as the cost of switchgear increases with the voltage. Fig. 6 gives fairly safe figures for the annual cost per switch at different voltages on the basis of annual charges of 8 per cent. on the switchgear and the corresponding building accommodation, and these figures have been used in the following investigation.

Taking a system comprising 24 sub-stations evenly spaced and allowing an average of 2½ switches per sub-station for controlling the step-down transformers, the total annual cost of switchgear and mains has been calculated for various distribution voltages and various sub-station loadings. In addition, the spacing of the sub-stations has also been varied so as to give several comparative proportions between the number of switches and the mileage of mains.

From these results the series of curves given in Fig. 7 have been plotted showing the most economical voltage under the varying conditions.

As might be expected, Fig. 7 shows that the heavier the loads to be supplied and the more they are concentrated the higher is the most economical voltage. It should be noticed that the curves show no signs that at 20,000 volts the maximum economical voltage has been reached, provided the system loading is heavy enough, and

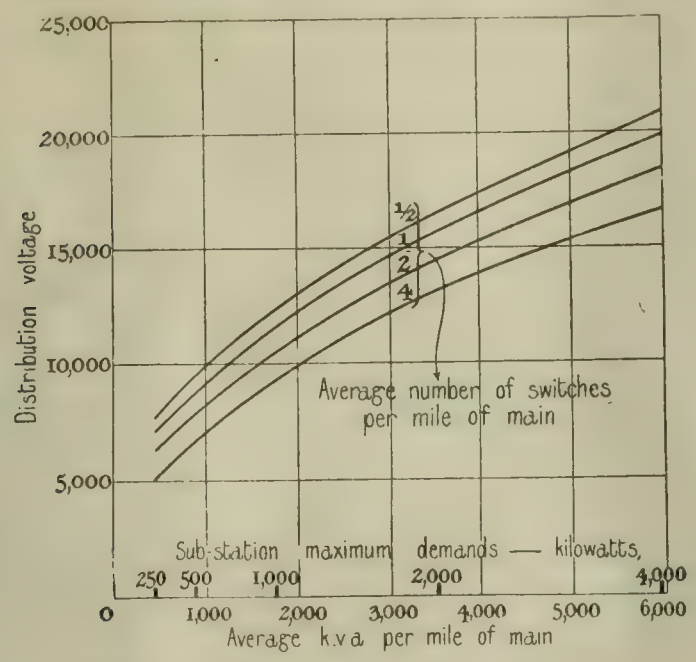


Fig. 7.—Economical Distribution Voltage.

hence for the larger systems of the future we may expect that for economical reasons alone the distribution voltage will be raised above 20,000 volts. These calculations only refer to underground mains; with overhead mains the economical voltage will be higher, since there is so little difference between their cost at various voltages.

THE NEW YORK MUNICIPAL CAR.

Summary.—The cars described have electro-pneumatic push-button door control, interconnected with an arrangement to vary the braking force with the load. A new and scientifically shaped seat is also employed. Cab-signals are used with an automatic braking system, including speed control.

The latest cars of the New York Municipal Railway Corpn. possess some unique features which have been described in the "Electric Railway Journal."

Among these is the "empty-and-load brake attachment," by which the capacity of the auxiliary brake reservoir is varied according to the load of passengers the car is carrying. By an interconnection with the door control gear this variation is accomplished when the doors are open and the car is at a standstill, the controlling factor being the extent to which the car springs are compressed. The effect of the arrangement is so to adjust the pressure in the brake cylinders by varying the capacity of the air reservoir that the most efficient retardation is imposed with any loading of the car. The mechanism is also connected with the starting relays so as to alter the current input and to control the acceleration.

The New York municipal car has three pairs of sliding doors on each side and a single door at each end. One operator stationed on either side of the car midway between the two middle doors is able, by means of a push-button board, to operate all doors on the side nearer to him, and also to operate both end doors from the same position. In all, each car has 14 door engines and eight electro-pneumatic valves. The doors can also be operated by hand, and the two end doors and each pair of middle doors can be opened or closed by means of push buttons outside the car.

The doors will operate at main reservoir pressures of 80 lb. minimum to 100 lb. maximum. It was specified that all door mechanism must be capable of making 300,000 strokes in service between applications of lubricant. It is also specified that all door engines should be capable of opening the doors in one and one-half seconds from the time that the operator pushes the button, and of closing them in two seconds. To ensure non-injurious closing, a spring has been interposed between the piston and the door, whereby the door is operated with a cushioning effect in addition to employing the usual rubber cushion at the edge of the door. The door-operating mechanism, built by the Consolidated Car Heating Co., embodies some valuable improvements to meet the New York municipal requirements.

A buzzer signal circuit replaces the slow and obstructive bell cord. The buzzer push buttons are mounted just above and on the same panel as the door-control buttons. This signal circuit is so wired that the guard who pushes his buzzer button transmits the signal no further than to the buzzers in the forward cab of his own car and the rear cab of the car ahead. In this manner the signal is transmitted ahead from car to car. The circuit is closed by means of interlocks operated by attachments on the doors.

The motorman depends upon the buzzer circuit only at such times as the light signal in the operating master-controller is out of order. These lights burn only when all the doors in the train are closed. The light signal consists of two lamps of 6-volt automobile type, and as but one is in use at a time the possibility of total failure is very remote. The second lamp goes automatically into circuit when the first one burns out. At the doors are fitted emergency lamps fed from the storage battery and cut in automatically by a voltage relay when there is no power on the line.

The marker and tail lights are interconnected with the control circuit in such a way that when the motorman changes his end, his tail lights automatically change from white to red as soon as he throws the reverse handle to the centre position, and the red lights turn to white on throwing the handle to the operating position. Should the train be broken up en route in any way, the tail lights will go red at the point of breaking. This is accomplished by combinations of the automatic coupler with the control

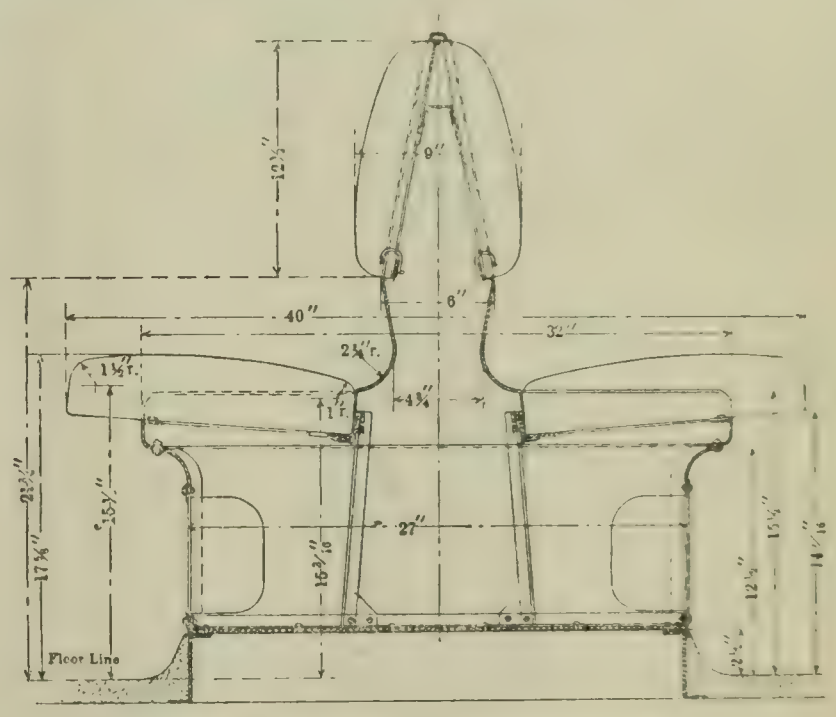


Fig. 1.—Detailed Dimensions of Correct Posture Cross-seat.

The heating equipment per car totals 21 kw. capacity divided among 30 heaters. Piping and wiring connections for thermostatic control have been installed in view of the possible later use of thermostats.

A radical departure has been made in the rattan car seating. The seats are of the design shown in Fig. 1, in developing which the engineers were assisted by the American Posture League, an organisation of experts on hygiene and anatomy. The distance from the highest point of the unoccupied seat cushion to the floor is 17⅝ in., approximating to the League's ideal figure of 17¼ in. A still more important feature is that the back is so shaped that the rattan section begins at a height of about 5 in. above an inwardly curved metal section which forms the base. This formation of the back allows the lower part to fit the natural curve of the human spine, while the upper part gives a proper support for the back. The result is to place the passenger in the most restful position. Since his body is properly balanced, he is also less likely to be disturbed by any sudden lurching of the car.

Each car is equipped with a cab-signal system so designed as to give the motorman necessary information as to when to apply the brakes, when to resume normal speed, the permissible speed, the available braking distance, and such other information as is necessary properly to control the train. In addition to the signals, each car will be equipped with a speed-control system which automatically applies the brakes if the motorman fails to obey the cab-signal indications. Also, the system is arranged so as to enforce obedience to fixed interlocking signals by automatically applying the emergency brakes if a train should attempt to pass such signals in the stop position.

Cab-signal indications are given by two lights as follows: A green light indicating "proceed" when the next two blocks ahead are clear; and a yellow light indicating "caution" when the next block ahead is clear and the second block ahead is occupied or is governed by an interlocked signal indicating "stop," or when the train is on a down grade or curve or when it has some other fixed hazard.

The audible signal, provided in each motorman's cab, is so designed and interconnected with the speed-control mechanism that it sounds sufficiently long in advance of the automatic speed-control application of the brakes to permit the motorman to control his train so as to avoid the automatic application of the brakes. An indication is given in each motorman's cab to show the maximum allowable speed and the distance within which, succeeding the giving of a caution signal, the speed of the train must be reduced to the prescribed minimum to avoid the automatic application of the brakes. When a train runs into an unsignalled section of track a distinctive indication is displayed in the motorman's cab, and the cab signals and speed-control equipment are automatically put out of service and automatically return to service when the train again enters the signalled section.

The speed-control equipment does not interfere with the operation of the train so long as the motorman runs his train according to the indications of the cab-signal; but if the motorman fails to obey the "caution" signal the speed-control apparatus enforces obedience by automatically applying the brakes, but only when and if the speed of the train at any point exceeds that prescribed by the predetermined braking curve. When a train running at a speed not exceeding the prescribed minimum approaches a clear block its speed control apparatus is, prior to entering the block, automatically re set in such a manner as to permit the train to accelerate. If a clear block is succeeded by an occupied block, the train is permitted to accelerate, slowing down should the speed thus acquired exceed that established by the predetermined braking curve. If a clear block is succeeded by another clear block, the train is permitted to attain normal speed.

The speed-control and cab-signal equipment is actuated by means of ramps located adjacent to the tracks at such points as provide the required track capacity and facility of operation.

The cab-signals are block signals, and indicate the condition of the blocks in advance; at crossings, junctions, terminals, &c., fixed signals, which are of the light type, are used to indicate the route set up. Should a train pass one of these signals at "danger," the emergency brakes are applied automatically.

Fig. 2 shows the principle of the signal system. At one end of the track circuit a transformer, T, supplies electric energy which flows through the track circuit, and, when the block is unoccupied, energises track relay R, and its front contact closes a circuit from battery B, or some other source of electric energy. Hence, when a car is at a ramp, as in this case, current flows through the ramp, through the contact shoe S, and then through the car relay C causing its armature to pick up, and back to the common return by way of the car axle and one of the track rails. In this condition current from the battery D flows through and energises the green light G of the cab signal, which gives the "proceed" indication. Energy from battery D also flows through and energises magnet E. After the train has passed an energised ramp a retaining circuit is established by way of contact A, so that current from the battery D energises the car relay C and the green light or "proceed" signal continues until the next ramp is reached.

If the track section were occupied, track relay R would be de-energised, and as a result the ramp, also the car relay C and the magnet E, would be de-energised. In this condition current from the battery D flows through and energises the yellow light Y of the cab signal to give the "caution" indication.

Magnet E controls the speed-control apparatus, which operates in the following manner: The rotating motion of the car wheels is transmitted by means of the bevel gear shown in the drawing to shaft J, on which is mounted a centrifugal device so connected that, as the speed increases, the arms K and L are moved to the left. The worm H is driven through the medium of shaft J, and is held out of engagement with the worm sector N by the attraction of the magnet E. When the magnet E is de-energised the worm H engages with the worm sector N, causing the cam M to move forward against the action of gravity. The shape, speed and general arrangement of cam M are such that if the speed of the train is not reduced, succeeding the giving of a caution indication, the surface of cam M, coming in contact with the lever L, opens the contact Q and the audible signal warns the motorman to apply the brakes.

If the motorman promptly applies the brakes, arm L moves to the right, away from the cam M, thus preventing the opening of the contact U and the consequent application of the brakes. If, however, the motorman fails to obey the audible signal, the contact U opens and an emergency application of the brakes occur.

Upon reaching the next energised ramp the magnet E is energised, which disengages the worm H and the sector N, and cam M is restored to its normal position by the action of gravity, thus restoring the speed-control system to the normal condition which allows the train to accelerate. If the next ramp is de-energised, the train may proceed through the block only at minimum speed, which minimum speed is determined by the maximum radius of the cam.

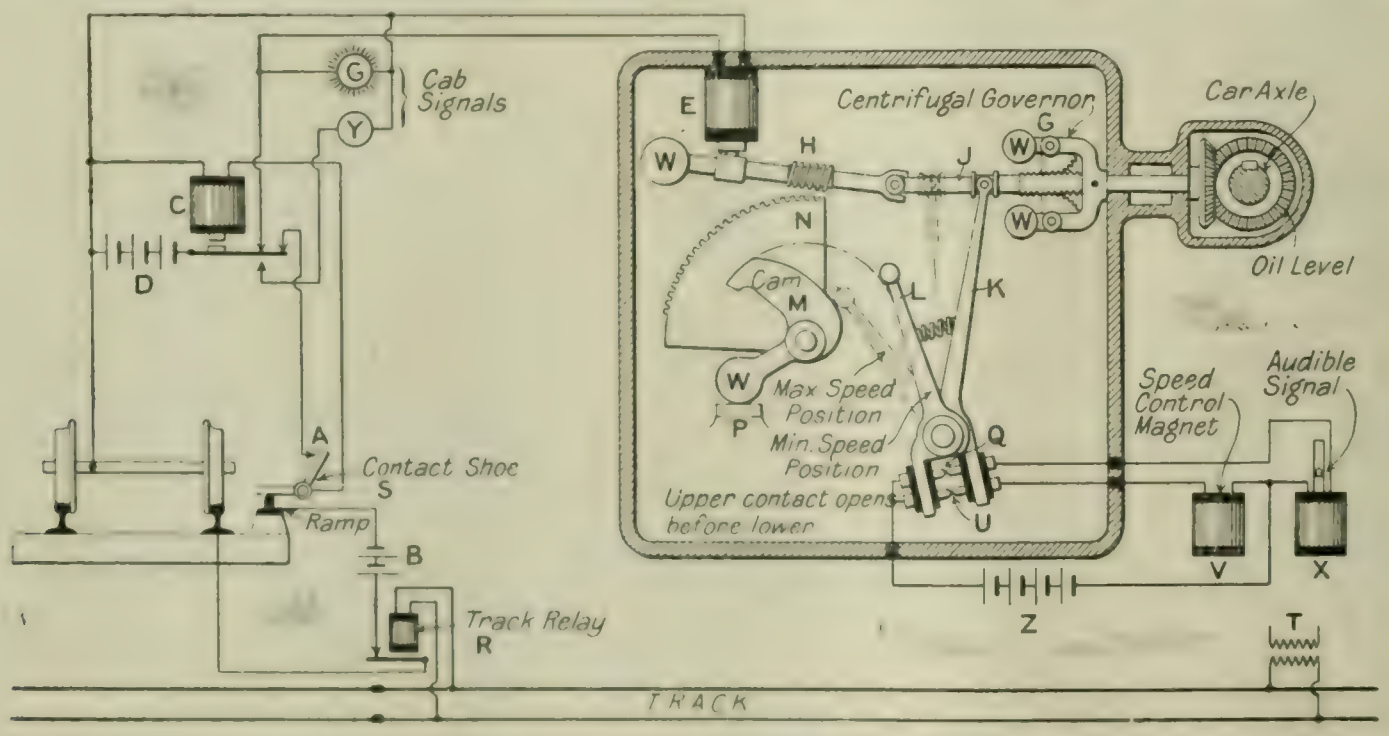


Fig. 2.—Diagram Showing Operation of Speed Control System.

There is also a "selector," which sets up the various "block combinations" and indicates the same to the motorman. Combinations are set up by selector ramps in the centre of the track, which lift up one or more of the tappets on the lower part of the selector. When lifted the tappets latch up and are so held until a new combination is set up, at which time the former combination is knocked down by the centre tappet. Complete information is given in the cab as to the point at which speed reduction must take place, in order that a lower speed combination may not be set up prematurely and apply the brakes. For example, if the change is to be from a combination of 50 miles per hour and 1,600 ft. braking distance to a combination of 20 miles per hour and 400 ft. braking distance, first, a "caution" signal is given to the motorman so as to allow him to reduce speed, and, after the speed is properly reduced, the new combination becomes effective, and a "proceed" signal is given, provided that conditions in advance are proper. If the motorman fails to obey the indications shown in the cab, an automatic application of the brakes occurs.

The contact shoe for the speed control is of the lifting rotary type, in which the disc makes contact with the ramp and travels over it with a scrubbing movement which ensures a smooth contact surface. The cab signal and speed control system requires a comparatively small amount of simple, substantial and efficient apparatus, and affords the maximum traffic capacity consistent with safety.

TEMPERATURE LIMITS FOR MICA INSULATION.

An abstract of Mr. F. D. Newbury's Paper on "Experimental Data Concerning the Safe Operating Temperature for Mica Armature Coil Insulation," read before the American Institute of Electrical Engineers, was given in THE ELECTRICIAN, Nov. 26. The Paper gave rise to a considerable discussion in which a number of engineers recommended that the standardisation rules of the American Institute of Electrical Engineers be revised to allow larger rises in temperature for mica insulation. Some of the speakers, however, urged the retention of the present allowable temperature limit. We have taken the following account of the discussion from the "Electrical World."

In a written discussion Mr. PHILIP TORCHIO, of the New York Edison Company, called attention to the conditions which resulted in the A.I.E.E. Standards Committee adopting the present allowable temperature limit of 125°C. for class B insulations. He also referred to temperature guarantees which he had accepted on two 20,000 k.v.a., three-phase generators employed by the United Electric Light & Power Company for supplying single-phase energy to the New York, New Haven & Hartford Railroad. In referring to the data presented by Mr. Newbury, he pointed out that if the temperature obtaining in the Niagara generators were permitted in the United Company's machines they would carry continuous single-phase loads of 16,000 k.v.a. and overloads of over 25,000 k.v.a. at 60 per cent. power factor. Mr. Torchio declared that on account of the high speeds required for high steam economy the diameter of rotors must be minimised and the radiation sacrificed so that insulating materials capable of withstanding high temperatures must be employed. Again, turbo-generators for carrying single-phase loads must have large overload capacities at low power factors. In this case it is doubly necessary that generator dimensions be minimised so as not to sacrifice steam economy, for in an unduly large machine carrying low power factor overloads iron and field losses are likely to be relatively large. Special guarantees on built-up mica-insulated machines might be allowed, he suggested, but a special protective apparatus should be provided to minimise stresses on the machine in case this is done. In closing, he questioned the value of applying the data obtained from the Niagara machines to higher voltage generators and those machines in which the windings consist of several wires instead of rigid bars.

Mr. W. J. FOSTER, of the General Electric Company, said that the high operating temperatures reported for mica insulation suggest a wide field for its application, especially in generators carrying single-phase loads and in frequency changers. He recommended that the standards Committee increase the allowable temperature limit of class B insulation from 125 to 150°C.

Mr. H. B. POPE presented a discussion from H. P. Wood, of the Edison Electric Illuminating Company, of Brooklyn, who said that when the binder of built-up insulation is damaged the mica may be injured by vibration or when cleaning the machine with compressed air. "Service should not be sacrificed to theory," he declared.

Mr. H. F. T. ERBEN, of the General Electric Company, expressed the belief that it is absolutely safe to permit temperatures up to 150°C. in built-up mica insulation. At high voltages, however, he warned against using shellac or copal varnish for binders as they will disintegrate at temperatures near 200°C., giving off gases which attack copper and increasing the liability of leakage along the interstices between the mica strippings. The speaker urged keeping temperatures below 170°C. for class B insulation. He expressed the belief that mica and asbestos are required in railway converters, but that in many other cases mica is not necessary and is more expensive.

Mr. C. E. SKINNER, Westinghouse Electric & Manufacturing Company, endorsed the plan of raising the temperature limit to 150°C., but called attention to the increase in dielectric losses with increase in temperature. He urged engineers not to be carried away by the Niagara tests since mica is inapplicable in some cases.

Mr. J. B. FISKEN, Washington Water Power Company, called attention to the displacement and stresses which would be caused by linear expansion if conductors were subjected to high temperatures while the ends were prevented from moving. Intermittent heating and cooling between wide temperature limits may even grind out the mica, he declared.

Mr. F. W. PEEK, jun., of the General Electric Company, correlated the conditions which will exist if insulations are subjected to high temperatures, pointing out that dielectric strength of insulation and conductivity of conductors will decrease with rise in temperature. Dried-out insulation, he pointed out, may be injured by transient voltages.

Mr. W. L. WATERS, of the Westinghouse Electric & Manufacturing Company, pointed out that with high-voltage wire-wound apparatus it is difficult to insulate with mica, owing to the flexibility of the conductors.

In closing the discussion, Mr. F. D. NEWBURY expressed the belief that no suitable binder will withstand more than 175 to 200°C. He declared that windings made of 0·25 in. square wires can be insulated with mica tape and made almost as rigid as solid bar. He expressed the belief that linear expansion can be so compensated that it will not be a limitation to the allowable temperature, but existing data do not warrant raising the temperature limit above 150°C.

Other members who took part in the discussion of the subject were Messrs. P. M. Lincoln, L. T. Robinson, C. F. Scott and B. A. Behrend.

THE ERECTION PLANT FOR THE QUEBEC BRIDGE.

Summary.—In this article reference is made to the crane equipment used in erecting the first Quebec bridge. A brief description is given of the new bridge and of the method to be followed in its erection, and the remainder of the article is devoted to a detailed account, including many valuable drawings, of the crane equipment used for the purpose.

At various times in these columns it has been our privilege to record the rapid rise and development of the electric crane, both as regards design and application. We have a two-fold purpose in view in returning to the subject. We desire to describe work of a high order executed in one of our most thriving colonies, and with all the energy and earnestness we can command we wish to indicate a field in which our engineers ought, by right, to be pre-eminent.

No one capable of forming a competent opinion can find fault with British-built cranes. As regards design, materials and workmanship they are excellent, and yet the volume of crane trade handled by the large German engineering firms during the past 10 or 15 years has been phenomenal. The steady growth of live agencies in London, and the training of young British engineers, of men who speak good English, by these firms as potential agents for capturing the bulk of our colonial trade are two of the reasons accounting for this success. This applies not only to cranes and crane material, but also to kindred machinery, such as ropeways, transporters, coal-handling plant and the like.

In few branches of heavy engineering work is the electric crane seen to better advantage than in the erection of large bridges. Of the several examples we can call to mind, the most notable is the crane equipment installed for the purpose of erecting the great cantilever bridge across the St. Lawrence at a point some 8 miles below Quebec, on the site of the old bridge.

It will be recalled that at the end of August, 1907, a large portion of the partially completed bridge fell into the river, and that, besides considerable loss of life, the damage amounted to something like a million pounds sterling. At the time the opinion was expressed that the design of the compression members was faulty, and the Commission appointed by the Canadian Government to investigate and report upon the causes of the disaster found that the failure was due to erection stresses. In view of these circumstances, of which, happily, we have few illustrations, it is thought that a brief descriptive note on the crane equipment used in erecting the portion of the ill-fated bridge, and a detailed account of the equipment now being used for erecting the new bridge, will be of interest.

Full particulars of the old bridge and many striking photographs of the structural work before and after the disaster were published some time ago in "Engineering."* To these the reader is referred for a more complete description than can be given here. We have prepared the following note from an article by Mr. Frank W. Skinner in the above-mentioned journal.

The traveller, with which all the superstructure (except the centre suspended span) was to be erected, was of the outside gantry type. With its equipment it weighed 1,000 tons, and it ran on tracks outside the main trusses of the bridge and cleared the completed structure, thus enabling all the members of the latter to be assembled and permanently connected as each panel was built out. The structural frame consisted of a high rectangular tower having a trussed cantilever extension at the base to counterbalance the upper front overhang. The equipment consisted of 36 main lifting tackles, besides numerous small tackles and whip lines operated by four electric hoisting engines. There were in all about 60 sets of lines, aggregating about 7½ miles of ⅞ in. plough steel wire rope, 15 miles of 1½ in. Manilla rope, 6 miles of 1¾ in. and 3 miles of 2 in. Manilla rope. The traveller was proportioned for a maximum total hoisting load of 225 tons, and there were eight 55-ton steel-rope tackles The hoisting engines each weighed about 25 tons and were driven by 115 H.P. 500-volt motors. Each of the two shafts

* Vol. LXXXIV., 1907.

had one 18 in. drum 48 in. long, and two spools, all normally running free on it and operated by independent clutches. Each drum had a capacity of 4,500 ft. of $\frac{7}{8}$ in. steel wire rope, and was provided with a V band brake and a safety appliance to prevent accidental disengagement of the clutch. The engine had two sets of gears of about 50 to 1 and 16 to 1 respectively, so that it could hoist on a single line either a 15-ton load at 100 ft. per minute or a 6·7-ton load at 150 ft. per minute. Two engines together lifted a load of 94 tons at 15 ft. per minute. The drums were used exclusively for the 55-ton tackles. Two sets of eye-bars and their attachments, having a combined weight of 170 tons, were simultaneously lifted by the four engines. The operating levers were all grouped together, so as to be controlled by a single man with assistants at the spools; and an electromechanical brake was arranged automatically to set and hold the armature shaft and prevent the loads from overhauling if any accidental interruption of the current occurred. All hoisting operations were controlled by the foreman from a station in the lower part of the traveller. This fine example of the crane-makers' art was lost in 200 ft. of water when the bridge collapsed.

When tenders were called for the reconstruction of the bridge, the Board of Engineers allowed the contractors to prepare designs of their own and to submit tenders thereon, in addition to tendering on the plans and specifications issued by the Board. The design which was ultimately selected was one submitted by the St. Lawrence Bridge Company, it being the opinion of the experts that a bridge built to this design would lend itself to easier erection than any of the others proposed.

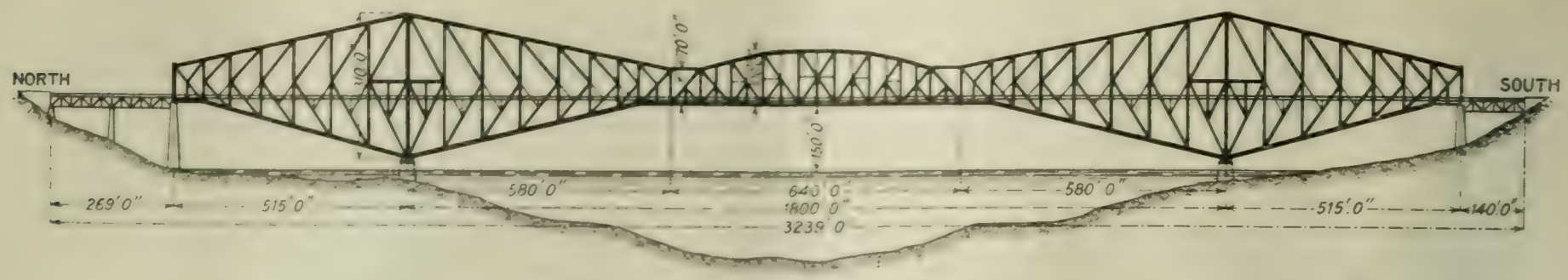


Fig. 1.—Outline Drawing of the Quebec Bridge.

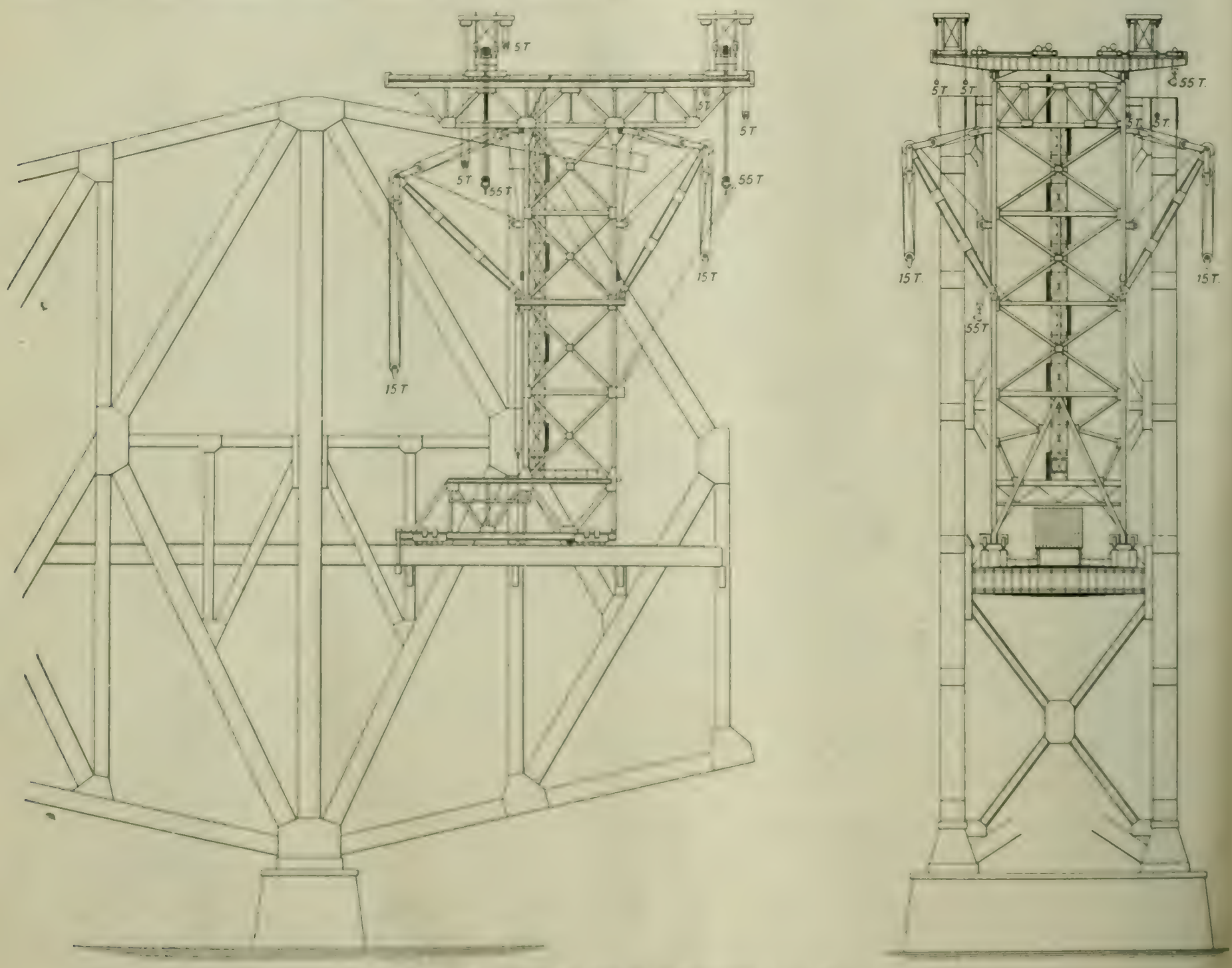


Fig. 2.—The Erection Traveller in Position on the Bridge.

Some idea of the magnitude of the undertaking will be gathered from the fact that the contract for the superstructure amounted to £1,750,000. The following figures and data speak for themselves. From the outline drawing (Fig. 1) it will be

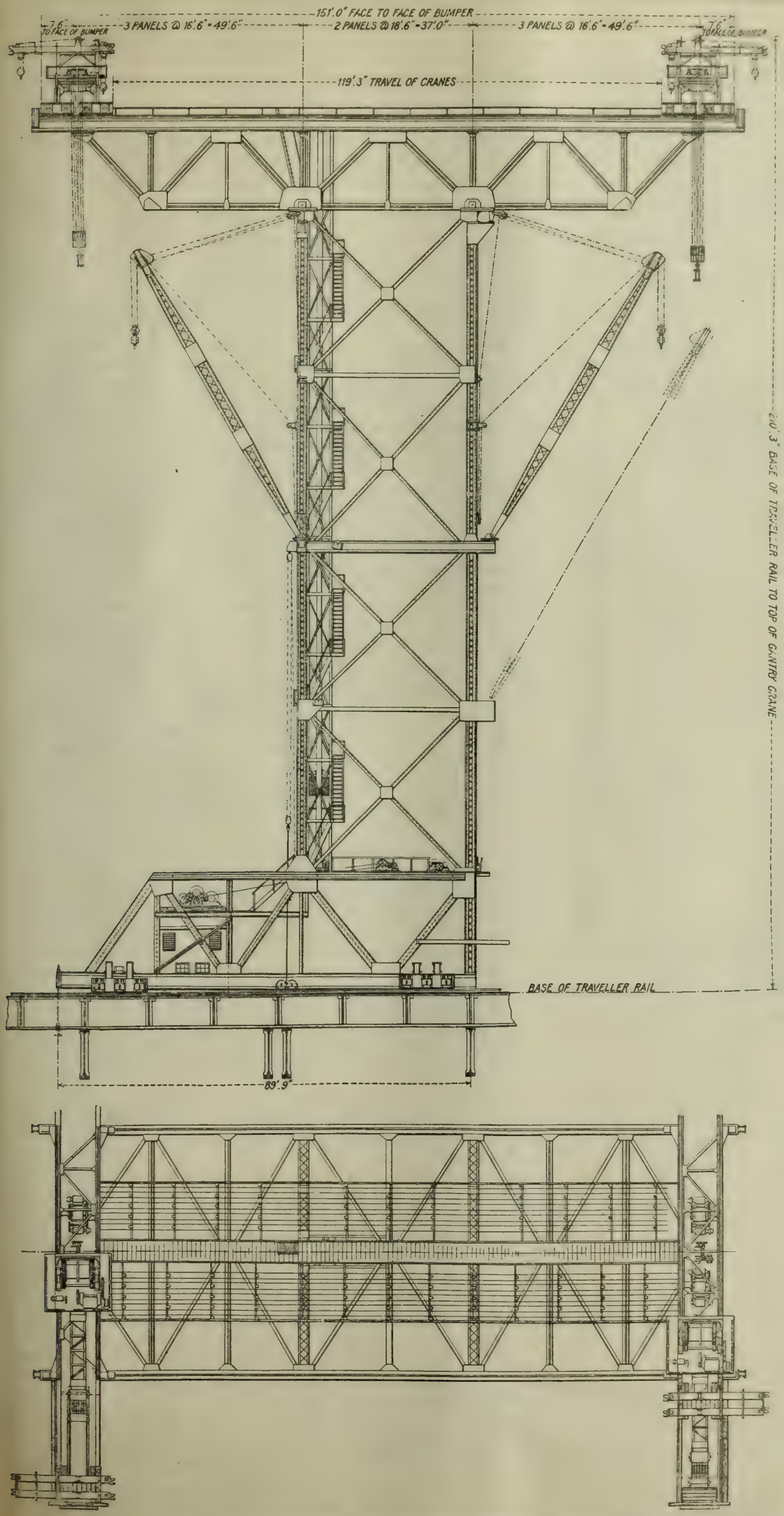


FIG. 3.—SIDE ELEVATION AND PLAN OF THE ERECTION TRAVELLER.

seen that the bridge is of the cantilever type with suspended centre span. Including approaches, the total length of the bridge is 3,240 ft., and the trusses are pitched at 88 ft. centres apart. The two anchor spans are each 515 ft. in length; the centre-to-centre distance of the piers is 1,800 ft., and each of the cantilever spans is 580 ft. in length. Over the main posts the cantilevers are 310 ft. and at the ends 70 ft. deep. The suspended span is a modified form of "Baltimore" or curved-chord "Pratt" truss 640 ft. in length, 110 ft. deep at the centre and 70 ft. at each end, and the clear height from high-water level to the underside of the truss is 150 ft. Nickel steel is being used for the cantilever arms and for the suspended span.

The bridge carries pathways for foot traffic and two railway tracks, the train load allowed for on each track being equivalent to two E-60 engines, followed by a uniform train load of 5,000 lb. per lineal foot of track. One of the most noteworthy features of the design is the arrangement of the diagonal members. From Fig. 1 it will be seen that the diagonal reaching outward and downward as a tension member from the top of a post intersects the middle point of the post of the adjacent panel, and then returns as a compression member to the foot of the post from the top of which it started. This arrangement is called the "half-shear design," and is also known as the "K" web system

For the erection of each cantilever a travelling tower, carried between the two trusses by the cantilever itself, has been provided, and as the length of the cantilever is increased this tower is moved out along the span. The towers, of which there are two, serve to carry a number of electric cranes of different types for lifting and manœuvring the members and pins into position, as well as for suspending the rams used for driving home the pins. An elementary diagram (Fig. 2), showing the tower in position on the cantilever arm and giving the capacities of the several cranes, has been prepared so as to enable the reader to obtain at a glance a good general idea of the nature of the equipment, and, incidentally, to enable us to be brief, for in these days no busy man has time either to write or to read a long article. At each of the four corners of

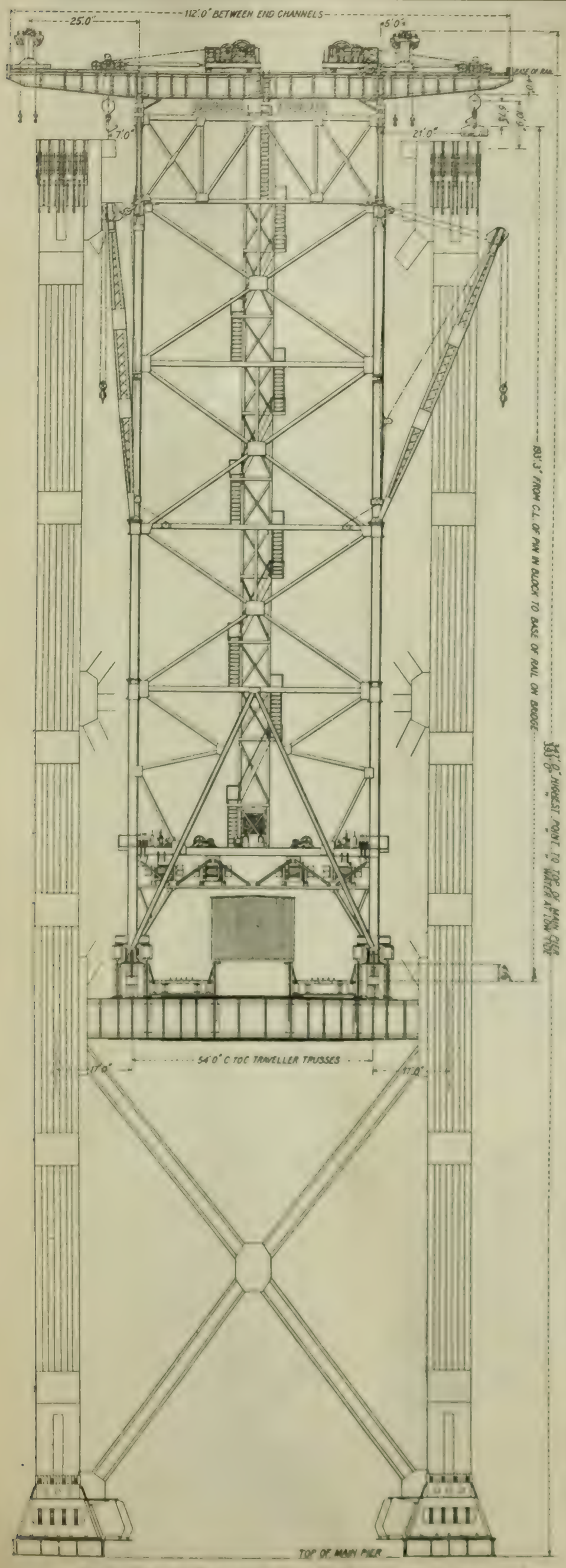


Fig. 4.—Front Elevation of the Erection Traveller.

the tower, and 97 ft. above the rail level, is mounted a 70 ft. 15-ton derrick. On a gantry at the top of the tower there are two travelling cranes, each of which is provided with two 55-ton hoists and two gantry cranes. Each gantry crane is equipped with two 5-ton hoists. To minimise weight, the crane girders are made of nickel steel. Access to the several floors of the tower and to the cranes is obtained by means of an electrically-operated elevator, and, in addition, a stairway is provided round the shaft of this elevator throughout its entire length. The tower is manned by 10 men, six being stationed on the operating platform on the third floor and two on each of the travelling cranes at the top of the tower.

It is planned first to erect the north anchor span over staging by means of the first erection tower. When this span has been erected the second tower will be set to work on the south anchor arm, and simultaneously the north cantilever arm will be erected by the first tower, so that these two spans of the bridge will be completed at substantially the same time.* The first tower will then be taken down and re-erected at a point 2 miles below the bridge site for the purpose of assembling the suspended centre span on barges. As this work proceeds the second tower will be at work upon the south cantilever arm, and the latter will be finished at or about the same time as the centre span. This span will then be transported on the barges to the bridge site and finally elevated into place.

Each movable tower (Figs. 3 and 4), or erection traveller, as it is called, consists of a structural steel tower composed of four suitably braced columns set at the corners of a rectangle measuring 54 ft. by 37 ft. in plan, with a trussed cantilever base. It is carried by four six-wheeled trucks on double lines of rails of about 6 ft. 6 in. gauge, the centre-to-centre distance of the tracks being 54 ft. and the total wheel base 76 ft. The tower has eight floors or stages, and it carries at the top a pair of gantry girders securely braced together throughout their entire length. These gantry girders, pitched at 54 ft. centres, are 20 ft. 6 in. in depth and 151 ft. in length, with 57 ft. cantilever extensions at each end, and are sufficiently long to admit of a crane travel of 119 ft. 3 in. They are of the "Warren" type, with intermediate verticals from the intersection of the diagonals at their lower extremity to the top boom, so as to break up the long panels of the latter into smaller bays to resist the severe bending stresses due to the concentrated wheel loads of the travelling cranes, which are additional to the direct stresses. The top chords are of box section, about 2 ft. wide and 2 ft. 6 in. deep, composed of plates and angles. Each carries a heavy flat-bottomed rail to form the crane track, which is 192 ft. 9 in. above the lower rail level. To give access to the travelling cranes there is a central platform, extending from end to end of the gantry, on a level with the crane track.

In addition to the four 70 ft. 15-ton derricks mounted at the corners of the tower, provision is made for the accommodation of a 90 ft. derrick on the fourth floor. The load is supported by four falls of steel wire rope $\frac{3}{4}$ in. in diameter, winding one part on to a 15 in. barrel. Under full load the lifting speed is 37 ft. per minute, and the lifting mechanism, driven by a motor rated at 51 H.P. 295 revs. per min., is mounted on the second floor of the tower. Each hoisting mechanism has four spools 12 in. in diameter and 15 in. long, each spool being loose on the shaft and provided with a hand-operated jaw-clutch. A 5 H.P. motor is used for slewing, and the mechanism is located on the third floor. The mechanism has a drum 13 in. in diameter and 14 in. long, and has a capacity of about 6,000 lb. at 25 ft. per minute. In order to lock the mechanism when not in use an electro-mechanical brake is fitted. Pulley block tackle is used for obtaining the necessary purchase for each block of the several motions of the derricks. Much of this work is a departure from ordinary crane practice, and some of the rope arrangements are novel.

The tower is moved along the cantilever at the rate of about 10 ft. per minute by two of the 51 H.P. derrick motors acting in concert through the medium of a pair of triple

* The north anchor span is now complete, and work has commenced on the north cantilever arm and the south anchor span. We regret that there has been some delay in the publication of this article.—Eds.

blocks. Six falls of $1\frac{3}{4}$ in. Manilla rope are used for the hauling lines on each side, and the pulls in the two sets of tackle are balanced by means of compensating sheaves. The two travelling ropes are of steel and $1\frac{1}{4}$ in. in diameter. Each rope passes round one or other of a pair of sheaves at the base of the tower, depending on whether the traveller is being moved forwards or backwards on the bridge. A 15 H.P. motor running at 575 revs. per min., and geared to give a full-load lifting speed of 75 ft. per minute, is used for driving the elevator. The car is supported by two falls of $\frac{5}{8}$ in. steel wire, winding one part on a 14 in. drum, and the whole of the machinery is located at the bottom of the shaft on the third floor.

(To be concluded.)

ST. MARYLEBONE ELECTRICITY SUPPLY, 1914-15.

The St. Marylebone undertaking is one of those which is feeling the adverse effect of the war, being concerned mainly with a residential and street-lighting load. The accounts for the year ending March 31, 1915, show that 22,547,171 units were generated altogether, of which a total of 15,926,167 were sold (14,881,950 to private consumers, and 1,044,217 for public lamps). The previous year there were 17,038,516 units sold, so that there is a decrease of 6·53 per cent. This, however, is the first decrease that has occurred and is, of course, due to the war, the greatest factor being the lighting restrictions imposed by the authorities. That this is so is well shown by separating the years into two periods of six months before and after September 30th. For the first half of the year there was an increase of 4 per cent. on the corresponding half of the previous year in the total units sold, and an increase of £910 (or 1·6 per cent.) in the revenue from consumers; but for the last half the units sold decreased by 12·2 per cent. and the revenue from consumers by £11,773 (or 9·6 per cent.).

The war has also been the cause of an increase in practically every item of cost, the greatest rise, however, being that of the fuel. The special expenses include war service allowances of £1,217 and expenses of guarding the works amounting to £1,083. Taking the net loss of income due to the war as £9,900 (allowing for generation expenses avoided) and adding £400 as shrinkage of profit to the sales department the loss of income comes to £10,300. Adding to this £4,200 extra expenses the total loss to the undertaking from this cause has been £14,500.

The adjusted balance in hand at March, 1914, was £29,540, two minor credits bringing this up to £29,667. The first charge on this is the debit balance of £7,057 on the past year's working, reducing the amount to £22,609. This has been charged with improvements and special works to the extent of £3,873. Two years ago the Council adopted the policy of meeting the cost of meters, &c., for new consumers out of revenue instead of raising loans, and this course has had the effect of reducing the loan service charges for the past year by £755 (net). The cost of meters so acquired during the year and of new mains (in excess of £42,500 loan) was £2,328. The advance in prices charged since March, 1915, however is expected to make up for these depletions of the balance. The accompanying Table gives some of the most important statistics for the last three years :—

	Year ended March 31.		
	1915.	1914.	1913.
Units sold :—			
Private consumers	14,881,950	15,206,254	13,313,757
Public lighting	1,044,217	1,832,262	1,694,530
TOTAL OUTPUT	15,926,167	17,038,516	15,008,287
Total units generated	22,547,171	22,701,042	19,695,853
Units lost in transmission and distribution	3,780,893	...	...
Units used in works, batteries and distribution	6,620,004	5,662,526	4,687,566
Percentage to units generated	29·4	24·9	23·8
Maximum load	8,514	10,497	9,680
Load factor	21·4	18·6	17·7
NUMBER OF CONSUMERS	10,175	9,755	9,234
Average price (*ex.* meter rents)	2·59d.	2·58d.	2·81d.

It will be noticed that the percentage of units costs in distribution, &c., has risen each year, but that there is also a steady rise in the load factor.

We give below a complete analysis of the year's accounts with the amount per unit sold of each item for the previous year as well as for that under review :—

		Per unit sold	
	1914-15.	1914-15.	1913-14.
Generating Costs.			
Fuel	£21,050	0·32d.	0·35d.
Oil, waste, water, &c.	506	0·00d.	0·00d.
Salaries and wages	6,383	0·10d.	0·08d.
Repairs and maintenance	3,432	0·05d.	0·06d.
Miscellaneous	171	0·00d.	0·00d.
Total Generating Costs	£31,542	0·48d.	0·50d.
Distribution Costs.			
Wages	£1,303	0·02d.	0·02d.
Repairs to mains	2,708	0·04d.	0·03d.
Repairs to meters, &c.	1,247	0·02d.	0·02d.
Repairs at sub-stations	1,425	0·02d.	0·02d.
Salaries and establishment charges	1,900	0·03d.	0·03d.
Total Distribution Costs	£8,583	0·13d.	0·12d.
Management Costs, &c.			
Salaries	£4,915	0·07d.	0·07d.
Meter reading	1,088	0·02d.	0·02d.
Stationery and printing	637	0·01d.	0·01d.
General establishment charges	1,198	0·02d.	0·02d.
Central establishment charges	350	0·00d.	0·00d.
Law and Parliamentary charges	288	0·00d.	0·00d.
Insurances	518	0·01d.	0·01d.
Special expenses	2,586	0·04d.	0·00d.
Total Management Costs, &c.	£11,580	0·17d.	0·13d.
Rents, rates and taxes	£15,554	0·24d.	0·21d.
Public lighting maintenance	3,553	0·05d.	0·06d.
Sales, publicity, &c. (£17,400 *less* £15,061 revenue)	2,339	0·04d.	0·04d.
TOTAL COSTS (*ex.* Capital Charges)	£73,151	1·11d.	1·06d.
Capital Charges.			
Interest	£71,752	1·08d.	1·01d.
Sinking fund	47,377	0·71d.	0·62d.
Total Capital Charges	£119,129	1·79d.	1·63d.
TOTAL COSTS (*inc.* Capital Charges)	£192,280	2·90d.	2·69d.
Revenue.			
Sales of current	£161,285	2·43d.	2·43d.
Public lighting	14,225	0·22d.	0·20d.
Meter rents	7,569	0·11d.	0·10d.
Rent of property (*less* repairs)	1,103	0·02d.	0·01d.
Bank interest	313	0·00d.	0·00d.
Miscellaneous	728	0·01d.	0·01d.
TOTAL REVENUE	£185,223	2·79d.	2·75d.
Balance (deficit)	£7,057	0·11d.	(*Cr.*) 0·06d.

The capital expenditure for the year was £11,922, bringing the total capital expenditure at March 31, 1915, to £2,136,622, made up as follows :—

Purchase of undertaking	£1,398,106
Land	41,010
Buildings	72,563
Machinery	225,597
Accumulators	19,808
Mains	165,364
Meters and indicators	28,488
Electrical instruments	417
Change of pressure and system	150,610
Tools	2,873
Furniture	940
Consulting engineer's commission	23,975
Cost of Order and Acts	5,216
Miscellaneous (in extending plant)	1,655
TOTAL	£2,136,622

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HIGH-PRESSURE TESTING.

A good deal of high-pressure testing is done nowadays—that is, at pressures much above what would have been regarded as high pressure 10 or 20 years ago. Especially is this the case with insulators to be used on transmission lines. A great deal of experience has been accumulated with regard to mysterious breakages on such insulators ; very slight, almost invisible, cracks are liable to be found on the surface, and there are other defects that can almost certainly be detected at the testing stage if proper care and proper tests are used. One insulator may appear to the naked eye to be just as good as any other in a batch ; yet the searching nature of a high-pressure test is quite sufficient to distinguish it easily from its fellows. It is found on transmission lines that if such tests are properly carried out for a sufficient length of time at pressures sufficiently high, the liability of the line to breakdown can be enormously decreased. It is, therefore, well that the nature and character of such tests should be properly understood, and that there should be some sort of standardisation in the matter.

But this is, perhaps, not so easy as it might appear at first sight. Almost all such tests are carried out with alternating currents, and all methods of estimating such voltages depend ultimately on the determination of the mean effective pressure of the transformer. This accomplished, it would appear that all ambiguity is at an end. But this is not so. Suppose a specification calls for a test at 200,000 volts. This means that the mean effective pressure is to be 200,000 volts, and the maximum electric stress will then be that due to the peak of the wave. If the wave is sine-shaped, this maximum pressure would be 282,000 volts, and if the insulator or insulating material under test could withstand this pressure without any sign of breaking down we should have this certain definite fact to go upon. But suppose the wave is not sine-shaped, or suppose from

some cause that the wave is distorted in some way due to harmonics of various orders; then the amplitude factor may not be 1·414, but something very seriously differing from it. Dr. BENISCHKE in a Paper which we reproduce in this issue, deals with this point, and his oscillographic records are instructive He bases his investigations on a certain testing alternator, which was specially ordered from a good firm, definite instructions being given with the order that the wave-form of the machine was to be as nearly sine-shaped as possible. But, investigation showed that there was only partial compliance with these instructions. The wave varied according to the character of the load on the transformer, and according to the pressure which the transformer was made to give. No doubt Dr. BENISCHKE's transformer, when coupled to his specially constructed alternator, gave an approximate sine wave on no-load; but the oscillograph records show waves of a very different description under other conditions, largely affected by the excitation and load on the transformer, and partly due to the capacity of the transformer itself, and the capacity of the load, which would probably be the insulators under test. The effects of the various harmonics are also very marked. It is not always the same harmonic which makes itself felt; sometimes it is the 7th, sometimes the 13th, sometimes the 5th, and with altered conditions it might quite possibly be one of the others. All these things tend to alter the amplitude-factor, and thus the stress on the insulating material under test. The only way to correct or allow for this is to map out the wave-shape, and then to correct by a certain factor. But specifications do not generally allow for this, and probably most consumers are entirely ignorant of the fact that there is a possibility, with a test at a given effective pressure, of a variation in the electric stresses of as much as 20 per cent. It is well that these matters should be understood, for such testing is on the increase. For example, in Japan a pressure of 1,000,000 volts is being used commercially for line testing.

The simplest way of getting over this difficulty is to use what may be termed a crest voltage indicator. If an oscillograph be used as a voltmeter with the time movement out of action, the deflection is a measure of the amplitude of the voltage wave. Special instruments have been made on this principle, and are being used by Messrs. LAWS, MIDDLETON and DAWES for testing in the United States. A similar method is to use a cathode-ray tube. This is particularly suitable for very high pressures and has the merit of simplicity.

It may be doubted, however, whether alternating current of low frequency is suitable for the testing of insulators, seeing that in everyday use they are subjected either to surges on the transmission lines which they support or to lightning discharges, the disturbances in either case being usually of very high frequency. Consequently, high-frequency methods have recently been developed. Here, again, however, there may be uncertainty as to the conditions, and so Messrs. A. CHERNYSHOFF and C. A. BUTMAN have used a method in which the pressure is obtained from continuous current on making the primary circuit of the transformer, a high pressure being avoided on breaking. Thus, at each make there is a single electrical impact, and the number of impacts is easily controlled. The method was described in THE ELECTRICIAN of July 16th. Whether the conditions are easily reproduced, so as to ensure that insulators are always subjected to the same electrical stresses may, perhaps, be doubted, and in any case such methods are not suitable for the testing of high-voltage cables, in which tests the uncertainties above described still remain.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

An Introduction to Applied Mechanics. By E. S. ANDREWS. Pp. ix. + 316. (Cambridge: University Press.) 4s. 6d. net.

The aim of this book is to present the elementary principles of mechanics in accurate though clear terms, and to show the application of these principles to the simpler problems arising in engineering work. The general treatment is based more upon graphical conceptions than upon purely mathematical analysis, because the author's experience leads him to believe that the mind of the engineering student reasons more clearly from diagrams than from symbols. In our opinion, incalculable harm is done by reasoning from symbols. The natural mode of expressing a thought is by means of a diagram. Of all the trades and professions, engineering comes first as regards the number of diagrams and drawings required for its successful pursuit. For this reason the works of the engineer have altered the surface of the earth, and virile men are engaged in the execution of such works.

There is only one section of the book with which we do not entirely agree. This is the chapter on the forces in framed structures. The graphical method of determining the forces in framed structures was devised by a genius, and is now used by engineering students on problems more readily and more accurately solved by other methods. By all means let the elementary student make freehand sketches of the force polygons for the several joints, but from these diagrams he should be encouraged to *calculate* the forces. In this way he sees what it is that makes up the load in the diagonals, chords and verticals of a truss. We should like every electrical engineering student in the country to read the author's notes on work, power, energy, velocity, acceleration, relative velocity, kinetic energy and momentum. His account of Newton's laws of motion makes the laws as real in mechanical work as Ohm's law is in electrical work, and the matter is equally convincing in the chapters devoted to beams and girders, centre of gravity and centroid, friction and lubrication, and motion in a curved path. The author is to be congratulated in producing a really serviceable book on a well-worn topic, and the Cambridge Press in publishing at a price commensurate with the means of many students a book of "Cambridge Press" standard.

Handbook of Patent Law. By W. P. THOMPSON, F.C.S., M.I.Mech.E. 16th edition. (London: Stevens & Sons.) 2s. 6d. net.

This little book gives a fairly good digest of the law and practice relating to British patents, designs and trade marks, together with a useful summary of foreign patent laws, and it will prove useful to patentees, manufacturers and others who are interested in inventions and their exploitation, but who have no legal training. It will enable them to steer clear of many pitfalls, as it contains sound advice on the steps necessary for protecting inventions and for the commercial development of patents. The author may be right in omitting figures as to the probable expense of obtaining a patent, as this must vary with the circumstances and the kind of patent, but we know that inventors like to have the cost of obtaining patent protection in the leading commercial and industrial countries. On more than one occasion we have called attention to the incomplete character of the British examination for novelty, and we are not, therefore, surprised to learn that patentees sometimes file a provisional specification here and then apply for a patent in Germany in order to have the opinion of the German patent office, because many inventions which would pass the United States or a British Court of law as novel are refused in Germany on account of the principle of the invention being old. After the war there will have to be an amendment of our patent law, and among other changes there must be an extension of the method of examination, a strengthening of the law as to holding up patents and compulsory working, a reduction of taxes, and, generally speaking, more encouragement must be given

to patentees. In the meantime Mr. Thompson's handbook will prove a reliable guide to the existing law and practice.

Alignment Charts. By E. S. Andrews, B.Sc. (London : Chapman and Hall.) Pp. 32. 1s. 3d. net.

The method of graphical representation of formulæ set out in this little book is one which is particularly applicable to the formulæ which arise in engineering practice. A clear explanation is given of the principles underlying the construction of alignment charts, and the reader should have little difficulty in making charts for the particular formulæ which he uses in his work. In future editions we should like to see more examples, as well as charts for a number of electrical engineering formulæ. As it stands, however, the book will be found helpful to those interested in the practical application of a neat geometrical principle.

AN ABAC FOR THE CALCULATION OF WAVE-LENGTHS.*

BY W. ECCLES.

In the calculation of the wave-length, λ, of an oscillatory circuit from given values of the inductance L and capacitance C, in the circuit, the formulæ commonly used are

$$\lambda \text{ in cm.} = 2\pi\sqrt{\{(\text{L in cm.})\,(\text{C in cm.})\}},$$

and

$$\lambda \text{ in metres} = 1{,}885\sqrt{\{(\text{L in } \mu\text{H})(\text{C in } \mu\text{F})\}}.$$

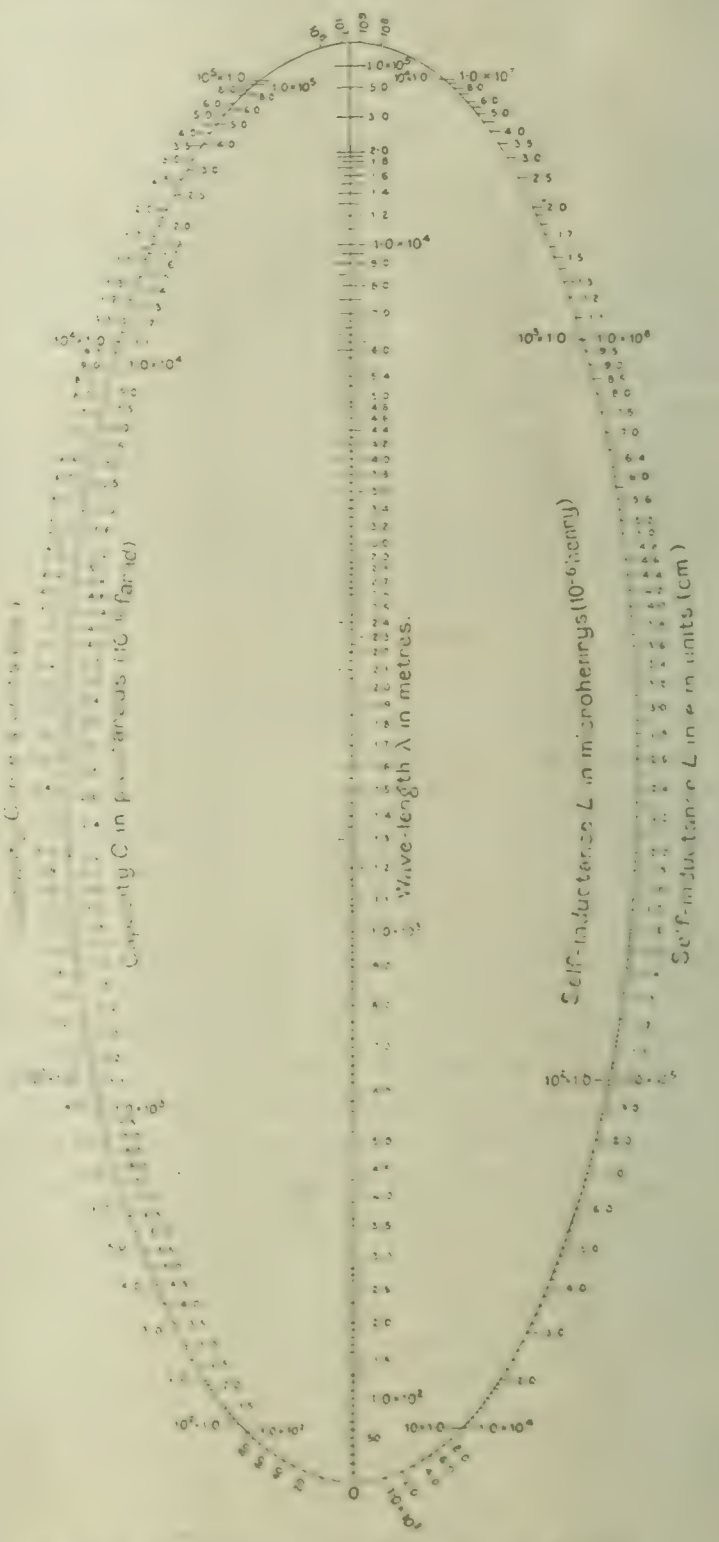
Where " L in cm." means that the inductance is expressed in electromagnetic units, " C in cm." means that the capacitance is expressed in electrostatic units, μH means microhenry and μF microfarad. Thus, any graphical method of multiplying two given quantities together can be applied to the evaluation of the above formulæ if the scale on which the products are ordinarily read be graduated so as to read square roots multiplied by 2π. Some half-dozen distinct graphical methods of multiplying are well-known, and have been applied to a large variety of formulæ during the past century (or longer); they have all been applied, on occasion, to the above formulæ, doubtless by many persons independently; but, so far as the writer knows, the particular alignment abac described below has not been previously developed, though it possesses some practical advantages over the known types.

Of the older abacs it is sufficient to mention a few types. Two well-known forms are squared-paper diagrams with values of L along one axis and values of C along the other. If these L and C scales are uniformly graduated, the lines of constant product are hyperbolæ, and each hyperbola should be drawn to correspond to a round number of metres in wave-length, and marked with that number. But the hyperbolæ can be replaced by straight lines if the axes are graduated non-uniformly in the appropriate manner, and another type of abac is thus obtained. There are several distinct derived forms of the above which have been much used. Logarithmically ruled squared-paper suggests, besides, obvious types of abac.

The alignment abacs are quite different from the above. In these there are three scales—one each for L, C and λ—which are so placed and graduated that points satisfying the wave-length equation lie on a straight line. The most obvious and the oldest form of this mode of multiplying consists of three straight parallel logarithmic scales similar to slide rule scales. The outer scales are graduated in values of L and C, the inner is the wave-length scale and is graduated twice as closely as the others, so as to extract square roots. For given values of two of the quantities the third is obtained by noting the intersection made on its scale by a line joining the two given values each read on its own scale. The easiest way of making the straight line is to stretch a fine thread across the scales, or to place over the scales a sheet of transparent celluloid with a straight line cut on it. Another form of logarithmic alignment abac consists of three straight lines radiating from a point.

A disadvantage of all these abacs when applied to the problem in hand is that, though they serve well enough for values of L, C and λ lying within the range for which they are graduated, yet when relatively large or small values have to be dealt with they involve a certain amount of mental arithmetic with positive or negative powers of 10. It is not possible to arrange a plain logarithmic scale so as to comprise the whole gamut of L and C used in wireless telegraphy, and at the same time keep a practical order of accuracy, and it is very easy to make serious slips in the square roots of the powers of 10.

In the oval abac shown in the figure this difficulty and danger has been circumvented. The whole range of values of L, C and λ, likely to be used in radiotelegraphy or in laboratory work, is covered. The range of inductance is from 10^3 to 10^9 electromagnetic units, that is, from a microhenry to a henry; the



Wave-length Abac on Reduced Scale.
Actual size of above, as published, is 14 ins. × 6 ins.

range of capacitance is from 10 to 10^7 electrostatic units, that is, from about $\frac{1}{1000000}$ mfd. to 10 mfd.; and the range of wave-length is from 10 metres to 100 km. Of course, there is not equal accuracy in the significant figures throughout these ranges; that would be impossible. The middle portions only of the scales are made very open, and these are devoted to the commonly-occurring sizes of L, C and λ, and are capable of giving the significant figures with about the accuracy required in practice. The extreme portions of the scales are occupied by the extremely large or small values of L, C and λ, and the scales become more and more compressed as the commonly occurring values are departed from. It is intended that these

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extreme portions of the abac should be used mainly for removing the opportunities for mistakes given by the powers of 10, as described above. Suppose that a pair of extreme values of L and C are given and that λ is required. One places the thread in position as correctly as may be in view of the lack of graduations near the ends of the scales, and one reads the approximate value of λ. Knowing now the answer approximately one drops all consideration of the powers of 10 concerned in the problem, and transfers the thread to the middle open parts of the scales to get the significant figures of the answer more accurately. The thread has to be placed so that the known values of L, C and λ —ignoring the powers of 10—again lie upon it. This will be made clear by the following examples :—

Example I.—Find λ, given L=370μH, C=1,650 pF. On the right-hand scale of the oval take the reading $3{\cdot}7\times10^2$ (near the letter *i* in the word units), and on the left-hand inner scale take the reading $1{\cdot}65\times10^3$ (near the initial C of the word Capacity) ; stretch a thread from one reading to the other and read its crossing on the central scale. It is λ=1,470 metres.

Example II.—Find λ, given L=3,700 μH, C=16,500 pF. The thread now passes across the top end of the oval, and gives a result between 14,500 and 15,000 metres. As the scales are most open about their middle portions, and better accuracy is given there, move the thread to about 1·5 near the letter *g* in the word length, set one end accurately at 3·7 on the right-hand scale (near *i* in units), set the other at 1·65 on the left-hand inner scale (near C in Capacity), and read the central scale as 1·47. Therefore λ=14,700 metres.

Example III.—Find the inductance needed with a capacity of 95 cm. to give a wave-length of 2,300 metres. Taking the reading 95 on the outer left-hand scale near the bottom of the oval and the reading $2{\cdot}3\times10^3$ about the middle of the central scale, a stretched thread shows L as somewhat greater than $1{\cdot}0\times10^7$ e.m. units. Rotate the thread round the reading 2·3 as a pivot till it passes through reading 9·5 on the outer left-hand scale, above the middle of the oval, say. Then the significant figure is read accurately on the right-hand scale as 1·41 ; and therefore L=$1{\cdot}41\times10^7$ e.m. units.

VARIATIONS IN THE WAVE-SHAPE IN HIGH-TENSION TESTING INSTALLATIONS.*

BY DR. GUSTAV BENISCHKE.

The idea of the mean effective voltage has been invented so as to enable us to use the same mathematical expressions for determining the heating effect of an alternate current that we use for a continuous current. It is also that value which can be most easily ascertained, because the torque of dynamometric instruments is proportional to it. So long as the working pressures of electric installations was low, and questions of insulation afforded no difficulty, insulating tests could be referred to the mean effective voltage as a kind of standard, though the actual electric stress depended, in point of fact, on the peak of the curve of the voltage wave, which was reached

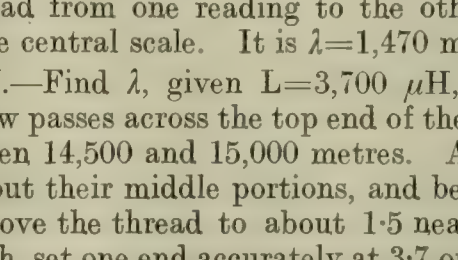


Fig. 1.—Showing Voltage-wave on No-load.

periodically. If the wave-form was always the same, the electric stress might always be supposed to be proportional to the mean effective voltage ; but experience shows that, owing to differences in construction and in armature reaction, there may be deviations amounting to as much as 15 per cent. from the true sine-wave above and below the mean. Therefore, if two different machines are employed for high-pressure tests, there may be differences amounting to as much as 30 per cent. in the electric stresses. For instance, if a piece of high-tension apparatus is to be tested for a working pressure of 100,000 volts, the test pressure would be 200,000 volts—*i.e.*, if the wave is sine shaped it must withstand a maximum pressure of 282,000 volts. Suppose now that it is tested later at another place with another machine, giving a more pointed wave with an amplitude factor of 1·55 instead of 1·41 ; here, at a testing pressure of 200,000 volts, it would have to withstand a maximum pressure of 310,000 volts. It would be worse if at the maker's works the volt wave had been flatter—*e.g.*, 10 per cent. below the sine-wave maximum, with an amplitude factor of 1·27. Then, at a test pressure of 200,000 volts, the maximum voltage at the peak would have been 254,000



Fig. 2.—Showing Voltage-wave with Load of 3 amperes. Amplitude-factor, 1·51.

volts. Therefore, although in all these cases the test pressure has nominally been 200,000 volts, there is an actual difference of 56,000 volts in the maximum pressure to which the insulation is subjected at the peak of the wave.

A deviation of 10 per cent. from the sine-wave shape is by no means extraordinary. It may even happen in the one machine in consequence of armature reaction. The following oscillograms are taken from an alternator of the usual kind which was ordered two years ago from a first-class firm for a high-pressure testing room, and in giving the order it was expressly stated that the wave was to be as nearly sine-shaped as possible. Fig. 1 shows the voltage curve at no

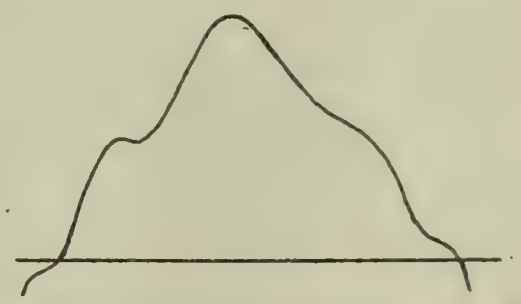


Fig. 3.—Showing Voltage-wave with Load of 39 amperes. Amplitude-factor, 1·57.

load. Fig. 2 shows the voltage wave at half the normal voltage, the load being 5 amperes, a testing transformer being connected to it. The amplitude factor is now 1·51. Fig. 3 shows the voltage wave at normal voltage, with a load of 39 amperes, the testing transformer being connected at full pressure, and the secondary giving 150,000 volts. The amplitude factor is now 1·57. The wave, however, becomes still more pointed when a number of insulators are joined up, and through the losses due to discharges there is an increase in the watt component. Fig. 4 shows the voltage wave if 20 insulators

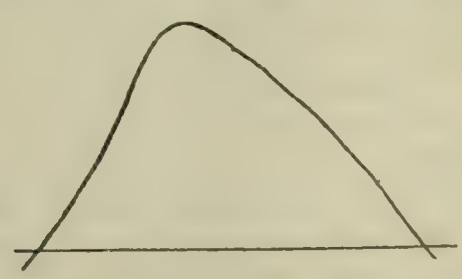


Fig. 4.—Showing Voltage-wave with Load of 19 amperes : Secondary Load of 20 Insulators, tested at 100,000 volts. Amplitude-factor, 1·58.

are being tested at 100,000 volts on the secondary side, the load on the alternator being 19 amperes. In spite of the fact that considerably less current is being taken from the machine, the tip on the wave is much more pointed than before, because the watt component is greater ; it is this, and not the total current, which causes the unsymmetrical nature of the voltage wave. If such a machine is used, it is plain that the figures shown on a voltmeter are no real indication of the electrical stresses to which the substance is submitted. The figures ought to be reduced to some kind of ratio to

* Abstract of an article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., p. 396,.1915.

the sine shape, multiplying by a factor, which represents the ratio of the amplitude factor to 1·414. It would really be better if the tests were carried out, not at any nominal value of the effective voltage, but at some actual value of the wave at the peak; this would give some proper idea of the stresses to which the substances were submitted. Unfortunately, there is no measuring instrument which gives in the form of a direct reading the value of the pressure at the peak of the wave; there is, therefore, no other method than to determine the effective voltage with a voltmeter and to ascertain the shape of the curve, and from this to deduce the ratio of the amplitude factor to 1·41 and to express one's results accordingly.

It would be possible to content oneself with the effective pressure if all voltage waves were sine shaped and no serious deformations were produced by the reaction of the current; but the above is sufficient to show that we are far removed from that stage; yet the production of a sine wave is not so very difficult. It could be done by a proper choice of the breadth of the pole shoes and a rounding off of the edges. This result could easily be produced if the air-gap

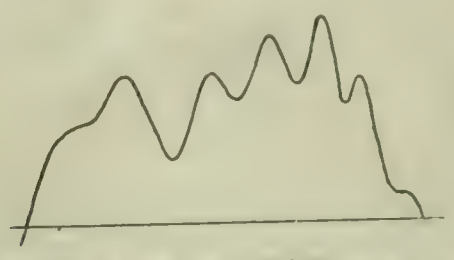


Fig. 5.—Current-wave of 150,000-volt Transformer, corresponding to Conditions in Fig. 2.

was sufficiently large and the slots narrow. If the air-gap is small and the slots are wide, then slanting pole shoes ought to be employed, having their edges not parallel to the axis. The deformation produced by the armature reaction can be much reduced by having a large air-gap. Therefore a better result is produced by large than by small machines. If this is not sufficient, devices for damping the eddy currents must be used; these can take the form of short-circuited copper rods, which have the effect of somewhat correcting the want of symmetry in the distribution of the magnetic lines of force, due to armature reaction. The Oerlikon Company has found that this can be done, as shown in a reproduction of an oscillographic record. The wave in this case was one of great regularity, the polyphase machine from which it was taken having one of its phases disconnected and being run, therefore, as a single-phase machine; the conditions were thus very unfavourable. The same machine as was used for the tests shown in Figs. 1 to 4 was then fitted with dampers for the eddy currents, as above suggested, and a new oscillogram was taken under the same conditions as previously shown in Fig. 3. The result was a perfectly smooth sine-shaped wave. The difference can be judged from the fact that before the dampers were

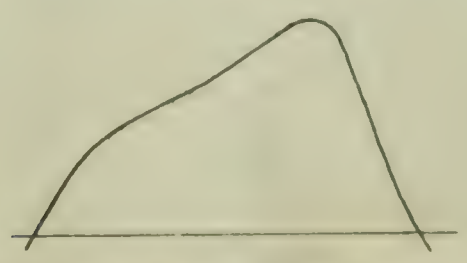


Fig. 6.—Current-wave of 5,000-volt Transformer, under the same Conditions as in Fig. 5.

applied the flash-over on a dry insulator took place at 95,000 volts, whereas afterwards it took place at 108,000 volts. The eddy-current damper is, therefore, not only an effective method of preventing hunting in alternators in parallel, but also removes the jags from the voltage wave.

In a current wave the harmonics of high order produce a greater effect if the capacity of the circuit is increased. Now a transformer has a higher capacity, other things being equal, the higher its voltage, because the number of turns and the length of the conductors are increased. It was, therefore, to be expected that the capacity of a transformer giving a pressure of 150,000 volts would have a noticeable effect on the shape of the wave of no-load current. Fig. 5 shows this very clearly, and gives the current wave corresponding to Fig. 2—*i.e.*, the no-load current of the half-excited transformer. The shape of this wave is due to peculiarities caused by the hysteresis loop. The basic shape is to be seen in Fig. 6, which is taken from a similar transformer wound for a pressure of only 5,000 volts, and is magnetised in the same way as the preceding. With a smaller winding the capacity is also quite small. In Fig. 5 a harmonic of the 13th order is superimposed on the basic form, and these effects can easily be counted on the number of ups and downs on the curve. It can also be seen in the number of indentations in Fig. 2 if carefully examined. As is well known, the influence of capacity is very marked on the current wave. Fig. 7 shows the current wave corresponding to the pressure wave in Fig. 3, with full excitation of the transformer. Another curve is given in the original Paper showing the corresponding wave on the 5,000-volt transformer, which may be taken as the basic form; it is somewhat similar to that in Fig. 7—that is, it is unsymmetrical to the same degree—and although the indentations do not entirely disappear, they are replaced by a much more gradual curve or bend. In Fig. 7 the effect is plainly seen of a harmonic of the seventh order, as in Fig. 3. The fact that in the one case the effect is due to the seventh harmonic and in the other to the 13th harmonic is due to the method of winding the machine; the phase displacement of the current at half and full excitation of the

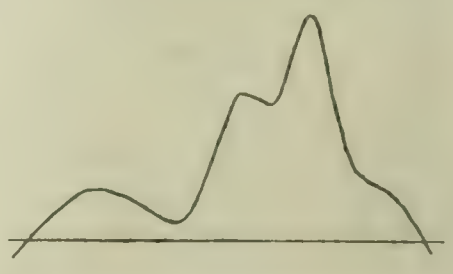


Fig. 7.—Current-wave of 150,000 volt Transformer, corresponding to Conditions in Fig. 3.

transformer is different. Therefore the position of the edges of the pole shoes with respect to the edges of the teeth at the moment when the maximum voltage is induced is different in the two cases. Another figure (not here reproduced) shows the current wave when 20 large insulators are being tested. This curve shows plainly the effect of a harmonic of the fifth order, which can also be recognised in the pressure wave. It is still more strongly marked than the effect of the 13th and 7th harmonic in the previous cases, because the effect due to the capacity of the insulators is added to that of the transformer. These current waves show that the capacity of the high-tension winding of the 150,000-volt transformer is large, in spite of the fact that the number of turns is not, relatively speaking, great owing to the large section of the core. With a transformer for 300,000 volts the capacity would be four times as great, seeing that it increases, roughly speaking, as the square of the number of turns. It would, therefore, be better not to use one transformer for a pressure of 300,000 volts, but to use two in series; this would have the effect of halving the total capacity.

A NEW HIGH EFFICIENCY INCANDESCENT LAMP.*

BY E. A. GIMINGHAM AND S. R. MULLARD.

Summary.—The authors describe continuous and alternating-current lamps suitable for projection, kinematograph, searchlight and street-lighting purposes.

In 1913, experiments were started in the lamp research laboratory of the Edison & Swan United Electric Light Company at their Ponders End works.

The first lamps constructed were made with the electrodes in contact, one of the electrodes being connected to an expansion strip constructed of a strip of molybdenum, to one side of which was welded a thin strip of copper or other suitable material having about the same coefficient of expansion. A spiral filament of tungsten or molybdenum was mounted close to the strip and wired in series with the arc circuit. To prevent the strip moving too far and the arc breaking, a thick wire was sealed into the glass support; this wire acted as a stop and maintained the correct length of arc gap.

For alternating-current lamps the electrodes were constructed of fused tungsten and were of equal size.

For use with continuous current, in one form of lamp the positive electrode was constructed of a globule of fused tungsten, while the negative electrode consisted of a number of tungsten wires or filaments mounted in the form of a brush. The whole of the parts were assembled as shown in Fig. 1, and sealed in an ordinary incandescent

* Abstract of a Paper published in the "Journal" of the Institution of Electrical Engineers.

lamp bulb, which, after being thoroughly exhausted of air, was filled with nitrogen at a pressure of approximately two-thirds of an atmosphere.

When connected to a continuous-current circuit through a suitable resistance the current passing through the coil A produced sufficient heat to cause the expansion strip B to warp, thus separating the electrodes E, E, and striking an arc between them. The temperature of the heating coil then dropped to a very dull-red heat due to the added resistance of the arc itself. The heat from the arc was more than sufficient to keep the expansion strip hard against the stop F, and thus to maintain the requisite length of arc gap.

The arc burned steadily and the electrodes emitted an intense white light. The lamp had, however, many disadvantages, the most important being the tendency of the electrodes to stick together, with the result that the expansion strip failed to separate them slowly. Again, a considerable amount of sputtering took place when the electrodes separated, which in consequence shortened the life of the lamp. However, in the course of development, principally by altering the shape and size of the electrodes, a lamp was evolved from which a life of over 100 hours was obtained. Other attempts to overcome the sticking of the electrodes included altering the physical state of one electrode, also the use of a short-circuiting piece placed between them, which on the current passing was removed. These and other devices did not entirely overcome the troubles of sticking and sputtering.

It is well known from the experiments of Sir J. J. Thomson, Dr. Fleming, and others, that the filament in an incandescent lamp gives off a strong negative discharge, and if an additional electrode sealed adjacent to the filament be charged to a positive potential, a current passes between the filament and this electrode.

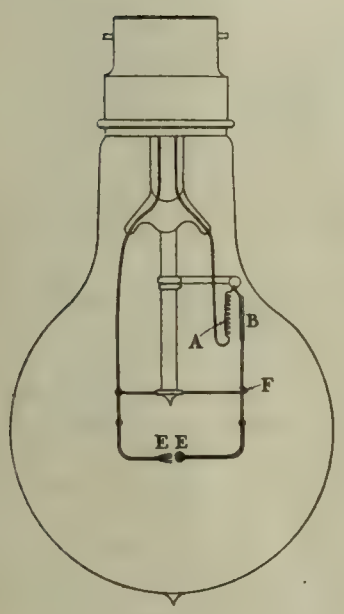


FIG. 1.

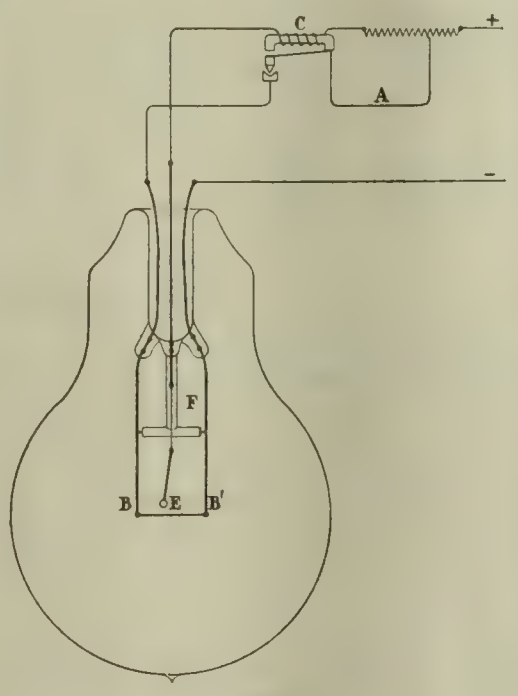


FIG. 2.

This principle was applied to overcome the difficulties encountered in making an arc incandescent lamp The first attempts on these lines were made with a lamp suitable for an alternating-current circuit. This lamp consisted of two small globules of tungsten fixed at a definite distance apart.

As used in the lamp, this ionising circuit was connected in parallel with the arc circuit through an auxiliary single-pole switch and suitable resistance. On starting, the ionising circuit was completed for a few seconds and then broken by means of the switch. This resulted in an arc being momentarily struck between one of the electrodes and the filament, this being followed by an arc between both electrodes, the filament acting as the ioniser being now entirely out of the circuit. This lamp showed great improvement as regards both facility in striking and life.

Efforts were then directed to make a lamp for continuous-current circuits. At the start, the construction of this lamp was similar to that used for alternating current, with the exception that the negative electrode was smaller. To start the lamp the filament acting as the ioniser was brought to high incandescence and then cut out by means of a switch in the positive lead. Difficulties were experienced in inducing the arc to leave the tungsten-filament ioniser and pass to the negative electrode. This trouble was due to the difficulty of bringing the negative electrode to a temperature high enough to form an arc. In the alternating-current arc the electrode which momentarily formed the arc with the ioniser helped to form the arc proper, but with the continuous-current lamp the arc persisted in passing between the positive electrode and the ioniser.

To obtain an ioniser which had a longer life than the previously used tungsten filament and which retained its activity throughout the life of the lamp, a study was made of the action of other materials than tungsten for use as an ioniser. It is well known that several refractory oxides possess to a very high degree the property of emitting electrons; experiments were therefore made with mixtures and combinations of tungsten with zirconia, yttria, thoria, and other oxides of the refractory class.

As a result of continued experiments, a satisfactory filament giving powerful ionisation properties was evolved, it being found that if the filaments were carefully made they were not destroyed by the action of the arc, and that they lasted considerably longer than a filament of pure tungsten, this being no doubt due to the difference in the physical state of the two filaments. However, difficulties still remained in the matter of restarting. The action of the arc after a time naturally destroyed the ionising properties of the filament, and in some cases difficulty was experienced in restriking after 200 hours' burning. This deterioration of the ionising properties of the filament was only local, being merely around a short length directly opposite the anode.

To overcome this objection, a short length of expansion strip similar to that used in Fig. 1 was linked between the anode and its stem lead. A lamp constructed in this manner is connected as shown in Fig. 2, which illustrates a lamp suitable for a continuous-current circuit. Three leads are necessary through the lamp stem; on one is mounted the electrode, E, while the other two hold the filament, acting as an ioniser, B B'. The positive main lead is divided into two circuits, one of which, A, passes through a resistance and the contacts on the electromagnetic switch, C, to one pole of the ioniser, B, the other being taken through a resistance and the coil on the electromagnetic switch to the positive electrode of the arc circuit, E. The negative main lead is connected to the remaining ioniser lead, B'.

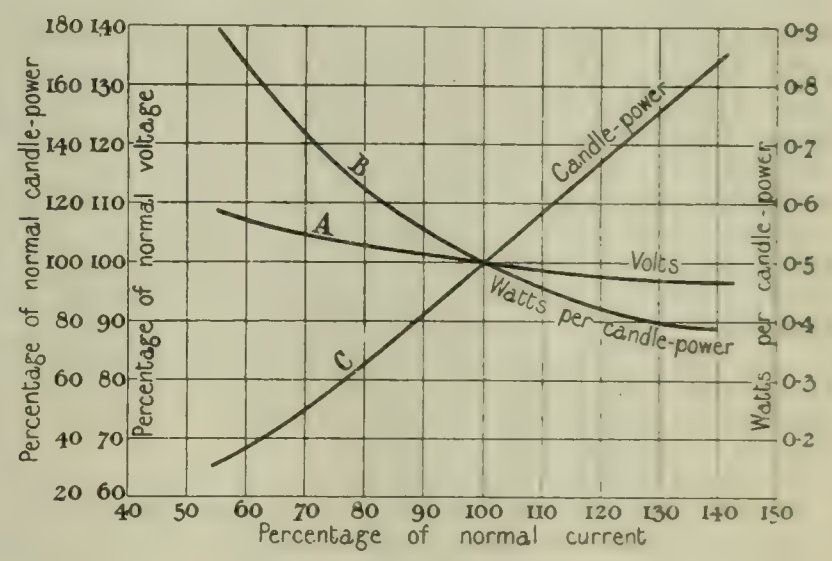


FIG. 3.

In operation the current first passes through the ioniser circuit, causing the filament to incandesce at a temperature sufficient to ionise the gas between it and the positive electrode. At first a small current flows in the arc circuit, this current rapidly increasing until the cut-out is operated. This breaks the ioniser circuit and the arc is "struck," the striking being assisted by the removal of the ioniser circuit, which, of course, shunted the arc circuit. The heat rising from the arc causes the expansion strip F to warp, and this moves the arc to another position on the ioniser.

On switching off the current the electrode returns to its original position, having left the inactive part and coming to rest opposite the still active portion of the ioniser. By this means the lamp may be restarted at any period of its life without difficulty.

In this lamp practically the whole of the intense white light emanates from a small globule of fused tungsten 1/10 in. in diameter.

Any size or shape of electrode may be made. A method adopted for controlling the arc stream in lamps of high candle-power is to employ an extra lead through the stem, holding a smaller electrode fixed between the positive plate and the filament, and situated at a definite distance from the former. By the operation of change-over switches in the circuit an arc is first struck between the filament as cathode and the small electrode as anode. On this electrode becoming brightly incandescent the change-over switch quickly operated brings into the circuit the large plate electrode, at the same time breaking the negative connection to the filament and changing the polarity of the small white-hot electrode. This latter now being negative, an arc is immediately formed between it and the large

positive plate. This arrangement enables electrodes of any size to be used, and the filament being out of the circuit is completely protected.

A flat electrode is also employed. To obtain the best results a definite relation of surface to volume must be maintained. This type of lamp is made in sizes of 500 c.p. to 1,000 c.p., the maximum intensity being given in a direction at right angles to the plane of the electrode.

As compared with the carbon arc lamp no regulating mechanism is required. The loss of light due to obstruction by the electrodes is small compared with that in the carbon arc. The arc is completely enclosed so that there is no danger from fire. No re-carboning is required.

For high candle-power lamps the bulbs are much smaller than for metal-filament lamps of corresponding candle-power, *e.g.*, electrodes to give 500 c.p. can be placed with safety in a bulb 4 in. in diameter.

Curve A (Fig. 3) shows the percentage variation of pressure with current. As will be seen, the curve is similar to that for an ordinary carbon arc, though showing greater stability. The pressure across the arc steadily decreases with an increase of current, and if continued until the sputtering point is reached, the pressure suddenly drops.

A representative efficiency curve is given by B in Fig. 3, which shows the efficiency for the normal working current to be about 0·5 watt per International candle-power, or 2 c.p. per watt. The current may be increased until the tungsten reaches the sputtering point, at which the efficiency is about 0·3 watt per candle-power or 3·33 c.p. per watt.

Curve C in Fig. 3 shows the variation of candle-power with current.

Lamps have been made with a life of 500 hours, and it is hoped that further experiment will make it possible to obtain a true half-watt lamp with a life of 800 hours. During life the average decrease in candle-power is about 10 per cent.

As compared with the carbon-filament lamp (3·5 watts per candle-power) with an intrinsic brilliancy of about 375 c.p. per square inch, and metal-filament lamps giving 1,000 c.p. per square inch, the intrinsic brilliancy of the new lamp at an efficiency of 0·5 watt per candle-power, or 2 c.p. per watt, is approximately 10,000 c.p. per square inch. The colour of the light can be made to vary from a bright yellow when running at low efficiencies, to a very intense white light when the lamp is run to the sputtering point of the electrodes. The range of intrinsic brilliancy between these limits is approximately 400 c.p. to 30,000 c.p. per square inch.

Comparisons of spectra clearly show the continuity and strength in the visible spectrum of the new lamp, the other sources of light showing weakness in the green and at other points.

A great advantage of a lamp of this type is its adaptability (by altering the shape and position of the electrodes) in so varying the light distribution as to make it most suitable for the particular purpose for which the lamp is required.

The lamp is made for both alternating and continuous-current circuits. The lamp is so suitable for projection work that there is every reason to believe it will supersede all other sources of light for this purpose. It gives constant, uniform screen illumination, whilst there is no flickering and no danger of fire in kinematograph work as there often is from the intense heat of the ordinary carbon arc. The bulb of the lamp, although smaller, does not become so hot as those of the half-watt metal-filament lamps. Moreover, the lamp requires no attention whilst burning, so that the whole of the operator's time is free to attend to his apparatus. Lamps of 1,000 c.p. to 2,000 c.p. are suggested as very suitable for kinematograph projection, and lamps of 200 c.p. to 300 c.p. for ordinary lantern work.

The lamp is very suitable for use in small searchlights, for daylight and night signalling, and as projection arcs for stage purposes.

Long-distance Radiotelephony. Shareholders in telephone companies and telephone manufacturing companies, on reading the extravagant claims made in the non-technical press concerning radiotelephony, need have no misgivings as to the security of their investments. Notwithstanding the rapid commercial development of long-distance radiotelegraphy, the position of the cable companies is unique, and although the cable companies work without limelight or publicity or big drum their service is of inestimable value to the country at the present time. Writing in the current issue of the "Engineering Magazine," Prof. H. Pender expresses an opinion, which we heartily endorse, namely, that radiotelephony will in no sense become a substitute for wire telephony, but will serve as an important adjunct thereto, making possible the extension of telephonic communication into regions where wire telephony is impracticable.

ELECTRICAL MACHINERY AT THE MEADOWSIDE GRANARY.

In a Paper presented to the Institution of Engineers and Shipbuilders in Scotland, Mr. George H. Baxter recently described the Clyde Trustees' new granary at Meadowside, and gave some interesting tabulated particulars of the electrical equipment.

All the motors are of the totally-enclosed type, with dust-proof bearings, the system of supply being 500 volts direct current. Each is capable of carrying overloads of 25 per cent. for half an hour, and of 50 per cent. for five minutes, without sparking. The insulation is of the Admiralty type throughout. There are altogether 37 motors throughout the granary, exclusive of those for capstans and traverser, varying from 5 B.H.P. to 65 B.H.P., and having a total of 860 B.H.P. Table I. shows the distribution of power throughout the various appliances.

Table I.—*Distribution of Power in the Granary.*

No.	B.H.P. of each.	Revs. per min.	Winding.	Rating.	Purpose.
4	5	500	Series	1 hour	Ship elevator travelling gear.
1	8	500	,,	,,	Passenger lift.
2	10	750	,,	,,	Ship elevator hoisting winch.
1	10	750	Shunt	Cont.	Inclined conveyer.
2	10	750	,,	,,	Quay subway dust plant.
2	15	750	,,	,,	Two sack bands in granary.
1	15	750	,,	,,	Horizontal conveyer.
2	15	750	,,	,,	Trimmer winches for ship elevator
2	25	600	,,	,,	Two sack bands.
2	25	600	,,	,,	Granary tunnel bands.
1	25	600	,,	,,	Elevator in granary,
8	30	600	,,	,,	Quay and cross subway bands.
1	30	600	,,	,,	Conveyer bands in gallery.
1	30	600	,,	,,	Two sack bands in granary.
2	30	600	,,	,,	Weighing elevators in structure
2	40	500	,,	,,	Ship elevators. [on quay.
2	65	500	,,	,,	Silo elevators.

A system of electric bell signalling is used between various parts of the building, as the noise of the machinery renders telephone conversation difficult.

At the west end of the granary building a traverser of the sunk type is provided to run on the cross line of rails, for the purpose of taking loaded wagons of about 18 tons gross weight from any one of the three lines of rails which pass through the granary and conveying them to either of two lines. The extreme length of travel of the traverser is approximately 100 ft., and the speed, with a load of 18 tons, is on an average about 180 ft. per minute. The traverser is driven by a compound-wound motor of 12 B.H.P., which runs at a speed of 450 revs. per min. when at full load. The wagons are run on and off the traverser by means of capstans, and are automatically scotched by means of sliding blocks operated by a lever actuated by the rim of the wagon wheel.

The control gear consists of a master controller, with notches corresponding to the various positions from which the wagons are run off and on. Two "inching" push buttons are provided to adjust the rails of the traverser in line with the fixed rails. Current is supplied by overhead bare wires, and collected by a double-arm trolly pole.

The main sub-station is situated near the entrance to Meadowside Quay from Castlebank-street, and contains the switchboard with panels for receiving current from the Partick Electricity Works of the Glasgow Corporation, and for distributing it to the granary, fan, traverser and about 20 electric capstans at a pressure of 500 volts. A main switchboard room is provided and fixed in a sub-station in the granary on the second floor. From it main cables are led along the cross and quay subways to supply current to the motors under the silo, the motors in quay subway, and also by means of the plug connections to the travelling ship elevators and loading-out apparatus. Another main cable runs right up through the building to the gallery floor, supplying all motors there and on the intermediate floors, while smaller cables carry current to the lighting circuits.

The cables between switchboard and the joint boxes in the trench at the sub-station are of vulcanised rubber insulated from the joint boxes, the cables are lead covered, paper insulated and laid solid to where they pass into the granary, sheds or capstan boxes; above the ground-level the cables are enclosed in galvanised gas tubing carried on insulators or clamped to the wall.

The pressure of supply is 500 volts continuous current for power and 250 volts for lighting. All these cables are of British manufacture Association class, paper-insulated and lead-covered, and have a

Table II.—*Current used in Discharging, Weighing and Delivering; together with Efficiencies and Energy used per ton.*

—	H.P. of motor	Running loaded. Volts.	Amps.	Units.	Running light. Volts.	Amps.	Units.	Effective units =D.G.	Efficiency % $= \frac{H \times 100}{D}$	Grain raised by ship elevator. Lbs. per minute.	Height. (feet).	Ft.-lbs. per minute.	Equivalent elec. units. Output.	Total effic. of the system $\frac{N \times 100}{D}$	Units per ton D ÷ 35
	A	B	C	D	E	F	G	H	J	K	L	M	N	O	
Ship elevator	40	497	74·33	36·944	520	14·0	7·28	29·664	80·29	10,560 Equal to 283 tons per hour.	82·0	865,920	19·575	53·0	0·1305
Weighing elevators —two driven by one motor	30	497	39·5	19·631	512	8·0	4·096	15·535	79·13		48·75	514,800	11·637	59·28	0·0658
Granary elevator	65	506	110.5	55·913	509	8·125	4·135	51·778	92·6		171·0	1,085,760	40·819	73·0	0·1976
—	Conveyer bands.										Length between centres in feet.	Speed of band in f.p.m.	R.p.m. of motors.	Feet of band per revolution of motor.	
In quay tunnel	30	506	41	20·746	512	22·0	11·264	9·482	45·7	10,560 equal to 283 tons per hour	329	800	600	$1\frac{1}{4}$	0·0733
In cross tunnel	30	500	34	17·0	515	19·5	10·042	6·958	40·93		$244\frac{1}{2}$	800	600	$1\frac{1}{4}$	0·0690
In gallery	30	505	31	15·655	508	23·0	11·684	3·971	25·36		168	800	600	$1\frac{1}{4}$	0·0140
															0·5412

minimum insulation resistance per mile at 60°F., of 70 megohms. The VI R cables are of 2,500 megohm grade, insulated with pure and vulcanised indiarubber, taped and braided and thoroughly compounded. The copper cables are of high conductivity, not less than 100 per cent. of the standard, each wire being carefully tinned. The whole of the cables, fuse boxes, fixtures and tubing above the ground level are painted with two coats of bitumastic solution.

Table II. gives the current used in discharging, weighing and delivering wheat from the hold of a vessel into any bin or floor, together with efficiencies and the energy used per ton.

TROLLEY WIRE ON DOUBLE-LEAF BASCULE BRIDGE.*

BY S. L. FOSTER.

In San Francisco the problem recently arose of installing trolley wire for an electric railway line over a double-leaf bascule bridge. The problem was a new one, and help was sought from the designers of the bridge and then from the builders, but nothing of practical value was received.

The final solution decided on is simple and satisfactory, and the diagram, Fig. 1, makes the plan clear. It was found that by selecting the points of support for the trolley wire there could be exactly the right amount of slack thrown into the trolley span at the hinge in the bridge when the leaf was lifted to suffice for this complicated movement of the bascule-bridge mechanism without straining the trolley wire attachments at the terminals of this span. To prevent the trolley wire from becoming crystallised or broken from repeated up and down flexures that would occur at the openings of the bridge, hinged frogs, BB, were installed at each end of the particular span referred to.

To prevent any injury to the trolley wire, to the bridge structure, or to persons coming into contact with the loose trolley wire of this span which might have occurred if the wire had been left alive, a pair of drawbridge frogs, CC, with special top contact plates, were provided at the outside lower end of the weight box or machinery platform to open and close the electric circuit in a vertical plane. There was a movable frog on the weight box and a permanent one on a permanent structural steel frame beyond, so that the current was automatically cut off the bridge at the instant the leaf and the outside lower corner of the weight box began to rise, the latter being slightly beyond the trunnion centre of the weight box.

To secure durability in the trolley wire, solid round No. 00 phono-electric wire was selected in preference to stranded or hard-drawn solid copper wire in spite of the smaller conductivity of the first-named wire. To provide for possible emergencies a section insulator was installed in the trolley wire just beyond the bridge at each end with a fuse and knife switch around it.

As each side of this bridge was fed by different feeder cables there was no necessity for a current-carrying contact device in the trolley wire at the middle of the bridge, and a pair of ordinary drawbridge frogs, AA, without contact plates, sufficed.

Thus, when the bridge leaf rose, the inside face of the weight box descended and the lower corner of the outside face of the weight box ascended, opening the circuit several inches and making the trolley wire on the bridge dead as it slackened off and began to lie loosely, though harmlessly, about on the top of the weight box. As the bridge leaf descended, the lower corner of the outside face of the weight box descended and as the trolley wire in the hinge span tautened up to its original condition, the drawbridge frogs at the outside face of the weight box closed the electric circuit and made the trolley wire alive once more and ready for the passing cars to draw power from it.

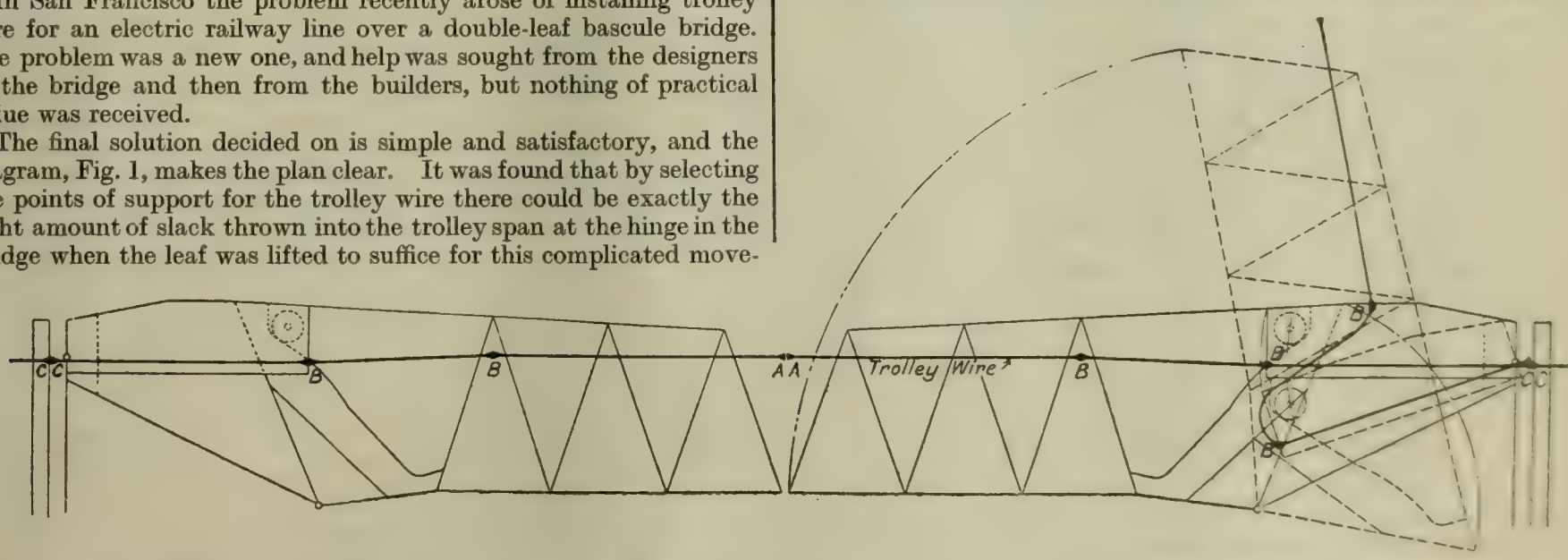


FIG. 1.—SKELETON OUTLINE OF DOUBLE-LEAF BASCULE BRIDGE, SHOWING LOCATION OF TROLLEY WIRE AND SPECIAL OVERHEAD PARTS FOR CLOSED AND OPEN POSITIONS OF BRIDGE LEAVES.

As the hard-drawn No. 00 trolley wire on a near-by swing bridge lasted 14 years without renewal, longer life is expected of this tougher phono-electric wire, and, with monthly examinations at the time of inspection and overhauling of electric track switches, block signals and sectionalising switches on the system, with re-earing of the clinched ears every five years or so, and with perhaps the replacement of an occasional frog, the whole installation is confidently looked upon as likely to require a minimum of attention and main-

* From the "Electric Railway Journal," slightly abbreviated.

tenance expense. All frogs were provided with case-hardened steel wearing plates.

The electric road over this bridge is a double-track line, but the description and illustrations were made to apply to but a single trolley wire for simplicity. The two trolley wires were cross-connected at each end of each leaf of the bridge, and elsewhere than at the hinge spans were provided overhead with flat 2 in. by 10 in. untroughed wooden guards with 4 in. by 4 in. wooden parallel stiffeners on top to prevent a possible wild trolley pole from coming into contact with the live trolley wire and the grounded steel superstructure of the bridge at the same time, a protection that proved entirely satisfactory on a near-by bridge for 14 years. All supporting rods, bolts and other metal parts of these trolley guards and overhead supports combined were hot-dip galvanised, and thoroughly painted after installation.

The electric motors that operate the bridge mechanism, and all the lights on the bridge receive their current from the local electric light company, so that the railway company's trolley wires are used only for furnishing power to the passing cars. As the bridge opens, there being no cars on it, there is no current to be broken at the switch surfaces on the weight-box devices and these switches are not likely to require any repairs.

The double-trolley line with the two parallel wires cross-connected assures a factor-of-safety of two in the contact-making devices at the weight boxes providing against the possibility of corrosion of their parts from exposure to the influences of the salt water and the sewage gases of the channel below.

RECENT DEVELOPMENTS IN ELECTRIC LAMPS IN RELATION TO ILLUMINATING ENGINEERING.

Last Tuesday evening a discussion was held at the Illuminating Engineering Society on the above subject. The chair was taken by Prof. S. P. Thompson, and the subject was introduced by Prof. J. T. Morris. An interesting discussion took place, of which we give an abstract below.

Prof. J. T. Morris, in opening the discussion, showed some tables indicating how the incandescent electric lamp had increased in efficiency in its various stages from the early days, and how the intrinsic brilliancy had varied. At the present time, in the United States, about three-quarters of the glow lamps manufactured were made of tungsten. It would, therefore, seem that the carbon lamp was disappearing and it was necessary to consider how the newer lamps would influence practice in illuminating problems. In giving a brief description of the new Ediswan lamp, Prof. Morris mentioned that a change of 1 per cent. in the voltage caused a change of about 2½ per cent. in the candle-power, as compared with about 6 per cent. in the older lamps. With regard to the spiral form of filament, Prof. Morris mentioned that the dazzling effect was more serious than with a plain filament, because the area that was covered was much less. In his experience the spiral form of filament showed a lower life to the extent of about 20 per cent., but it might be worth while to pay more for lamps if the gain in efficiency was sufficient. In the newer lamps there was the question as to how the candle-power should be stated, which was a matter requiring consideration. He thought that makers would do well to issue polar diagrams with their lamps showing the variations of candle-power. Such lamps also required special reflectors, and it might be an advantage if the bulbs were made with the upper part of opal glass, so as to give a permanent reflector. In conclusion, Prof. Morris showed some examples of platform illumination and the illumination of a chemical balance.

Mr. S. R. Mullard gave an interesting demonstration of the new Ediswan lamp, which he stated could be made up to a candle-power of 1,200.

Mr. F. W. Willcox preferred the vertical form of filament, because it lent itself better to easy treatment by reflectors. Really nothing was to be gained by using a horizontal spiral filament in a lamp from the illuminating point of view, unless this was justified by an increase in efficiency, as in the half watt lamp. The half watt lamp had many advantages, including low cost. Its extreme brilliancy would bring about its own remedy, which would consist in an alteration in the present form of shades. The height of lamps would be raised to, say, 12 ft. above the plane of illumination; fittings with cone would disappear, as also open opal shades and similar devices, and some form of bowl would be adopted. There would be a less tendency to cluster lighting, and the ordinary forms of arc lamps would be superseded. Lamps with spiral filaments (at least in the low candle-powers) required careful adjustment in a reflector in order to have the source of light in the proper position, and for this purpose it was necessary to have a means of adjusting the lamp in the reflector. In the ordinary rippled glass it was necessary to modify the ripples so as to avoid striations in the light. It was also advisable to provide adequate ventilation in reflectors so as to allow the heat to pass away, and fittings for outdoor use must be waterproof, otherwise the hot bulbs might crack if a drop of water fell upon them. There was some difficulty in obtaining an "extensive" distribution of light as compared with the less efficient metal filament lamps, and for this purpose a deflector should be used beneath the lamp, or a prismatic glass globe should be fitted below the lamp. Owing to the source of light being more concentrated, the shadows were proportionately heavier, and so diffusers of light became necessary.

Mr. W. R. Cooper expressed his interest in the new Ediswan lamp, and only wished that Mr. Mullard had given much more information. In regard to intrinsic brilliancy, he suggested that this might be overcome by including a reflector of unglazed porcelain in the lamp bulb above the filament, but possibly this might interfere with the maintenance of a good vacuum. He was inclined to think that there was not very much advantage in makers issuing polar diagrams with their lamps, as such lamps would never be used by themselves. It would be better for makers to develop certain shades which they considered satisfactory, and to issue polar diagrams of the lamps combined with those shades. With regard to the balance lighting shown by Prof. Morris, he had himself designed some balance lighting recently which he thought was simpler, and which had proved quite effective. This consisted of a small tubular lamp carried on a bracket at the top of the balance.

Mr. A. E. Cunnington asked what was the meaning of candle-power in connection with metal filament lamps, and what was the effect of over-running. He had found that slight over-running had a very bad effect on the life of metal filament lamps, and that it was probably better to under-run. He thought it would be of some value to have definite information on the effect of under-running lamps.

Mr. E. Stroud remarked that the rating of lamps was very important. He did not agree with Mr. Willcox that the distribution of light had been seriously altered by the spiral filament in the half-watt lamp, and he showed a number of polar diagrams of half-watt lamps in holophane fittings supporting his contention. It was impossible to design special fittings for each new type of lamp, as the number would be so large.

Mr. L. Gaster congratulated the makers upon having illuminating engineering departments, and upon the good relations between the lamp maker, the buyer, the shade maker and the Illuminating Engineering Society. It was necessary for the makers to educate the public, and in doing so they should state the disadvantages as well as the advantages of new lamps. Lamps should not be pushed before they were ready, and it was a mistake to sell high-voltage lamps before the low-voltage lamps were satisfactory.

Prof. S. P. Thompson, in bringing the discussion to a close, referred to some historical points, starting from the date of Dec. 18, 1878, when Sir Joseph Swan first showed his lamp. He thought it was not improbable that history had been made that evening by the exhibition of the new Ediswan lamp. He felt that this lamp would not for long remain where it was, and that there would very soon be many other makers striving in the same direction.

CORRESPONDENCE.

EARTH RESISTANCE.

TO THE EDITORS OF THE ELECTRICIAN.

Sirs: The note on earth resistance that I submitted to the British Association has served its purpose, if it has done nothing else than elicit the very interesting Paper which Prof. Howe has published in your journal. The main difference between Prof. Howe's calculations of resistance and that we found, is, I think, due to the fact that our bars were pointed whereas he assumed his to have square ends. I do not think it is of much use to calculate earth resistance to any high degree of accuracy, as it varies from day to day with the amount of moisture in the ground. The main object of my note was to suggest a simple way in which the order of magnitude of earth resistance might be estimated for any given site, and for any given form of earth plate. The quantity which I defined as the equivalent length is, of course, a geometrical quantity calculable by the same rules as those by which capacity is found. I hope Prof. Howe will continue his mathematical investigations to the "radiating" type of earth plate which is generally used in wireless stations. As he says, the current distribution with currents of wireless frequencies will be quite different from that with low frequency or continuous current. Some interesting experiments have been made recently here by Mr. McLachlan, in which he has shown that the specific resistance of moist sandstone for alternating currents is very nearly constant for all frequencies from 50 to a million. When the specific resistance is measured with direct currents, there is, of course, some polarisation; but if a fairly high voltage is used the error involved by making the test in this way is a great deal less than the day to day differences in earth resistance. The estimation of earth resistance can only be approximate, and it is misleading to state it with apparent precision.—I am, &c.,

Liverpool, Dec. 11. E. W. Marchant.

LEGAL INTELLIGENCE.

Vandervell v. A. P. Lundberg & Sons.

On Friday Mr. Justice Younger delivered judgment in this action by which plaintiff claimed an injunction and other relief in respect of an alleged infringement of two registered designs for electrical switch boxes. In delivering judgment his Lordship said that with the exception that one was registered for wood and the other for metal the two designs registered by plaintiff were identical and no distinction was to be drawn between them so far as the conduct of defendants complained of was concerned. After reciting the defences set up, he said the characteristics of the design were to be found in the drawing. At the time of the registration the rules did not require, and plaintiff, in fact, did not specify the particulars in which his design was new and original beyond the statement that they were switch boxes for use in electric installations, and were particularly adapted for motor cars. The design showed a base with a particular sloping top surrounded by a beading, but it also dealt with the representation of push plugs between rows of switches six in number set in a plate of metal or some other substance. Two dials were also shown, and the plugs for attaching the electric connection were shown at the bottom right-hand side of the box. Plaintiff's contention with regard to the design was that it was a design for the whole structure and not for any separate property. So far their claim that the design was novel and original was strongly supported, but looked at in that way defendants' design was not an infringement of it. It did not resemble plaintiffs' design in the sense, but plaintiffs said defendants had taken novel features in their design. Defendants had, as the plaintiffs had, their switches arranged in a row and six in number. Then the two dials were arranged in the sloping top of the box, which was said to be very essential to switch boxes for motor cars. But the registered design was not limited to switch boxes for motor cars. He thought the law was quite clear that unless plaintiff could get novelty and originality by taking the design as a whole their claim failed. It was admitted that similar shaped boxes had been made and used before, and there was no novelty in or infringement of the design as a whole in respect of shape. It had been urged for plaintiffs that there was distinctiveness in the design not only because plaintiff's tumblers were all in a row, but also from the fact that they were six in number, and that was sufficient to enable plaintiff to claim originality of design. No evidence had been given to show that these were the characteristics of plaintiff's design, and the question was whether on that statement of facts the Court was bound to come to the conclusion that plaintiff's design so limited had sufficient novelty and originality to entitle it to protection. The Court would not go out of its way to find originality and novelty in a design, and in considering originality and novelty it was not only entitled but was bound to consider the nature of the infringement. It was said in plaintiff's advertisement that six switches were sufficient and an appropriate number for motors, but these switch boxes were not limited to motors. The advertisement also said that though six switches as a rule were all that were required to give the utmost control, the number of switches could be increased to meet the cases of individual purchasers. He could not hold, therefore, that there was anything novel or original in the number of switches so as to entitle plaintiff to protection on that ground. With regard to the position of the switches he could not hold that there was such a modicum of novelty and originality as would by itself justify a claim for protection, nor would it justify a claim for a combination, everything else of which was old just because of that one novelty. He did not think, therefore, plaintiff could justify a claim for originality at all, and on the whole he must hold that there was not sufficient novelty and originality in this design to entitle it to be registered. To his mind there was a much broader ground on which plaintiff's claim ought to be rejected. As he had pointed out this was a design for a switch box, not for a switchboard inside the box. No claim was made for the design of the switchboard or its arrangement. He found in plaintiff's 1910 catalogue that that was a switchboard which contained many novel features and had been made the subject of a patent. That patent was taken out in 1909, before the switch box was registered as a design. The design was for the box and not for the switchboard already patented. The box was designed for the board and not the board for the box. Plaintiff now claimed as a part of the design of the box a feature which was part of the board. Plaintiff was endeavouring to obtain for the switch box an implied protection which they as patentees were entitled to for the switchboard. To his mind it would be a most dangerous thing to extend the scope of the Designs Act to such a claim, and if there was no other defence that objection would be fatal. With regard to the second defence, it had been shown that for the purposes of the exhibition of 1913 two boxes, if not more, were made, which, though not in accordance with the design, bore the registered number of the design, but having regard to his decision on the first point, he did not think it necessary to dwell upon the consequences of that. It was not necessary also for him, in the view that he took of the first point, to express any opinion on the question of infringement. If another tribunal should hold that plaintiff was entitled to protection it was better to leave the question of infringement for them to deal with. The action would, therefore, be dismissed, with costs.

Alien Enemy Patents.

On Friday the special Patents Court heard an application by the Refractory Zinc Ore Treatment Co., of London and New York, for a licence to manufacture zinc by an electrical process under patent 605 of 1909, belonging to the Siemens & Halske Co., of Berlin. The patent related to a process for making anodes of [illegible] to be used in saline solutions under electricity for securing the deposit of pure form of zinc. Zinc was a difficult material to deal with [illegible] lytically, and to-day was very scarce, its price having gone up from £20 to more than £89 a ton. Pure zinc such as was [illegible] electrolytically with that anode was in great demand.

Applicants were represented by Mr. Edward [illegible] and Mr. Barnard Burton, patent agent, represented the patentees.

Mr. EVANS said that unattackable anodes were [illegible] lysis of aqueous saline solutions, such as solutions of zinc sulphate, copper nitrate and sodium chloride in which free acid might be present. In the attempt to provide an unattackable anode lead peroxide had been used, but (beside the disadvantage of its usual form of rods) under certain conditions reduction occurred and lead ions passed into solution. It had been found that crystalline manganese peroxide conducted the current well, and possessed the great advantage that any reduction which occurred entailed only the passage of manganese ions into the solution, and those had no injurious effect on the deposition of the metal at the cathode. The attempt was made to use electrodes of manganese peroxide in the form of sheet platinum electrolytically-coated with amorphous manganese peroxide, but such electrodes as anodes were not a success, because in that form the peroxide was liable to be converted by the electric current in dilute sulphuric acid into higher stages of oxidation soluble in water. Crystalline manganese peroxide, obtainable by heating manganese nitrate, was capable of being secured in massive form as a cake, and by electrolysis that was not oxidised to higher stages of oxidation or only very inconsiderably so. Applicants proposed to arrange a company for making those anodes and for employing them to obtain the pure zinc, thus coping with the present difficulty about spelter. Manganese nitrate heated to a temperature of 150°C. or 200°C. yielded in the mould an anode of sufficiently massive form for the process of electrolysis. It was not so long since that the Zinc Gesellschaft, a powerful syndicate, cornered the ore supply in America. The price of zinc had risen since the war from roughly £20 a ton to £100, and with its reduced supply, in a commercial form, owing to the lack of imports from Germany and Belgium, it was in greater demand than ever to-day for cartridge cases, shells and the like. The President of the Board of Trade and the Colonial Secretary had appointed a special committee to arrange an immediate scheme which should guarantee a continuous British supply, and applicants were ready to place the results of their experiments at the disposal of the committee. They had made considerable experiments in association with Messrs. Siemens for the production of zinc by electrolysis.

The Controller of Patents (Mr. TEMPLE FRANKS) observed that to him, as an outsider, it was astonishing that anybody should allow those "gesellschafts" to corner zinc in every part of the world in the way they had done. He knew what the spelter difficulty was, and how the Australians were seeking to meet the situation by taking the matter into their own hands. It was that which had brought the Colonial Secretary into the business. If applicants' use of the electrical process for zinc was practicable it would be extremely valuable, and prima facie there was good ground for granting them the licence for which they asked.

Dr. P. C. C. ISHERWOOD, technical director of applicant firm, stated that Germany had made half a million tons of zinc annually from ore imported from Australia. Applicants were ready to pay 5 per cent. on the anodes manufactured. They preferred to pay royalty in that form rather than on the zinc recovered. An anode might last a twelve month, and 20,000 would be required for a fairly large electrolytic installation.

Mr. BURTON argued that as an anode might vary in size from a rod as small as a lead pencil to a plate as big as a blackboard, that was not the fair way of estimating royalty. The royalty should be upon the output on what the patented process enabled them to obtain. The anode was vital to the entire method.

Dr. ISHERWOOD intimated that applicants proposed to begin with a unit yielding 10 tons a day. As the need arose they could increase the units. They were entitled to have taken into account the experimental work they had conducted in order to apply the process to zinc. Messrs. Siemens recognised its value, and had offered to make them an equivalent return. One of those anodes cost, perhaps, 8s. or 9s., and if the royalty was to appear as a permanent and substantial tax on the undertaking, it would jeopardise at the outset the promotion of the company. It would be necessary to have a separate factory for making anodes, possibly under a subsidiary company. The initial step was to secure the Board of Trade's licence. Other licences had yet to be asked for—2,767 of 1915 and 15,128 of 1911. Witness said one of the patents taken out was the result of his own experiments. Some time ago they received a licence from Messrs. Siemens for experimental purposes, and conducted their experiments at works in Surrey. That investigation was done on an undertaking that they should supply the results to Messrs. Siemens, and with that condition they had complied. That arrangement with Messrs. Siemens came to an end before the war. In 1913 applicants had a scheme for manufacturing in America upon a large scale. At present zinc was cheaper on the London market than elsewhere. Water-power would have been used in America; a steam plant would have to be set up in this country. With the ore at £80 a ton, the freights were not prohibitive. Every ounce of zinc made in England came from imported ore. The demand at the moment was great. It would lie with the Government Committee to say whether they desired applicants to obtain zinc by that method. It would not be possible to promote a company to manufacture zinc without Treasury sanction. Applicants were the only people who knew how to make those anodes; they had actually done more work upon them than Messrs. Siemens had. The initial plant, if the Committee favoured the project, would be very expensive, and they would

not be able to get to work for six months. Dr. Isherwood said that when he began experimenting the Siemens Co. supplied him only with 10 anodes they had made, copper connections, switchboard, voltmeter, &c. It should be remembered, when the question of royalty was considered, that the process was electrical, and the patent applied only to one incident. Antecedent processes for treating the ore applicants already had. They had a plant running for 12 months in America, but the price of zinc was not particularly good, and there was the trouble of the ore supply, because of the Zinc Gesellschaft's corner. He added that the zinc made electrolytically by his process was particularly suitable for all the present demands, as it came out absolutely pure, and there was no difficulty with the electrical reduction and ions in the solution. When they experimented here they paid Messrs. Siemens and Halske a royalty of 4 marks per ton of electrolytic zinc obtained. They had the option of compounding the royalties by a lump sum, to be estimated on five years' output of 300 working days without deducting the ton royalties already paid. Their relations with the Siemens Co. came to an end while they were discussing the joint use of the witness's and Siemens' processes.

The Controller intimated that he should recommend that a licence be granted to the applicants. The shortage of zinc in this country made it desirable that they should get to work as soon as possible if they could produce it in commercial form, and they would hear from the Board of Trade in due course as to their licence.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.).

On Wednesday the Court of Appeal dismissed the appeal of plaintiffs from the judgment of Mr. Justice Joyce dismissing an action for an injunction to restrain an alleged infringement of plaintiffs' letters patent. A full report will appear in our next issue.

Alleged Fraudulent Use of Electric Current.

At Dewsbury Police Court recently, Geo. Strecker (trading as Margaret Strecker & Son) was summoned for having fraudulently used electric current to the value of £1. 15s., the property of the Corporation.

The town clerk (Mr. H. ELLIS) stated that until March, 1912, defendant was supplied through separate meters with current for lighting and power, current for power being supplied at 1½d. per unit less than for illumination. At that period defendant informed the borough electrical engineer (Mr. R. H. Campion) that he had not been using electricity for lighting for 12 months, and, so far as he knew, he was not going to use it again; therefore, at his request, the lighting meter was removed from the premises. On Nov. 14 last two of the Corporation inspectors and a police constable visited the premises and saw an electric light burning in the sitting room above the shop. When they entered the premises Mrs. Strecker (defendant's mother) called upstairs: "Turn that light out, George." The lamp in the sitting room was fed with electric current obtained by means of a flexible wire connected to a chopping machine. In the kitchen two lamps were also connected in a similar way, but there was no evidence to show that they had been used for lighting purposes.

The explanation given by defendant was that he thought that as a user of electricity for power he was entitled to use electricity for one light. That (said Mr. ELLIS) was allowed in Leeds, Bradford and some other places, but it was not permitted by Dewsbury Corporation. He would leave it to the magistrates to judge whether this was a case which would be met by defendant paying the difference between the price of the current when used for lighting and that charged for power.

The MAGISTRATES' CLERK pointed out that the justices must either convict or dismiss the case, and in the latter event the Corporation would lose all remedy.

Mr. G. E. B. BLAKELEY (for defendant) said the facts were not disputed, and if he had not thought that it would be considered an act of disrespect to the Bench he would have tendered to the Corporation the amount due. If the summons were withdrawn, the amount due, together with costs, would be paid at once.

Mr. ELLIS said that was the first case of the kind in Dewsbury. If there had been a previous case, he would have considered that the publicity given to it amounted to notice of the legal position, and that defendant must have been aware that he was fraudulently using the current. In the circumstance, he was content for the case to be reported and for the summons to be withdrawn on the terms mentioned by Mr. Blakeley, especially as there seemed to be a reasonable excuse in the mind of defendant as to the use of the electricity for one light.

The magistrates allowed the summons to be withdrawn on the terms stated.

Mayor and Corporation of West Ham v. Hart Accumulator Co.

Last week Mr. Justice Bailhache had before him this appeal.

Mr. WILLIAMSON, for respondent company, said that the appeal would not now be argued, as terms had been agreed between the parties, and by consent the award that had been made in the arbitration would be set aside without costs. The matter related to a complicated set of facts arising out of the question of terminals.

Mr. STEPHEN LYNCH (for the Corporation) said that a new arrangement had been come to which would make the arguing of the appeal which was set down a year ago unnecessary. The appeal had reference to the fact that evidence was admitted at the arbitration which was objected to.

By consent, the award was set aside without costs.

Re British Electric Traction Co. (Ltd.) On the 8th inst. Mr. Justice Astbury gave judgment on the petition of the company to confirm a reduction of capital by £1,001,602.

He sanctioned the scheme in the terms of the petition.

PARLIAMENTARY INTELLIGENCE.

TRADING WITH THE ENEMY (EXTENSION) BILL.

The second reading of this Bill took place in the House of Commons on Monday. Lord R. Cecil, who moved the second reading, said the object of the Bill was to impede, if not to stop, trading with the enemy in neutral countries. At present for belligerent purposes the nationality of anybody depended upon his domicile. A German with a domicile in a neutral country was treated as a neutral. The result was that it was no offence for a British subject to trade with a German firm in a neutral country, and it was no offence for ships to carry his goods or for banks to finance his business. The result was that we found in a number of neutral countries, particularly in South America, neutral firms doing a very good business, and at any rate in times past they had been of direct assistance to the enemy. He admitted there was great difficulty in dealing with the trade of an old mercantile country like our own. Extreme care had to be taken lest the blow aimed at German trade reacted on British trade. The whole matter had been carefully considered by the Government. The best result could be achieved by forming a black list of traders in neutral countries, who, whether of enemy nationality or not, were substantially enemy firms who could be safely cut off from British intercourse without doing serious injury to British trade. In addition the Bill would do something to put upon equal terms the British and French law on that question.

MUNITIONS OF WAR (AMENDMENT) BILL.

The text of this Bill has been issued. It gives power to the Minister of Munitions to declare Government factories in which munitions work is carried on to be controlled establishments. The principal Act is amended so as to make the issue of certificates of discharge compulsory upon an employer when he dismisses a workman or suspends him for more than three days unless the tribunal is of opinion that the workman was guilty of misconduct in order to secure dismissal. The definition of munitions work is extended so as to include, among other things, the supply of power, light and heat certified by the Minister of Munitions to be of importance for carrying on munitions work, and the erection of munitions factories or other buildings required for naval or military purposes.

MANCHESTER ELECTRICITY SUPPLY.

In the House of Commons on Tuesday, Mr. NEEDHAM asked the President of the Board of Trade whether attention had been drawn to the anxiety of the Manchester Corporation Electricity Committee in regard to the maintenance of the supply of electric power, and whether facilities would be afforded to that Committee to secure an ample and regular supply of coal, and so obviate the curtailment of electric power supplies.

In reply, Mr. RUNCIMAN said that the matter had been brought to the notice of the Board and it was receiving attention.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Offices on payment of the prices indicated in parentheses. It is only necessary to specify the number when sending remittance.]

614. "Table of Logarithms of the Natural Numbers from 1 to 108,000." By C. Babbage. 5s. net (5s. 4d.).

615. "Electric Wiring." By W. C. Clinton. 4th edition. 2s. net (2s. 3d.).

616. "Relativity." By A. W. Conway. 2s. net (2s. 3d.).

617. "Mechanical Technology." By G. F. Charnock. 7s. 6d. net (7s. 9d.).

618. "Testing of Machine Tools." By G. W. Burley. 4s. net (4s. 4d.)

619. "Telegraph Engineering." By Erich Hausmann. 12s. 6d. net.

620. "Euclid's Book on Divisions of Figures." By R. C. Archibald. 6s. net (6s. 4d.).

621. "Collected Papers of Spectroscopy." By Liveing and Dewar. 30s. net.

622. "Mathematical Tables for Class Room Use." By M. Merriman. 2s. 6d. net (2s. 9d.)

623. "The Telephone and Telephone Exchanges; Their Invention and Development." By J. E. Kingsbury. 12s. 6d. net (12s. 10d.)

624. "Auto Transformer Design." By A. H. Avery. Cheap edition. 2s. 6d. net (2s. 10d.)

625. "Diesel Engines for Land and Marine Work." 4th edition. By A. P. Chalkley. 8s. 6d. net (9s.)

626. "Text Book of Inorganic Chemistry." Vol. VIII. 10s. 6d. net (11s.)

627. "Steam-boiler Economy." By W. Kent. 2nd edition. 19s. net.

628. "Elements of Railroad Track and Construction." By W. H. Wilson. 2nd edition. 10s. 6d. net (10s. 10d.)

629. "Land and Marine Diesel Engines." By G. Supino. 12s. 6d. net.

630. "Submarines, their Mechanism and Operation." By F. A. Talbot. 3s. 6d. net (3s. 10d.).

631. "Introductory Course in Mining Science." By J. Parker. 2nd edition. 1s. 6d. (1s. 9d.).

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	397	A Nursery Electric Cooker. Illustrated	76
Imports and Exports of Electrical Manufactures	398	Industrial Electric Heating. Illustrated	77
Business Notices	398	Popularising Electric Supply	77
Bankruptcies, Liquidations, &c.	398	"Brookhirst" Switchgear	78
Electricity Supply	398		
Lighting and Power Notes	400	Miscellaneous Notes	403
Traction Notes	400	Tenders Invited	404
Empire Notes	401	Tenders Received & Accepted	404
Foreign Notes	402	Companies' Meetings and Reports	406
The Round Table	73	New Companies, &c.	407
Electro-Harmonic Society	73	City Notes	407
New Dowsing Catalogues. Illustrated	74	Electrical Companies' Share List	407

COMMERCIAL TOPICS.

Electricity Supply in Australia. In another column will be found an abstract of the report for 1914 of the proceedings in regard to the applications for orders in Council (under the Electric Light and Power Act of Victoria) for the supply of electricity. This report, which is the last one published, gives a good idea of the steady progress of electricity supply in the State of Victoria. There were eleven new applications and nine orders were issued, making a total of 107 orders since the passing of the Electric Light and Power Act of 1896. At the end of 1914 there was a capital of over £2,750,000 sunk in electricity supply works in the State, apart from electric tramways and railways, independent plants for mines, &c. In Melbourne the demand for electrical energy for lighting, power and heating is increasing at a highly satisfactory rate, the total connections in the city and suburbs representing about 55,000 kw., including about 30,000 H.P. in motors. There is also good progress to report from the smaller inland towns. At present there is a great prejudice in favour of British manufactures, and we believe it would pay our manufacturers and exporters to devote time and attention to nursing the Australasian market for electric machinery, apparatus, fittings, &c. Hitherto great quantities of German goods have been imported, while American manufacturers' goods are also much in evidence in Australia. It will not be difficult to displace the former if ordinary care be exercised in ascertaining the trend of events and by keeping in touch with the particular requirements of Australia. Now is the most favourable time to make a start to capture the whole of the trade hitherto in our enemies' hands.

* * * *

We think that, in view of the present circumstances, the following resumé of the Electric Light and Power Act (1896) of Victoria may be useful, as showing Australian practice in electricity supply. The Act is based upon our Electric Lighting Acts of 1882 and 1888, but contains various modifications to suit local conditions. Under its provisions the period of an order issued to an undertaker, other than a local council, is limited to 30 years. Provision exists for the review of rates of charge for a supply of electricity in the case of a company or person, and for municipalities to purchase such undertakings within six months before the expiration of 30 years from the date of the order, or of such shorter period as may be stated in the order. A company or person may, upon the expiration of his or its order, obtain a further order to act as undertaker, but such order would contain such provisions as the Governor in Council may think fit, to enable a municipality to acquire such undertaking within a shorter period than that of the 30 years above mentioned. The Act provides that no Council, company or person shall use, lay or erect any electric line or supply electricity for public or private purposes except under the authority of an Order in Council; but this provision does not extend to any case where any electric line is not laid beyond the limits of any premises in which electricity is generated. Although the Orders in Council authorise the supply of electricity, they do not necessarily authorise the erection of overhead lines for that purpose, but are framed chiefly for systems of underground distribution to consumers. Sec. 30 of the Act prohibits undertakers from placing any electric line above ground without the consent of the local Council and of the Minister, neither of which is withheld except in special circumstances. Distribution is thus effected almost wholly by means of overhead low-tension conductors, the total mileage thereof throughout the State being 3,233, against 80 miles of similar conductors underground. High-pressure and extra-high-pressure overhead mains are subject to special consent and methods of construction in each case. The granting of an order to a company or person is subject to the consent of the local Council, and such consent is contingent upon a poll of the ratepayers being taken to ascertain whether it is desired to forbid such consent. The Minister for the time being administering the Act may recommend the Governor in Council to dispense with such consent if the circumstances should warrant it. Differing rates of charge for lighting and for power are permitted. Charges are by flat rate and by maximum demand, and also by rates depending upon hours of use, and of maximum monthly consumption, the basis of all such alternative methods being that no preference or unfair discrimination shall be made, and that every Council, company or person within that part of the area shall be entitled to a supply on the same terms on which any other Council, company or person in such part of the area is entitled under similar circumstances to a corresponding supply.

* * * *

The Export of Manufactured Goods. The Board of Trade figures of our foreign trade in the month of November show a welcome advance in the value of exports—in fact they exceed those of any month since the outbreak of the war, and a good feature of it is that there is an increase in nearly every class of goods. The exports were valued at £35,639,166 against £24,601,619, and £44,756,138 in the corresponding months of 1914 and 1913 respectively. The value of the exported electrical goods was £405,910, an increase of £169,967 on the month, and an increase of £88,687 to date, as compared with 1914; iron and steel manufactures were exported to the value of £4,172,984, an increase of £1,586,873 on the month; exports of chemicals increased by £690,939, but machinery exports showed a decrease of £137,070. On the whole this is good record under present circumstances, and we hope that the most strenuous efforts will be made to maintain and even to improve upon it.

* * * *

Power in Agriculture. The Smithfield Club Annual Cattle Show, which closed its doors on Friday last, the 10th instant, and at which a variety of engineering exhibits is always made, presented features of more than ordinary interest than in past years. In exhibitions of this kind it is usually possible to detect tendencies in certain directions. On the present occasion it was particularly noticeable in regard to the present and prospective use of petrol and paraffin as sources of agricultural power. From a purely electrical point of view it is instructive to record the appearance of a large number of small power petrol and paraffin engines which can be used for dynamo driving and also for mechanical service. The output of these engines has evidently increased to such an extent that they can be offered at competitive prices. We believe the chief stimulus in production has come from the United States, but whether the Americans will succeed in holding the market remains to be proved. In a number of cases the American engine is belted to an English dynamo, with English accumulators and English switchboards, to make complete country house lighting sets. Possessing the advantages of convenience and safety, these electric lighting outfits are proving more attractive than acetylene or petrol gas; the engine which drives the dynamo can always be used for chaff cutting, horse clipping, sheep shearing, &c. We were particularly impressed with the developments in petrol-driven ploughs. A self-contained plough with petrol engine for propelling purposes attracted large crowds. In these days, when horses are scarce, such a mechanism cannot fail to attract on commercial grounds alone, quite aside from its mechanical features. Hitherto power ploughing has presented little more than an ordinary problem in mechanical

haulage and it is in this form that the electric plough as at present known has been used. The self-contained power plough is, however, another proposition, and it will be instructive to observe to what extent this latest application of petrol power to agriculture is taken up by the farming interests. In the halcyon days of peace, to which we are looking forward, electric power on the countryside may become an established fact. In the meantime we must derive what satisfaction we can from the change in the habits of the farmer which the power plough is bound to introduce. Probably the jump from horses to electric power was too great, and it will be necessary to have an intermediate stage in which petrol is the source of energy.

* * * *

U.S.A. Export Trade. The Federal Trade Commission, which has been authorised by Congress to make an investigation of the conditions that affect American foreign trade and to report the facts with such recommendations as it deems advisable, is sending out 30,000 letters of inquiry as a part of the investigation.

By public inquiries throughout the country and by other means the Commission has been gathering facts and information as a basis for its report, but it now desires to obtain information from a large number of men who were unable to appear at the hearings. About 20,000 letters will go to American manufacturers and producers, and about 10,000 will be sent to other authorities on foreign trade conditions, such as export commission merchants, manufacturers, export agents, importers, domestic merchants, engineers, publicists, economists, bankers, &c. To those who will co-operate with the Commission in furnishing facts, &c., a schedule of inquiries will be sent covering the topics on which the commission desires information. The 20,000 manufacturers and producers will comprise every important branch of American industrial enterprise, and represent every shade of opinion in regard to the present problems of foreign trade. It is quite evident that our American cousins are paying close attention to the development of their export trade, and it is to be hoped that the Board of Trade, as well as our manufacturers and exporters, will not forget the great importance of not only maintaining our position as an export nation, but of expanding our exports if possible.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Dec. 6, 1915, *to* Dec. 11, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]: *France:* Unenumerated, 72 pkgs.
Germany—*Denmark:* Elec. machinery, 111 pkgs.
Italy—*U.S.A.:* Unenumerated, 83 pkgs.
[illegible]—*U.S.A.:* Elec. machinery, £1,438; carbon candles, £679; telegraph material, £153; lamps, £1,479; wire and cable, £1,574; unenumerated, £8,441 pkgs. *Holland:* Elec. lamps, £64; 919 pkgs.; lamps, £1,648; unenumerated, £272. *France:* Carbon candles, £28; elec. meters, 9 pkgs.; unenumerated, £76—4 pkgs. *Denmark:* Elec. machinery, £13; unenumerated, £453. *Italy:* Elec machinery, £615—39 pkgs.; wire and cable, £1,575. *Canada:* Unenumerated, £432 *Switzerland:* Elec. lamps, £140; elec. machinery, £312; unenumerated, £4,885 *Japan:* Unenumerated, £45.

EXPORTS.

[illegible]—*Auckland:* Wire and cable, £1,157; unenumerated, £751 *Melbourne:* Elec. machinery, £577; unenumerated, £1,042. *Sydney:* Elec. machinery £325; unenumerated, £1,019. [illegible]: Wire and cable £1[illegible]; unenumerated, £1,084. *Brisbane:* Unenumerated, £1,514 *Dunedin:* Unenumerated, £787 [illegible]: Elec. meters, £172; unenumerated, £50 [illegible]: Unenumerated, £147 *Fremantle:* £120 *Perth:* Unenumerated, £178 *Christchurch:* Unenumerated, £372 *Gisborne:* Unenumerated, £13. *Hobart:* Unenumerated, £52 *Cairns:* Unenumerated, £134 *Geelong:* Unenumerated, £182. *New Plymouth:* Elec. machinery, £60. *Wanganui:* Unenumerated, £15. *Napier:* Unenumerated, £16.
[illegible]—*Durban:* Elec. machinery, £9; wire and cable, £215; unenumerated, £234. *Port Elizabeth:* Wire and cable, £[illegible]; unenumerated, £34. *Beira:* Unenumerated, £61.
Ascension.—Telegraph material, £82.
Egypt.—*Alexandria:* Unenumerated, £52. *Port Said:* Elec. machinery, £[illegible]; telegraph material, £20; unenumerated, £16.
South and Central America—*Guayaquil:* Telegraph material, £28 *Jamaica:* Telegraph material, £16; unenumerated, £119 *Trinidad:* Unenumerated, £20 *Valparaiso:* Wire and cable, £222; unenumerated, £4
U.S.A.—*New York:* Unenumerated, £130
Holland.—*Amsterdam:* Wire and cable, £1,421; unenumerated, £1,365. *Rotterdam:* Unenumerated, £95.
Portugal.—*Oporto:* Elec. machinery, £79; unenumerated, £37.
Spain.—*Bilbao:* Unenumerated, £21 *Cadiz:* Wireless telegraph material, £30
Italy.—*Genoa:* Unenumerated, £108
Norway.—*Christiania:* Elec. cable, £4[illegible]
Russia.—*Vladivostok:* Unenumerated, £37
India, Ceylon, Indo-China and Straits Settlements—*Bombay:* Wire and cable, £3,314; unenumerated, £67 *Calcutta:* Elec. machinery, £[illegible] and Elec. Meters, £[illegible] *Madras:* Unenumerated, £46 *Singapore:* Wire and cable, £[illegible]; unenumerated, £237; unenumerated, £121. *Penang:* Wire and cable, £[illegible]; unenumerated, £32 *Ceylon:* Unenumerated, £[illegible] *Aden:* Unenumerated, £14. *Rangoon:* Unenumerated, £178. *Port Swettenham:* Unenumerated, £78
Sourabaya.—Elec. machinery, £85; unenumerated, £28.
China.—*Shanghai:* Unenumerated, £8[illegible] *Hongkong:* Telegraph material, £[illegible]; wire and cable, £2,482; unenumerated, £377 *Foochow:* Unenumerated, £133 *Tientsin:* Unenumerated, £52.
Japan.—*Yokohama:* Telegraph material, £[illegible] unenumerated, £2 *Kobe:* Unenumerated, £38
Java.—*Batavia:* Unenumerated, £162
West Indies.—*Jamaica:* Unenumerated, £12. *Trinidad:* Elec. machinery, £19. *Curaçao:* Electric machinery, £440.
[illegible]: Unenumerated, £24.
Malta.—Wire and cable, £127; unenumerated, £52.
[illegible]: Unenumerated, £531. *Paris:* Unenumerated, £84. *Calais:* Wire and cable, £[illegible]; unenumerated, £168. *Boulogne:* Unenumerated, £133.

FOREIGN GOODS (duty paid and free).

[illegible]: Unenumerated, £251. *New York:* Unenumerated, £67. *Dunedin:* Unenumerated, £65 [illegible]: Unenumerated, £63 *Lyttelton:* Unenumerated, £97. *Timaru:* Unenumerated, £14.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Thos. Wm. Allan, sen., and Fredk. Niemeyer, electric lighting and power engineers, 27, Endell-street, London, W.C., have dissolved partnership. Debts by Mr. Allan, who continues as Allan & Co.

The partnership between Wm. Sanders (deceased), Wm. Preston and E. J. Selby, electrical engineers, Ridding-lane, Wednesbury, has been dissolved. Debts by Mr. Preston, who continues the business as Wm. Sanders & Co.

Patent Development.—The proprietors of patents Nos. 3,097/1912 and 3,098/1912, relating to "Intercommunication telephones," is prepared to sell the patents or grant licences thereunder. Applications to Messrs. Boult, Wade & Tennant, 111 and 112, Hatton-garden, London, E.C.

Plant for Sale.—Southend-on-Sea Corporation have for sale some electrical plant manufactured for two electricity sub-stations, the erection of which has been postponed by direction of the L.G. Board. The plant includes two Diesel generators of 150 kw. each (engines by Belliss & Morcom and dynamos by British Thomson-Houston Co.), and three Diesel generators, each of 200 kw. (engines by Belliss & Morcom and dynamos by Phœnix Dynamo Mfg. Co.). Particulars from the borough electrical engineer (Mr. Robert Birkett), Corporation Electricity Works, Southend-on-Sea. *See an advertisement.*

For Sale. The patents and stock, &c., of "The Checkogram" are advertised for sale in another column. Particulars from the liquidator (Mr. H. Robinson), 150, Oxford-street, London, W.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 6½d. is payable at 26, Baldwin-street, Bristol, to creditors of Geo. J. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, near Bristol.

The first meeting of creditors of G. B. Bowell, engineer, lately trading at 4A, Zion-place, Margate, will take place on Dec. 18 at 68A, Castle-street, Canterbury, and the public examination on same date at the Guildhall, Canterbury.

A second and final dividend (1s. 2d.) will be payable on Dec. 21 at 27, Brazennose-street, Manchester, to creditors of Chas. Hellyer Pearson, electrical engineer, &c. (trading as Pearson & Co., and as the B.O.A. Engineering Co.), 51A, Mosley-street and Stockton-street, Manchester, and 4, Manchester-road, Hyde.

A meeting of creditors of the Renew Electric Lamp Co. (Ltd.) will be held to-day (Dec. 17) at the office of Mr. J. E. Percival, 6, Old Jewry, London, E.C.

Winding-up Petition.—A petition for winding up National Alloys (Ltd.) will be heard by Mr. Justice Astbury on Dec. 21.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—At last week's meeting of the Council there was considerable discussion on the recommendation of the Electricity Committee to put down additional generating plant.

The convener (Mr. Ginn) moved the adoption of the report, and said the records of the department showed continual increases in the supply. They had a monopoly of the supply of electricity in the city, which carried its responsibilities, one of these being to maintain supply. They were dealing with a department which, in the last five years, had increased its annual revenue from £47,500 to £60,000. They supplied over 3,000 consumers, including many works and industries which were the mainstay of the town's business and prosperity.

An amendment not to proceed with the proposed extensions at present was carried by 17 votes to 14.

Burton-on-Trent.—At last week's meeting the Council approved a proposal to apply to the L.G. Board for sanction to a loan of £3,500 for extensions of the electric supply cables.

Hastings.—Application has been made to the L.G. Board for sanction to a loan of £500 for house services.

Kingston-on-Thames.—An inquiry was held on Wednesday into the application of the Council for sanction to a loan of £16,792 for the electricity supply undertaking.

Nuneaton.—The L.G. Board have notified the Council that they have reconsidered their application for sanction to raise a loan of £10,000 for extensions of the generating plant and mains, and that they would not take exception to the Council entering into definite contracts.

Pembroke (Dublin).—A special meeting of the Urban Council was held last week to consider the question of putting down an additional Diesel engine for the electricity works.

A letter was submitted from Messrs. Sulzer Bros. as to their tender for a Diesel engine and there was also some correspondence with the L. G. Board regarding loans for electricity supply and other works. The chairman (Mr. C. P. O'Neill) said there had been a deputation to the Board since the meeting of the Council on the 29th ult. and he asked the electrical engineer (Mr. Price) first, was it necessary to purchase a new Diesel engine; and, secondly, could he get on with his work in the electricity department without getting a new engine?

Mr. PRICE, having answered the first question in the affirmative and the second in the negative,

The CHAIRMAN proposed that the resolution passed at the last meeting should be rescinded. He said that the deputation had put before Sir Henry Robinson what was required, and they were promised that there would be an inquiry at the earliest moment, and that he would be prepared to ask the Treasury to sanction the loan if the Council could furnish him with the reasons for purchasing the engine. Messrs. Sulzer Bros. had made a certain offer and the chairman asked the Council to accept that offer, subject to the sanction of the L.G. Board, which would not be given until the inquiry had been held. Having read a statement of what was needed in the electricity department, he said he did not think that any member wished to see Pembroke plunged into darkness.

Mr. J. GOOD went into the details of the history of the proposed extension. The Committee wanted to know the result of the interview with the L.G. Board. There had been two proposals before the Committee—first, to repair the old Diesel engine in the Ringsend works; and second, to scrap that engine and install a new one. If a motor car broke down after 18 months, would not any member of the Council have it repaired? As a business man, he held that the proper course was to have the present engine repaired. Two London engineers reported that the engine could be made as good as it had been the first day. In the present crisis an order had been issued that the Council was to avoid any expense that it possibly could. Even if the Council decided to purchase the new engine, the engine would not be delivered for about three months. The winter load on the electricity works would then have passed and they should be easily able to meet their summer requirements. Supposing that the repairs took three months, they should have the old engine ready as soon as the new one, and should avoid the additional worry and expense (£3,000) of purchasing the new engine.

Mr. PRICE said that they would not "scrap" the old engine; it would be in stock; it was necessary to have a new engine.

The motion was then carried by six votes to four, and it was resolved to purchase the engine from Messrs. Sulzer Bros., subject to the L.G. Board's sanction, and to apply to the Board for sanction to a loan of £15,000 for electricity and other works.

Sutton Coldfield.—Mr. E. F. Clarke has been appointed consulting electrical engineer at £125 per annum. Mr. Clarke is a member of the Council who has done much good work for the electric supply department for nothing, and the present arrangement is a temporary one.

West Ham.—The electrical engineer (Mr. J. W. Beauchamp) has reported on the existing arrangements for the supply of feed water at the generating station and has submitted estimates for extensions and alterations which were provided for in a loan sanction obtained in connection with the last extensions, but which had not hitherto been carried out.

Mr. BEAUCHAMP points out the desirability of now proceeding with the work, which is estimated to cost £1,350. The amount of the unexpended sanction in regard to the work being approximately £1,100, the Electricity Committee recommends that the balance (£250) be defrayed, if necessary, out of current revenue, and that the engineer be instructed to order the necessary apparatus and material.

GENERAL.

Andover.—A site for the erection of electricity supply works near the present gasworks has been acquired.

Battersea (London).—The Metropolitan Water Board proposes to enter into an agreement with the Borough Council for the supply to the Battersea station of current for lighting and power at a flat-rate of 1d. per unit for power and 3½d. per unit for lighting, plus a temporary increase of 10 per cent.

Brighton.—Owing to the high price of coal, the charges for electrical energy supplied by the municipal undertaking are to be again increased. The flat rate of 4d. per unit was recently advanced to 4½d., and in future it will be 5½d., and special charges to customers of more than 20,000 units are to be abolished. The charge for tramway current has also been advanced, and the rate for supply outside the borough is increased by 1d. a unit.

Bristol.—Of the employees of the electricity department 77 are serving with H.M. Forces, 61 are Derby Reserves, B[illegible] in the Naval Reserve, while 50 have been rejected.

Of the remaining members of the staff 70 are over age, 10 under age, three are physically unfit and there are 13 ladies in the clerical department. There are also two badged and two unbadged men at Arnoldin's works, and one unbadged person on the management and clerical staff. The Minister of Munitions has issued war service badges to several employees.

Darwen.—Mr. C. E. Garnett, borough electrical engineer, and Mr. F. J. S. Hosken, manager of the Corporation tramways, have enlisted under the Derby group system.

Fakenham.—The Parish Council recently decided not to enter into any agreement in regard to the supply of electricity in the district during the continuance of the war.

Hackney (London).—At the meeting of the Borough Council yesterday (Thursday) the Establishment Committee reported that the Electricity Committee had informed them that they had had under consideration a report of the borough electrical engineer (Mr. L. L. Robinson) in reference to the resignation of Mr. H. G. Barraclough, generating engineer, who left the service at the end of October.

Mr. ROBINSON had intimated that it was imperative to fill temporarily the vacancy thus caused, and that he had experienced great difficulty in obtaining suitable men for the position. In view of the large demand on the undertaking for power purposes in the borough the number of generating engineers now required was four; but as at present there were only two on the staff, it had been necessary to engage another man at a salary of £3 per week, which is obviously unfair to the engineers on the staff of the Council whose maximum salary was below this figure. The generating engineers in the service of the Council were Mr. E. K. Wilkinson and Mr. F. D. Osborn, and their salaries were £135 and £120 per annum respectively. The Electricity Committee are endeavouring to get the assistant distributing engineer (Mr. A. G. Hilling) released from service with H.M. Forces, and, if successful, it was intended to use him on distributing work generally and to take the place of a generating engineer in case of emergency. In the event of Mr. Hilling being released it would only necessitate the engagement of one man at £3 per week. The Electricity Committee had requested the Council to forthwith increase the salaries of the above-mentioned officers to £156 per annum, and in view of the exceptional circumstances now prevailing the Establishment Committee were of opinion that the proposal should be adopted.

Islington (London).—The Guardians have decided to wire their Liverpool-road offices and dispensary.

Lambeth (London).—At last week's meeting of the Borough Council it was reported that the South London Electric Supply Corpn. had given notice to its consumers that an addition of 9 per cent. would be made to the charges for current supplied as from the December meter readings. The present charge for energy is 5½d. per unit for lighting.

Loughborough.—At the Council meeting last week, in moving the adoption of the half-yearly accounts of the electricity undertaking, Alderman A. A. Bumpus said they had a largely increased output of current during the half-year, approximately one-third increase.

Unfortunately, that came nearly entirely under the heading of power which was sold at a low rate. That did not assist their finances as did the current for lighting, which had not expanded in proportion. The figures under the heading of units sold at 4d. showed that only £743 was realised, against £800 in the corresponding half-year last year. Economy during the war and the closing of some businesses accounted for the diminution. Their expenses, owing to the increase in the cost of coal, wages, &c., had been heavier. Nevertheless, whereas a year ago for the corresponding period the gross profit was £517, they had now a gross profit of £878.

Luton.—At the last meeting of the Council it was decided, in order to reduce the difficulty of getting a supply of coal, to purchase 15 10-ton railway wagons at £580.

It was also reported that during the past month the units generated for general supply showed an increase of 43 per cent. over the number generated during the corresponding period of 1914, and that there were at present applications in for over 4,366 additional lamps, 652 H.P. in motors and 513 kw. in heating. There are 1,864 consumers, representing the equivalent of nearly 70,000 8 c.p. lamps connected to the mains.

Manchester.—The members of the Electricity Committee and others inspected the generating stations on the 8th inst.

The first station visited was Dickinson-street, where a recently erected converter for converting the current from Stuart-street to low-pressure was inspected. At Bloom-street the large storage battery to assist in dealing with the morning and evening peak loads was also inspected. At Stuart-street station types of the older and newer forms of plant were seen. Here were to be seen the exhaust turbine of 1,500 kw., which takes the steam from the old

Yates & Thom engines put in when the station began work, and a 15,000-kw. high-pressure turbine, which has been in use some 18 months. Here also is the new 6,000-kw. turbine, recently installed by the Westinghouse Co., running at 3,000 revs. per min., and before another year passes the machine will be duplicated. At this station there are about 50 boilers, and each boiler is fed automatically with chain-grate type stokers. Considerable difficulty is experienced in getting deliveries of the coal contracted for. It is stated that either through the fault of the coal-owners or the railway companies, or both, the deliveries are short to the extent of 50 per cent. The Committee's stock of coal, which at the end of July was 21,000 tons, has dropped to 12,000, so that unless there is a rapid change for the better the position will be critical. The help of the Government has been invoked, and Deputy Chief Inspector of Mines had been to investigate the situation on behalf of the Board of Trade.

The visitors were conducted through the works in two parties, one under the direction of the chief engineer (Mr. S. L. Pearce), and the other under the guidance of Mr. Arthur McKenzie, chief assistant engineer. The chairman of the Committee (Councillor Dagnall) and Ald. Walker (deputy chairman) also acted as guides. It is stated that the British Carbide Company will soon transfer its works from Norway to the vicinity of Stuart-street, and the department should benefit considerably thereby. The Company has chosen the neighbourhood of Stuart-street almost wholly on the ground that it can get a full and uninterrupted supply of electric current for power purposes.

Queensbury.—The Electrical Distribution of Yorkshire (Ltd.) has postponed its proposed application for an electric lighting order until after the war.

The Council resolved that, so far as it was at present constituted, it was in favour of the proposals of the company, and while assenting to the postponement owing to the exigencies of the war, the Council hoped the company would renew their application on the tetmination of the war.

Stretford.—The Council is recommended to reappoint Mr. T. L. Miller as consulting engineer for a further period of 12 months at a fee of 25 guineas.

Swansea.—At the last meeting of the Tramways and Electric Lighting Committee the borough electrical engineer (Mr. J. W. Burr) reported that 35 new applications for supply had been received since the last meeting.

The equivalent number of 30-watt lamps applied for since the last meeting was 495 for lighting, 583 for heating and 577 for power. In regard to electric light installations for Cwmbwrla and Brynmill schools, a supply could easily be given to Brynmill schools, but the cost of giving a supply to the Cwmbwrla schools would be £800, and he could not recommend that expenditure. Mr. Burr's suggestion was approved.

Walsall.—At the meeting of the Council on Monday, Mr. Hayward, in submitting a report of the Electricity Committee, expressed regret that the consumption of coal per unit showed a serious increase.

When the Committee decided in July last not to increase the price charged to consumers it was made clear that it required a good deal of courage to come to such a conclusion. What was rather anticipated then had since come to pass. Up to a certain point the increased demands made on the station told in the direction of economy, but ultimately the department had to bring into use old and inefficient machinery, with the result that the cost of production began to rise. It had been hoped that for at least three months of the year the Committee would have had the advantage of being able to use the new works, but owing to the slow progress made there was no prospect of the works being brought into use this winter. Under the circumstances, they were bound to do the best they could with their old plant. There had been some prospect that a a profit would have been made on the undertaking sufficient to defray the cost of superseded plant, but a big increase in the coal bill would now have to be reckoned with. The appeal to private consumers to restrict their demands in the early part of the evening had been responded to splendidly, and a continuance until after Christmas might avert a breakdown.

Mr. Talbot characterised the report as a most unsatisfactory one, stating that the undertaking had new machinery more than sufficient to carry the maximum load. The Ministry of Munitions had commandeered a 3,000 kw. turbo-generator ordered for the new generating station, and the Committee had only themselves to thank for having the new works so far behind. In spite of that, however, there was no excuse for an increase in the coal bill in one month by £465.

In reply, Mr. Hayward said the statement was inaccurate, as the most obsolete machinery had to be used to keep the works going.

Wednesbury.—At the meeting of the Council last week Ald. Pritchard explained the cause of the recent failure of the electricity supply.

He said there was no use disguising the fact that the supply did not meet the demand on all occasions. An extensive quantity was being taken for power purposes, some works being run night and day. Delivery of a rotary converter, ordered in June, was promised in October; but the makers were so busy on other work that it was not possible for them to discriminate in the delivery of that particular machine. It was now ready for despatch and would be erected as soon as delivered. The Committee had done all in their power, and they could be helped if the public would curtail the use of current between 4 and 6 p.m.

West Bromwich.—On Tuesday the Council adopted the Electricity Committee's recommendation to increase the price of electrical energy to ordinary power consumers by 15 per cent. Increased cost of coal and higher wages have caused the increase.

Wigan.—The chairman of the Electric Light Committee (Ald. Grimshaw) referred at the last meeting of the Council to the recent breakdown at the electricity works.

Ald. Grimshaw said that they had felt it was quite possible that such a breakdown might take place, and quite early they took the opportunity of asking for powers to put in two new boilers. The capacity of those two boilers would be equal to the whole of the existing eight boilers. The eal stoppage was due to the bursting of the tubes and two of their best boilers were put out of service, and later on the same evening seven boilers out of the eight were out of service for the same reason. The next day (Sunday) gave time to get some of them put into proper condition. No. 8 boiler, which had an evaporative capacity of 13,000 lb. per hour, had 12 tubes burst all at once. That presented a problem to the Council which they would have to consider if they had to do for the town and the tramway system anything like justice. Six of their boilers were supposed to be 10,000 lb. evaporative capacity per hour, but he thought he had proved to the Committee that they were not getting 5,000 lb. They could not afford to have out of service more than one boiler at a time. Apart from that, they were burning fuel to an unusual extent because of having to continually force the boilers, and when they had their two best boilers shut down it was impossible for them to produce sufficient power from their six old boilers. The L.G. Board only gave them 15 years' borrowing powers for boilers, and those had been in service for that period. More than 12 months ago they put up a water-softening plant, but the hardness of the water was so peculiar that no mixing was able to cope with it. They would have to approach the Water Committee, and he hoped the Chairman would see that in the interests of the town they must make an effort to supply water from the Corporation mains. As regards the progress of the undertaking, he would say frankly that it had developed with greater rapidity than the boiler house had been capable of meeting. They might, had they known the condition of the boilers, have made arrangements for the new boilers earlier, but it was only when they were face to face with an enormous demand for electricity that they found out they were over-running their plant. In October, 1913, they had 1,061 consumers, to-day they had 1,197, an increase of 136. In October, 1913, they had 121,949 8 c.p. lamps; to-day they had 153,095 8 c.p. connected. They had 163 motor consumers in 1913; now they had 207, an increase of 44 H.P. In 1913 they had 35 consumers for heating, and now they had 60. In the two years their output had increased by 127,457 units, and they had still consumers waiting to be linked up representing over 2,000 8 c.p. lamps. Now they were having to meet that increase with the same plant, the same boilers, and, if possible, with a worse water. They were now supplying a large number of works who employed people who lived in the town. Any breakdown or hindrance was a hindrance to them and a loss to the working classes, and they wished for a supply of water from the mains which would give them a guarantee of some security. They were spending £7,000 on the new boilers.

LIGHTING & POWER NOTES.

Electricity in Mining.—At the recent meeting of the Aramayo Francke Mines (Ltd.) it was stated that in Chorolque they had made additions and improvements to the general plant and completed the installation of electric rock drills, which would facilitate and hasten the investigation works in depth of that big mountain. In Tasna they had made additions to the driving power and improvements in the sintering and smelting plant. They had completed the tin and wolfram concentration plant.

Hydro-Electric Works in Scotland.—It is proposed to form a company to obtain powers for the utilisation of the water power of Loch Awe, in the Scottish Highlands, for generating electrical energy for steel works which it is proposed to establish in the district. Mr. J. Campbell Robertson is chairman of the promoting syndicate.

Wolverhampton.—The Board of Trade have granted permission to the Corporation to supply energy to the sewage outfall works at Barnhurst.

TRACTION NOTES.

Bournemouth.—Last week the Council adopted the recommendation of the Tramways Committee that until Jan. 10 the time of stopping the tramcar service in the borough be 10:30 p.m. The change is stated to have been made in the interests of motormen and for the safety of the public owing to the darkened streets.

Manchester.—The Board of Trade have ordered that the time limited by the Manchester Corporation Act, 1911, for the completion of tramways, &c., except the portion of tramway (about 210 yds. in length) being so much of tramway No. 2, authorised by the Man-

chester Southern Tramways Act, 1903, as is authorised to be constructed in the Cheadle & Gatley Urban District, be extended for one year from Aug. 18, 1916.

Pontypridd.—The scale of wages for tramcar drivers and conductors has been revised.

After five years' service the men will receive an increase of ½d. per hour upon the present maximum rates of 7d. and 6d. per hour respectively.

Sheffield.—There will be no tramway service on the 26th inst., as owing to the severe strain on the motormen and conductors as the result of the present heavy traffic it is desired to give the employees a much needed rest.

It was estimated that the total receipts for the year ending March 25, 1916, would be £433,337, and the estimated expenditure £391,331, and after allowing for payments to the accumulated surplus fund the estimated net balance was £34,974. For the year ending March 25, 1917, the total receipts are estimated at £425,744, and the expenditure £398,100, net balance being £23,635. As to motor omnibuses, the estimates are as follows: For year ending March 25, 1916, total receipts £26,211, expenditure £21,596, net balance £4,615; and for year ending March 25, 1917, estimated total receipts £26,332, expenditure £22,620, and net balance £3,712.

Wharfedale.—At the Council meeting last week the Board of Trade regulations as to the speed of the trackless trolley cars between Guiseley, Otley and Burley were submitted.

The CLERK (Mr. E. C. Newstead) reported that there were many causes for complaint against the boy-conductors in the cars. They were very uncivil to the passengers, and invariably took passengers from 150 yds. to 200 yds. beyond the place where they wished to alight, and when remonstrated with they were discourteous.

EMPIRE NOTES.

Australasia.—We have received a copy of the report respecting applications and proceedings under the 1896 Electric Light & Power Act (No. 1,413 of the State of Victoria) for the year 1914.

During the year 11 applications for orders to authorise the supply of electricity were considered by the Minister of Public Works and nine orders were granted, viz., to the Municipal Councils of Heidelberg, Warribee, Lilydale, Coburg, Lancefield and Doncaster, to the Waranga Shire Council for the township of Rushworth, to the Cock's Pioneer Gold & Tin Mines No Liability (Ltd.) for portion of shire of North Ovens, and to the Melbourne Electric Supply Co. for portion of shire of South Barwon.

Since the passing of the Electric Light & Power Act in 1896 107 orders in Council have been granted authorising the supply of electricity. Of this number 57 were granted to Municipal Councils, 49 to companies or persons and one to a Commonwealth Department. Eight of these orders have been cancelled (either wholly or in part) and six Municipal Councils have transferred all or portion of their powers under their powers to private companies. The most important undertakings are those at Melbourne and suburbs, Ballarat, Bendigo and Geelong. At Melbourne the total connections to the mains of the electric supply department of the City Council were equal to 23,271 kw. (including motors of a total horse-power of 13,235) at the end of 1914; the connections to the mains of the Melbourne Electric Supply Co. were 30,884 kw. (including 13,509 H.P. of motors), while the North Melbourne Electric Tramways & Lighting Co. had 1,489 kw. connected. The total capital expended on electricity supply works was over £2,750,000 in the whole of the State.

The "Australian Mining Standard" says the bulk of the estate of the late Mr. Thos. Cawthron, estimated at £250,000, has been devised for the erection and maintenance of an industrial technical school, institute and museum in New Zealand, to be called the Cawthron Institute.

Evidence in favour of automatic telephones was given at Geelong (Victoria) recently before the Federal Parliamentary Standing Committee on Public Works. The first automatic installation in the Commonwealth was erected at Geelong. The system has worked satisfactorily and has been approved by Geelong subscribers.

The Greater Melbourne Bill, having failed to receive the approval of Parliament, and the lease of the Melbourne Tramway & Omnibus Co. being about to expire, a further effort of the Government to take the service out of the hands of the municipalities is to be made, and a Tramway Board Bill has been drawn up. The bill provides for the constitution of a Tramway Board of five members (to be appointed by the Governor in Council) to maintain, manage and operate the service of the company at the expiration of the lease. Each member, who will receive a salary of £250 a year, will hold office until the expiration of the Act on Oct. 31, 1917, or such earlier date as may be proclaimed. The board may borrow, by way of overdraft, or, with the consent of the Governor in Council, by debentures, &c., on the credit of its revenues and tramway undertakings. The Governor in Council may advance £500,000 to the board, or may guarantee repayment of moneys borrowed. On June 30, 1916, at latest, the Melbourne Tramways Trust is to be dissolved, and the board is to become its successor, and the rights, powers, &c., of the trust, or of any municipality in the leased tramways, are to vest in the board. With a view to securing the uninterrupted working of the tramways at the termination of the leases, provision is made for the compulsory acquisition of the whole of the tramway undertaking (rolling-stock, &c.) not included in the trust's leases, the company to receive compensation by arbitration.

The "Commonwealth Engineer" says Blayney (N.S.W.) Council recently invited offers for the supply and running of electric or gas lighting plants for street and private lighting.

With reference to the Perth electric and gas supply undertakings, which are now owned by the Western Australian Government, Mr. [illegible], a member of the Legislative Council, recently asked that all contracts and papers relating to the erection of the electric power house at East Perth, and the supply of electric current therefrom, be laid on the table. He said a section of the House never contemplated that it would be a huge concern, extending its "octopuslike tentacles" from Fremantle to Midland Junction, stifling every other enterprise of the kind in the locality. If the Government at the outset had placed before Parliament the whole scheme of tramway purchase and power house to cost between £800,000 and £900,000, it would have been rejected on the ground that the financial position did not warrant the diversion of so much money from the proper task of developing the resources of the country. Two years ago the Premier told Parliament that the contracts then let in London totalled £188,000. Three weeks ago the Colonial Secretary gave the estimated cost at £295,000. He asked if that was the total. The Colonial Secretary had said that had it been a matter of supplying power for the trams and to provide light the 50-cycle system would have been preferable, but in view of the proposed electrification of the railway through the Darling Ranges the 40-cycle system had been adopted. That seemed to suggest either that the metropolitan community had been committed to something that was not the best, or else that the Government had definitely determined on the electrification of the railway system through the ranges. Had the Government so decided?

An electric supply plant is being erected by the Castlemaine (Victoria) Electric Supply Co., and it will be in operation about Christmas. The generator will be driven by a 108 H.P. Hornsby suction gas engine. A temporary electric generator will be used at first, and will be replaced later by a more suitable one to be obtained from England. 400 street poles are being erected. Mr. Clements is contractor for the poles and mains. Mr. Geo. W. Stewart, A.I.E.E., is consulting engineer and manager.

Bundaberg (Queensland) Gas & Coke Co. has been authorised by the ratepayers to establish electricity works.

A report is being prepared for North Bulli (N.S.W.) Council by Mr. Sellars on electricity supply works.

The Tauranga (N.Z.) electric lighting was recently inaugurated. The capital outlay was £16,139. Messrs. Clinie & Son, Auckland, are consulting engineers.

Timaru (N.Z.) Council has decided to purchase the local electric lighting and power plant owned by Messrs. Scott Bros., of Christchurch. The purchase price is £34,500. A loan of £50,000 to complete the purchase and make additions has been sanctioned. The capacity of the plant is about 185 kw.

The Tramway Lighting Committee of Townsville (Queensland) Council has had before it the offers of three firms to report on a scheme for the electric lighting of the city.

Wangaratta (Victoria) Council has applied for an Order-in-Council for electric lighting.

Australian Tariff Commission.—The following is an abstract of the general report of the Australian Inter-State Tariff Commission:—

The Commission's special objective was to ascertain the relevant facts regarding (1) industries in urgent need of tariff assistance; (2) correction of technical and consequential anomalies; and (3) lessening cost of living, subject to safeguarding the tariff policy and workers now employed. It was found impossible to exclude any application for tariff assistance on the ground that the need was not urgent, and this, with the large number of applications for hearings received, resulted in so broadening the task of the Commission as to lead to an investigation of practically the whole tariff. The Commissioners visited 120 factories, most of which were well equipped, but many instances were found in which the tariff had not succeeded in stimulating progressive methods and economical management. The expansion of the manufacturing industries of the Commonwealth in the five years ended 1913 is shown by a table, from which the following figures were abstracted: Value of output, £99,529,631 in 1908, £161,560,763 in 1913, increase 62·32 per cent.; cost of raw material, wages, fuel and light, £83,018,819 in 1908, £133,254,465 in 1913, increase 60·51 per cent.; value of plant and machinery, £25,927,763 in 1908, £37,256,958 in 1913, increase 43·69 per cent. It will be seen that, taking the whole of the manufacturing industries of Australia, the increased cost of production had been more than compensated for by the increased value of the output. Between 1908 and 1913 dutiable imports (with duty added) increased from £38,037,000 to £57,529,000, increase 51·2 per cent. The proportion of duty paid imports to the value of the output of local factories was 38·2 per cent. in 1908 and 35·6 per cent. in 1913. Serious difficulties occasionally arise owing to the conflicting interests of different industries dependent upon or seeking tariff assistance. When the finished article of one industry is the necessary raw material of another, the tariff encouragement to both industries may fail to stimulate development in either case. Careful discrimination appears, therefore, necessary, so that suitable tariff assistance under such circumstances should be extended to that industry which promises the greater success, as being likely to employ the greater proportion of labour. If it be found that tariff assistance to the lesser works to the detriment of the greater industry, then it is to the advantage of employés generally, and of the public, that the progress of the latter should not be subjected to a restriction which brings no adequate compensation. It may be found an advantage to withdraw tariff encourage-

ment from certain subordinate industries when the effect of such encouragement is proved to be a hindrance rather than an aid to the total of industrial development. This is desirable in the case of certain subordinate industries which depend upon imported raw material. Satisfactory as the progress of Australian industry has been, it would have been more so in certain industries if the encouragement given by the tariff had not been largely diminished by import duties on the raw material and the partially manufactured material indispensable for the purpose of local manufactures, and not produced or likely to be produced in Australia on a commercial scale. Duty has also been chargeable on indispensable machinery, not manufactured, and not likely to be manufactured, in Australia in the near future. It is fully recognised that where suitable raw material is conveniently available in Australia its use should be encouraged; but it should be a condition of encouragement that such raw material is available in quantity, that it is of fair average quality, and that it is geographically accessible. No rule appears to have been observed in this respect in the past.

It is important that raw materials for the purpose of manufacture should be made available at the least possible cost. That cannot in every case be realised if the encouragement of the local production of raw material takes the form of import duties. On this reasoning, encouragement for the local production of raw material should, where practicable, be by means of bounty and not of import duty. The policy of tariff encouragement to Australian manufactures adopted by Parliament involves the following general principles: That tariff assistance should be of such an amount as to enable the Australian manufacturer, under an efficient system of production, and with modern business methods, to compete with outside competitors with a margin for a fair and reasonable profit. Assistance which ignores these conditions will not tend to the genuine development of Australian industry; and that encouragement should specially be extended to those industries which (*a*) materially strengthen the national resources, and are likely to be permanently and successfully established; (*b*) extend the avenues of employment for labour under satisfactory conditions, and at fair and reasonable rates of remuneration; (*c*) and are not injurious to the health of the employés engaged therein; (*d*) are proved, by a frank disclosure (confidentially made) of the affairs of the manufacturers, to be in need of tariff assistance. The population of Australia is small and does not rapidly increase, and the requirements of the population in manufactured articles are likely to be successfully met by Australian industries within a reasonably brief period of time. The population of Australia from 1908 to 1913 increased by 15 per cent., and during that period the persons employed in factories increased by 30 per cent. In the open markets of the world Australia cannot successfully compete with the manufactured products of cheap labour, or with the manufactured products of those countries whose larger populations enable them to manufacture in quantities much larger, and consequently at a cost much less, than is possible in Australia under present conditions. No anxiety need be felt in regard to Australian export trade in those natural products for which there is an increasing world-wide demand. Improvements in machinery and labour-saving appliances are lessening the proportionate demand for workers in manufacturing industries. This, with a less rapid industrial expansion in the future than that which has marked recent years, makes it necessary to provide for the time when Australian manufacturing industries may no longer be relied upon to absorb the ordinary natural increase in the ranks of the workers.

Appendices issued in advance of reports by the Commission in the certain industries may be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Such appendices deal with electrical machinery and electrical and gas appliances, and vehicles and parts, including motor vehicles.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a company has just been formed in Trelew (territory of Chubut) for the supply of electrical energy for light and power in the town and district. The capital has been found locally.

The Hydro-electric Co. of Tucuman has been condemned by the Court of First Instance to pay $38,000 m/n (about £3,300) to the Cia. Santa Ana Hileret as the value of the land occupied by the power house installed in the Quebrada de Lules.

Dr. Naon, Judge of the Commercial Court, gave his decision recently in the action brought by the Cia. Alemana Transatlantica de Electricidad against Buenos Ayres municipality for the recovery of $858,103.48 m/n., for current supplied. The debt was admitted and the company sought an embargo upon certain municipal funds, namely, the proceeds of the 6 per cent. tax on the company's takings, this tax amounting approximately to $300,000, quarterly. Dr. Naon held that to accede to the petition for embargo would be equivalent to allowing direct taxation due by private parties, to be compounded for, which would be contrary to Article 823 (par. 1) of the Civil Code.

A scheme of arrangement between the municipality and the company has since been presented to the Court. The bases of the arrangement are as follows:—(1) The municipality to give pagarés (bills of exchange) for $900,000 paper, maturing on July 31, 1916, and carrying interest at 6 per cent. per annum. (2) The Municipal Executive to instruct that a liquidation shall be effected of all accounts and amounts owing to the company not including the amount claimed in the judicial arbitration now pending. Bills of exchange to be issued to the company, for the amount in excess of the $900,000 which may be arrived at by this liquidation. (3) In respect of the accounts of the company for October, November and December of the current year, the Municipality shall pay the company one-half of the sum which the company would have to pay as tax to the Municipality in January next, the company being authorised to retain such sum and credit it to the account of the Municipality. For the balances in favour of the company in respect of the October, November and December accounts the Municipality to give bills not subject to interest, maturing respectively in February, March and April, or alternatively, all maturing on April 15. (4) For the accounts for January, February and March, 1916, the Municipality to assign half of the taxes due by the company in April next, the company to retain such sum and credit it to the Municipal account. As to balances in favour of the company which may result from the accounts of January, February and March, the Municipality shall deliver to the company, bills, not subject to interest, maturing respectively in May, June and July, or alternatively all on July 15. (5) The same procedure as regards payments shall be observed in subsequent three-monthly periods, the present arrangement remaining in force till Oct. 16, 1916, when it may be prolonged by mutual consent.

Future Trade with Germany and Austria-Hungary.—At the last meeting of Glasgow Corporation the following resolution, which was recently adopted by Manchester Council, was referred to a Committee for report:—

No contract shall be entered into with any person of German or Austrian nationality; no contract shall be entered into with any firm or company whose subscribed capital (whether by way of shares or otherwise) is held or controlled to the extent of one-third or upwards by persons of German or Austrian nationality.

Aberdeen Corporation have subscribed to the resolution this week.

Italy.—Mr. Consul Morgan (Rome) says:—

Machinery imports into Rome from the United Kingdom in 1914 were valued at £2,427 (against £1,303 in 1913), from France £2,788 (£1,456), and Germany £2,949 (£13,923). Total imports from the United Kingdom decreased by about 25 per cent. The necessary steps, however, are being taken to increase British trade in the district, and in Italy generally. A branch of the British Chamber of Commerce in Italy has been established in Rome. Catalogues, preferably in Italian or French, should be sent to the Secretary, 75, Piazza delle Terme, Rome. It is desirable to adopt metric weights, measures and currency. The Customs Tariff is protective, and the exchange of the day has to be added, so that prices should be as low as possible.

The tramway company operating in Rome made a profit of £26,770, which enabled a dividend of 10s. to be paid on each fully-paid £7 share. Passengers were 72,425,117 (a decrease of over two million). The municipal tramways made a profit of £31,310, from which income tax (£3,300) is deducted. Passengers carried were 28,657,200. Extensions were opened, and another (in the suburbs) is under construction.

The municipal electricity department is reported to have paid its way during its first year of working, the outgoings (including £22,336 for redemption of capital) tallying with the receipts. A hydro-electric station at Vicavaro, an addition to the Rome municipal electricity undertaking, is expected to be opened shortly.

An electric railway is being contracted by an Italian company from Rome to Fiuggi, and will be extended to Alatri, Guarcino, &c.

Paraguay.—The British Consul at Asuncion reports that there are openings for electrical and other fittings, pumps and windmills from the United Kingdom.

The report says probably less depends upon the quality of goods than upon the terms of payment. Bills are generally drawn at 90 and 180 days' date or sight, according to the custom of the trade. Since the war cash against documents has become the rule. The greater part of the business is done by travellers or resident agents. More interest in the country is now taken by the United States than formerly. A French commercial mission has also visited Paraguay this year.

Patent Legislation in France.—It is announced that the French Government (by Bill No. 1,388) propose to allow the Ministers of War and Marine to exploit, either in State or private factories, inventions of interest to the army or navy which are patented or deposited for patent. By this proposal the inventor will lose the exclusive right to exploit his invention, but he will receive as compensation an indemnity which will be fixed by three arbitrators, the Minister interested and the inventor each choosing one, and the third (if not agreed upon) nominated by the First President of the Paris Court of Appeal.

Portugal.—H.M. Minister at Lisbon reports that in almost all matters concerning electrical installations, fittings and material in Portugal the Government have adopted the regulations of the Verband Deutscher Electrotechniker, of Berlin.

The electrical engineering trade has for some time past been largely in German hands. The war, by the stoppage of electrical supplies from Germany, has caused difficulties to the electrical trade in Portugal, nor could the shortage in supplies be met by the importation of British small electrical fittings, as these do not comply with the regulations.

H.M. Minister drew the attention of the Portuguese Government to the matter, and urged that material in accordance with the British Board of Trade regulations should be accepted, and the reply was that in future that course will be followed.

MISCELLANEOUS NOTES.

Customs Duties.—The New Zealand Finance Act, 1915, which was assented to on Oct. 1, amends the rates of import duty on certain articles.

Amongst the duties specified by the Act are the following, the duty on foreign goods being given first in each case and on British goods second (the old duties in cases where the duties have been altered being given in the same order in parentheses):—Gas engines and hammers and oil engines, 20 per cent. ad val., 10 per cent. ad val. (20 per cent., free); gas engines, hot-air engines and oil engines, 20 per cent., 10 per cent. (20 per cent., free); electric generators and electric motors, including slide-rails therefor, electric lamps, electric transformers (this item previously included globes for arc lamps), 20 per cent., 10 per cent. (15 per cent., 10 per cent.); chassis for motor vehicles, attached or unattached to vehicles, including wheels, 20 per cent., 10 per cent. (both free); motor vehicles, motor car bodies, or bodies for motor-buses, attached or unattached, 20 per cent., 10 per cent. (both 20 per cent.); motor vehicles, for road traffic, n.o.e., including motor cars and motor carriages, 20 per cent., 10 per cent. (both 20 per cent.); material for manufacture of carriages, wagons, motor vehicles, and railway cars or wagons, also iron or metal fittings (except steps, lamp-irons, dash-irons, seat-rails, and fifth wheels) for the manufacture of carriages, wagons and motor vehicles (other than motor-bicycles or railway or tramway cars or wagons), both free.

The Act also provides that, notwithstanding anything to the contrary in the Customs Duties Act, 1908, there shall be levied a primage duty of 1 per cent. ad val. on all dutiable and free goods, with the exception of certain specified goods, including exhibits for display in public museums, upon declaration that such goods will not be sold or otherwise disposed of in New Zealand without payment of duty; apparatus, appliances, articles and materials for educational purposes approved by the Minister, under conditions prescribed by him; official supplies for consular officers of countries where a similar exemption exists in favour of British consuls; passengers' baggage and effects, including personal effects that have been worn or are in use by persons arriving in New Zealand; also implements, instruments and tools of trade, occupation, or employment, not exceeding £50 in value; returned empties; goods exported from New Zealand for the repair or for prescribed purpose, on re-importation within five years, either free of duty or at such duty as is determined by the minister; all goods the property of the Crown in respect of the Government of New Zealand at the time of entry for home consumption.

The Governor may exempt any other class of goods from primage duty.

The Act further amends sub-section 3 of sec. 154 of the Customs Act, 1913, respecting a refund of duty on materials used in the manufacture of machinery. The section now reads as follows, the words in italics being new: 154. (1) In such cases and on such conditions as may be prescribed by regulations any person who manufactures machinery in New Zealand shall be entitled to a refund of any duty paid on materials which have been used by him in such manufacture. (2) In this section the term materials means raw materials used in the manufacture of machinery, and also such parts of machinery as cannot in the opinion of the Comptroller be advantageously manufactured in New Zealand. (3) Nothing in this section shall apply to any machinery of such a class that, if imported into New Zealand, it would be liable to any duty, other than duty imposed only on goods not produced in British Dominions *or imposed by way of primage duty.*

It is provided in the Act that the Governor may by Order in Council direct that on importation into New Zealand of any goods specified or of a class specified in such Order, being the produce or manufacture of any country now at war with His Majesty, there shall be imposed, in addition to the duties (if any) imposed by the Customs Duties Act, 1908, or by this Act, a surtax of 50 per cent. ad val.

Electro-Harmonic Society.—The next smoking concert of this Society will be held this (Friday) evening in the King's Hall of the Holborn Restaurant, London, at 8 p.m., when Mr. J. E. Kingsbury will preside. An excellent programme has been arranged.

Enemy Shareholders in British Companies.—At Bow-street (London) Police Court on Monday there were two cases of failure to notify the Public Trustee of shares held by and for the benefit of enemies. In one case penalties amounting to £400, and in another case to £450, were imposed, with 15 guineas in each case.

Exports to China.—Mr. E. W. Frazar has been added to the list of persons in China to whom goods may be consigned. Messrs. Wallem & Co., Shanghai, have been removed from the list.

Fire.—Owing to erroneous reports of the fire at the Ponder End works of the Ediswan Co. on the 11th inst. having appeared, we are asked to state that the fire broke out in the joiners' shop, which is an extensive building of two floors, employing nearly 90 hands.

Fortunately the fire did not spread, and was confined entirely to that department. The work in hand at the time was solely for the Government. The self-contained nature of the Ediswan works enabled things to be set going on Monday morning, when work was resumed.

Goods of Enemy Origin.—The Board of Trade have issued a warning to importers that goods which originated in an enemy country, even though they may have left enemy territory and become neutral property before the war, are liable to seizure under the Customs (War Powers) Act, 1915, if imported without the Board's permission.

Such permission is, as a rule, granted only upon production of incontrovertible evidence that the identical goods which it is proposed to import left enemy territory before the war. The evidence should be produced and the Board's authority obtained before any steps are taken to have the goods shipped to this country.

Inquest.—Last week an inquest was held at Mountain Ash on Thomas Bebb, who was recently killed on the rubbish tip at the Lletty Shenkin Colliery.

Albert Barnes, driver of a haulage engine, said that whilst he was engaged in hauling rubbish Bebb signalled to him to stop. He got a flash on the bell, proceeded to the top and found the body of deceased. There was no sign of life. Some ambulance men were called and artificial respiration resorted to, but without result. He had never seen anything of the kind happen before.

W. R. Harliss, engineer to the Powell Duffryn Co., said it was surmised that the wind had dislodged the signal wires at the spot where they crossed the tramway, that the journey rope at that place shot 6 ft. high, and that as a result the signal wires were thrown into the air and carried by the wind, subsequently coming into contact with electric wires some distance away, which were conveying current at a voltage of about 290.

Medical evidence was to the effect that death was due to shock from electric current, and a verdict to this effect was returned.

Patents in Enemy Countries.—A new order has been issued by the Board of Trade which permits persons living and carrying on business in the United Kingdom to pay fees for obtaining the grant of or for obtaining the renewal of patents or for obtaining the registration of designs or trade-marks or the renewal of such registration in an enemy country and to pay to enemy agents their charges and expenses. It also gives permission to pay on behalf of an "enemy" fees due in converse circumstances.

Prohibition of Exports.—An Order in Council has been issued governing the export of certain articles:—

The export of magnesite, magnesium and its alloys is prohibited to all destinations.

Coal (all kinds) and coke, are prohibited to all destinations abroad other than British possessions and protectorates, but not including coal allowed to be shipped as bunker coal.

All articles which are wholly or mainly manufactured of copper or its alloys and which are not at present prohibited to be exported to any destination, and silica bricks are prohibited to all foreign countries in Europe and on the Mediterranean and Black Seas, other than France, Russia (except through Baltic ports), Italy, Spain and Portugal.

Trading with the Enemy.—The Board of Trade have issued a notice directing the particular attention of manufacturers and traders concerned in the export trade to the need for scrupulous care in the transaction of their business abroad.

It is pointed out that the Government's reprisals policy, formally announced by Order-in-Council of March 11, 1915, is directed to suppress all enemy trade, whether import or export. The main difficulty in making this policy thoroughly effective arises from the fact that some traders in some neutral countries are making themselves agents for the supply of goods to enemy countries. British firms engaged in foreign trade, therefore, must have regard to these circumstances and survey with great caution every opening for business which is offered them by neutral importers or exporters. Especial care should be taken in opening new accounts in neutral countries, and in relation to any orders or inquiries of an abnormal character. In any case of doubt as to the bona fides of particular consignees, business should be suspended pending reference to the Chairman, Trade Clearing House, Central Buildings, Westminster, London, S.W. It is inadvisable that new accounts should be opened by any British trader in neutral countries, during the war, without the fullest inquiries as to the character of the business proposed to him. The proclamations relating to trading with the enemy cover indirect trading with the enemy through neutral agents, and carelessness in transacting neutral business may involve traders in the severe penalties attaching to trading with the enemy.

Who Are Munition Workers?—The position of tramway employees under the Munitions Act came before the Wolverhampton Munitions Tribunal on Tuesday.

Two workmen complained that their certificates of discharge had been unreasonably withheld by their employers. The applicants (a blacksmith and a blacksmith's striker) stated they were engaged at the tramway depot and were employed solely on repair of tramcars. They had secured work on Government contracts and wished to leave, but the tramway company refused to grant certificates. In a letter to the Court the employers remarked upon the importance of maintaining an efficient tramway service for munition workers and the necessity of keeping the remainder of their depleted staff.

The Court decided that as applicants were not engaged on munition work at the tramway depot, and that they did not come within the meaning of the section, no discharge certificate was necessary, and applicants were free to go where they liked.

TENDERS INVITED.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *See advertisement.*

In reference to the invitation of tenders by DURBAN Corporation for (1) Telephone Apparatus and Materials; (2) Underground Cables (paper insulated, armoured, silk and cotton covered, &c.); and (3) 540 Cast-iron Pipes, 9 ft. in length, for the cables, it has been arranged that firms who tendered by the date originally announced (Dec. 1) may, in consequence of the fluctuations in the cost of material, amend their figures and send them to Messrs. Webster, Steel & Co., 5, East India-avenue, London, E.C., by Dec. 31.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. Jan. 4, for the supply of Detectors, Galvanometer Shunt, Keys, Megohm and Milliameter (Schedule 1,216); Telephone Cords, Earpieces, Receivers and Lamps (Schedule 1,275); and 500 Automatic C.B. Telephones (Schedule 1,276) for AUSTRALIAN COMMONWEALTH, Postmaster-General's Department.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Electric Power Plant.

Tenders will be received at the Negociado Quinto de la Segunda Sección (Material) del Estado Mayor Central de la Armada, Ministerio de Marian, Madrid, until Jan. 26, for the Construction and Installation in the Cadiz Naval Arsenal of an Electric Power Plant. Conditions of tender may be seen at the above-mentioned Negociado. Tenders in the Spanish language, on paper bearing a 1 peseta stamp, must be accompanied by specifications and plans. A provisional deposit of 20,000 pesetas (about £800) is required to qualify any tender. Local representation is necessary.

Electric Tramway.

Tenders will be opened on Jan. 28 at the Dirección General de Obras Públicas, Ministerio de Fomento, Madrid, for the Construction and Working, for 60 years, of an Electric Tramway in Madrid (Monte del Pardo district). Minimum rolling stock required, three motor coaches and three trailers. The concession is held by the Sociedad Tranvia del Este de Madrid.

Electrically-operated Pumps.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections (contract No. 20,491), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fishplates (contract No. 28,685). Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

Boiler.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c., of two Water-tube Boilers and Accessories at Newcastle. Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Overhead Line.

NUNEATON Electricity Committee require tenders by Dec. 24 for the supply and erection of an Overhead Line. Specifications from the Acting Borough Electrical Engineer.

TENDERS RECEIVED AND ACCEPTED.

WOLVERHAMPTON.—The tender of Hadfields, Ltd. (at £595) has been accepted for the supply of 14 pairs of points.

SOUTHAMPTON.—The Corporation have accepted the tender of British Insulated & Helsby Cables for the supply of 450 yds. 1 in. h.t. concentric lead-covered paper-insulated cable at £121. 10s., and 800 yds. 0 025 cable at £90. 18s.

STOCKPORT.—The Corporation have accepted the following tenders for tramway stores:—

Dick, Kerr & Co. (Ltd.), H. Hollingdrake & Son, British Thomson-Houston Co., Baxendale & Co., McClure & Whitfield, Brecknell, Munro & Rogers, and Brush Electrical Engineering Co.

The Council have also accepted the tender of McClure & Whitfield for wiring work and for supply of electric irons at the laundry of their hospital.

PRAHRAN AND MALVERN (VICTORIA).—The tender of Noyes Bros. (at £4,116. 16s.) has been accepted by Prahran and Malvern Tramway Trust for overhead cables and trolley wires.

SYDNEY (N.S.W.).—The City Council recently decided to order from W. G. Watson & Co. (under their existing contract) 50 5-ampere, 50 25-ampere and 25 100-ampere m.d. indicators.

The Council also approved of 10 additional joint boxes being ordered from Noyes Bros. for the 33,000-volt cable on order from them, at £9. 1s. 6d. each, and also four for terminal trifurcating boxes, one spare bot, and one complete set of insulators, at £214.

Approval was also given for the purchase for stock of one gross each of three sizes of ball bearings, used for electric motors, from Gardner, Waern & Co., at £198.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government departments:—

Postmaster-General's Dept., Sydney.—India Rubber, Gutta Percha & Telegraph Works Co., five condensers (£5 each) and five relays (£7. 8s. each); Oliver Co., 150 cable terminals (£2. 10s. each), 225 ditto (£3. 10s. each), 100 ditto (£4. 15s. each), 50 ditto (£5. 10s. each); Dick, Kerr & Co., 2,200 25 c.p. English drawn wire lamps (1s. 1½d. each), 4,000 32 c.p. (1s. 1½d.), and 3,000 50 c.p. (1s. 1½d. each); Western Electric Co., 17 strips metallic circuit protectors and mounting plates, £935.

Postmaster-General's Dept., Melbourne.—Lawrence & Hanson, 12 lb. granulated carbon, 13s. per lb.; 2,000 cords, 10⅝d. each; 2,000 ditto, 1s. 2d. each; 1,000 ditto, 5⅜d. each; 100 ditto, 1s. 8¾d. each; 400 ditto, 9d. each; 300 ditto, 2s. 2d. each; 1,000 diaphragms, 2d. each; 1,000 mouthpieces, 8d. each; Western Electric Co., 3,250 diaphragms, 1d. each; 500 microphones, 6s. 3d. each; 660 c.b. telephones, £2. 8s. 6d. each; 1,500 jointing sleeves, 7s. 7d. per 100; 15,000 ditto, 11s. per 100; 3,500 ditto, 15s. 6d. per 100; 3,000 ditto, for use with bronze wire, 51 mils diameter, 6s. 7d. per 100; 5,000 ditto, 7s. per 100; India Rubber, Gutta Percha & Telegraph Works Co., 2,000 copper binders, 3s. per 100; 20,000 ditto, 2s. 5d. per 100; 2,500 ditto, 4s. per 100; 500 ditto, 16s. per 100; 17,000 ditto, 2s. 1½d. per 100; 50,000 copper tapes, 2s. 10½d. per 100; 2,500 ditto, 3s. 3d. per 100; 100,000 ditto, 6s. per 100; 30,000 ditto, 7s. per 100; 500 ditto, 15s. per 100; 17,000 ditto, 2s. 1d. per 100.

Postmaster General's Dept., Adelaide.—Newton, McLaren (Ltd.), 300 dry cells, 3s. 4d. each; J. Bartram & Son, 100 magneto bells, 6s. 6d. each; 2,000 earth clips, 4.5s. 10d. per 100; 50 switches, 24s. each; 100 c.b. switches, 35s. each; 50 magneto telephones, 61s. 6d. each; 12 condenser telephones, 58s. 6d. each; India Rubber, Gutta Percha & Telegraph Works Co., 75 magneto bells, 14s. 11d. each; 100 trembling bells, 5s. 9d. each; 50 ditto, 7s. 3d. each; 25 ditto, 13s. 9d each; 25 ditto, 16s. 6d. each; five ditto, £2. 6s. each; Western Electric Co., 880 yds. cable, £149 per mile; 880 yds. ditto, £19 per mile; 880 yds. ditto, £35 per mile; 220 yds. ditto, £45 per mile; 220 yds. ditto, £57 per mile; 220 yds. ditto, £66 per mile; 660 yds. ditto, £78 per mile; 880 yds. ditto, £105 per mile; and 880 yds. ditto, £183 per mile; 300 lightning arresters,

4s. 3d. each, and one resistance testing set. British General Electric Co., 440 yds. cable, £212. 10s. per mile; 1,880 yds. ditto, £96. 5s. per mile; 770 yds. ditto, £156. 5s. per mile; Steele & Baker, four standard resistances, £9. 7s. 6d.; Firebrick Insulator & Pottery Co., 15,000 porcelain insulators, 6¾d. each; British Insulated & Helsby Cables, 12 condensers, £6. 15s. 3d. each; six relays, £6. 17s. 6d. each; 12 rheostats, £6. 2s. 3d. each; 250 switches, 1s. 10½d. each; E. A. Machin & Co., two insulation resistance testing sets, £27. 5s. each; Ramsay, Sharp & Co., 25 counters, recording 99,999, 5s. each.

Commonwealth Railways.—Western Electric Co., 100 portable telephones, £4. 5s. each; 100 contact rods, £1. 1s. each.

Metropolitan Board of Water Supply, Sydney.—Zollner (Ltd.), centrifugal pumps and 35 H.P. G.E.C. motors, £1,827. 8s.

Victorian Railways.—Belliss & Morcom, air compressors for Jolimont car shops, £385 each; and motor-driven air compressors for Ballarat and Bendigo workshops, £673 each; Johns & Waygood, mild steel tension bridges and masts for overhead equipment of Melbourne suburban railways, at rates; Gray Bros., ditto, at rates; Forman & Co., mild steel tension masts, at rates.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

3,583 MAITRE & MARTIN. Contact-breaker for electromagnetic vibrating members. (20/2/13.)

7,692 MAITRE & MARTIN. Contact-breaker device for electromagnetic vibrating members.

16,558 HUGHES & PAYNE. Apparatus for actuating signals on trains and for stopping trains independently or drivers. (26/11/14.)

21,536 BEIN. Water-tight electric bells and the like. (23/3/15.)

22,057 GROTE & REYNOLDS. Manufacture of tungsten filaments for electric incandescent lamps.

Gelatinous aluminium hydrate is employed in conjunction with a solution of tungstic acid or other tungsten compound to produce the required binder or carrier for metallic tungsten or its compounds.

22,131 B.T.-H. Co. (G.E. Co.) Direct-current dynamo-electric machines.

A compensated direct-current dynamo electric machine in which the compensating winding is adapted to overpower the armature reaction, thereby producing a commutating flux, the machine having definite commutating teeth, and having non-magnetic wedges closing the slots adjacent to the commutating teeth and magnetic wedges closing the remaining slots.

22,251 MURRAY. Train control systems.

22,265 MUIRHEAD & CO. & SQUIER. Telegraphy.

22,328 W. R. SYKES' INTERLOCKING SIGNAL CO. & SYKES. Means for automatically arresting railway trains provided with automatic brakes.

22,383 KUYSER. Dynamo-electric machines.

22,437 GIMINGHAM. Arc incandescent electric lamps.

22,549 KERSTING. Inter-communication telephone systems.

22,550 MACNICOL. Electrical heating unit, and method of manufacture thereof.

22,715. RELAY AUTOMATIC TELEPHONE CO. Formerly known as Betulander Automatic Telephone Co. & Aitken. Automatic and semi-automatic telephone systems.

22,867 JENKINS, PATTINSON & WELLESLEY. Electrolytic cells.

22,868 BARWELL, JUDD & EASTERN TELEGRAPH CO. Electric relays.

22,931 GALVANOPHOREN-WERKE (SYSTEM VOGT), S. SZUBERT, KOMMANDITGESELLSCHAFT & VEREINIGTE ELEKTRICITATSWERKE GES. Methods of manufacturing electric condensers. (22/11/13.)

23,282 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Telephone hand sets or instruments.

23,292 BUCHER. Electrical process for producing cyanides. (25/6/14.)

23,676 GROGAN. Electrical heating elements.

24,108 PICKERINGS (LTD.) & FOTHERGILL. Controllers for electric motors.

Comprises an apparatus in which the reversal of the armature connections is effected by a single solenoid and whereby the main circuit is made and broken separately by a switch that is operated by another solenoid.

24,631 SOC. CERAMICA RICHARD-GINERI. Electric insulators. (30/4/14.)

1915 SPECIFICATIONS.

569 HARLAND & WOLFF (LTD.) & BENTLEY. Electrical steering and like gear.

1,404 FOSTER & SHARPE. Controlling dynamo-electric machines running at varying speeds.

Comprises a machine having a movable brush rocker connected to the throttle lever of the carburetter or valve of a hydro-carbon or other engine operated either from the steering column or accelerator pedal or the like.

1,671 TALLENT-BATEMAN. Protective apparatus for dynamo-electric generators.

Comprises apparatus in which the current in the generator field circuit is automatically reduced by means of a trip coil device which operates when the main circuit-breaker automatically opens and in which the hand-operated control switch for closing or opening the main circuit-breaker is mechanically connected to a switch in the circuit of the trip coil for the generator field switch so as to open said trip coil circuit and prevent the generator field being reduced when the main circuit-breaker is closed or opened by hand.

1,892 HOLDSWORTH. Electrically-heated fluid-pressure boiler. (Patent of addition not granted.)

2,036 GOLDSTONE. Portable dry battery electric torches. (4/5/15.)

2,289 W. T. HENLEY'S TELEGRAPH WORKS CO. & SAVAGE. Gripping of electric cables and the like.

2,349 UCAR. Method of establishing a voltaic arc between electrodes not in contact.

2,928 HOUGH & HARRISON. Electric light fittings or brackets.

3,326 NAYLOR. Secondary electric batteries or accumulators.

3,502 B.T.-H. Co. (General Electric Co.) Induction motors.

Relates particularly to the secondary member for an induction motor comprising laminations in the form of annuli mounted upon a central spider and provided with openings near their outer periphery through which conducting members pass, a shaft upon which the spider is mounted, thrust collars about said shaft, fan blades and end rings at the ends of said laminations, connecting the conducting members and spider, the conducting members, spider, thrust collars, fan blades, and end rings being formed of a single casting around the shaft.

3,837 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electro-magnetic switches.

4,561 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Pressure-operated electric switches.

5,001 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric motor controllers.

6,098 COLLET. Electric generating set. (30/5/14.)

7,206 MIDGLEY & VANDERVELL. Electric starters for internal-combustion engines.

7,675 SMITH. Manufacture of electric cables. (23/5/14.)

9,411 KILNER. Electrically-operated bells.

10,130 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Electrically-controlled electric circuit-breakers. (11/7/14.)

An electrically-controlled circuit-breaker in which the tripping magnet has two magnetic circuits, one provided with a main winding energised from the electric circuit to be protected and the other with an auxiliary winding the energisation of which controls the effect of the main winding and is itself controlled by a relay.

10,131 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Arrangement for supplying electrical energy to direct-current electric motors. (11/7/14.)

Consists in the combination of a source of single-phase alternating current, a rectifier, two anodes of which are connected to two terminals of said source, and an even number of direct current electric motors connected in series between the cathode of the rectifier and a point of the source substantially midway between its terminals, a point between the motors being connected to earth.

10,133 MARINO. Process for the electrolytic deposition on all metals of aluminium, tin, nickel, copper, zinc, iron, steel, or alloys thereof.

10,604 NELSON. Electrolytic cells. (17/8/14.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

November 8, 1915.

15,759 WHEELER. Cathode for electrolytic cells. (25/1/15, U.S.)*

15,761 SMITH. Replenishing electrolytic cells. (3/6/15, U.S.)*

15,762 LANGDON-DAVIES & SOAMES. Electrically-controlled clutches.

November 9, 1915.

15,792 OSIUS. Eleetric motors.*

15,810 TURNER. Control of alternating-current motors.

15,824 SMITH. Construction of grids for secondary batteries.

November 10, 1915.

15,869 EDMUNDS & EDMUNDS. Head-lights, searchlights and the like.

15,873 IRELAND. Sparking-arrangements for electric ignition devices.

15,878 B.T.-H. Co. (G.E. Co., U.S.) Electric switches.

15,883 BLOXAM. Electric switches or bell-pushes.

November 11, 1915.

15,915 SHARMAN. High-frequency alternating-current relays for radiotelegraphy and the like.

15,922 BEGG. Combination electric turn switch and wall plug.*

15,930 FERY. Electric cells.*

November 12, 1915.

15,971 STEELE. Trolly collectors for overhead tramway, railway and like vehicles.

15,978 SYKES & FORD. Electro-chemical microphones principally for use in connection with wireless telephony and telegraphy.

15,985 WILSON, SHEPHERD & POWELL & HANMER (LTD.). Electric lampholders for vehicle head lamps.

15,986 WILSON, SHEPHERD & POWELL & HANMER (LTD.). Electrical connections for use in the electric lighting of automobiles.

15,989 MARKT. Construction of terminal for electric switches, couplings and the like.*

16,017 CANION. Combined air and electric triple valves.*

November 13, 1915.

16,044 SATINOVER. Electric fly-traps. (27/11/14, U.S.)*

16,050 HIRD. Mine-shaft signalling and analogous purposes.

16,053 ROSENBAUM & COUSE. Automatic protective gear for electrical systems.

16,056 MARKS. (Carl Bancken, Germany.) Lightning arresters.*

16,057 NEVILL. Venting appliance for use in connection with accumulators or secondary batteries using wet acid.

16,058 MERRIMAN & SPEIRS. Electric meters.*

16,060 AUTOMATIC TELEPHONE MFG. CO. & SMITH. Telephone systems.

November 15, 1915.

16,082 BAMBURG. Hydrolysis.

16,094 & 16,095 CONSTANTINESCO & HADDON. Wave transmission.

16,107 GIRARDEAU. Dynamo-electric machines. (16/11/14, France.)*

16,112 TRENT. Ohmmeters and like electrical measuring instruments.*

16,113 TRENT. Wattmeters and like instruments for the measurement of electrical power.*

November 16, 1915.

16,118 ALEXANDER. Sparking plug.

16,151 MARCONI'S WIRELESS TELEGRAPH CO. & BANGAY. Wireless telegraphy.

16,155 GRAHAM. Glands or grips for the cables of electrical apparatus and the like.*

16,176 PEACOCK & SWAN, HUNTER, & RICHARDSON. Masts for wireless telegraphy.

November 17, 1915.

16,184 NEILSON. (Charles Cormack Gordon, Portuguese East Africa.) Switch-holders for electric lamps.

16,185 MULLER. Electric insulators. (Addition to 27,738/12.)

16,207 GRAHAM. Telephonic transmitters.*

November 18, 1915.

16,260 NELSON. Galvanic sock.

16,270 B.T.-H. Co. (G.E. Co., U.S.) Arc lamps.

16,271 HIGGINS. Magnetically-operated prime mover.

16,281 CONSTANTINESCO & HADDON. Wave transmission motors.

16,290 PORDES. Portable electric battery lamps.

November 19, 1915.

16,336 TAINTON & PRING. Electro-deposition and extraction of zinc.

16,345 B.T.-H. Co. & SPORBORG. Electric safety devices.

16,349 BENNETT. Electric incandescent lamp-holders.

16,364 PLANIAWERKE AKT.-GES. FUR KOHLENFABRIKATION. Arc lamp electrodes. (31/12/14, Germany.)*

November 20, 1915

16,379 GOAD. Electric couplings.

16,389 DERRIMAN. Electric light fittings.

16,393 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Loaded line system. (Addition to 12,434/15.)*

16,395 WYNNE. Electrical switches.

16,402 LOWENSTEIN. Electric signs.*

16,407 REDMAN. Apparatus for receiving or detecting submarine sounds.*

16,408 ETABLISSEMENTS DE DION-BOUTON SOC. ANON. Magneto-ignition systems. (6/9/15, France.)*

November 22, 1915.

16,441 STEELE. Apparatus for transmitting Morse and like code signals.*

16,443 B.T.-H. Co. (G.E. Co., U.S.) Producing and distributing electric current waves.

16,452 CLEMENS. Electric soldering irons. (21/11/14, U.S.)*

16,464 EBORALL. (Akt.-Ges. Brown, Boveri et Cie, Switzerland.) Dynamo-electric machinery.

16,466 COSTELLO. Electric contact thermometers.

16,469 HEFFORD. Portable electric and other lamps.

16,471 BRONSTED & HELLESENS ENKE & LUDVIGSEN. Producing durable galvanic battery cells with zinc anodes and alkaline electrolyte.*

16,474 DIDIER. Magnetos. (3/9/15, France.)*

16,475 ETABLISSEMENTS DE DION-BOUTON SOC. ANON. Magneto-ignition systems. (Addition to 16,408/15. 28/10/15, France.)*

16,476 NEULAND. Alternating-current motors.*

16,477 FORSTER. Audible and visual indicators for use in mines and the like.*

16,479 WESTERN ELECTRIC CO. (Western Electric Co., U.S.) Loaded telephone line system. (Addition to 12,434/15.)*

November 23, 1915.

16,492 STEELE. Metal and carbon filament electric incandescent globe and like illuminators.

16,495 WRIGHT & BULL & MOULIN. Ignition and electric lighting apparatus for automobiles.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

ADELAIDE ELECTRIC SUPPLY CO. (LTD.)—The net capital expenditure at Aug. 31, 1915, was £817,547. 9s. 2d. The capital necessary to keep pace with the continued growth of the business has been provided for by the issue during the year of the balance of 10,365 preference shares, and of a further £25,000 debenture stock. Further capital being required to enable the company to fulfil its statutory obligations, the capital was increased by a further 50,000 shares of £5 each. The Treasury have given permission to issue 20,000 further ordinary shares at a premium of 30s. per share to the holders of the existing ordinary shares residing in Australia. The area of the districts covered by the company's statutory powers is approximately 155 sq. miles, and a supply is now available in 390 miles of streets, an increase of 29 miles during the year. 2,142 new consumers were connected to the mains during the year, bringing up the total number connected to 15,334, an increase of 16 per cent. over the preceding year. The power supply has increased by 12 per cent., the electric motors now connected being equivalent to 8,236 H.P.; while the total connections, including lamps, motors, heating and other apparatus, have increased by 14 per cent., the total units sold by 5 per cent., and the gross revenue by 7 per cent. The gross revenue for the year amounted to £119,897. 10s. 2d., compared with £111,985. 19s. 11d. for the preceding year, an increase of 7 per cent. After payment of debenture interest and management and general expenses in London and Adelaide, and after allocating £9,129. 3s. 3d. to debenture stock service fund, the balance is £42,067. 18s. 1d., to which must be added £10,815. 5s. 6d. brought forward, making a total of £52,883. 3s. 7d. Deducting the preference dividend for the half-year ended Feb. 28, 1915, and the interim ordinary dividend of 5 per cent., paid in June last, there remains £32,920. 10s. 7d., which the directors recommend should be applied as follows: Dividend on 6 per cent. preference shares for half-year ended Aug. 31 (£7,500), final dividend of 5 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year (£12,500), and bonus of 2 per cent. (tax free) on the ordinary shares (£5,000), leaving £7,920. 10s. 7d. to carry forward. The business continues to make good progress, and the demand for electric light and power in the extensive area served by the company is being maintained satisfactorily.

COSTA RICA ELECTRIC LIGHT & TRACTION CO. (LTD.)—The net earnings in Costa Rica for the year ended June 30 amount to £21,662. 5s. 3d., against £26,351. 11s. 9d. for the previous year, a decrease of £4,689. 6s. 6d. (mainly due to the adverse exchange). The net surplus profit is £3,832. 13s. and the directors propose to carry this amount to credit of discount and commission on debenture issue account. The power plant at El Brasil has worked well throughout the year. Some trouble which was experienced in times of floods has been eliminated by larger sluice gates. Electrical cooking has continued to develop during the year, and the revenue from this source has been satisfactory. The business has suffered considerably from the interruption of exports and the general upset of trade relations owing to the war.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—The directors' report for the year ended Sept. 30 states that, after provision for doubtful debts, the net profit was £80,403 19s. 9d. Adding £1,033. 12s. 2d. brought forward, deducting £12,500, the dividend on the preference shares paid in January and July and accrued to Sept. 30, and £12,500, the interim dividend on the ordinary shares paid in July, there remains £56,437. 11s. 11d., which, after providing for the proposed dividend on the ordinary shares, will leave £18,937. 11s. 11d. to carry forward. The directors recommend payment of the half-yearly dividend of 5s. per share, or at rate of 5 per cent. per annum, be made to the preference shareholders, and that a dividend of 15s. per share (tax free), amounting to £37,500, making with the interim dividend paid in July a total payment of 10 per cent. for the year, be paid to the holders of ordinary shares. The directors are pleased to be able to make such a satisfactory report in spite of the constantly increasing cost of coal, labour and raw material, and the dislocation of transport. Although the works at Persan remained closed till after the beginning of the financial year, and labour has been exceedingly scarce in France owing to the war, it is a matter of congratulation that the loss of the previous year has been converted into a profit in the year under consideration. The branches abroad have also shown much better results. The foregoing statement proves that the directors were justified in paying an interim dividend in July last. The directors cannot now estimate the amount of tax on profits which may become payable under the Finance Act when it becomes law on account of this year's trading, but the carry forward has been considerably increased. The "Dacia" has had a fair share of employment, and the "Silvertown" was chartered for a short period during the year. The directors regret to report the death, on Sept. 2 last, of Mr. Matthew Hamilton Gray, who had been associated for so many years with the work of the submarine department at Silvertown, and at the time of his death was consulting engineer to the company in these matters.

MELBOURNE ELECTRIC SUPPLY CO. (LTD.)—The directors' report states that the sum of £5,000, as provided for in last year's accounts, has been applied during the year in writing off certain items in the Melbourne account, and the net expenditure at Melbourne is now £939,547 and at Geelong £172,086. The area of the suburban districts in Melbourne covered by the company's statutory powers is approximately 74 sq. miles, and a supply is now available in 526 miles of streets, an increase of 44 miles during the year. 4,125 new consumers were connected to the mains during the past year, bringing up the total number connected to 23,191, an increase of 22 per cent. compared with the preceding year. The power supply has increased by 41 per cent., the electric motors now connected being equivalent to 17,609 H.P.; the total connections, including lamps, motors, heating and other apparatus) have increased by 26 per cent., the total units sold by 25 per cent. and the gross revenue by 20 per cent. The gross profit derived during the year from the Melbourne and Geelong undertakings amounted to £117,676. 19s. 4d., against £104,339. 18s. 9d., an increase of 13 per cent. After payment of debenture interest and management and general expenses at London head office and after making the usual allocations and writing off balance of cost of increase and issue of capital (£516. 11s. 4d.), there remains £77,208. 4s. 8d., to which must be added £7,819. 11s. 7d. brought forward, making £85,027. 16s. 3d. Deducting dividend on the 7 per cent. first cumulative preference shares for the half-year ended Feb. 28, 1915, and the interim dividend of 5 per cent. (tax free) on the consolidated ordinary stock, paid in June, there remains £64,777. 16s. 3d., which the directors recommend should be applied in paying the dividend on the 7 per cent. first cumulative preference shares for the half-year ended Aug. 31, and a final dividend of 5 per cent. (tax free) on the consolidated ordinary stock, making 10 per cent. for the year, and dividend of 5 per cent. (tax free) on the consolidated ordinary stock issued in March, 1915, leaving to carry forward £40,778. The business has been well maintained. There is an increasing demand for light and power from all classes of consumers, including numerous engineering firms in Melbourne and Geelong.

WESTERN UNION TELEGRAPH CO.—The report for the year ended Dec. 31 last shows gross operating revenues $46,264,776.61, and operating expenses, including repairs, depreciation, taxes, &c., $40,578,750.90. Income from loans and investments was $1,022,611.30. Interest on company's bonds required $1,337,242.50, and balance transferred to surplus account was $5,371,394.51. The surplus at Dec. 31, 1913, was $9,705,791.85, and adding balance from income account ($5,371,394.51) and balance of other surplus reserve ($3,451,921.72) made a total of $18,529,108.08. After transferring to reserve for depreciation prior to Dec. 31, 1913, $1,000,000.00, and deducting miscellaneous adjustments, $8,300.92, and dividends paid and declared, $3,988,886.00, the surplus at Dec. 31, 1914, was $13,531,921.16. The value of telegraph lines and equipment has been increased by $3,851,798; 2,449 miles of pole line, 27,458 miles of iron wire, 15,752 miles of copper wire and 2,464 miles of wire in cables (a large portion of the latter being underground) have been added. There are 25,784 offices operating in conjunction with 1,581,571 miles of telegraph wire, 210,515 miles of pole line, and 26,768 miles of ocean cables, the latter having been extended by 494 miles. Gross operating revenues increased over those of previous year by $1,475,900, due to unprecedented cable business during the last five months, the land line earnings remaining approximately constant with 1913. Combined operating expenses for land lines and cables (including taxes) show a net decrease of $588,800, or 1·43 per cent. Pursuant to agreement (effective Jan. 1, 1915), the Canadian Northern Telegraph Co. and the Great North Western Telegraph Co. combined and acquired control of the shares owned by the Western Union Co. in the Great North Western Co., equal to 66 per cent. of the capital stock. Prior to the arrangement, the Great North Western Co. was confined to a limited territory in Canada without access (save through other companies) to the Pacific seaboard. As a result of the consolidation the lines of the new Great North Western Co. extend entirely across Canada from coast to coast and the Western Union Co. will benefit by obtaining a strong ally in Canada. The Western Union Co. is now subject to the authority of 43 public service commissions and 23 workmen's compensation or industrial commissions. Besides voluminous reports to these commissions the company has also to prepare 3,100 annual reports to tax authorities, these reports being further subdivided by taxing districts. In all, there are required 7,700 statements to public authorities. In addition the company has now to collect and remit monthly to the Government the internal revenue tax recently levied upon commercial telegraph messages. The company has operating contracts with 260 railroad systems. It would seem to be in the public interest that a company doing a national business, like the Western Union, should be relieved of supervision by State legislatures and commissions so far as regards the regulation of rates and the preparation of accounting statements, and should report, in these respects, to the Federal Commission alone. The dividend on the company's stock is at the rate of 7 per cent. per annum, payable quarterly.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES

AMP WELDING CO. (LTD.) (143,342).—Reg. Dec. 8, capital £1,000 in £1 shares, to carry on the business of acetylene welders and general mechanical and electrical engineers and repairers, founders, manufacturers of implements and machinery, metallurgists, &c. Private company.

ARCORUNDUM ABRASIVES (LTD.) (142,352).—Reg. Dec. 9, capital £2,000 in £1 shares, to carry on the business of manufacturers of abrasive materials, engineers, founders, machinists, electricians, manufacturers and workers of and dealers in electricity and electric motive power, &c., and to adopt an agreement with W. R. Hague. Private company. First directors are F. E. Tidswell, W. R. Hague and G. J. R. Millington.

FREDK. R. BUTT & CO. (LTD.) (142,314)—Reg. Dec. 4, capital £7,500 in £1 shares, to take over the business carried on as Fredk. R. Butt & Co., and to carry on the business of scientific and general electrical engineers, manufacturers of X-ray, medical, electro-medical, wireless telegraph and telephone and other instruments and apparatus, constructors of radio-telegraph and radio-telephone stations, &c. Private company. First directors are H. F. Bigge (managing) and F. R. Butt (both permanent). Reg. office: 147, Wardour-street, W.

NEWTONS (CAMBORNE (LTD.) (142,373)—Reg. Dec. 10, capital £5,000 in £1 shares, to carry on the business of scientific and mathematical instrument makers, mechanical, electrical, civil and hydraulic engineers, &c. Private company. First directors are S. Staples and A. W. Kelly (provisional directors). Reg. office: 47, Bishopsgate, E.C.

O'NEIL'S RECORDER SYND. (LTD.) (142,362).—Reg. Dec. 9, capital £2,000 in £1 shares, to acquire certain patents for inventions in relation to signalling for use on vessels and recording course steered by vessels at sea, and to carry on the business of mechanical, electrical, hydraulic and general engineers, &c. Private company. C. A. Beldam and R. S. O'Neil are governing directors.

REPUBLIC RUBBER CO. (LTD.) (148,279)—Reg. Dec. 1, capital £25,000 in £1 shares, to carry on the business of manufacturers, importers, wholesale and retail brokers, factors, and agents for and dealers in tyres, soft and other rubber and rubber goods, tubes, &c., asbestos goods, electric and other cables, motors, &c. Private company. E. A. Gleich is first director. Reg. office: 5, Giltspur-street, E.C.

STATUTORY RETURNS.

CHEPSTOW ELECTRIC LIGHTING & POWER CO. (LTD.)—Capital in return to Oct. 23 is £10,000 in £1 shares. 5,510 shares taken up. £1,537 paid. £3,905 considered as paid. Mortgages and charges, £1,000.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Return to Aug. 10 gives capital as £201,500 in 20,000 ordinary shares of £5 each, 40,000 deferred shares of 1s. each, and 19,900 preference shares of £5 each. All shares taken up. £1 per share called up on the ordinary, 1s. per share on the deferred and £5 per share on the preference. £121,500 paid. Mortgages and charges, £27,813. 10s.

ELECTRO-MECHANICAL BRAKE CO. (LTD.)—At Aug. 12 capital was £30,000 in 2,500 preference and 27,500 ordinary shares of £1 each. 987 preference and 17,317 ordinary shares taken up. £1per share called up on 987 preference and 11,282 ordinary. £12,269 paid. £6,035 considered as paid on 6,035 ordinary. Mortgages and charges, £7,500.

MORTGAGES AND CHARGES.

BARRACLOUGH BROS. (LTD.)—Particulars of £1,000 debentures, created July 27, 1915, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

COLNE VALLEY ELECTRIC SUPPLY CO. (LTD.)—Debenture dated Dec. 2, 1915, charged on company's undertaking and property, including uncalled capital, to secure all moneys due or to become due from company to Barclay & Co.

NAYLORGRAPH (LTD.)—Debenture dated Nov. 13, 1915, to secure £400 charged on company's undertaking and property, present and future. Holder: J. M. Hunt.

RAWLINGS BROS. (LTD.)—Issue on Nov. 19, 1915, of £1,100 debentures, part of series of which particulars have already been filed.

STERLING TELEPHONE & ELECTRIC CO. (LTD.)—Mortgage dated Nov. 11, 1915, to secure £48,253. 17s. 1d. charged on company's undertaking and property, including uncalled capital and freehold land at Dagenham, Essex. Holder, the Minister of Munitions.

RECEIVERSHIP.

RESIDE & CO. (LTD.)—W. H. Sayers, 17, Pelham-terrace, Eccleshill, Bradford, ceased to act as receiver on Nov. 20, 1915.

CITY NOTES.

MEMORANDA (Dec. 15).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58⅜. Consols Pay Day, Jan. 5. Stocks and Shares Ticket Days Dec. 29 and Jan. 12. Pay Days Dec. 30 and Jan. 13. Price of silver, 26⅜d.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold to consumers during the four weeks ended October 29th amounted to 1,889,945, compared with 1,262,426 in the corresponding four weeks of 1914.

BLACKPOOL, ST. ANNES & LYTHAM TRAMWAYS CO. (LTD.)—The directors propose to pay 4 per cent. per annum on the debenture stock on account of arrears. Last year no distribution was made.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The directors have declared a quarterly dividend of 1¾ per cent. for the quarter ended Dec. 31.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 5 per cent. first and 4½ per cent. second debenture stocks are closed from 17th to 31st inst., inclusive.

EASTERN TELEGRAPH CO. (LTD.)—The company announce the payment on Jan. 15 next of dividend at rate of 3½ per cent. per annum (less tax) on the preference stock of the company for the quarter ending 31st inst., and the third quarterly interim dividend of 1¼ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1915. The transfer books of the ordinary stock will be closed from Jan. 7 to 14 January, inclusive.

INTERNATIONAL LIGHT & POWER CO. (LTD.)—The usual quarterly dividends on the preference shares have been deferred for the present.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD).—The directors have decided to pay on the 1st prox. an interim dividend of 3 per cent. (being at rate of 6 per cent. per annum) on account of the dividend accrued on the cumulative preference shares.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 14. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Dec. 14.	Rate per cent Yielded. £ s. d.	Dividends Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9¼	8 0 2	Mar, Sept
10	4⅛%	Do. 4⅛% Cum. Pref.	9⅛	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅛	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	90¼†	4 8 5	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3 15/16	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	3⅛	6 0 0	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅛	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar, Sept
10	6%	Do. 6% Pref.	10¼	5 19 9	Feb, Aug
St.	4½%	Do. 1st Deb.	90¼	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77¾	5 15 11	July
5	9%	Kensington and Knightsbridge Ord.	6 7/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 6 4	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 1/16	7 3 7	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/16	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 1/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 1/16	7 10 7	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3⅝	5 16 2	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	85¼	6 4 3	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	73	8 4 5	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	71½	5 12 3	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 3	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅝	5 11 4	May, Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	⅝%	London Electric Ry. Ord.	11⅝	4 5 1	Jan, July
St.	4%	Do. 4% Pref.	59	7 6 5	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	21⅜	4 2 9	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74	4 13 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	80½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	66½	6 15 10	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	113½	5 5 9	Jan, July
St	4%	Do. 4% Debs.	72	5 11 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	73	5 9 7	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅜	..	..
1/0	..	Do. A Ord.	⅝	..	..
St.	6%	Do. 6% Inc. Debs.	105	5 14 3	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Tues., Dec. 14.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	77	7 15 10	Mar, Sept
..	4½%	Do. 4½% Bds.	100½	4 9 6	Jan, July
5	..	Yorkshire W. Riding Ord.	½	..	March
5	6%	Do. Pref.	4⅛	6 19 6	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅜	6 2 9	Apl, Oct
1	6%	Do. 6% Pref.	1⅛	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 9 9	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	⅜	7 2 3	Jan. July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 8 2	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅞	8 0 0	April
100	6%	Do. 6% Prior Lien Debs.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅞	7 7 3	Jan, July
5	2/6	Do. 5% Pref	4⅛	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3 1/2†	6 12 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	9⅛	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅜	..	Feb, Aug
St.	4%	Do. 4% Deb.	61⅛	6 10 1	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅛†	7 4 6	Jan, July
St.	4%	Do. 4% Debs	72½	5 7 3	Jan, July
..	10%	General Electric Ord.	10⅛	9 11 1	July
10	6%	Do, 6% Pref.	9⅛	6 3 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	8⅛	6 4 0	Feb, Aug
10	5%	Do. Pref.	7½	6 13 4	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34⅛	6 18 8	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅜	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	83⅛	4 15 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99½†	4 10 3	Jun, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	101	5 19 0	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	22⅜	6 11 10	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69⅞	5 14 6	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	7¼	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	6½	6 10 7	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½	5 9 10	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80⅞	4 18 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 11	Feb, Aug
10	7%	Do. Ord.	12⅛	5 12 7	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8.	33½	6 10 4	Ja, My, Jly
25	13%	Indo-European	48	6 15 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	13⅞	5 8 6	April
1	7%	Do. 7% Pref.	1⅞	4 0 0	July
10	1%	West India & Panama Ord.	1⅛	9 5 3	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 5	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 10 11	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	93	4 11 10	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	135	5 18 7	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 0	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101	4 9 0	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79½	5 0 8	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 5 11	Jan, July
5	8%	United River Plate Ord.	5⅛	6 14 9	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	93	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10⅛	5 15 8	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10⅞	5 15 0	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	86⅞	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68⅛	5 17 3	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	8⅛†	6 3 8	Jun, Dec
St.	4½%	Do. 4½% Debs	79½	5 18 10	Jan, July
St.	4%	Do. 4% Debs.	75⅛	5 6 4	Jan, July
5	2/9	Do. 5% 1st Pref.	4⅞	6 15 5	Jan, July
5	2/9	Do. 5% 2nd Pref.	3⅛	8 0 0	Jan, July
100	2%	Brazilian Traction Ord.	53	7 10 11	Fb,M,Aug,N
100	$1⅛	Do. 6% Pref.	93	6 9 0	Ja,Ap,Jly,O
5	8%	Brisbane Trams Ord.	6⅞	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62½	6 15 0	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅛	7 12 0	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	89	5 12 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅞	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	42	..	Fb,M,Aug,N.
..	5%	Do, 5% Bds	49	10 8 4	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94½	4 15 3	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	78⅛	6 6 11	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	97	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	15⅞	5 12 3	..
St.	4½%	Do. 4½% Debs.	86⅛	5 2 10	Jan. July
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4⅛	5 17 3	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	122½	5 14 4	Ja.Apl,Jly,O
St.	5%	Melbourn eElec. Supply5% 1stMt. Debs	93	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	95⅛	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29⅛	..	Ja,Apl,Jly,O
..	..	Do. Pref.	43	..	May, Nov
..	5%	Do. 5% Bds.	43	13 5 1	Jan, July
..	5%	Shawinigan Water & Power 5% Bds.	104⅛	4 15 5	Jan, July
..	6%	Do. Cap. Stock	141⅛	4 4 10	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	83⅛	5 8 1	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	⅛	..	Jan, July
..	5%	Do. 5½% 2nd Mort. Debs.	92⅛	5 18 5	Jan, July

* And 13⅛% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec.. 15, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14d.
Solid Drawn Copper Tubes	14½d.
Brazed Copper Tubes	14½d.
Brazed Brass Tuber	16d.
Brass Wire	13⅞d.
Copper Wire	13½d.
Rolled Brass	13⅝d.
Brass Sheets	14½d.

	per ton
Copper Sheets	£112 0 0
Spelter	£85 0 0

	per ton
English Lead	£28 15 0
Antimony	Nominal.

Old Metals:	per ton.
Clean Scrap Copper	£74 0 0
Brazlery Copper Scrap.	£68 0 0
Clean Scrap Brass	£56 10 0
Old Lead	£22 0 0
Old Zinc	£40 0 0
Hollow Pewter	£115 0 0
Black Pewter.	£80 0 0
Gun Metal	£65 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark. London, S.E., quotes under date Dec. 14, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£125 0 0
Clean Mixed Brass	£56 0 0
Clean Copper	£70 0 0
Brazlery Copper	£64 0 0
Gun Metal	£64 0 0

	per ton.
Old Lead	£24 0 0
Tea Lead	£22 0 0
Old Zinc	£55 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 8	1,656	+ 46	27	49,364	+ 2,693
Anglo-Argentine	„ 9	54,110	+ 1,998	27	2,503,149	— 133,181
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	„ 11	234	+ 16	30	12,293	+ 658
Birkenhead Corporation	„ 12	1,378	+ 159	37	50,403	+ 4,001
Birmingham Corporation. Trams	„ 4	14,707	+ 2,322	36	504,526	+ 70,026
Birmingham Corporation. Buses&c.	„ 4	721	+ 59	36	30,330	+ 17,884
Blackburn Corporation	..	..	..	..	..	..
Blackpool Corporation	„ 9	656	+ 83	37	66,768	+ 1,543
Blackpool and Fleetwood	„ 11	244	— 19	49	38,054	— 340
Bolton Corporation	„ 12	2 554	+ 138	37§	98.640	— 1,743
Bournemouth Trams	„ 8	1,709	+ 72	36	77,212	+ 3,792
Bournemouth Buses	„ 8	8	— 2	36	898	— 101
Bradford Corporation	„ 11	5,746	— 187	36	238,683	+ 9,515
Brighton Corporation	„ 12	275	+ 63	37§	42.105	+ 319
Bristol Trams Trams	„ 10	4,890	+ 716	49	231,137	+ 5,045
Bristol Trams Buses,&c	„ 10	5,133	+ 1,387	49	239,835	+ 44,024
Burmah E. Trams & Ltg.	„ 11	R3,605	+ R252	..	..	..
Burnley Corporation	„ 11	1,499	+ 196	10	26,038	+ 1,964
Burton Corporation	„ 12	293	+ 29	37	10,427	— 409
Bury Corporation	„ 12	1.182	— 56	37§	49,989	+ 498
Calcutta Tramways Co.	„ 11	R66,940	+ R4,751	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	„ 4	2,540	— 33	35	95,180	— 2,759
Cork Electric Trams Co.	„ 9	451	+ 27	49	24,529	+ 42
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	„ 4	1,016	+ 115	36¶	38,502	+ 1,215
Dover Corporation	„ 4	263	+ 43	35	11,316	+ 2,041
Dublin & Lucan Railway	„ 10	99	— 7	23	3 487	+ 75
Dublin United	„ 10	5,756	+ 260	49	298,785	+ 10,871
Dundee Corporation	„ 8	1,264	+ 25	30§	40,527	+ 2,148
East Ham Council	„ 11	1,325	+ 122	36¶	47,621	+ 5,309
Exeter Corporation	„ 10	223	+ 17	36	13,934	+ 787
Glasgow Corporation	„ 11	21,013	+ 865	28‡	602,263	+ 41,414
Glossop Trams	„ 11	127	+ 30	50	6,266	+ 286
Gloucester Corpn.	„ 8	303	+ 11	36	12,109	+ 123
Halifax Corpn. Trams	„ 7	1,812	— 38	36	81,290	+ 912
Halifax Corpn. Buses	„ 7	38	— 1	36	1,792	..
Hastings Elec. Trams Co.	„ 9	678	— 46	49	87,310	— 228
Huddersfield Corpn.	„ 11	2,365	+ 115	36	98,167	+ 13,317
Hull Corporation	„ 11	3,232	+ 334	36	111,929	— 2,570
Ilford District Council	„ 11	614	+ 21	36	23,750	+ 2,930
Ilkeston Corporation	„ 8	129	+ 16	36	4,868	+ 168
Ipswich Corporation	„ 11	476	+ 92	35	20,294	+ 3,267
Isle of Thanet Co.	..	..	..	..	..	..
Kilmarnock Corporation	„ 11	149	+ 1	30	5.074	+ 148
Lanarkshire Trams Co.	„ 9	1,862	+ 163	49	96,956	+ 5,475
Lancashire United	„ 8	1.482	+ 39	49	84,789	+ 3,156
Leeds Corporation	„ 11	8,483	+ 463	37	328,318	+ 25,264
Leicester Corporation	„ 11	3 241	+ 442	50	150,265	+ 9,164
Leith Corporation	„ 11	698	+ 45	30	23,192	+ 1,416
Lincoln Corporation	..	..	..	..	..	..
Liverpool Corporation	„ 4	12,671	+ 30	48¶	642,865	+ 9,092
Llandudno&Colwyn BayR.	„ 10	168	+ 12	1‖	251	+ 1
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	„ 9	180	+ 18	36	8,055	+ 230
Manchester Corporation	„ 11	17,289	+ 847	36	654,113	+ 20,790
Nelson Corporation	„ 11	181	+ 45	36¶	7,165	+ 271
Newcastle-on-Tyne Corpn.	„ 11	5,724	..	37‖	230,056	..
Newport (Mon.) Corpn.	„ 11	849	+ 112	37	30,762	+ 528
Northampton Corporation	„ 10	652	+ 59	36¶	26,607	+ 4,708
Nottingham Corporation	„ 9	3,619	+ 471	36	135,551	+ 9,570
Oldham Corporation	„ 12	2,093	+ 155	38	86,601	+ 3,727
Portsmouth Corporation	„ 4	1,947	— 93	36	90,818	..
Preston Corporation	„ 8	977	+ 138	36••	34,996	+ 1,191
Rochdale	..	..	..	..	..	..
Rotherham Corporation	„ 8	1.162	+ 217	36	42,154	+ 4,862
Salford Corporation	„ 13	4,923	+ 294	37‡	191,461	+ 7,966
†Sheffield Corporation	„ 12	9,400	+ 1,621	36‖	336,000	+ 45,428
Southampton Corpn.	„ 8	1,409	+ 173	36	54,692	+ 5,924
Southend Corporation	„ 8	579	— 36	36	30 769	— 7,906
South Shields	„ 4	707	+ 11	35‖	28,519	+ 1,120
St'lyb'dge,Hyde,&c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	„ 12	1,525	+ 211	37	55 239	+ 561
Sunderland District	„ 8	510	+ 4	6	3,189	+ 128
Swindon Corporation	..	..	..	..	..	..
Tyneside Tram Co.	„ 1	474	— 41	22	13,474	— 573
Wallasey Corporation	„ 11	1,136	+ 103	36‖	47,401	+ 566
Walsall Corporation	..	..	..	..	..	..
Walthamstow	„ 11	758	+ 49	37	33,359	+ 3,343
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	..	..	..	..	..	..
Wigan Corporation	„ 10	1,498	+ 143	36	55,581	+ 2,640
Wolverhampton Corpn.	„ 8	1,129	+ 123	10	10,791	+ 999
Yorkshire W.R. Trams	„ 12	1,610	+ 298	50	78,713	+ 6,871

(a) These comparisons are with the corresponding period last year. * Partly electrical. † Includes omnibuses, &c. § Minus 2 days. ‖ Minus 3 days. ¶ Plus 2 days. •• Compared with one week more last year. ‡ Plus 3 days.

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CONTENTS OF THE CURRENT NUMBER.

NOTES..... 409
Arrangements for the Week.. 412
Standard Marine Electrical Installations. By H. A. Hornor.—*Concluded* 413
The Electric Arc in Vapours and Gases at Reduced Pressures. By W. A. Darrah. Illustrated 415
The Erection Plant for the Quebec Bridge. Illustrated. *Concluded* 417
The Design of High-Pressure Distribution Systems..... 420
Electric Heating: Its Present Position and Future Development. By George Wilkinson. Illustrated..... 421
Lighting of Factories and Workshops 423
The Melting-Point of Tungsten. By Irving Langmuir 424
Pacific Cable Board 424
SQUARE PEGS IN ROUND HOLES 426
REVIEWS..... 427
The Callendar Steam Tables [Callendar].
A First Course in Engineering Science [Haler].
Continuous and Alternating Current Machinery Problems [Ryan].
Engineering Colleges and the War. By R. Mullineux Walmsley, D.Sc., and C. E. Larard 428
Collective Power for British Manufacturing 431
CORRESPONDENCE 431
Some Problems of Electromagnetic Induction (G. W. O. Howe).
Electric Lifts. By H. Marryat 432
LEGAL INTELLIGENCE 433
PARLIAMENTARY INTELLIGENCE 436
The "Electrician" Commercial and Industrial Section .. 437–444

NOTES.

"On Earth Peace, Good Will Toward Men."

DURING the last year and a half many people in many lands must have asked themselves the question: "If the present untold misery and unspeakable suffering is due to the engineer and his works, would it not be better to get rid of him as one would get rid of an unclean thing?" Educated men have asked the question, "If the purpose of science is the devising of engines for the destruction of mankind, ought the study of science to be encouraged?" At the moment we are not prepared to answer either question. We recognise and admire the works of the engineer; but we know that man has an unhappy knack of misapplying his talents, whilst some assert that man defiles the things with which he comes in contact. We know also, that if the responsibility of Europe's shame rests with the engineer, future generations will demand a full account of his stewardship, and if such responsibility be admitted, "it had been good for that man if he had not been born." To-morrow's message comes booming through the ages louder far than the din of battle, and those who were amongst the first to accept the message in these days know neither the meaning of peace nor of good will. To-morrow, we say, comes a message to those who have substituted strife for peace; might for right; deceit for honesty; crime for virtue; shame for honour; guilt for innocence; folly for wisdom; hatred for good will; and murder for sacrifice. Let *them* tremble for themselves!

Receptivity.

THE speech of Mr. LLOYD GEORGE in the House of Commons last Monday may well be taken as a commentary upon the British nation. It was an indictment of the nation from the point of view of receptivity. Progress depends largely upon initiative, upon that kind of initiative possessed by the inventor; but equally important is the faculty of receptivity. As a nation we are defective in this respect, a fact which has been demonstrated in many advances. This defect was seen in the opposition to railways, to telephones and to motor cars when they were first introduced. There is a lack of imaginative appreciation on the part of the public, and this prevents them from seeing what the future holds in store for new developments. How many inventors in this country have found their efforts fruitless because they were not properly appreciated in the light of their possibilities? The same thing has been apparent in the present war. High explosive shells, machine guns, and big guns were all considered relatively unimportant. We do not so much complain that the value of these implements was not appreciated in the first instance, but what seems lamentable is the fact that it should be necessary to suffer a whole year of warfare before the minds of those responsible for directing the war can appreciate new conditions. If our national receptivity cannot be greater than this, what industrial progress can we expect to make in comparison with other nations after the war?

The Lighting of Factories and Workshops.

THE third volume of the first report of the Departmental Committee on Lighting in Factories and Workshops, which has just been issued by the Home Office, consists of a mass of observations taken in 54 factories, selected for the purpose in various parts of the country. These factories were concerned with textiles, engineering, the making up of clothing and certain miscellaneous industries. Elsewhere we give a short account of what the report contains. Probably one of the points which will strike the reader is the great variation noticeable between one factory and another in regard to both daylight and artificial illumination. For example, taking the daylight factor, which is the ratio of the internal illumination by daylight, compared with the external illumination in the open, expressed as a percentage, the highest average figure observed in an engineering factory is 11 per cent. More generally the highest figure varied from 5 per cent. to 6 per cent. and the minimum average was as low as 0·1 per cent. With regard to illumination at the point of work, the average illumination varied from over 4 ft. candles as a maximum down to 0·5 ft. candle as a minimum. In the case of foundries, one case is given where the daylight factor was as high as 25 per cent., the minimum being 0·38 per cent. The artificial illumination in foundries varied from 2·30 ft. candles down to 0·18 ft. candle. It is quite clear, therefore, that there is no such thing as uniformity in the amount of illumination provided at the present time, and that variations of 10 to 1 and even more are quite common. It is a testimonial to the human eye that work can be carried on under such varied conditions, but it is

obvious that the best results cannot be so obtained, and, therefore, we hope that some conclusion will soon be reached as to the minimum of illumination that is desirable, and that manufacturers will do something to improve undesirable conditions.

A Monstrous Injustice.

FROM various parts of the country come reports to the effect that considerable increases in the selling price of electricity are contemplated, partly on account of the extra cost of coal and freightage and partly on account of restricted street lighting and diminished consumption. We are completely at a loss to understand why the consumer should be called upon to bear the whole of the burden of the increased cost of production. The most the consumer can be expected to pay is the extra cost of the coal and carriage, materials and labour. The attempt to saddle him with the capital charges and working charges (which are more or less fixed quantities for a given generating station) is impudent, and if allowed to pass unchallenged would be a monstrous injustice to the consumer. The present unenviable position of certain of the municipal electric generating stations is traceable to the folly, which we have so often condemned, of appropriating the profits made out of the electricity consumers for the purpose of relieving the rates, instead of first building up a reserve sufficient to meet emergencies. If the profits had been so used the present situation could have been met without difficulty. We urge consumers of electricity to resist being victimised by those who place a higher value upon economy than upon honour. Decisive and speedy action by the consumer will be necessary in order to convince the "economists" on Town Councils that the profit-sharing scheme applies equally to fat and lean years. Under existing conditions the ratepayers, through their representatives, are attempting to practise the heads I win, tails you lose argument, and in clean business such men are to be avoided.

Lighting of Artisans' Dwellings.

IN our issue of December 3rd we published an article by Mr. J. CLEARY on "The Lighting of Artisans' Dwellings." This article has called forth some adverse comments in our contemporary, the "Journal of Gas Lighting," but in these criticisms certain essential points seem to have been missed. It is suggested that the cost of decoration cannot be materially affected by the use of electric light. It should be remembered, however, that the cost of decoration falls upon the Health Committee of the Brighton Corporation, and it is thus quite out of the hands of the Electricity Committee. If the former Committee finds that the use of electricity makes a material difference in this respect, its judgment is not likely to be affected by the Electricity Department, and considering that the first experiment led to two further requests for the lighting of other dwellings, we see no sound reason for disputing the conclusion that has been reached. Presumably the Health Committee is able to determine the cost. The critic in our contemporary also points out that he has experienced no blackening from the use of gas lighting; but we think it must be remembered that the rooms in artisans' dwellings are probably not as lofty as those of our critic, and it is a common experience that if gas-lights are placed at a distance of 2 ft. or 3 ft. from the ceiling blackening results. On the other hand, if they are placed low down the lighting is unpleasant from the point of view of glare. Our critic is also troubled in regard to the financial result. In this connection it may be pointed out the cost, except for meters and lamps, falls on the Health Committee, and that the charge to the Electricity Department for a new lamp is not 2s. 8d., but 1s. 7d. Consequently, a small charge of ½d. per unit will easily cover this renewal. Actually, lamps are of 50 c.p., and not 40 watts. Consequently the illumination is ample and the lamps can be placed at a reasonable height. No great cost is involved in the frosting of lamps so as not to expose the filament to view and thus to avoid eye strain, to which our critic rightly objects, and we understand that much attention is given to suitable shades. The breakages mentioned by Mr. CLEARY are the total breakages, and so far no tenant has been called upon to buy a new lamp. Lastly, it is suggested that the special lead-covered wire is not such as would be used in better-class houses. Perhaps it is sufficient for us to say that many large country houses have been wired on this system and that no such objection need be taken to it.

Available Water Power in the United States.—Excluding Alaska, this is estimated at 28,000,000 H.P., one quarter of which is already utilised.

Census of Gas Producer Plants in New York City.—In a Paper read at the November meeting of the American Society of Mechanical Engineers, Mr. C. M. Ripley dealt with the performance of 33 producer gas plants, as regards operating costs, &c.

Electric Welding.—In "Engineering" a form of machine for welding sheet brass was recently illustrated. It is so efficient that a welded sheet may be "spun" without any seam or joint being visible. Since brass is an alloy of copper and zinc, the fact that the zinc does not sublime is remarkable.

The Late Thomas Parker.—ERRATUM.—We regret that in our obituary notice of the late Mr. Parker an error was made in stating that he supported the metric system of weights and measures. His sympathies were in the opposite direction, and he was in fact a very active member of the Controlling Committee of the British Weights and Measures Association.

Value of Electric Furnaces.—Mr. H. Etchells, lecturing before the Sheffield Society of Engineers and Metallurgists, stated that the simple induction type of furnace had worked successfully in Sheffield in competition with the crucible. The electric furnace had opened up a new field in the production of low-carbon nickel-chrome steel and low-carbon steel castings.

Freight Rates.—Mr. J. E. Barlow, writing in the "Daily Telegraph" on "Work after the War," suggests the reform of our goods transport system. Before the war the British railway rate was three times the German rate, and for shipping it was 1s. 9d. for London, as against 4d. per ton in Hamburg. There are 45,000 goods stations in the United Kingdom, and reform of these is suggested as a means of providing work for unemployed.

Production of Damped Oscillations.—Entitled "The Production of Damped Oscillations" Mr. L. O. Heath contributes to the current issue of the "General Electric Review" (U.S.A.) an article in which are described the three most important ways of producing such damped oscillations, namely, the simple, the coupled and the quenched-spark methods. The subject is treated clearly and comprehensively, and the value of the contribution is materially increased by the many well-drawn diagrams and illustrations. The article is likely to be of service to those interested in the increasingly important part being played by damped high-frequency oscillations in the testing of certain forms of electrical apparatus and of insulation.

The Gravitational Constant.—In a recent Paper by Mr. P. E. Shaw, read before the Royal Society, the author shows that the Newtonian constant is affected by temperature. When a large mass attracts a small one (as in Cavendish's experiment) the gravitative force between them increased by about 1 500 for a temperature rise of 200° C. It is not at present known whether the relation is linear. A long series of tests confirm this result. In the course of the above investigation it was found that silver bars after being heated to 130° C., and kept in a strong magnetic field, were permanently magnetised. The magnetism, though weak, had considerable coercive force.

Mining Motors.—It is pointed out in the "Sheffield Daily Telegraph" that, owing to the shifting of the floors in mines, the gearing, driving pumps, &c., are apt to get out of alignment, causing wear of the bearings. Where modern motors are installed with a very small clearance between pole-pieces and stator this wear of the bearings may cause serious breakdowns.

Train Disaster at Jarrow.—We regret to record a train collision at Jarrow in which 17 persons lost their lives and 50 were injured. Gas was used as an illuminant, and the bodies of many of the unfortunate victims were unrecognisable. This again raises the question of the added danger to life in the use of gas for the lighting of trains.

Non-Rusting Steels.—A special chromium alloy known as Stainless steel," which neither rusts nor tarnishes when in contact with food or acids, is being largely used. In a communication to the Faraday Society, Sir R. Hadfield states the composition as 12·7 per cent. of chromium, 0·28 per cent. of carbon. Specimens after 23 years were found quite free from rust.

Electric Vehicle Development.—The "Daily Telegraph" states that there are over 660 electric vehicles now in use in Great Britain. A year ago the number was 150. Harrod's Stores use over 60 delivery vans driven by storage batteries. The experience of Blackpool is that one electrically-driven street sprinkling machine does the work of six horse-drawn watering vans.

Experiments with Wind Power.—According to the "Electrical World," a windmill specially constructed for the purpose of experiment in generating electricity by wind power is being erected at the Kansas State Agricultural College. It is believed that the design of windmill now planned will be adapted to drive electric generators, and will thus greatly enhance the power facilities of Kansas farms.

Turbine's 32 Months' Non-Stop Run.—The "Electrical Review and Western Electrician" reports a remarkable case of continuity of service in power-plant operation. The Quincy Market, Cold Storage & Warehouse Co., Boston, Mass., has a 500 kw. Westinghouse-Parsons steam turbine, which was on load continuously for two years and eight months without the steam being turned off at the throttle. A short time ago when it was shut down for inspection the machine was found to be in perfect condition, and it was immediately started up and put back into service.

Rate of Heat Loss.—A Paper was read recently before the Royal Society by Messrs. Flack, Griffiths and Hill giving results of an investigation on the rate of cooling of a surface at body temperature—(1) wet, (2) dry. A large bulbed spirit thermometer—the Kata thermometer—was employed. If the rate of cooling is expressed in milli-calories per square centimetre per second, then $H=0{\cdot}27\theta$, where θ is the excess of body temperature above that of enclosure. For cooling in still air, $H=0{\cdot}0644(1+0{\cdot}002t)\theta^{5/4}$, where t is the temperature of the air in the enclosure. It was found that the cooling effect of wind up to 35 miles per hour agreed with the expression $\frac{H}{\theta}=0{\cdot}27+0{\cdot}36\sqrt{v}$. It was shown that within limits air temperature, vapour pressure and velocity may be varied, the heat loss remaining the same.

Electric Power in New Zealand.—To the current issue of "Cassiers" Mr. W. Wilson contributes an interesting article on this subject. For some months the power plant at Lake Coleridge, the first of the hydro-electric schemes to be carried into effect by the Government of New Zealand, in accordance with its "Aids to Water-power Act," has been fulfilling its functions, after the formal opening by the Prime Minister on November 26, 1914. As the successful accomplishment of the work will in all probability be quickly followed by others of the series, it is evident that no ordinary interest attaches to its opening enterprise. At present the Public Works engineers are actively surveying several sites in the North Island, with the object of carrying out a comprehensive plan for supplying the whole of that portion of the country with electricity. It can, therefore, be said that the Lake Coleridge scheme constitutes the opening chapter in an extensive history of water-power engineering, only possible in a land so especially favoured as New Zealand for enterprises of this description.

Electric Propulsion of Battleships.—In an informative Paper read last month before the Society of Naval Architects and Marine Engineers (U.S.A.), Mr. W. L. R. Emmet dealt with some comparisons relating to electric propulsion of a battleship, and gave a description of the electric propelling machinery for the 32,000-ton 37,000 S.H.P. battleship "California." The contract with the General Electric Co. of America covers two turbo-driven generating units, four propelling motors, switching apparatus, two turbo-driven exciters, and a complete equipment of condensing auxiliaries and ventilating blowers, all motor driven from the exciting units. In fact, the contract covers practically the entire engine-room equipment, except the main condensers. We hope to publish an illustrated abstract of the Paper in an early issue.

New National Business Policy.—The directors of the Institute of Industry, which is in reality a great British economic league, have now definitely formulated their plans for the coming campaign in 1916, and these are fully set forth in a pamphlet which has been issued during the week. In addition to the objects and policy which seem to have been carefully thought out, there is a copy of the memorandum of association. It is gratifying to learn, therefore, that this very powerful and influential group have been developing a national business policy during the last 15 months, including plans for the establishment of an industrial bank. The campaign for 1916 will commence with a luncheon, and will be followed by a discussion, which will be opened by Mr. J. Taylor Peddie, F.S.S. British subjects and manufacturers from any part of the British Empire desiring to become members of the Institute should apply to the secretary, Aldwych Site, Strand, London, W.C.

10,000-Volt Continuous Current Generator.—To the "E.T.Z." Mr. W. Linke recently contributed a description of a 10 kw. 10,000-volt continuous-current generator used by the Physikalisch-technische Reichsanstalt for experimental work. The generator is so constructed that either pole may be earthed or connected with thef rame, while the other pole has the full voltage of 10,000 against iron. The set consists of two double-commutator machines, so that there are four commutators, each of 2,500 volts. The voltage between commutator bars is no higher than in usual practice, there being 212 bars per commutator. The greatest difficulty was found with the insulation, especially of the armatures, against the full voltage of 10,000. By using the best insulating materials and by seamless covering of the winding with "micarta foil" according to the Halfely method, sufficient insulation was obtained. The single coils were tested with 22,000 volts and the finished armature with 20,000 volts alternating current. Commutation is sparkless up to 50 per cent. overload.

Artists' Rifles O.T.C.—The Officer commanding the Second Battalion of the Artists' Rifles, Officers' Training Corps, has decided to form a special Company to consist mainly of professional men whose technical experience renders them qualified for appointment as officers to those units or branches of the Army in which knowledge of construction and civil engineering is especially useful in the conditions obtaining in modern war.

A large number of men have already been enrolled, but there are still vacancies for civil, mechanical and mining engineers, architects, public works surveyors and borough engineers, to receive the military training which is essential if the military authorities are to make full use of their professional skill and experience. The training will be directed to the development of that portion of the candidates' peace training which is applicable to military work and such further instruction as will enable them to apply their technical knowledge effectively to military requirements. The scope of the training will extend beyond ordinary field engineering and will be both of an individual and collective character. It will include engineers' reconnaissance, building and repair of bridges and roads, work in connection with embarkation and disembarkation of troops, military sanitation and water supply, the construction of defensive positions, and such other instruction as is necessary to render the candidate for a commission a thoroughly efficient officer. Professional men having Colonial experience will be particularly welcome and during their training will be associated with men of like social position and education. Application for nomination to the Corps should be made to the Headquarters, Artists' Rifles, O.T.C., 7, Duke's-road, Euston-road, W.C.

OBITUARY.

THE RIGHT HON. SIR HENRY ENFIELD ROSCOE.—We regret to record that the Right Hon. Sir Henry Enfield Roscoe, F.R.S., LL.D., died suddenly at his residence, West Horsley, Leatherhead, in his 83rd year. Sir Henry came of a notable family. His grandfather was William Roscoe, the biographer of Lorenzo di Medici; his father was an able lawyer, while his mother wrote a life of Vittoria Colonna. In the autumn of 1852, after taking his B.A. degree at London University and the prize of £10 in chemistry, he went to Heidelburg University, and became with Lothar Meyer, Quincke and Dittmar, a pupil of Bunsen. In 1857 he was appointed professor of chemistry in Owens College, Manchester. At that time Owens College was not in a flourishing condition, and the landlord of a house Roscoe wished to take refused him as a tenant, since the landlord expected that the college would close within a year. Here, with Schorlemmer, he wrote the famous treatise on chemistry, and his classes in chemistry appealed to the manufacturers and rapidly became very large. Among his researches the distillation of dilute acids and perchloric acid may be mentioned. His "Elementary Lessons" and "Primer of Chemistry" had great success, and he published, with Dr. Harden, "A New View of the Origin of Dalton's Atomic Theory." A fourth edition of his lectures on "Spectrum Analysis" was revised by Prof. Schuster in 1886. In 1885 he was elected Liberal member for South Manchester, but was defeated as a Unionist in 1895. His services on various Government Commissions were frequent, including the Royal Commission on Technical Education, which led to the passing of the Technical Instruction Acts of 1889 and 1890. For those services he was knighted in 1884. He married in 1863 Lucy, daughter of Mr. Edmund Potter, F.R.S. Lady Roscoe died in 1910, and his only son died in early manhood. He is survived by his two daughters, one of whom married Mr. C. E. Mattei, formerly M.P. for Plymouth. His tall figure and genial and kindly manner endeared him to everyone.

W. P. SLATER.—We regret to record the death of Mr. W. P. Slater, telegraph engineer, which took place on the 9th inst. Mr. Slater, who was born in 1846, entered the service of the old Electric Telegraph Co. at Southampton, and after doing duty at several stations in the S.W. district left for Egypt in April, 1865, to join the telegraph staff of the Egyptian Government. He was one of the few to stick to his post during the terrible cholera epidemic which occurred in that year, and for this his services were specially acknowledged. In March, 1869, he was transferred to Ismailia, the headquarters of the Suez Canal, and had charge of the arrangements there in connection with the inauguration festivities at the opening of the canal. At the beginning of 1872 he temporarily resigned his appointment, but at the end of 1872 he returned to work and spent much time in the laboratory of the late Lord Kelvin. The knowledge thus gained enabled him to take part in the inspection during construction of cables to be laid on the coast of Brazil. He was the first superintendent appointed at Rio Janeiro, and was in charge when the Emperor Dom Pedro II. opened the cables north of Rio on January 1, 1874. Later he was sent to the north of Brazil, but returned to Rio in 1883 as representative and general superintendent of the then Western & Brazilian Co., in Brazil. In 1891 he was transferred to Buenos Ayres, and in 1889 he was decorated by the Emperor of Brazil with the Order of the Rose (officer), and retired in 1899 owing to ill-health.

F. G. MACLEAN.—The death is announced of Mr. Frederick Gurr Maclean, ex-Director-General of Indian Telegraphs, which occurred suddenly at Woking, at the age of 67 years. He was appointed to the India Telegraph Department in 1868, and served as superintendent of Field Telegraphs during the Afghanistan War. He was appointed Director-General of Telegraphs in India in 1900 and retired in 1903.

A. E. WHITWHAM.—We regret to announce the death, which occurred recently, of Mr. A. E. Whitwham, station superintendent of Huddersfield Corporation electricity works.

KILLED IN ACTION.—Second-Lieut. Jas. Forbes, Royal Engineers, has been killed at the Dardanelles. Deceased, who was the son of ex-Baillie John Forbes, of Greenock, served his apprenticeship as an engineer with Messrs. Caird & Co., and subsequently took up a position with the British Thomson-Houston Co. at Rugby. When war broke out he enlisted as a private, and was given a commission eight months ago.

We also regret to have to record the death of Major H. H. Stanley Marsh, electrical engineer, who died of wounds received in action on April 2 last.

PERSONAL.

Dr. J. Read has been appointed to the chair of organic chemistry in the University of Sydney.

The President of the Board of Trade has appointed Mr. Louis J. Kershaw, C.I.E., on the nomination of the India Office, and Mr. James W. Murray, President of the Glasgow Chamber of Commerce, to be members of the Advisory Committee to the Board of Trade on Commercial Intelligence, in place of Mr. Francis C. Drake and Mr. Henry Brock, deceased.

ROYAL ENGINEERS (T.F.)—The following promotions have been made:—

London Electrical Engineers.—Lieutenants Herbt. A. Cope, Harold F. Haworth and Egerton B. Hunter to be Temporary Captains. Second Lieutenants John Gibson, Jas. R. Birch and John B. S. Gabriel to be temporary Lieutentants. Second Lieutenants Guy S. M. Taylor, Hubert F. G. Roose and Reg. Engelbach to be temporary Lieutenants and to remain seconded.

APPOINTMENTS VACANT AND FILLED.

A capable cable operator with knowledge of repairing and testing cable instruments, is advertised for.

A fully qualified electrician is required to take charge of all electrical equipment in large airplane works on the south coast. *See advertisement.*

Mr. Edward Lafferty, of Preston, has been appointed traffic manager of the Edinburgh District Tramways Co. at £300 a year.

Mr. J. W. Bachelor, of Hendon, has been appointed station superintendent at Walthamstow, at a commencing salary of £150, rising by annual increments of £10, to £200 per annum.

Mr. E. Lunn has been promoted to the position of station superintendent at Huddersfield, in succession to the late Mr. Whitwham. Mr. E. Comdby, of Rugby, has been appointed mechanical engineer.

Middlesbrough Corporation have approved the promotion of Mr. R. H. Scotson, mains superintendent, to the position of borough electrical engineer in succession to Mr. H. M. Taylor.

INSTITUTIONS AND SOCIETIES.

Junior Institution of Engineers.—Mr. W. A. Tookey, M.I.Mech.E., Chairman, read a Paper for discussion on "Modernisation of Power Plant in Factories," on Monday, December 20th. The Paper was of interest not only to engineers but to factory owners and manufacturers generally. It alluded to the waste that has been a somewhat usual feature of industries hitherto, pointed out how savings can be made, and carefully weighed the financial, industrial and technical considerations in a manner which could readily be comprehended. Strong emphasis was laid upon the vital importance of maintenance and increase of British industry and enterprise in the immediate future, and not the least acceptable portion of the Paper sought to show how the State could do much to assist smaller manufacturers whose lack of ready capital often hindered real progress.

Rugby Engineering Society.—At the General Meeting of the above Society it was decided that no papers or lectures would be given before the Society this session, in view of the fact that the time of the officials and members was largely occupied with war work, and that owing to so many members having joined His Majesty's Forces the effective membership was greatly reduced.

ARRANGEMENTS FOR THE WEEK.

ROYAL INSTITUTION.

Meetings at Albemarle-street, Piccadilly, London, W. Six illustrated lectures adapted to a juvenile auditory on "Wireless Messages from the Stars," by Prof. H. H. Turner, D.Sc., D.C.L., F.R.S.

Tuesday, Dec. 28th.
3 p.m. Lecture I.: "How the Messages are carried."

Thursday, Dec. 30th.
3 p.m. Lecture II.: "How the Messages are received."

Saturday, Jan. 1st.
3 p.m. Lecture III.: First Message, "We are very far away."

Tuesday, Jan. 4th.
3 p.m. Lecture IV.: Second Message, "Some of us are Giants and some are Dwarfs."

Thursday, Jan. 6th.
3 p.m. Lecture V.: Third Message, "But we all behave much as you do."

Saturday, Jan. 8th.
3 p.m. Lecture VI.: Fourth Message, "And, in fact, we are your Blood Relations."

STANDARD MARINE ELECTRICAL INSTALLATIONS.*

BY H. A. HORNOR.

(*Concluded from p.* 375.)

Summary.—The requirements of merchant and naval nstallations are cited in brief. Then follows the specific applications to a number of different types of ships, including both merchant and naval vessels.

Installations on Various Types of Vessels.

The general requirements of both merchant and naval practice having been described, a brief outline of the electrical equipment on a few typical vessels will be given. Such installations are so flexible that many things are done for no better reason than that of individual preference; but these descriptions will show the trend of development.

Launches and Yachts.—Certain manufacturers design and build complete outfits including generator, switchboards, and storage batteries, especially for this service. The generator is usually operated by a friction pulley on the flywheel of the propelling engine, and the storage battery is used for steadying the voltage and supplying energy when the main machine is not in operation. Larger steam yachts are fitted with a 1 kw. direct-connected steam turbine generating set preferably of 110 volts. Standard lamps and standard searchlights may then be installed. A special fused circuit is provided for the signal lights. All the fixtures of a house installation are followed and the applications merely depend upon the luxury desired.

Tugboats, Fireboats and Similar Vessels.—Sea-going tugs usually carry two generating sets of 10 kw., 110 volts, one 18-in. searchlight, the usual signal lanterns, including towing lights and approximately 120 incandescent lights. Government tugs in addition to this are supplied with a submarine signal receiver set, a night signal set, a call-bell system, and wireless telegraph outfit.

Mine-planters and lighthouse tenders for the Government have a generating plant arranged to carry the day and night load instead of the customary duplicate generating set. One turbo-generating set has a capacity of 7 kw., and the other 20 kw. Besides this they are supplied with a submarine receiving set and frequently with a wireless outfit. The installation and installation material must conform to naval practice. Approximately 120 to 150 lights are installed.

Dredges.—The ordinary merchant type dredge has an installation of approximately 150 lights, carries one or two searchlights, depending upon the length of the vessel, and uses the high wattage tungsten lamp in lieu of the arc lamp. The generating plant consists of a total of 20 kw., usually comprising two 10-kw. marine reciprocating engine-driven generating sets. Special searchlights similar to those used in the Suez Canal, are available for this type of vessel. A diverging lens is placed on the searchlight barrel and the rays are thrown to each bank of the stream and leave a dark space ahead. This permits of up and down traffic without interfering with the regular signal lights. There is now a growing tendency toward the use of electric power also for the main purposes of dredging.

Ferryboats.—The general practice to-day in lighting ferryboats is to outline the cabins with 25- or 40-watt tungsten lamps, arranged so that in cases of emergency every other light may be in operation and total darkness avoided. Two generating sets, one of small capacity for the daylight load and one of large capacity for the night load, are furnished. An interesting mechanical signal is connected to the disengaging gear of the steering engine, and automatically warns the engineer at which end of the boat the steering gear is working. The signal lights are also so wired that when the pilot unlocks his steering wheel the correct lights for that direction go on and the other set of lights go off.

Excursion Steamers.—For river and lake traffic two types of vessels are designed—those that make night trips and those that make short day-light pleasure trips. The day boats are usually equipped with a duplicate dynamo installation. They are lighted by approximately 300 to 400 lights, and carry one 18-in. searchlight. As these vessels are light in construction, of shallow draft and do not encounter severe storms it is possible to adapt modern methods of illumination, and so it will be found that indirect and semi-direct fixtures are installed with ample reason, because of the higher deck spaces and the artistic effects of the decorations.

In the larger Sound and Lake steamers all the artifices of the lighting expert are requisitioned; and concealed incandescent lamps, lights in glass columns, lights for the paintings, garlands of small lights, newel post lights, semi-direct and indirect lighting units all go to make up the appearance of luxury which is required. Such vessels are equipped with plants ranging from 100 kw. to 200 kw. One of the interesting installations which differ from other vessels is the fire alarm system. As an illustration of the care observed in such matters the installation of the fire alarm system on the Sound steamer "Commonwealth" may be considered typical. The system was the open circuit type. Mercurical thermostats of navy pattern were installed. A testing receptacle is located at the end of every line. The collision and general alarm gongs located throughout the vessel are also operated by this system, as well as by the regular switch installed in the pilot house. The system is energised by both the regular interior communication dynamotor, and also by batteries thrown in automatically if the dynamotor is not running. The bells throughout were of the short circuit type in order to eliminate the possibility of an open circuit in the bell. The annunciator in the engine room was located at the valves for the sprinkler system, so that response by water could be immediately given. The saloon deck annunciator was a duplicate of the engine-room instrument, and the eight local annunciators had the circuits sub-divided in order to facilitate testing and upkeep.

Freight Vessels, Colliers and Oil Tankers.—Freight vessels of 5,000 tons dead weight carrying capacity are usually equipped with 10-kw. marine reciprocating-engine generating sets in duplicate. Approximately 150 fixtures, a few portable hand lamps, cargo reflectors and one 18-in. searchlight, which is mounted on the top of the pilot-house and controlled from the inside, are furnished. With the exception in a few cases of a small inter-communicating telephone system, the signalling systems installed are only those required by law.

The equipment of oil tank vessels differs only slightly from that of regular freighters and colliers. In some cases great care is exercised in the permanent fixtures located in the pump rooms, these embodying a special sealed globe so as to prevent the entrance of oil fumes, and in other cases the owner prefers the use of navy standard fixtures in this particular compartment.

Coastwise Passenger and Freight Vessels.—Such vessels are more elaborate, and so the electrical equipment becomes larger and assumes greater importance. These ships carry electricians so that the questions of reliability and readiness of service do not enter to such an extent as on smaller and less important vessels. Some vessels, especially on the Pacific coast, have a complete electric air-heating system, because the evenings on the West Coast are sometimes chilly, and it would not pay the owners to install a steam system for so infrequent a service. On the Atlantic coast the winters are severe enough to require steam heating. As an illustration of the type of electrical installation on coastwise vessels, the equipment of the s.s. "Great Northern" and the s.s. "Northern Pacific"—vessels recently completed for the Great Northern Pacific Steamship Company—will be described.

The generating plant consists of four 35-kw., 110-volt, direct-current, commutating-pole, compound-wound generators, direct connected to 3,200-revs. per min. water-cooled bearing turbines, supplied normally with steam at 200 lb., and a vacuum of 28 in., and designed to carry full load at 175 lb. steam pressure, and 10 lb. back pressure.

From the main switchboard are led 24 feeder circuits supplying lighting, searchlights, hull ventilation, supply and exhaust fans, cargo elevators, galley and pantry motors, as well as a shore feeder of sufficient capacity to light the entire vessel from a shore plant, or light the dock from the ship's generator. The wiring is on the two-wire system, and the material used represents the very latest marine construction. The highest grade rubber-covered wire is used, over which is supplied a lead sheathing, this being protected by a basket weave galvanised steel wire armour. This wire is secured directly to the structure of the vessel eliminating customary conduits and moulding, and the collection of moisture in them. Water-tight junction and feeder boxes and fixtures are used throughout, except in living quarters. The lighting circuits are divided into four classes—general illumination used as required, stateroom lighting always at the disposal of the passengers, police lights which are never extinguished, and the individual cargo lighting throughout the cargo spaces. Every passenger compartment is supplied by duplicate feeders. Majolica fixtures decorated in gold are used in the staterooms and stateroom passageways. Each cabin is provided with a receptacle of the same construction for reading lamps, fans, curling irons, or warming pans. The reflected lighting for the oil paintings in the saloon, lobby, writing room, and "A" deck entrance, as well as the massive semi-indirect lighting fixtures used exclusively in the dining room, are departures in marine work.

The ventilation and heating of the vessel is most complete.

* Abstract of a Paper read at the Panama-Pacific Convention of the American Institute of Electrical Engineers.

Fourteen ventilation and heating units supply all cabins and public spaces. These consist of conical flow fans, used for the first time in marine work, which on test develop an efficiency of 56 per cent. These fans are direct-connected to enclosed adjustable-speed motors and discharge the air through coil heaters. Six fans of the same type without heaters are used to exhaust the air from lavatories, toilets, galley, pantry and smoking rooms, and, when run at maximum speed, will change the air in these compartments every minute. Electric motors are used quite extensively in the galley and pantry where the following apparatus is located: One one-barrel dough mixing machine operated by a 2-H.P. motor, one 40-lb. vegetable paring machine operated by a ½-H.P. motor, two one-tank dishwashing machines operated each by a ½-H.P. motor, one meat and food chopping machine operated by a 1-H.P. motor and capable of chopping 144 lb. of food per hour, one 2,800-watt, three-heat hotel griddle used for toasting bread, frying eggs, bacon and chops. The large cold storage compartment which extends the width of the vessel, as well as each of the cargo holds, is provided with a 3-ton hoister operated at a speed of 100 ft. per minute, and driven by a 40-H.P. motor equipped with automatic starting and limit switches.

The call-bell push buttons in all the staterooms have been utilised as a part of the fire alarm system by the installation of a thermostat button which expands when subjected to a temperature of 160°F. This will announce on the call-bell annunciator an excess of temperature in the particular location even if the room is not occupied. The main fire alarm system, consists of a small pipe of minute internal diameter which is carried throughout the living spaces of the ship. An indicator board representing small plans of the different decks is mounted in the pilot-house and small battery lamps give the location of the fire upon the sounding of the alarm. This system is based on the expansion of air due to increase in temperature. A commercial standard type of telephone is used for communication between other locations. A motor-driven type of electric whistle operator is installed with switches located in a number of places both for blowing the whistle at will and also for blowing the whistle automatically during foggy weather. A powerful 18-in. searchlight is mounted on each end of the forward bridge in such positions that they can sweep the entire length of the vessel.

This vessel carries two wireless outfits both of the navy type, one of 2-kw. capacity and the other of ½ kw. The latter was for emergency purposes, and could be operated from the battery. Every precaution was taken in mounting the apparatus, which was extremely compact so that if the ship were sinking the wireless telegraph station would be in service until the water reached the radio room. The motor generator for the largest set was supplied with energy from the ship's 110-volt system, but could also be energised from battery. The batteries were automatically charged, and the machinery in general so controlled. The transmitter was of the quenched-spark type, 500 cycles, a blower being used to cool it. The transformer stepped the 220 volts of the generator to approximately 12,000 volts. The oscillation transformer was constructed of copper ribbons edgewise wound, spiral mounted on hard rubber discs. The aerial inductance is similarly constructed. The receiver detector is of the carborundum crystal type. The aerial is of the two-wire "T" type with 14 ft. spread between wires. The "Great Northern" on a trip from San Francisco to Honolulu retained communication by night from the time of her departure from San Francisco until her return.

Submarines.—The energy for the lighting and power system is supplied from the main storage batteries. The lighting supply contains a dimmer by means of which the 110 volts may be maintained reasonably constant. Approximately 40 to 60 steam-tight guarded fixtures are installed. The auxiliary motors, such as for ventilation, pumps, or air-compressors, are of standard design wound for 120 volts. The main propelling motors are wound for 120 to 240 volts. These operate as generators when the vessel is on the surface for charging the storage batteries. There are three separate switchboards, one for the main battery, another for the lighting and power systems, and a third for the interior signalling systems. These latter consist of telephones, call-bells, engine telegraphs, torpedo tube indicators, market buoy, submarine signals, gyro-compass, and wireless telegraph. Remote control systems are much employed, especially for such systems as the diving apparatus, steering gear, and the elevating gear for the periscope.

Torpedo-Boat Destroyers.—The growth of the generator plant for torpedo-boat destroyers has been very marked in the last few years and two 25-kw. 125-volt turbo-driven sets are now installed. Approximately 200 incandescent lights, two 30-in. searchlights, a night signal set, electric fans, hull ventilation, and a system of interior communication comprise the equipment. This latter system consists of call bells, general alarm gongs, smoke indicators, shaft revolution indicators, torpedo firing, and wireless telegraph.

Fleet Auxiliary Vessels.—The navy has many vessels such as transports, supply ships, colliers, submarine tenders, and torpedo-destroyer tenders, which carry about the same electrical equipment. This equipment usually consists of a turbo-generating plant of approximately 300 kw., 125 volts, four 30 in. mechanically-controlled searchlights, about 700 to 800 incandescent lights, two night signalling sets, electric fans, hull ventilation, and a system of interior communication. The signalling system comprises call-bells, fire alarms, general, alarm gongs, boat hour gongs, telephones, shaft revolution indicators, helm angle indicators, electric whistle operator, fuel oil indicator, submarine signals, and wireless telegraphs.

It is interesting to note in this connection that the fleet collier "Jupiter" is equipped with electric motors for the purpose of propulsion and that this vessel is the first sea-going vessel so propelled. She has now been in regular service about two years, and has shown herself very much superior to the reciprocating engine-driven ship. Comparisons cannot be made with the geared turbine-driven ship, as data from this vessel has not yet been made available.

Battleships.—The electric plant consists of four 300-kw. turbine-driven, direct-connected generating sets of 240 volts, direct current. Two sets are located forward and two aft. These sets are either three-wire machines or two-wire; in the latter case rotary balancer sets are required so as to provide 120 volts for the lighting and searchlight systems. There are two distribution boards (fore and aft) interconnected, so that energy may be supplied to either board from the other. Auxiliary switchboards form the centres of distribution for the feeding system. Eight 36-in. searchlights and two portable 12-in. single projectors are furnished.

The lighting system consists of 3,000 regular standard fixtures, and an auxiliary lighting system is provided for the more important working spaces of the vessel; this system is supplied by batteries. Each turret has an independent auxiliary battery lighting system. There are installed 135 electric bracket fans, an electric heating system, a complete interior communication system, and a complete system of power-driven deck auxiliaries.

The power system comprises electric-driven hull-ventilation fans and heating coils, turret turning, turret ammunition handling, turret gun ramming, turret gun elevating, boat cranes, deck winches, capstan, 5-in. ammunition hoist, ammunition conveyors, sanitary, fresh water, main drainage and secondary drainage pumps, air-compressors, anchor windlass, steering gear, independent laundry equipment, independent workshop machinery, main turbine turning equipment, independent commissary appliances, such as dough mixers, ice cream freezers, meat choppers, potato peelers, dish washers, and the energy supplied to bake ovens. Of these equipments the largest is the steering gear and two systems—the contactor control and the motor-generator control—are now in the trial stage. This system requires a motor rated at 350 H.P., and capable of working under a 100 per cent. overload for a few minutes. Next to the steering gear equipment in size, is the anchor windlass, requiring two motors of 175 rated horse power, and the same overload capacity as the steering gear motor.

The interior communication system comprises call-bells, telephones, fire alarm, general alarm gongs, boat hour gongs, shaft revolution indicator, steering telegraph, steering emergency signal, gyroscopic compass, engine revolution telegraph, fire room telegraph, engine order telegraph, loud-speaking telephones, rudder indicator, gun firing systems, warning systems for closing water-tight doors, air-lock indicators for indicating when air-lock doors are open, water-tight door signals, submarine signal, electric whistle operator, drainage tank indicator and wireless telegraph.

The electric propulsion on the "Jupiter" has been so satisfactory that it is being adopted on the U.S.S. "California." A total of 37,000 H.P. will be provided, and each of the four shafts will be operated by an induction motor receiving energy from two steam turbine-driven alternators wound for approximately 2,500 volts three-phase. The advantages to be gained in this electric coupling, instead of the mechanical reduction gear, are very obvious in the case of a battleship, as it is necessary at certain times to drive the vessel at high speed, but it is just as necessary to drive it under normal conditions at low speed; for this large variation in horse power the electric equipment is more flexible and more economical, permitting of like water consumption at low, intermediate, and high speeds. The motors are provided with two windings using the slow-speed winding at ship's speeds lower than 15 knots, and the high-speed winding at higher speeds. One generator will supply all four motors for intermediate speeds and each generator will supply two motors for full power.

It is interesting to note that the cost of the electric propelling apparatus for the U.S. Battleship "California," inclusive of electric engine room auxiliaries, was approximately £2. 8s. 6d. per shaft horse power.

THE ELECTRIC ARC IN VAPOURS AND GASES AT REDUCED PRESSURES.*

BY W. A. DARRAH.

Present commercial arc lamps operate with few exceptions in an atmosphere rich in oxygen or the oxide compounds of the electrodes. As a result the electrodes are oxidised as rapidly as they are vaporised (if not already composed of oxides as in the case of a magnetite arc), and as the oxides cannot be used again commercially it is necessary to provide means for disposing of them. This cycle of vaporisation and oxidation of the electrodes naturally results in their comparatively rapid consumption, which necessitates the trimming and cleaning of the arc lamp—one of the large factors of arc-lamp operation.

If it were possible so to design the lamp that the supply of material for the arc did not come from the electrodes, but from a surrounding gas or vapour, and if in passing through the arc the vapour were not destroyed, it would then seem to be possible to construct an arc lamp which would not require trimming or materially more attention than an incandescent lamp. A lamp of this type, if it had a white light and good efficiency, might in some cases even occupy the field of the present incandescent lamp.

The research described in this Paper was carried on to investigate the possibilities of accomplishing this object, and while the results are very promising from a practical standpoint, they are outlined here for their scientific value and should be considered only as a scientific research.

A study of the light efficiency of an arc from a chemical standpoint shows that there is a certain rather limited class of substances which, when introduced into the arc in small quantities, produce a very great increase in luminosity. Thus the addition of small quantities of cerium or calcium compounds to the carbon arc may increase its efficiency over 300 per cent., and the addition of titanium (preferably as an oxide) to the magnetite arc similarly produces an increased luminosity without a corresponding increase in energy consumption. It is a peculiar coincidence that the addition of cerium or calcium to the magnetite arc, or titanium to the carbon arc does not result in approximately the same gain in efficiency. The chemical compounds in which the element appears is apparently of little importance. A study of these facts led to the conception that perhaps an arc could be maintained in a closed vessel, and supplied with these light-producing elements in the vapour form. On investigation this seemed practicable, especially after a consideration of the liquid "inorganic" compounds shown in Table I., which contains some of the elements which produce highly luminous arcs. The table is discussed at length later on in this Paper, but it is interesting to note that titanium, tungsten and other elements which increase the luminous efficiency of an arc, may readily be secured in the form of volatile liquids.

Accordingly, a crude apparatus was arranged in which two hard carbon electrodes were placed vertically above each other in a tight glass vessel, and an arc drawn between the electrodes. As might be expected, this arc was non-luminous and very unstable. Accordingly, a small amount of carbon tetrachloride was poured into the vessel with a rather marked result. The arc then became stable and could be drawn out to several times the length which was previously possible, although its luminosity was not much increased. A flaky soot formed by the decomposition of the carbon tetrachloride also filled the glass chamber. A trial was next made with stannic chloride, with a similar increase both in stability and allowable arc length. In this case, also, the luminosity of the arc was much greater. The stannic chloride, however, was decomposed by the air and moisture present, forming a white insoluble powder upon the walls of the chamber, soon shutting out most of the light.

A more elaborate apparatus was therefore constructed in which the graphite electrodes were separated by an electro-magnet acting upon an iron core within a glass chamber.

The air was exhausted from the chamber, a small quantity of stannic chloride vapour at a pressure of from 3 cm. to 4 cm. was allowed to enter and the arc drawn. Under these conditions a stable arc 3 in. to 4 in. long could be produced with 6 to 7 amperes direct-current, and 220 volts impressed. The arc was intensely white and so steady that it had the appearance of a thick incandescent filament slightly bowed and surrounded by a flame-like less luminous shell of yellow. The vapours from this arc, however, soon collected on the walls, forming a dense brown coat, which proved to be mainly tin carbide with a mixture of stannous chloride and other intermediate compounds.

* Abstract of a Paper read before the American Electrochemical Society.

These preliminary tests having indicated possibilities as well as having shown the difficulties to be overcome, additional smaller lamps were constructed along somewhat improved lines.

With these a detailed study was made of the effects of the various available electrode materials, as well as the different vapours and lamp designs.

For convenience a hard glass was employed, as this permitted the sealing of tungsten wires and rods directly into the globe by the use of a flux of potassium nitrite and borax. This allowed the free use of heavy seals which were necessary for the tests. Fig. 1 shows the latest designs which have eliminated many of the difficulties encountered.

The type of lamp shown consists essentially of an arc chamber at the centre of which the arc is drawn between two tungsten electrodes about $\frac{3}{16}$ in. in diameter. The electrodes are partly surrounded with a refractory insulator, designed to prevent the arc from moving far from the ends of the electrodes, as this allows the magnetic blow of the arc to continue to extend it, ultimately tending to rupture the arc. The refractory insulator also assists in maintaining the electrodes at a high temperature, thus increasing the efficiency of the lamp and the stability of the arc.

The upper electrode is fastened by means of a tungsten rod to an iron core, which is surrounded by a glass shell to protect the iron from corrosion, as the vapours used readily attack nearly all metal except tungsten, platinum, gold and a few other inert materials. A flexible tungsten spiral serves to conduct the current from the upper movable electrode to the upper seal.

It was found after a number of trials that a certain combination of gases to be described later gave a minimum amount of "soot"

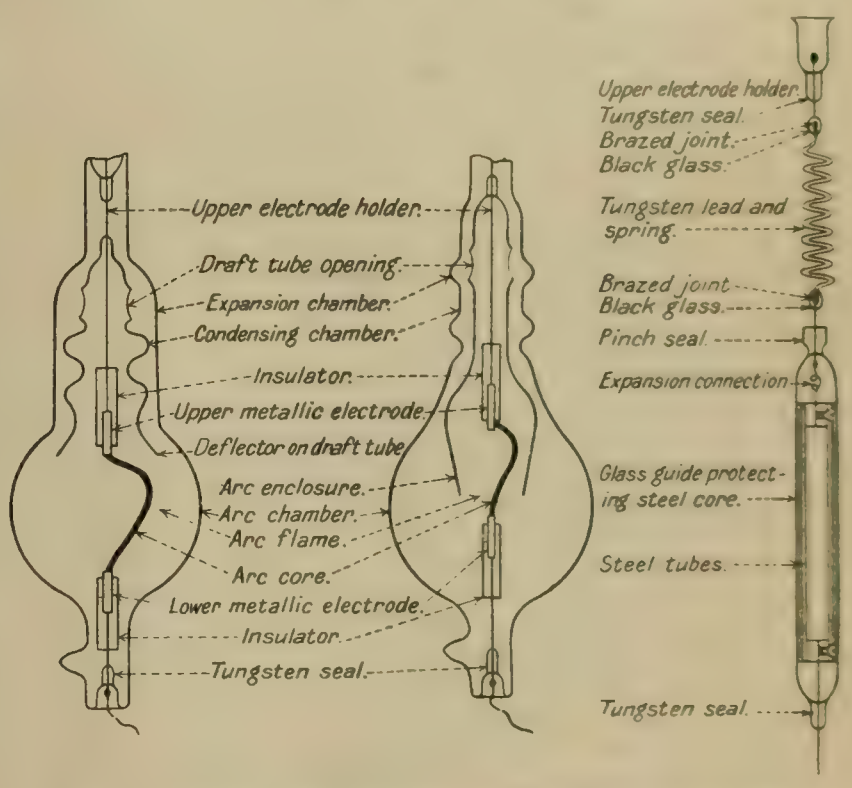


FIG. 1.—LATEST CONSTRUCTION OF NEW TYPE ARC LAMP.

(decomposition products), which gradually collected upon the globe, thus reducing the amount of light radiated. In order to overcome this difficulty the arc chamber was extended somewhat above the upper electrode, thus forming a condensing chamber in which the soot could collect, allowing the walls to remain clean.

Further study developed that while this would remove a large quantity of the suspended soot a certain amount was still deposited on the glass walls adjacent to the arc. In order to eliminate this deposit, a draft tube was placed around the upper electrode in such a position that the heated gases from the arc would pass upward through the draft tube out into the condensing chamber, and then back downward into the arc chamber for use again. The corrugations shown on the draft tube and condensing chamber has the effect of slightly compressing and expanding the gas as it passes from a chamber of small volume to one of large volume. The alternate expansion and compression of the gases, as well as the contact with the walls thus produced, was found to aid materially the condensation of the suspended matter.

The search for a satisfactory electrode material developed that carbon, either in the form of graphite or in the amorphous state, was unsatisfactory because of the disintegration by the action of the vapours, and also the deposit of free carbon which it caused on the walls of the arc chamber, apparently by direct radiation, as the draft tube and condensing chamber did not affect it as much as an increase of pressure of the gas around the arc.

Table I.—*Effect of Vapours on Arc.*

Substance.	Boiling point C°.	Melting point.	Effect on arc.	Luminosity	Colour.
Carbon tetrachloride...	77	Liquid at ord. tem	Stable	Low	White
Stannic chloride.....	114	,,	,,	Medium	Yellow white
Titanium tetrachloride	136	,,	Unstable oscillatory arc	Very high	White
Antimony trichloride .	220	,,	Stable	High	Yellow white
Arsenic chloride.....	130	,,	,,	Low	Purple
Silicon tetrachloride ...	57	,,	Unstable	High	White
Boron chloride	18	,,	,,	,,	,,
Phosphor trichloride...	75	,,	Stable	Low	Pink and green
Aluminium trichloride	183	Volatile	,,	,,	Yellow
Cerium chloride.....	1,400	...	,,	Very high	White
Calcium chloride.....	1,200	780	,,	High	Strong yellow
Calcium iodide.....	1,100	740	,,	,,	Yellow
Chromic chloride.....	White heat	...	Unstable	Low	Green
Titanium chloro-brom.	180	...	Very stable	Very high	White
Bromine.....	63	7	,,	Low (high absorption)	Yellow
Iodine	114	Volatile	Unstable	Low	Blue
Chlorine	33	102	Stable	High	Yellow

It was demonstrated that practically all of the materials available (*see* Table I.) formed carbides under the influence of the arc, and these carbides mixed with free carbon formed so heavy a deposit on the walls of the arc chamber that it was decided to abandon carbon.

Chromium, titanium, molybdenum, nickel, iron, and silver were all tried without satisfactory results. Decomposition of the electrodes, decomposition of the surrounding gases and heavy deposits on the globe made the use of these materials impractical.

The substance which was found to be satisfactory in all respects was tungsten, which proved to be practically inert even at a white heat in the presence of the various vapours used. The tungsten terminals, moreover, did not melt or evaporate in the arc except at a very slow rate, which seemed to be comparable to the evaporation of the filament in an incandescent lamp. A rather interesting phenomena resulting from the gradual evaporation and deposition of the tungsten electrode was exhibited in the growth of a thin star-shaped fringe on the edges of the arc surfaces of the electrodes. This fringe was composed of points 2 mm. or 3 mm. long formed of small needle-like crystals of tungsten, and appears to be caused by the slow precipitation of free tungsten from the surrounding gases under the influence of temperature changes.

Having devised a satisfactory construction it was found that in order to introduce the gases and eliminate air and moisture, special methods were required. As all of the liquids employed are hygroscopic, and many of them readily decomposed by ordinary moist air, it became necessary to exhaust the air from the lamp, heat the lamp and electrodes while at a low pressure in order to remove the air films and then admit the liquids without opening the lamp chamber to the air. This was accomplished by means of a bottle sealed to the lower extremity of the lamp, and provided with a ground stop cockconnecting it with the lamp, as shown in the photographs. After the proper degree of exhaustion was reached, the desired liquid was carefully poured into the bottles and the stop cock opened slightly when atmospheric pressure forced the liquid into the lamp chamber.

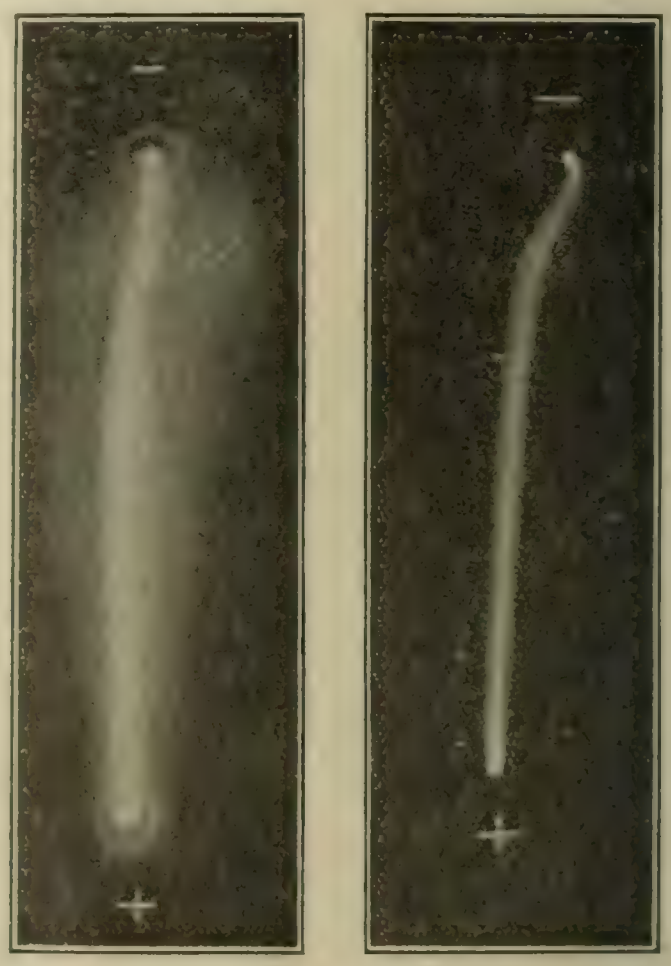
The appearance of the arc in this lamp is quite different from other commercial arc lamps (*see* Figs. 2 and 3). It is usually very stable, about $\frac{1}{8}$ in. in diameter, tubular in form and varies from 2 in. to 5 in. in length with 110 volts direct current applied, the variations being due to differences in pressure, natures of the gases supplied, &c. A high pressure naturally increases the intrinsic brilliancy of the arc, but makes it necessary to operate at a shorter length as the gas currents due to temperature differences and arc reaction are correspondingly more violent. The diameter of the central luminous tube is also reduced with an increase in pressure.

Some of the arcs revolve very slowly, but as a rule the low pressure of the gases minimises the motion of the arc, and the general appearance is that of a thick intensely white incandescent filament slightly bent at the upper end. With some of the vapours, as, for example, the metaloid halogen compounds, antimony, phosphorus and arsenic chlorides, the central tubular portion is surrounded by a ragged flame, which is light pink in the case of arsenic and pale green in the case of phosphorus.

The flame portion acts somewhat as an absorbing screen, thus reducing the total useful radiation. It is a curious fact that this flame may exist for a short but appreciable time after the circuit has been interrupted, thus indicating that it probably does not have a part in the conduction of electricity through the vapour, but appears to be a zone in which the vapours after being dissociated by the heat and electrical effects of the arc recombine. The spectrum of the flame is usually quite different from the arc spectrum, and is characteristic of the elements involved, while the spectrum of the arc independent of the ends of the electrodes (which, of course, give a hot body spectrum) is usually a band spectrum and is practically continuous except for a few absorption lines.

A curious phenomenon noticed with an 8-ampere, 220-volt arc at low pressure in the presence of cerium chloride was a separated arc which gathered into a glowing sphere at one corner of the chamber, while the space between the electrodes through which a current of 8 amperes passed was entirely dark.

The complete Paper contains typical performance curves which indicate the electrical characteristics of the antimony pentachloride



Figs. 2 and 3.—Views of New Type of Arc.

lamp, which is illustrative but does not have as high an efficiency as the titanium tetrachloride or titanium bromo chloride lamp.

Fig. 4, plotted between arc length and voltage, shows the rate at which additional arc lengths require an increased voltage. The curve is also interesting as indicating that a 4-in. arc at 10 amperes requires no more voltage than a 1-in. arc at 2 amperes. In other words, a 10-ampere arc is four times as long and therefore emits four times as much light as a 2-ampere arc. In addition, its intrinsic brilliancy is about five times that of a 2-ampere arc. Accordingly, the light emitted by a 10-ampere arc *under these conditions* is 20 times that of a 2-ampere arc, and since the wattage of a 10-ampere arc is only about five times that of the 2-ampere arc, the efficiency is approximately four times that of the 2-ampere arc.

Efficiency curves indicate that 20 amperes is approximately the point of maximum efficiency of this particular antimony pentachloride lamp. It should be understood, however, that the current of maximum efficiency differs widely with differences in the nature and pressure of the gas as well as the volume and available radiating surface of the lamp, and very efficient titanium bromo chloride lamps have been constructed with a maximum efficiency of about 5 amperes.

Regarding the efficiency secured, it is to be expected that these will vary widely with the condition and nature of the vapours used, and

actual results range from 1 watt per mean spherical candle-power to less than one-quarter of the value. This performance may be secured with a white light which closely resembles afternoon daylight (north sky). An analysis of the colour of the arc with the spectroscope as well as colour-matching tests confirm this fact.

As a matter of interest, Table I. shows some of the different compounds tested, and some of the general results secured. These compounds may be roughly divided into three classes, as follows :—

1. The illuminants, or those materials which give a high luminous efficiency. They usually produce unstable arcs if used alone.

2. The stabilisers, or those compounds which have a low luminous efficiency, but when introduced into an arc allow a very stable arc at relatively low voltages.

3. The " catalisers," or those compounds which are introduced to assist recombination in the flame zone, thus minimising deposit.

Table I. is interesting as it is the peculiar properties of the compounds, many of which are not very commonly used, that render possible a lamp of the kind described. The problem is to introduce as dense an atmosphere as possible of the various illuminants as titanium tetrachloride into an arc in such a form that it will not be permanently decomposed but may be used again and again. Some of the liquid halogen compounds shown in the table allow this. Some of those compounds (as, for example, those with the metaloids) which have a relatively slight affinity for a halogen, are too readily decomposed to be useful. Others, like stannic chloride, are too readily reduced to a less oxidised state, passing from a tetrachloride to the dichloride.

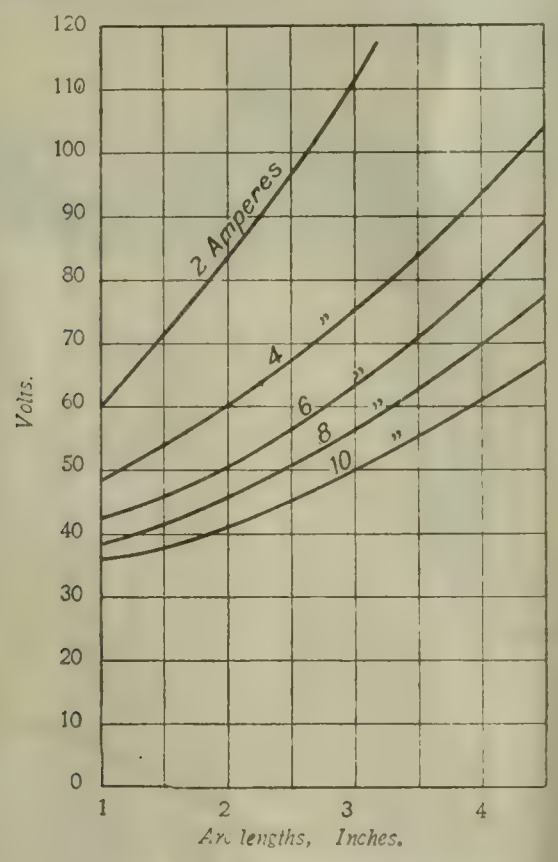


FIG. 4.—PERFORMANCE CURVES.

Titanium tetrachloride is an example of this condition, but the addition of a small quantity of free bromide to the $TiCl_4$ (in which it is readily soluble) forms a compound (the bromo chloride) which readily recombines after dissociation.

Fortunately also, since the chloride and bromo chloride of titanium dissociate at a higher temperature than tungsten chloride, and therefore recombine at a higher temperature than tungsten chloride, these vapours will not attack metallic tungsten even in the presence of the electric arc.

In order to avoid oxidation effects it was necessary to eliminate all oxides from Table I. More complex compounds such as sulphates, nitrates, could not be considered because of the tendency to dissociate and not recombine. Sulphides, nitrides, phosphides, &c., were eliminated because the chemical stability of these compounds in most cases was too slight to be satisfactory.

Chlorine was the halogen most generally used because of the stronger union of the chloride, and the reduced tendency of the dissociation products to attack the tungsten electrodes.

It would appear that an investigation along the lines here described opens up new possibilities in light production, but it cannot be too strongly emphasised that while the results set forth in this Paper offer considerable promise from an applied, practical standpoint, yet they are not presented for consideration as representing a finished device, but merely a research in what seems to be a new and interesting field.

THE ERECTION PLANT FOR THE QUEBEC BRIDGE.

(*Concluded from p* 385.)

Summary.—In this article reference is made to the crane equipment used in erecting the first Quebec bridge. A brief description is given of the new bridge and of the method to be followed in its erection, and the remainder of the article is devoted to a detailed account, including many valuable drawings, of the crane equipment used for the purpose.

The three illustrations, Figs. 5, 6 and 7, have been prepared from photographs. They give a good general idea of the nature and arrangement of the crane equipment as well as an indication of the progress of the work on the bridge. The photograph, from which Fig. 7 was made, was taken early in May, 1915. From this illustration it will be perceived that on this date the north anchor span was practically complete, and in the background the second erection traveller at work on the south anchor span is visible.

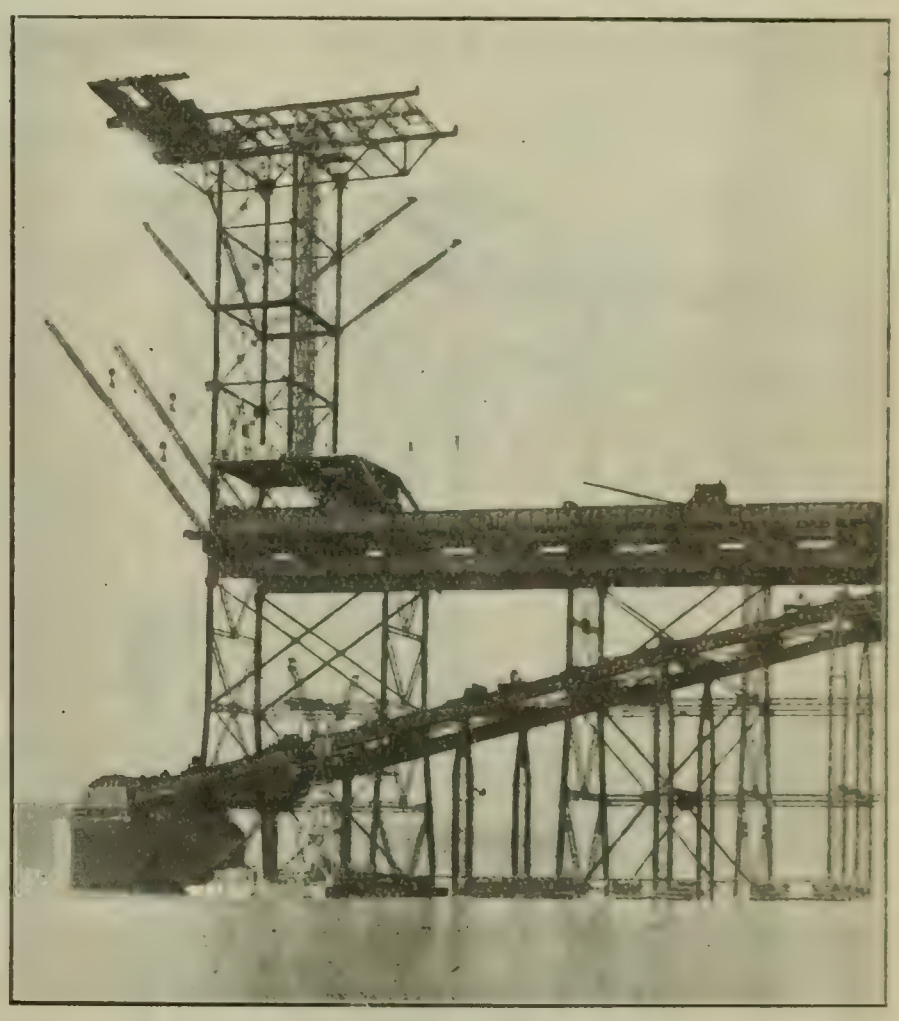


FIG. 5.

Arrangement and detail drawings of one of the travelling cranes are given in Fig. 8. From these it will be seen that the main girders are of the plate web type, suitably stiffened, pitched at 8 ft. 6 in. centres apart, 5 ft. 6 in. deep at the centre, and 112 ft. in length over all, with 29 ft. cantilever extensions at each end. They are rigidly braced together over the centre portion by transverse and diagonal members, and are carried by four two-wheeled compensating trucks. The wheel-base is 12 ft. 6 in., and the truck wheels are each 2 ft. 6 in. diameter and 3 in. wide on the treads. A motor of 16 H.P. is used for driving the travelling mechanism, and it is geared to give a travelling speed of 24·2 ft. per minute. To prevent cross-winding, the crane is driven positively at both ends by a cross-shaft, the motor being mounted on a platform between the main girders at the centre of the span.

In order to minimise weight, the two main hoisting machines are mounted on trucks near the centre of the span, and each is connected to the corresponding trolley by a pair of pin-jointed struts. The principal structural and mechanical details are clearly shown on the several drawings (Fig. 8). The 55-ton load is carried by 10 falls of $\frac{7}{8}$ in. steel wire rope, winding two parts on a 3 ft. barrel, and the lifting mechanism is driven by

a motor of 75 H.P. output, 550 revs. per min., which is geared to give a full-load lifting speed of 12 ft. per minute. Two plate girders, 3 ft. deep and 3 ft. 10½ in. centres apart, are built in between each of the cantilever extensions of the main girders for the purpose of carrying the tracks for the trolleys. These trolleys are supported by four wheels, each 2 ft. diameter and 3 in. wide, the wheel base being 5 ft. 6 in. They can be racked out any distance from 34 ft. to a maximum of 48 ft. from the centre of the span, and racking is effected at the rate of 10·4 ft. per minute by a 3 H.P. motor. In its highest position the main block is 193 ft. above the base of the rail on the bridge. To prevent over-winding, each main trolley is provided with a "Youngstown" limit stop, which interrupts the lifting motor current and applies the brake immediately the block reaches the limiting position.

The auxiliary gantry cranes, of which there are four, two per travelling crane, are each furnished with two independent 5 ton lifting mechanisms, driven by motors rated at 30 H.P., 575 revs. per min. The motors are geared to give a full-load lifting speed of 75 ft. per minute, and the entire lifting mechanisms are located between the main girders of the two travelling

Table I.—*General Data of Electric Equipment.*

Crane.	Motion.	Motors. H.P.	Speed, r.p.m.	Rating, min.	No.	Motor Brakes.	Controllers.
Derricks	Lifting	51	295	60	4	None	"Dinkey" non-reversing
	Slewing ...	5	700	30	4	E-M. Disc	Reversing
Elevator ...	Lifting	15	575	...	1	...	...
Travellers	Main lifting	75	550	60	4	E-M. Disc	Magnet switch
	Traversing	3	1150	60	4	E-M. Disc	Reversing
	Travelling	16	725	30	2	E-M. Disc	Reversing
	Aux. lifting.	30	575	30	8	E-M. Disc	"Dinkey"

All motors continuous current, 220 volts.

(Fig. 8). The traverse and travel are respectively 18 ft. and 20 ft.

With the exception of the auxiliary gantry travelling and traversing motions, the whole of the motions of all the cranes

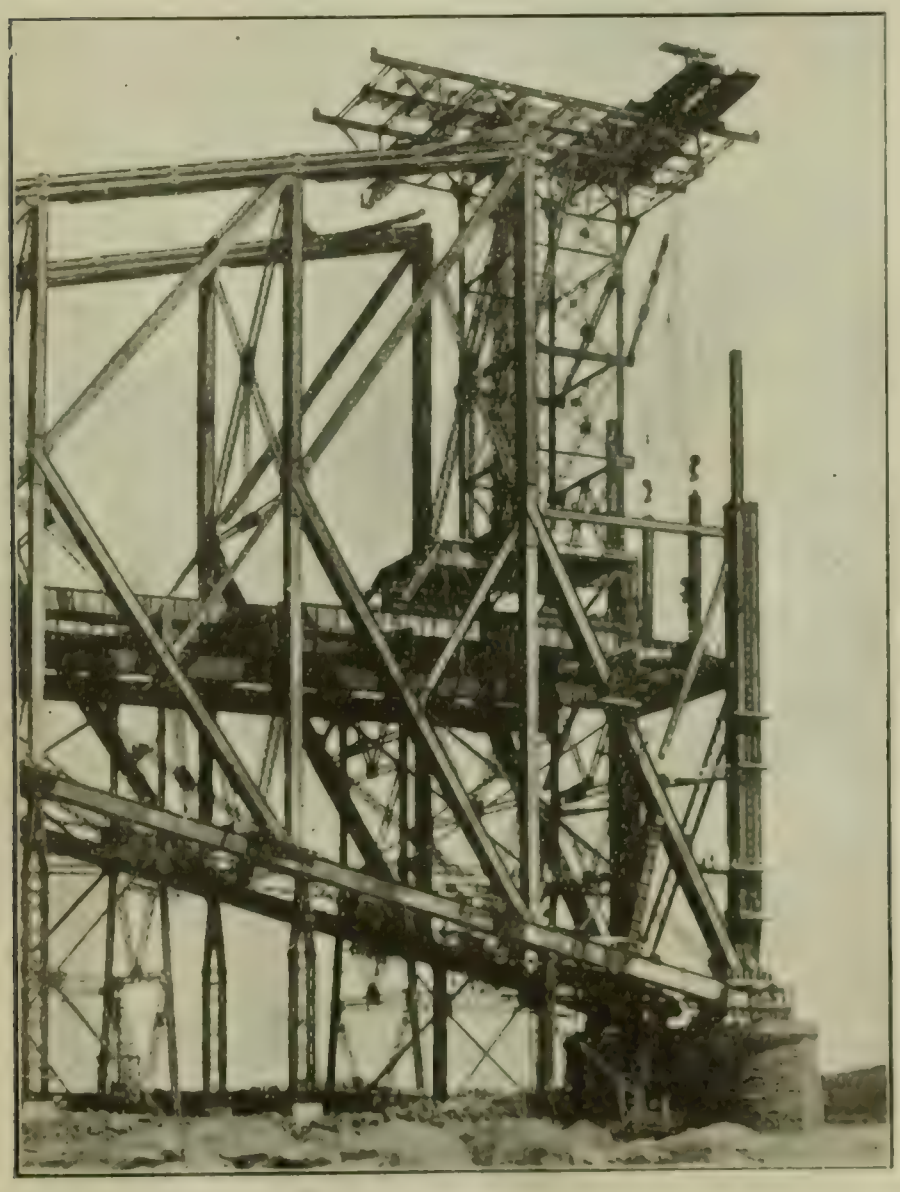


Fig. 6.



Fig. 7.

cranes at the centre of the span, the ropes being arranged in the manner common to single motor cranes, as shown in Fig. 5. Each of these gantry cranes has a 9 ft. 9 in. cantilever extension at one end, and a 2 ft. 6 in. extension at the other end. The girders are composed of two pairs of channels, arranged double box fashion, 3 ft. 6 in. centres apart, and are 21 ft. in length. They are mounted on and well braced to a portal sufficiently high to allow the main trolley to pass through. The tracks are formed of steel channel sections direct on the main girders, which gives a gauge of about 8 ft. 6 in., and the wheel base is 6 ft. The tipping moment, due to the overhanging load, is balanced by rollers which bear against the flanges of the channel rails. These cranes are provided with hand travelling and traversing mechanisms, clearly shown on the drawings are motor driven. From the particulars of the electric equipment set forth in Table I. it will be seen that on each tower there are 27 motors, aggregating 823 H.P. output.

All the lifting motors are arranged for dynamic braking, and, with the exception of the derrick hoists and elevator, the whole of the motors are provided with electro-mechanical brakes of the "Weston" multiple-disc type.

The control gear is of a most elaborate character. The switchboard in the base of each tower carries a voltmeter, an ammeter and a main knife-switch, as well as two overload coils and a double-pole magnet-switch for each motor. Each of these instruments and switches is mounted on a separate panel to facilitate easy inspection and repair, and there are 73 of these panels per board. Conveniently situated push-buttons enable

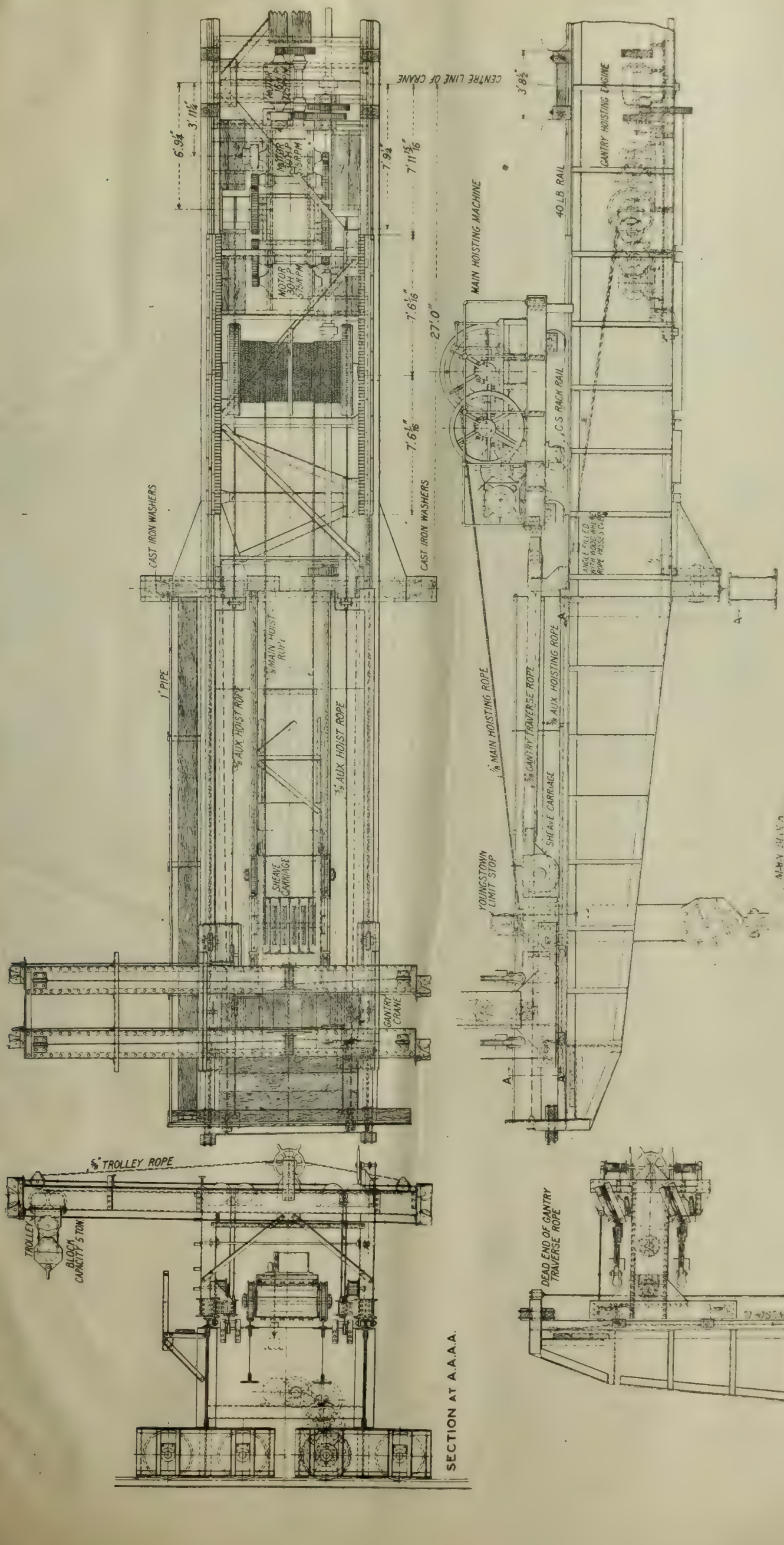


Fig. 8.—Arrangement Drawings of the Travelling Crane on the Bridge Erection Traveller
(Each traveller carries two of these cranes.)

the operators to actuate any of the motor circuits through the magnetic switches, and to re-set the latter in case they open on no voltage or overload.

Controllers of the well-known "Dinkey" type, developed for steel works service, are used for the derrick hoist and auxiliary hoist motors, and for each of the main lifting motors a dynamic braking magnet switch controller is installed, the latter being operated through the medium of a small master-controller.

Readers will appreciate the difficulties encountered in arranging for the control of 16 crane hooks from a platform at a considerable distance from the cranes, and of using the hooks singly or in concert, in which case the several motions must be absolutely synchronous. This in itself is an achievement of no mean order on which the designers are to be congratulated. To control the travelling cranes, some four dozen trolley wires with sliding contacts are required on the gantry at the top of the tower, in addition to the usual cross-wires on each crane.

A loud-speaking telephone system with central exchange has been installed to facilitate the giving of orders by the responsible officials and to provide efficient means of communication between the shore and the bridge.

The towers and erection equipment are supplied with current from two interconnected sub-stations, one on each side of the river, fed from two separate high-tension lines which serve the district, either sub-station being sufficiently large to supply the whole of the machinery on both sides of the river. In preparing the description of this fine example of heavy engineering work, in addition to the sources mentioned above, we have received valuable assistance from the St. Lawrence Bridge Company, the designers of the equipment and contractors for the bridge.

THE DESIGN OF HIGH-PRESSURE DISTRIBUTION SYSTEMS.

The following is a report of the discussion at the meeting of the Institution of Electrical Engineers on Thursday, December 16th, on Mr. J. R. Beard's Paper on the above subject. An abstract of the Paper appeared in our last issue.

After reading the Paper the author showed on the screen a slide giving the development of the North-East Coast distribution system described in the Paper. In 1901 they began with one power station and four sub-stations. By 1905 practically all the load of the North bank of the Tyne and the North-Eastern Railway supply and so on had been connected, and during that period Mr. Merz and his chief electrical assistant, Mr. Bernard Price, had begun to realise that the existing methods of feeder protection were inadequate, and consequently the balanced current protective system was developed about 1905. In 1910 the system had grown to 10 power stations and 229 sub-stations. Since then it had been more a case of consolidating the system, but the development had been continuous and rapid. In 1915 there were 15 power stations and 355 sub-stations.

Mr. P. V. HUNTER, in opening the discussion, said the preparation of the Paper necessitated an enormous amount of work. With the exception of the top curve, all the six curves showing the most economical cross-section of three-phase mains for various maximum currents were prepared from the series of curves shown in Fig. 3, and for each point in each curve a complete curve such as Fig. 3 had to be calculated and drawn. He imagined that something in the order of several hundred curves such as Fig. 3 had been drawn. The author's main theme was a justification of the complicated distribution system in the Paper, and his object was to show whether the development carried out there could be justified on theoretical grounds. He (Mr. Hunter) had always taken it for granted that an inter-connected system must be economical, and he had never thought it necessary to attempt to prove it. He had felt sure the author, considering the matter from a theoretical aspect, would not reach any conclusion, but he had been surprised to find he had been able to put forward the subject in such a concise and clear manner. His (Mr. Hunter's) interest was chiefly excited by incidental points, particularly the effect of copper losses on the load-factor of the system. It was not generally realised that the copper losses could have such a widely different load-factor from the load-factor of the system. This was illustrated in Fig. 2. The load-factor of the copper losses for the system load-factor of 50 per cent. might be anything between 25 and 50 per cent., which was a remarkable figure. The shape of the curve in Fig. 3 also surprised him. It showed the most economical section of mains for different carrying capacities. The current density came very low, but the explanation was apparently quite simple. The author had assumed a high load-factor, and if the cable were run on a high-current density it amounted to a considerable value. It paid to spend a little more capital and save on losses. Some people would argue against the figure of ¼d. a unit for losses, but in view of the way in which the losses altered the character of the load-factor there was a good deal to be said for the author's argument. He did not think he (Mr. Hunter) would have put the figure as high as ¼d. It seemed that the cost of the losses was more than the cost of generating for the consumer, because of the bad effect of the losses on the load-factor.

Mr. G. W. PARTRIDGE was glad the author referred to the early work of Dr. Ferranti, who was a pioneer engineer when the extra high power transmission scheme in Deptford was first put in. In those days they had to make their own 10,000-volt cable with joints every 20 ft., and design their own transformers and generators. He (Mr. Partridge) had been associated with that scheme from the beginning—over 27 years. He was disappointed that the author had not gone into pressures of about 20,000 volts underground cables. In future, pressures for above 20,000 volts would be used, and they appeared to be quite feasible. He was considering systems of underground mains up to 60,000 volts. From a transmission point of view he imagined there would be less difficulty in running such a system on a lower frequency, such as 25~, assuming it were a large system. With a lower frequency there would be less trouble from inductance and capacity current, there would be less trouble in the rise in pressure due to switching or any other such work, and the use of large rotaries on any railway supply would, he thought, be worked better on the lower frequency. At the same time from the general point of utility he agreed with 50~ as most advantageous. In the lower frequency he thought there was a great future for single lead-covered cables, more especially with extra high pressures. He had considered high-tension switchgear for many years, and he had seen every accident on switchgear that could occur. It was important that switchgear should be kept proportional to the capacity of the generating station. He endorsed what the author said on that subject. He had seen systems laid out for a comparatively small station, and when the capacity of the station had risen to 10 or 20 times the former capacity, and same oil switches were used and fuses were connected in circuit with the bus bars of the generating station. The result was sooner or later an old type switch was asked to open a short-circuit with the main generating station behind it, and the whole thing blew up, and possibly the whole station was shut down. It was vitally important that engineers should consider this matter carefully. He was installing oil switches at his generating station capable of dealing with over 200,000 kw. The generation of gases in oil switches was one of the chief causes of their failure. An oil switch should have a quick break—as many breaks as possible—so as to dissipate the energy and not have it all in one place in the oil, and a good head of oil should be kept above the break. It was better to have a good head of oil and a short break—say, 6 in.—than a long break and a small head of oil. An oil switch should be as strong as possible, so as to take care of those explosions which often took place. The pressure of the gas set up was sometimes enormous. He had known of one case in which an oil switch was blown together again after it had opened the circuit owing to the gas acting on the plunger which passed through the gland. This plunger, being made of wood, had rather a large surface, and after opening it blew the switch together again. This was got over by reducing the size of the plunger—by substituting a steel rod for a wood rod. All bare parts should be covered up, to protect them against the discharging gases which came from oil switches. He always covered up all conducting metal in the neighbourhood of an oil switch. In America he witnessed experiments in which an engineer proposed to destroy two large oil switches. He had 36,000 k.v.a. connected to them. In the first experiment the switch opened the circuit, and at the same time the gases came out of the tank and actually short-circuited all the terminals on the top of the first switch, and the whole thing was burnt up. Afterwards the other switches exploded after they had been tested in the usual way. He had designed switchgear for his generating station in which all the cables were single lead-covered and also the 'bus bars. There was no cleaning except the outside of the lead. The magnetic switch referred to by the author was an interesting problem. He (Mr. Partridge) had such a switch in his station, but up to the present he had not had the courage or the time to test it. The author says attempts have been made to use the magnetic forces of the current for this purpose, since such an arrangement has the advantage that the more severe the short-circuit the greater the speed of the break. It was a bad thing to open the circuit too quickly. He had known switches endeavour to open the circuit on the top of the phase in which cases the switches had been blown to pieces, and in other cases if they had opened too soon at the first rush of current on the short-circuit there had also been disastrous results. It was better to have a time-lag in the opening of all switches, only when they did open they must open quickly.

Mr. B. WELBOURNE said the question of wayleaves was extremely important in considering the design of high-pressure systems. Protection with the ring main system was the right one under the best conditions. It gave the greatest economy of copper and the greatest possible flexibility, and was the best for maintaining pressure and giving a satisfactory supply to every consumer who had 100 kw. and over, which he thought was contemplated by the author. The author told them he had allowed for the replacement of cables in 22½ years and overhead mains in 17½ years. It had gone out as the considered opinion of that Institution that the life of cables should be taken as 30 years. He (Mr. Welbourne) considered the life of an overhead main to be the life of the pole. There was evidence from the Post Office and the National Telephone services to show that the life of a modern well-creosoted pole was not less than 35 years. There was no evidence in the Paper as to whether the author considered whether 11,000 and 20,000-volt step-up transformers were necessary, and he would like to ask the author whether he had included in the cost of the transmission main the cost of step-up transformers and the running charges on them. What did the author consider the maximum kilowatts per cable which it was now safe to transmit?

Mr. W. B. WOODHOUSE said he did not think anyone would dispute the author's main conclusion. With regard to the author's definition of a well-designed distribution system, a further factor came in. An essential characteristic of a system was its suitability for extension and development on commercial lines. No system could be laid down commercially as a complete thing. A large amount of the demand always came at the tail end of the feeders or in a district where there were no feeders. There were 100 sub-stations dependent on a single feeder out of a total of 350. Those feeders might be split mains or duplicate overhead mains, but as the system developed a large proportion of the load must be carried on a single main. It was obviously the sound thing to do. The North-East Coast system was an example of sound engineering. Referring to a diagram in the Paper, if the necessity for a new sub-station arises one could not afford to lay down another square of mains. The economical thing to do was to feed it with a single main, and absorb it into the interconnected system as the system developed. If one took into account the fact of the supply being given from more than one source the logical basis of the network became a honeycomb rather than a chessboard, and it was worth while considering whether there was any economy of copper if one developed it on the basis of a hexagon rather than a square. It seemed to him the criterion of the system was not what current cost delivered at the sub-station, but what it cost after distribution and transformation. The transformer losses should be taken into account.

Mr. H. BRAZIL said he favoured the inter-connected system, but the problem treated by the author was different from that in restricted areas like the City of London, where they had much larger sub-stations. When continuity of supply was very important he thought the inter-connected system, combined with the "interleaved" system, was advisable. In that system there were two distinct sources of supply, not connected on the high tension side at all. That was the system he was working with.

Mr. E. B. WILLMOTT said they had to err on the high side in selecting a

distribution voltage and in selecting the cross-section of mains, and the author suggested that they should be prepared to spend considerable sums of money in protective apparatus to enable them to obtain the substantial savings represented by his figures. The problem was whether they should spend a hundred pounds more or less to cut increased losses, and it was one that was not generally considered. The conditions of a hydro-electric system were different from those dealt with in the Paper. In hydro-electric systems one was apt to think that losses were of small import, but it was found after a time that every unit lost did not cost a farthing or a fraction of a farthing, but the loss was what you could get for it on the market. If the network was tied solidly together to obtain the tremendous economy that could be obtained by so doing, oil switches must be used, each of which must be reliable, and have a good factor of safety. He had seen tests in which an oil switch opened quietly on five tests, but on the sixth it threw a little oil, and in five tests out of the next six the switch behaved very badly. One had to make a large number of tests under a given condition to arrive at a valid conclusion as to the operation of an oil switch. High pressure *per se* was not useful in an oil-switch. It was not a good thing to compress the arc. The arc could be made to behave as if it were a metallic conductor. The head of oil was an important feature. If the switch were speeded up until the whole stroke was completed in half a cycle the zero part of the curve might only just be reached at the end of the stroke, and there would be no factor of safety on the switch at all.

The AUTHOR, replying to the discussion, said, in reference to Mr. Hunter's remarks about the load-factor and the copper losses, he (the author) had only taken account of the copper losses. He showed a slide at Manchester on the previous Tuesday giving the effect of the dielectric losses in a similar way to the effect of the copper losses shown in the Paper. These dielectric losses were negligible, being only about one-thirtieth of the copper losses on a 30,000-volt cable. With regard to the high load-factor assumed, i.e., 50 per cent., he actually worked out in Fig. 3, a case for a 40 per cent. load-factor compared with the 50 per cent. he had assumed in the main argument. For a system of the type which they hoped to get in the future with considerable diversity of load, 40 per cent. was really low. For cost of copper losses he took first 0·25d. He checked it by referring back to Prof. Klingenberg's Paper, which was read before the Institution some two years ago, and also by taking the figures given by Mr. Pearce, of Manchester. Mr. Partridge was disappointed at his not giving pressures above 20,000 volts. He thought gear was at present only sufficiently standardised up to 20,000 volts to enable one to read a Paper in which actual costs were dealt with. He thought the curves in the Paper showed to some extent what the results of higher pressures would be. In the connected system the frequency was 40. That was fairly high, yet the operation of the system was very good; no trouble occurred. He was glad Mr. Welbourne suggested higher figures for the life of cables and mains. He (the author) was afraid his capital charges would have been considered too low. Step-up trans-transformers had not been included anywhere in the Paper. It really only affected the 6,000 volts, and made a rather more favourable case for that. In the present state of cable development 15,000 kw. per cable was as much as most people would like to go in for. Mr. Woodhouse added a fourth essential characteristic of the system. He (Mr. Beard) agreed that it was desirable that a system should be easily capable of extension. Mr. Brazil had dealt with the case of very condensed loads. It was a question whether the extra security given by the duplicate system would justify the considerable extra cost. Mr. Wedmore thought it was not a good thing to compress the arc, but he (Mr. Beard) came across an article the other day in THE ELECTRICIAN which was in support of the theory that the higher the pressure which could be developed in the arc the more efficaciously would the switch break the circuit. That showed how opinions differed.

A vote of thanks to the author, proposed by the President, was carried unanimously.

ELECTRIC HEATING: ITS PRESENT POSITION AND FUTURE DEVELOPMENT.*

BY GEORGE WILKINSON.

Summary.—The author draws attention to the advantages of thermostatically-controlled heaters, and describes a thermostat he has devised for the purpose.

CORRECT RATING.

Electric heaters to be permanently satisfactory must be capable of quickly raising the atmosphere of the apartment to a comfortable temperature during the coldest day of winter and under the most unfavourable weather conditions. This entails a rating of not less than 1½ watts per cubic foot of room space. In apartments with abnormal window area, an exposed aspect, or subject to draughts and traffic, the rating should be at least 2 watts per cubic foot. Assuming a rating of 1½ watts per cubic foot as being sufficient for the coldest day of winter, this rating is obviously too high and therefore wasteful for every other day of the year.

It follows, therefore, that all apartments heated by electric fires of adequate power are at the present time (except in the few instances where thermostatic control is employed) costing substantially more for electric current than they should do, while such apartments are not so comfortable as they might be owing to the constant fluctuation of temperature ensuing on the unstable weather conditions.

Mr. W. A. Gillott has already demonstrated* that an apartment is heated more economically by means of a high-power heater or heaters suitably controlled than by a heater or heaters of lower power in the aggregate continuously in operation.

AUTOMATIC TEMPERATURE CONTROL.

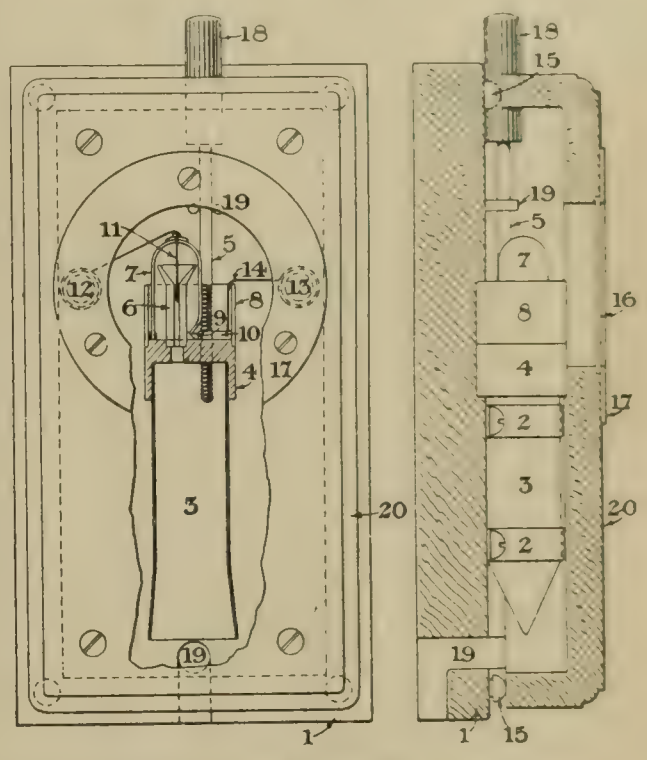
The advantages of electric heating need not be commented on at length as they are already recognised. From the health standpoint, heating by electricity is ideal, there being no vitiation of the atmosphere. There are no fumes, dirt or smoke, the quantity of oxygen is undiminished, and the apartment does not get "stuffy."

The few disadvantages may be set out as follows:—

(*a*) With radiators of the correct power the apartment will, except on the coldest days, often become overheated. This objection is not confined to electric heating.

(*b*) This frequent overheating causes a great waste of the heating medium. Fortunately, in the case of electricity the way to prevent waste is obvious.

It is essential to complete success that automatic temperature regulation should not be obtained at the expense of cheerfulness,



Front Elevation—Part Section. FIG. 1.

End Section. FIG. 2.

1. Base. 2. Metal clips. 3. Steel tube filled with mercury. 4. Cover carrying temperature-adjusting screw 5, capillary tube 6, glass dome 7, which is rendered gas-tight by a mercury seal carried in the glass ring 8. A slot 9, in glass dome 7, submerged beneath the mercury seal, and the slot 10 in the metal cover provides for the insertion of a nozzle for charging the glass dome 7 with inert gas. 11. Platinum wire forming one pole of the instrument; it is connected to terminal 12 and hermetically sealed in the glass dome 7. Terminal 13 is the other pole connected with the mercury seal by the dip wire 14. 15. Distance stops to allow of free ventilation between base 1 and wood cover 20. 16. Glass inspection window secured by plate 17. 18. Adjusting screw with insulated handle for raising or lowering the height of the mercury in 6, thus regulating the temperature at which the electric circuit is made. 19. Duct for connecting wires.

especially in living rooms where the ladies of the household insist on having a cheerful hearth to sit by.

SUPPLEMENTARY HEATING.

Another promising field open to electric heating with automatic temperature control is in the almost numberless cases where coal fires or hot-water radiators are in use. It is well known that both these methods of heating are subject to wide variations of temperature. The application of temperature-controlled electric radiators as an auxiliary method of heating will automatically remove these cool periods at little expense for current and with no trouble or attention, thus producing the ideal condition for comfort and health.

It is well known that for long periods during the spring and autumn and occasionally in the summer, there are days when the mornings and evenings are cold, while the rest of the day is warm and comfortable. The only economical and effective way of dealing with the heating problem during these periods appears to be by means of thermo-

* Abstract of a Paper read before the Institution of Electrical Engineers at Edinburgh.

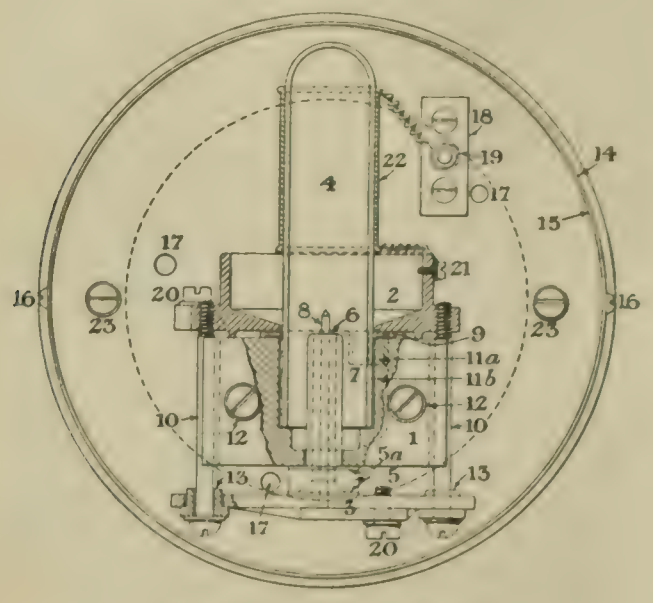
* "Journal" I.E.E., Vol. LIII., p. 49, 1915.

statically-controlled electric heaters ready for duty at all times, for long or short periods, and requiring no attention.

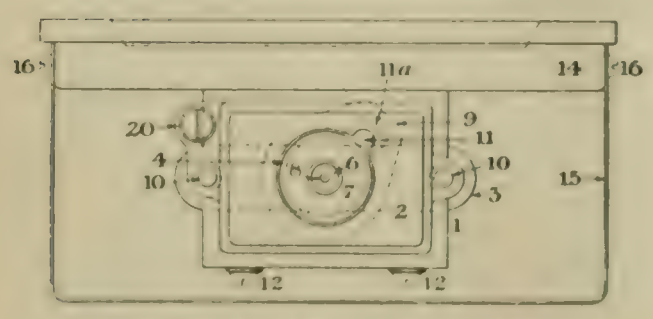
Apparatus for Automatic Temperature Control.

This controller, which is absolutely silent in its operations, has no mechanical moving parts, the only moving element being mercury. The apparatus consists of two parts: (*a*) The thermostat, shown in Figs. 1 and 2; (*b*) the circuit breaker, shown in Figs. 3 and 4. A diagram of connections is shown in Fig. 5.

Thermostat.—The thermostat is constructed with a steel tubular body terminating in a faucet at the top, surmounting which is a fine-bore glass tube enclosed by an inverted glass dome. The steel tubular body is charged with mercury, which, due to expansion and contraction under the influence of heat variation, rises and falls in the fine-bore glass tube into which the murcury chamber vents. Within this glass tube a platinum wire is suspended which makes and breaks contact with the mercury as the latter rises or falls, due to heat variation. For reliable and successful use it is desirable that such a thermostat should operate, without oxidation of the mercury or destructive sparking, on the pressures used by electricity-supply authorities. This is achieved by surrounding the "make and break" contact by an inert gas. By referring to Figs. 1 and 2 it will be seen that this is accomplished by carrying the platinum wire through the top of a superimposed glass dome into which it is hermetically sealed. The rim of the glass dome is closed round the bottom by a mercury seal in the faucet, thus forming a permanently gas-tight chamber of sufficiently flexible dimensions to allow the mercury column to travel freely the whole length of the fine-bore tube. The glass dome is filled with a suitable inert gas, preferably hydrogen. It will be noted that the platinum contact is fixed, but the temperature at which the instrument operates can be controlled by screwing or unscrewing the adjusting screw protruding through the top of the cover. Thus the thermostat can be readily set to any desired temperature. Due to the protection afforded by the inert gas, the thermostat is capable of breaking an alternating or continuous-current circuit conveying 30 watts or over at 250 volts without destructive sparking or discoloration at the point of "make and break." This is about five to six times its normal duty.



Elevation, Part in Section.



Plan. (Winding and Connections not shown.)

Figs. 3 and 4.

1. Porcelain block. 2. Iron tray forming one pole of the circuit breaker. 3. Bar forming the other pole of the circuit breaker. 4. Glass tube closed at upper end and filled with inert gas. 5. Hollow porcelain insulator. 5*a*. Rubber [illegible]; 7. Annular spaces filled with mercury and forming the two poles of the circuit breaker. 8. Steel pin to indicate the correct level of the mercury on charging. 9. Rubber [illegible] ring. 10. Fixing screws securing the mercury-tray and the bottom bar to the [illegible] block. 11. Mercury duct between the glass chamber 4 and the mercury-tray 2. 11*a*. Snug cast on tray 2 in which is formed the mercury duct 11. 11*b*. Constriction of the mercury duct 11 in the porcelain block to the chamber 4. 12. Wood screws fixing the instrument to the base 14. 13. Insulators. 15. Pressed steel cover. 16. Fixing screws for the same. 17. Leading-in holes for the connecting wires. 18. Porcelain [illegible] ing insulated terminal. 19. 20. Main terminal screws. 22. Heating coil of fine high-resistance wires connected to terminals 19 and 21. 23. Screws for fixing circuit breaker to wall.

Circuit Breaker.—This is formed by two bodies of mercury concentrically arranged and forming the two poles of the electric circuit. The point of "make and break" is on the top rim of the hollow porcelain insulator separating the two concentric mercury poles. The "make and break" takes place in an inert gas which is impounded by the superimposed glass tube carried in the earthenware fixing block. The outer pole of mercury also fulfils the function of a permanent gas-tight seal to the tubular glass chamber. The arrangements of the parts will be quite clear from Figs. 3 and 4, in which it will be seen that the inner mercury pole makes contact with the bottom insulated metal bar to which one line wire is attached. The outer mercury pole makes electrical contact with the metal dish surmounting the earthenware fixing block, and to this metal dish the other line wire is attached. The "make and break" is effected between the two poles by the slow rise and fall of the concentric ring of mercury. Notwithstanding this slow rise and fall, however, both the "make" and "break" are instantaneous owing to the surface tension of the mercury, and the breaker can be depended upon to interrupt a current of 20 amperes at 250 volts without oxidation or discoloration. The breakers have successfully dealt with a current of 30 amperes at 200 volts (6 kw.), but the standard rating is fixed at 15 amperes.

It now remains to describe how the rise and fall of the mercury within the breaker are controlled by the thermostat. A small coil of enamelled high-resistance wire is wound upon the cylindrical glass chamber of the breaker as shown in the illustrations. This coil, which takes approximately 8 watts, is connected through the thermostat to one pole of the supply as shown in Fig. 5. When the mercury rises to a point corresponding with the temperature for which it is set, contact is made in the fine-bore tube with the platinum wire, and the circuit is thus completed through the high-resistance heating coil upon the circuit breaker. This coil quickly becomes warm and causes the inert gas within the glass cylinder to expand, thus expelling a portion of the outer concentric column of mercury through the connecting duct into the surrounding receiver until the connection with the centre pole is broken, thus opening the circuit and putting the radiator out of action.

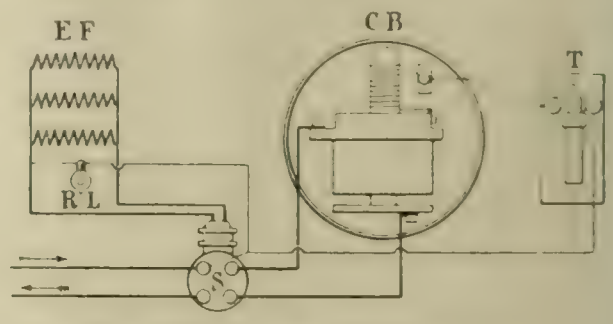


Fig. 5.—Diagram of Connections.

C.B. Circuit breaker. T. Thermostat. S. Four-terminal plug switch.
E.F. Electric fire or convectors. R.L. Red lamp or luminous radiator, not controlled.

It is obvious that the mercury within the circuit breaker is always subject to change of level due to barometric effect. This variation approximates to $\frac{1}{4}$ in. between the extreme limits of the barometer, and is negligible in actual working.

An unusual feature in the equipment is that the instruments require charging with inert gas after they are fixed in position and charged with mercury. This may sound formidable, but is in practice a simple operation which can be carried out by any man of average intelligence. A simple apparatus is described which generates hydrogen from acid, and a definite amount of zinc. This is attached to the instruments, and enough hydrogen passes in 10 minutes to charge the circuit breaker.

Later Type of Controller.

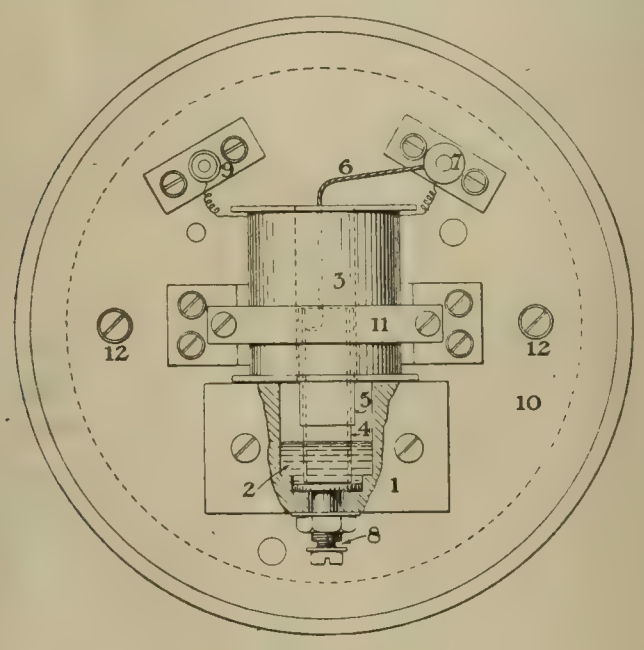
The controller already described has been unfavourably criticised, due to the fact that both the thermostat and the circuit breaker require charging with inert gas after fixing. Again, their field of application is limited due to the type of circuit breaker used: for instance, it is obvious that it cannot be used on board ship or on a train.

Both these objections have been successfully met in the more recent types as follows:—

The thermostat is now made with a very small glass dome surmounting the capillary tube and having a gas space of less than one-sixth the capacity of the earlier pattern. The small amount of air impounded therein by the mercury seal is not expelled, but the oxygen it contains is allowed to combine with the mercury at the

point of " make and break " while the thermostat is at work. After working for a short time the mercury absorbs the small amount of oxygen in the impounded air and a film of mercurous oxide gradually forms in the upper part of the capillary tube, thereby making the temperature regulation less accurate. This oxide is then expelled and washed over into the mercury seal by screwing down the adjusting screw, thus again providing clean pure mercury at the point of " make and break " and restoring the sensitiveness of the instrument. After the wash-over the thermostat is again set to the required temperature point, and the mercury then continues to " make " and " break " without deterioration.

The circuit breaker is of the magnetic class, and has a light moving element of the simplest type The construction will be readily understood by reference to Fig. 6, which shows the circuit breaker with the cover removed. The energy absorbed by the shunt coil when the heating circuit is broken is about equal to the loss in a modern electricity meter, viz., approximately 2 watts. The split iron tube performs the double function of armature and conductor ; it falls by gravity into the mercury bath and rests upon the terminal at the bottom of the mercury bath, thus completing the heating



Elevation.

FIG. 6.

1. Porcelain block, part in section. 2. Mercury bath. 3. Shunt coil. 4. Steel armature forming part of the electric circuit. 5. Paper covering on upper part of armature. 6. Flexible conductor from armature to terminal. 7 and 8. Terminals. 9. Shunt-wire terminal. 10. Wood base. 11. Clip securing shunt coil in position. 12. Fixing screws.

circuit. The " break " is very quick, owing to the light moving element, while the spark on breaking is most effectively blown out by the strong magnetic field set up by the shunt coil on the end of the armature.

This type of circuit breaker has operated continuously at from 15 to 20 breaks an hour on a circuit loaded to 3·25 kw., and has aggregated over 10,000 interruptions with little or no wear on the end of the armature ; thus it can be depended upon to operate for years without attention.

DISCUSSION.

Mr. WEAVING (Ferranti Limited) said his experience confirmed the view that high loadings were economical, and by the use of a thermostat a still further saving could be effected with even higher loadings. He believed that electricity at ½d. per unit for heating was equal to gas at 2s. 3d. per 1,000 cubic ft. As against the suggested use of a lamp radiator and a convector, he advocated the electric fire. He hoped the thermostat would be developed to make it suitable for the regulation of water temperatures and oven temperatures.

Mr. LACKIE (Glasgow) said that an ordinary fire consumed 4 lb. of coal per hour, or the equivalent of, say, 40,000 B.T.U.s. The equivalent of this would be a 12 kw. radiator, but they knew that a 1 kw. or 2-kw. radiator should take the place of 4 lb. of coal fire. This meant that 80 per cent. of the heat from the coal fire was simply wasted. The full advantage of the electric radiator was obtained when it was placed exactly where it was wanted—*e.g.*, under the table in a dining room. An apartment in a suite of offices in Glasgow 60 ft. by 36 ft. by 12 ft. high had been heated for a year with 10 kw. of radiators placed at individual desks. The consumption was 17,000 units at ¾d., equal to a bill of £55, or a return of £5. 10s. per kilowatt. He thought there was a a large outlet awaiting them in the electric furnace for the treatment of metals. He called attention to recent articles in THE ELECTRICIAN on this subject. They were trying to educate the Glasgow public in the application of electricity to heating. During the first 10 weeks of its existence their recently opened showroom had sold 450 pieces of apparatus, representing 752 kw., and makers and suppliers of appliances had testified to increased sales as a result of advice given at the showroom. Mr. Lackie then proceeded to give some figures with regard to the eight villas which had been equipped electrically in a Glasgow suburb. With contents varying from 12,000 to 7,000 cubic ft., the houses had each 12 kw. to 10 kw. of appliances installed. The year's consumption varied from 14,000 units to 7,000 units per house, and the bills ranged from £40 to half that figure. Their aggregate maximum demand was 17 kw., or a diversity factor of 5, which was practically the same diversity factor as they had for lighting. They had 10,000 domestic consumers in Glasgow, and 2,500 of these had heating appliances, with a consumption of 1,000,000 units. They had water heaters in a number of underground lavatories taking from 3 kw. to 10 kw. each, and their bills varied from £7 to £30 per annum. He knew of many cases where electricity had been successfully used for the heating of glue pots in joiners' workshops. Mr. Goslin, of the Glasgow tramways department, had carried out extensive experiments in office heating which had yielded many interesting results.

Mr. ROBERTSON (Glasgow) asked the cost of the thermostat and the extent of the saving likely to be effected by its use.

Mr. SYDNEY F. WALKER, in a written communication, said that a northern exposure, amount of window space and other local conditions had to be considered in calculating the amount of heat necessary. While believing that economies were possible by the use of thermostats, he thought that nitrogen gas would be preferable to hydrogen gas in Mr. Wilkinson's type of thermostat, always providing that the mercury could be relied upon to leave the platinum wire.

Mr. HUGHES (Edinburgh) did not agree with the main conclusion of Mr. Gillot which was given in the Paper. Generally speaking, the curves in the Paper seemed to ignore unduly external temperature conditions.

Mr. W. A. GILLOT (Sunderland), in a written communication, stated he did not think a thermostat was the right thing to use in a private house, and his experience with thermostats was that they were unreliable. He thought that a radiator hand operated was to be preferred to the arrange ment advocated in the Paper.

Mr. C. G. NOBBS (Falkirk Iron Co.), in a communication, stated that an electric fire should be not less than 2 kw. capacity, the elements having a temperature of 1,500°F., combined with a reflector to focus the heat rays on the person. Not less than 2 watts per cubic foot should be allowed for radiant heating. He had found a radio-convector with a series-parallel three-heat switch the most suitable form of device for electric heating, and the readiness with which it could be hand-operated permitted of the easy maintenance of equable air temperature. He thought the field for automatic control of electric heating was mainly in special rooms, wine cellars and in connection with industrial processes. He favoured the tank form of thermometer with automatic switch suitable for breaking up to 30 amperes at 250 volts direct current, two and three wire, rather than mercurial type thermometers with auto-switches.

Mr. WILKINSON replied briefly. He had not had time to calculate the saving which could be effected by the use of the thermostat, and he would prefer that an outside user should produce the figures. The cost of the device complete was about 55s.

Mr. W. R. COOPER (in communicated remarks) pointed out that, for simplicity and cheapness, it was an advantage to make the thermostat also play the part of the main circuit-breaker ; but difficulties arose unless the current and voltage were small. If reliance was placed on the expansion of metals, the movement at break was very small, and could not be magnified beyond a certain point without producing uncertainty of action. Such devices as bi-metallic strips and Bourdon tubes did not provide sufficient pressure on the contact to permit any but the smallest currents to be carried. He had overcome these difficulties by adapting the relay of the well-known tubular fire alarm of Associated Fire Alarms (Ltd.), and had used the device experimentally for the direct control of 1 kw. at 220 volts. This thermostat was both small and cheap.

LIGHTING OF FACTORIES AND WORKSHOPS.

Vol. III. of the first report of the Departmental Committee on Lighting in Factories and Workshops has now been issued by the Home Office (price 7s. 6d.), and contains a mass of observations, the report running to 190 pages. We referred to the recommendations of the Committee (contained in Vol. I.) in THE ELECTRICIAN for September 10, page 850. It is quite impossible to give an abstract of a report of this kind, and in what follows we merely give an indication of the contents and of the summaries.

Factories were visited in London, Glasgow, Belfast, Manchester, Leeds, Liverpool, Newcastle-on-Tyne, Nottingham, Sheffield and Bristol. Altogether 54 factories were selected of a representative character. Attention was directed mainly to (*a*) illumination of floors and gangways, (*b*) illumination at the point where work was being carried on. Measurements were made of both natural and artificial illumination. As natural illumination varies very much between summer and winter, the observations of daylight illumination are expressed by means of the daylight factor, which is the ratio of the illumination at any point in a building compared with the illumination that would be obtained if the roof and walls were removed, expressed as a percentage. In the centre of some workrooms, depending entirely on lateral windows, the daylight factor falls as low as 0·01 per cent. On an average day in December the outside illumination varies from 500 ft.-candles at 10 a.m. to 700 ft.-candles at

mid-day, and consequently so low a factor may mean a very low illumination internally.

The observations are partly expressed in the form of "frequency-of-occurrence curves," in which the abscissæ are either daylight factor or foot-candles, and the ordinates are on an arbitrary scale proportional to the number of observations. On each of these curves a point is marked which is called the "mid-point," such that above and below this point there is an equal number of observations. The mid-point, therefore, gives an idea of the average illumination.

In dealing with factory floors the lighting is divided between (*a*) roof glass, (*b*) side windows, and (*c*) the combination of both roof and side windows. It is pointed out that the importance of lime washing walls is not often properly appreciated; even where this is done there is a tendency to diminish the good effect by tinting the lime wash. The mid-point of curves dealing with daylight factor show the following results :—

1. *Roof lighting*—		
Foundries	1·4	per cent.
All factories, excluding foundries	2·35	,,
All factories, including foundries	1·95	,,
2. *Combined roof and side lighting*—		
Foundries	0·6	,,
All factories, excluding foundries	1·8	,,
All factories, including foundries	1·05	,,
3. *Side lighting only*—		
All factories	0·25	,,

In regard to artificial lighting, mid-points of the curves gave the following results on floors :—

Foundries	0·4	ft.-candle
All factories, excluding foundries	0·5	,,
All factories, including foundries	0·45	,,

The detailed observations are divided up as follows :—

1. *Textile Industry.*—(*a*) Weaving, (*b*) spinning, &c., and incidental processes, and (*c*) lace and hosiery making.
2. *Engineering Industry.*—(*a*) General engineering, excluding foundries, and (*b*) foundries.
3. *Making up of clothing and similar work.*
4. *Miscellaneous industries.*

The following figures give the mid-point values of the curves for floor illumination :—

Foundries	0·4	ft.-candle
Engineering shops	0·6	,,
Weaving sheds	0·4	,,
Lace and hosiery factories	0·35	,,
Clothing workrooms	0·85	,,
Spinning mills	0·6	,,

In the case of weaving sheds, the mid-points show the daylight factor to be 2·7 per cent. on the looms and 1·5 per cent. on the floors, the corresponding artificial lighting being 2 ft.-candles and 0·4 ft.-candle. In the spinning sheds illumination is considerably lower, and also somewhat lower in the case of factories for lace and hosiery making.

In engineering shops the mid-points for daylight factor and artificial illumination show the following results :—

	Daylight.		Artificial.	
Machine work	1·5	per cent.	1·6	ft.-candles
Bench work	1·8	,,	1·85	,,
Heavy work	1·0	,,	1·0	,,
Floors	1·2	,,	0·6	,,

For foundries the mid-points show the following figures for daylight factor :—

Roof lighting	1·4	per cent.
Combined roof and side lighting	0·6	,,

For artificial illumination the result was approximately 0·4 ft.-candle.

In the case of factories for clothing and similar work, the mid-points gave the following figures for the daylight factor and artificial illumination :

	Daylight.		Artificial.	
Sewing on coloured cloths	1·6	per cent.	3·6	ft.-candles
Cutting and pressing	1·3	,,	2·0	,,
Sewing on white linen	3·3	,,	2·5	,,
Floors	1·2	,,	0·85	,,

THE MELTING-POINT OF TUNGSTEN.*

BY IRVING LANGMUIR.

Observations made during the investigation of the characteristics of tungsten filaments in evacuated and gas filled lamps indicated that the intrinsic brilliancy of solid tungsten, at a temperature just below the melting point, is about 7,200 international candles per square centimetre. This should correspond, according to Busch's equation, with constants determined by Nernst, and an emissivity determined by von Wartenberg, Coblentz and von Pirani, to a melting point of 3,540 K., instead of 3,200 K. to 3,300 K., which had appeared from a consideration of the results of previous investigations to be the most probable value.

An analysis of the sources of error in the method used showed no reason to suspect an error greater than 50 deg.

It was found repeatedly, however, that the presence of minute amounts of hydrocarbon vapours, such as are given off by vaseline or stopcock grease at room temperature in vacuum, not only lowers the melting point and raises the resistance, but also increases the emissivity. This factor has entered into many of the methods heretofore used.

In view of the lack of agreement in the values given, it was decided to re-determine the melting point by methods which should eliminate former sources of error.

The two methods employed consisted of (1) determining the black body melting point of large filaments in nitrogen, and obtaining the emissivity from helically-wound filaments of various sizes in vacuum and in nitrogen, and (2) measuring the brilliance of a surface of molten tungsten and simultaneously determining the brilliancy of the image of a second surface of molten tungsten reflected in the first, thus determining the reflectivity of the molten metal directly.

A pyrometer of the Holborn-Kurlbaum type was used with several nearly monochromatic screens in the eye-piece of the telescope. The equivalent monochromatic wave-lengths for these screens were estimated by direct spectroscopic examination, and also by measuring the relative brilliancy of a large nitrogen-filled lamp with a straight filament, as a series of different temperatures, by means of a Lummer-Brodhun photometer, using the different screens successively in the eye-piece.

The pyrometer was calibrated by first determining the relation of the luminous intensity of the pyrometer filament to the current flowing through it. This was done by means of rotating sectors, and by comparison with the nitrogen-filled lamp photometered through the three screens over the range of temperatures from 1,850°K to 3,040°K.

Next the currents through the pyrometer filament corresponding to several fixed temperatures were determined from the melting points of gold, copper and platinum. The pyrometer was also checked by a heavy filament vacuum tunsten lamp previously calibrated against a black body furnace at the melting points of gold and palladium.

The emissivity of solid tungsten was obtained by determination of the relative brilliancy of the brightest and darkest portions of a helically-wound filament in nitrogen. The best value appeared to be 0·485 or less for $\lambda = 0{\cdot}537$. The emissivity of molten tungsten measured by the method mentioned below was found to be 0·425, and that of the solid distinctly higher. Hence 0·46 was adopted as the most probable value of $\lambda = 0{\cdot}667$.

The melting point of short, single hair-pin filaments in bulbs containing pure, dry nitrogen was determined on the pyrometer by raising the temperature. The nitrogen atmosphere prolonged the life of the filaments at the highest temperature so considerably that it was possible to approach the melting point very slowly, and the actual melting lasted several seconds. After burn out the bulbs were opened and the absorption coefficient determined.

The emissivity and melting point of tungsten were also determined from an alternating arc between tungsten electrodes in nitrogen. At sufficiently high current density the ends of both electrodes formed molten convex surfaces, showing multiple reflections of the two electrodes, and could be maintained in this condition for half an hour or more. Repeated measurements of the intrinsic brilliancy of the molten tungsten and of the successive images were made, giving a direct measurement of the reflectivity and black body temperature, the arc being practically non-luminous with an intrinsic brilliancy less than 1 per cent. of that of the electrodes. The emissivity thus obtained was 0·425 for $\lambda = 0{\cdot}667$, and the true melting point derived therewith from the pyrometer measurements 3,566°K.

The values for the melting point by the several methods are then as follows :—

1. Total photometric method	3,540°K.
2. Filaments by pyrometer method	3,332 K.
3. Arc electrodes by pyrometer method	3,566°K.

A consideration of the probable errors indicates that the best value is 3,540°K.+30 deg.

* "Physical Review," 6, 138-57, 1915 (issued in August)

PACIFIC CABLE BOARD.

The accounts for the year ended March 31, 1915, together with the report of the Board, have been issued.

The traffic receipts for the year were £221,279. 11s. 8d., and the total revenue £223,947. 17s. 1d., an increase of £26,000 over 1913-14. The total expenditure (£8,460. 4s. 8d. for head office, £81,427. 4s. 7d. for cable stations, £21,032. 11s. 9d. ships' salaries and expenses, £2,241. 13s. 2d. provident fund and £32,100 renewal account) was £145,261. 14s. 2d., leaving £76,686. 2s. 11d. to meet interest and sinking fund (£86,601. 11s.) on the £2,000,000 advanced for capital expenditure and the interest and sinking fund (£9,040. 13s.) on the moneys provided for the Sydney-Auckland and Doubtless Bay-Auckland cables. The balance to be provided by the Imperial and Dominion Parliaments is £7,915. 8s. 1d., or £12,035. 0s. 10d. less than the deficit of the previous year.

Owing to the interruption of the Fanning Island cables the transmission of international traffic was suspended for two months, with the result that revenue of over £50,000 was lost. The loss was more than compensated by the increase of traffic resulting from war conditions. While there was a decrease of words in the traffic at ordinary tariffs compared with the preceding year, the deferred traffic showed an increase of 599,879 words, and the week-end traffic rose from 326,920 words in 1913-14 to 1,074,252 words in 1914-15. After allowing for the cost to the Board of the expedition, there remained £2,118, and £2,100 of this sum has been placed to credit of renewal fund. The expenditure shows an increase of £14,065 over that of the preceding year and £18,583 over the original estimate, due almost entirely to the war.

With the exception of the section between Fiji and Norfolk Island, the cables have not suffered any interruption caused by natural conditions. In August a fault developed in the section near Norfolk Island; the repairing vessel commenced operations on Sept. 14th and successfully completed the repair on Sept. 18th. The cause of the fault was rock chafe, and it was found that the cable in the vicinity of the fault was extensively corroded, necessitating the cutting out of several miles of old cable and the substitution of new. A minute fault was observed in June and the delay in commencing the repair was due to the fact that at the time the fault developed, the "Iris" was in the vicinity of British Columbia, but traffic was not materially affected by the development of the fault or by the interruption necessary for its repair.

On Sept. 7, 1914, the cables from Bamfield and Suva were interrupted at Fanning Island by the German cruiser "Nürnberg," which approached the island flying the French flag. The ruse deceived the Board's officers as to the true character of the vessel until she landed armed men and a machine gun. The landing party immediately arrested the superintendent, surrounded the station and trained the machine gun on the office buildings. They then entered the offices, and having made prisoners of the staff on duty, they attacked the instruments with axes. The staff had been able to transmit brief intelligence of the occupation both to Bamfield and to Suva before the enemy entered the instrument room and cut off communication. The station cash (£690) was taken, together with stamps and cash to the value of £71, the property of the New Zealand Postal Department. The Germans also wrecked the engine house, engines, refrigerator and electric light plant with dynamite. They did so under the erroneous impression that some portion of the plant was used for wireless telegraphy. The cables were damaged by dynamite at low-water mark and were also cut about 600 yds. from the shore, and then dragged out of position. The cutting of the cables was undertaken by a collier which accompanied the "Nürnberg." The Board engaged a vessel at Honolulu (the s.s. "Kestrel") on Sept. 19th to take emergency provisions to the island and ascertain the position of the staff and the extent of the enemy's depredations. In the meantime the staff at Fanning had been actively employed in efforts to restore temporary communication over the cable, and in spite of the absence of suitable appliances for handling and repairing cables, and of the improvised character of the apparatus available, temporary communication was successfully established with Suva on Sept. 22nd, and the welcome news was received that the staff and their families were well. The s.s. "Kestrel" arrived at the island three days later. In effecting the repair of the Suva cable the members of the staff concerned displayed remarkable ingenuity and skill. In particular, the work of one of the operators (Mr. Hugh Greig) is worthy of special mention. This officer adapted an ordinary pickaxe to the purposes of a grapnel, and succeeded by this means in partially raising the heavy shore-end where it was cut. He also dived, and, working under the sea, secured the end by ropes, thus enabling it to be raised above the sea level. Attempts were also made, at first by the staff alone and later with the assistance of the "Kestrel," to effect a temporary repair of the Bamfield cable; but as the end of the cable had been dragged a considerable distance out of position and dropped in deep water, the attempts did not meet with success. Skilful and valuable work was also performed by the station electricians at Fanning. The special services rendered by Mr. Greig and by the electricians were suitably rewarded by the Board. The "Iris" was on her way from Bamfield to Norfolk Island, to repair the fault which had declared itself there, when the cable was cut at Fanning Island. It was necessary for her to proceed to Auckland, to take on board instruments, materials, cable and staff; and her departure thence was delayed for a time under the instructions of the Naval Authorities. She arrived at Fanning Island on Oct. 25th, and on Oct. 27th commenced the repair of the cables, which was successfully completed on Oct. 30th. Owing, however, to the difficulty experienced in recovering the duplex balances, it was not possible to accept traffic until Nov. 5th. The replacement of the apparatus, buildings and plant destroyed involved an expenditure of about £5,000.

An extensive reclamation of the foreshore of Suva Harbour is being undertaken by the Fiji Government for providing additional wharf accommodation suitable for steamers of high tonnage. When this scheme has been brought into complete effect the site on which the Board's cable tanks and depot are will be entirely removed from water frontage, and it would be a matter of impossibility to transfer cable between the tanks there and the maintenance ship. The Government has provided a suitable site elsewhere, and have agreed to bear the cost of erecting new tanks, sheds, fittings, &c., the Board undertaking the expense of transferring cable buoys and gear from the old depot. The landline across Canada which the Board leases from the Canadian Pacific Railway Co. enjoyed a year of comparative freedom from serious interruption. On July 19, 1915, the Commonwealth Post and Telegraph Department handed over for the exclusive use of the Pacific Cable traffic emanating from or destined for Melbourne or places beyond, a 400 lb. g.i. wire between the Board's office in Sydney and the Post Office in Melbourne. The wire is operated in Melbourne by officers of the Department and in Sydney by the Board's staff. The Board's house property at the stations has been maintained in good repair. Since the close of the year the construction of a further house at Fanning Island station for the accommodation of six bachelors has been decided upon, and also the erection of two further houses at Bamfield station. The Board have taken steps to reinstate refrigerator and electric lighting plant at Fanning Island as early as possible and contracts have been placed. The Board regret to report that the auxiliary schooner "Strathcona," which was built for maintaining regular communication between Honolulu and Fanning Island, was lost whilst on her maiden voyage in June of this year. All the ship's company were rescued by the "Iris" from the North Minerva Reef, which also succeeded in salving some of the cargo, &c. The schooner was not insured and the loss is approximately £10,000. The "Iris" was employed during the year to a greater extent than in any previous year. She was in commission from the middle of June to the middle of December uninterruptedly. During this period she carried out the laying of a cable between Bamfield and Victoria (British Columbia) in August, the repair of Suva–Norfolk Island cable in September, the repair of Fanning Island (Bamfield) and Fanning Island–Suva cables in October and the repair of the New Caledonia cable in December. The vessel made her voyage from Bamfield to Norfolk Island and Auckland, and from thence to Fanning Island to repair the cables damaged in the vicinity of that station, at a time when enemy warships were at large in the Pacific. For this reason and for future purposes it was decided in September to instal a wireless telegraph set on the "Iris." The utility of the installation has been demonstrated in connection with the search for the schooner "Strathcona." Captain T. W. Sharp, who had been in command of the "Iris" since 1904, relinquished the command in December for reasons of health, and he was succeeded by Captain W. R. Holmes, formerly chief officer.

In October, Lieut.-Col. Sir Matthew Nathan, G.C.M.G., retired from the Board and was succeeded by Sir George S. Gibb. The vacancy in the representation of the Dominion of Canada, caused by the death of the Lord Strathcona and Mount Royal, was filled by the appointment (in October) of the Hon. Sir George H. Perley, K.C.M.G. Since the close of the year the Board have had to deplore the death of Mr. G. Scott, Clerk-in-Charge of the Vancouver City station, who died suddenly on May 14 last, and Mr. J. C. Lockley, in charge of the Melbourne office, who died on July 21st. The staff have been much affected by the war; the amount of work has more than doubled owing to the very large increase of business, and the whole staff have been obliged to work at high pressure not only during their normal periods of duty, but during long hours of extra time, including Sundays and holidays. Efforts have been made and are being continued to engage additional operators, but owing to the increased demands of all cable administrations and to the number of men with cable experience engaged on military field work, it has not been possible to obtain the number required. A number of young clerks are being trained for the service at four of the stations and in London. In view of the increased cost of living and other inconveniences arising from circumstances due to the war, and also as an acknowledgment of zealous service, the Board have recently authorised the payment of a special allowance amounting to 10 per cent. of net salary during the year commencing Jan. 1, 1915, to all persons in their employ (subject to certain conditions). Nine members of the head office staff are serving with H.M. Forces. The conditions arising out of the war created a large amount of Government and Press traffic, and also increased the number of business and private communications passing over the cable. Further, the total prohibition by the Censorship Authorities at the commencement of the war of code language in telegrams resulted in a very large increase in the number of words transmitted, owing to the absence of any means of condensation. To reduce the hardship caused to the public by the additional expense of sending ordinary messages in plain language, a system of counting the text and signature of the messages at the rate of 10 letters to a word, irrespective of the division into actual words, was introduced by the Telegraph Administrations. On Nov. 1, 1914, the code restrictions were partially relaxed, and the 10-letter counting system was then withdrawn. Seven well-known and widely used codes are now admitted. With the exception of the period of two months during which the Pacific Cable was entirely interrupted, deferred and week-end cablegrams as well as ordinary messages have continued to be accepted for transmission via Pacific. At the beginning of the war both the deferred and week-end cablegram services with Australasia were suspended except by the Pacific Cable Board's route, and the week-end service is still only available by the Pacific Cable. The report recalls that the Pacific Cable Committee of 1896 estimated the probable carrying capacity of the Bamfield–Fanning Island Cable, the longest cable in existence, at rather less than 2,000,000 paying words per annum. Since the close of the year under review, the cable has frequently carried more than 175,000 paying words per week, or at the rate of about 9,000,000 paying words per annum. The progress of invention since 1896 has effected improvements in transmitting and receiving apparatus, which have largely increased the speed of transmission over cables of great length. This partly accounts for the very striking superiority of the results realised over the original estimate, but it is also to be noted that the estimate allowed for the use of the cable during 18 hours a day only, whilst the introduction of the deferred and week-end rates has permitted its employment during the whole of the 24 hours. The Board have reduced the New Zealand tariffs by the difference between the terminal rates levied by the Australian and New Zealand Governments respectively.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Displayed Advertisements not for proof before first insertion can be taken until NOON ON WEDNESDAY, and Official Announcements, Auctions and "Smalls" of all kinds of which no proofs are required before insertion can be accepted up to FIRST POST THURSDAY MORNING.

SQUARE PEGS IN ROUND HOLES.

Many mistake platitudes of pompous pretentiousness for patriotism, regardless of the fact that oftentimes the true patriot is the one who opposes. At one time it was thought that education would lead to the abolition of war, and, maybe, there are still some old-fashioned people who hold this opinion. It is generally admitted that education promotes happiness, and that higher education promotes industrial prosperity. Both happiness and prosperity are of importance to a nation. We side with the old-fashioned people, and believe that universities and technical colleges were founded, and conducted, till a few months ago at any rate, with the sole object of reaping victories from peaceful pursuits.

Elsewhere is given an abstract of a Paper on "Engineering Colleges and the War," read last week by Dr. R. M. WALMSLEY and Mr. C. E. LARARD, before the Institution of Mechanical Engineers. Under three headings the authors dealt with munitions work in technical college workshops, the training of munitions workers and war workers generally, and other engineering war work in technical colleges. It is seldom that we find ourselves so entirely at variance with the authors of a Paper on essential points.

In an introductory note we are told that "Anyone who during the last few years had followed closely the developments of armaments could have predicted that . . . . the next great war would be essentially an engineers' war," and, in the next paragraph, "It was, therefore, a national duty, from the military and naval as well as from the educational point of view, that the equipment and staffing of engineering technical colleges and their organisation should be brought to a high state of efficiency as a preparation for national defence and offence, if need be,

against the contingency, which was not very remote, of this country having to face a European war."

It was not till we read the Paper that we were aware that any engineering technical college in the country had been equipped and staffed with so base an object. Had we been told that such was the case we should have been tempted to echo Mr. BURCHELL'S comment on Lady BLARNEY'S conversation at the Michaelmas Eve celebrations. Even now we are not convinced that Dr. WALMSLEY'S college was equipped and staffed as a preparation for defence or offence of a military or naval character. If such was the intention of the governing body they showed little of the sound common sense for which they are famous either in the selection of equipment or of personnel.

For the past eight months technical colleges have been engaged either in the making of munitions or in the training of munitions workers. Paper schemes in connection with the latter have been devised by the Board of Education, and we believe that in many of the engineering colleges, on the initiative of the staffs of these colleges, workers are being trained and munitions are being made. It would be idle to deny the ability of the colleges to undertake such work, but we question the desirability of giving to all and sundry 60 or 70 hours' practice on lathes or the like to make them into semi-skilled workers, and we question the necessity for the manufacture of munitions in our colleges. In isolated cases workers so trained may be able to find employment, but the combined output of munitions from all the college workshops is inappreciable.

The dabbling in war by the technical colleges and schools would be less intolerable if the ordinary work were being done. But it is not. As we pointed out last week, our colleges are empty, and no decisive action has been taken by the Board of Education to prevent senior students joining the army before completing their courses of study. In all likelihood few of these men will ever return to the class room or laboratory, and of those who do return only a small percentage will be in a condition to engage in work of an advanced character. At the present time the colleges are not engaged in the training of men in the higher branches of engineering, science and technology, nor will an adequate supply of properly trained men be available till several years after the termination of the war. It is not our purpose to paint a gloomy picture, but we cannot help wondering what is to become of our industrial development (about which we heard so much 12 months ago and now so little) if such a state of affairs is allowed to continue. Without an abundant supply of trained engineers and technologists there can be no industrial development in the future, nor can our present position be maintained.

Anyone unfamiliar with the training of engineers, on reading the Paper by Dr. WALMSLEY and Mr. LARARD, might conclude that workshop practice is an important feature of technical training. In reality it is relatively unimportant, apart from its spectacular value, otherwise a student would go straight into the works and stay there, for nowhere but in the works can a student learn, or even hope to learn, the "artisan side" of engineering. We wish it to be understood that we do not use the term "artisan side" in an offensive sense, but the navvy is surely as entitled to call himself a civil engineer, as the turner or fitter is entitled to be called an engineer, or the wireman an electrical engineer.

The authors do not touch upon what we consider to be a most important function of technical colleges in time of war. We refer to the filling of junior positions in the engineering branches of the Army and Navy. Surely trained engineering students hold higher qualifications for, and are more entitled to such positions than many to whom they are offered. Of the engineering students holding commissions in the new armies probably 90 per cent are square pegs in round holes, and this, we take it, is what was meant by those who proclaimed, "Business as usual." As far as we are aware in no other respect is business as usual, nor has it been since war was declared. To the training of officers for the new armies the whole weight of the technical colleges could be given, and on this work we venture to think that the staff of the Northampton Polytechnic, in common with the staffs of many other colleges, would bring at least the zeal, enthusiasm and thoroughness which they have shown in the higher branches of technical education, and in the manufacture of munitions. The credit for what has already been done would be dwarfed by that which would be given to the colleges if they made the opportunity of training and laid themselves out for the training of the men who lead, and incidentally, the importance of technical education would be brought home to those who are of the opinion that a classical education alone makes men fit to hold high positions.

Provided they left the blackboards and chalk, the laboratory equipment, the students to use such equipment, and a sufficient number of lecturers to teach the students, we would gladly see the Ministry of Munitions commandeer every vice, lathe, machine-tool and workman from every college in the country. In this way would the gauge-making be uninterrupted, as also would technical education, and we should stand a fair chance of "winning through."

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Callendar Steam Tables. By H. L. CALLENDAR, F.R.S. (London: Edward Arnold.) Pp. 39. 3s. net.

These new steam tables are the result of many years accurate thinking and extremely careful experimental research. They mark a distinct advance in the application of the best results of what is often styled pure science to practical use.

Hitherto the values of heat per pound of steam have been calculated from empirical equations devised to suit the results obtained by the direct experiments of Regnault, and which were published in the "Memoirs of the Institute of France," 1847.

These experiments of Regnault, made so long ago, were conducted with minute care, and the fact that the results deduced from them were, and are, in general use up to the present time testifies to their accuracy over a wide range. For ordinary purposes of comparison of engine and boiler performances the engineer is chiefly concerned with relative values; provided that these are to be relied upon, the need of absolutely true values is not a necessity, however desirable such may seem to be. For all good scientific work the need for accurate data is paramount, and these Callendar Steam Tables, by virtue of their accuracy, are a necessity for every physical and engineering laboratory and up-to-date testing plant installation.

The development of steam turbine engineering and the use of steam down to very low pressures make the fundamental equations upon which these tables are based of direct use, inasmuch as the determination of the properties of steam at such low pressures by experiment is very difficult and the results unreliable.

The volume under review consists of a brief explanation of the tables and definitions of all units used in the book, together with expressions for the total heats of water and steam and the characteristic equation for dry steam. There are seven tables

which occupy 20 pages, and inset at the end cover is a large diagram giving pressures and temperatures plotted as abscissæ, with values of total heat as ordinates. Across this diagram are drawn lines of constant dryness, constant entropy or adiabatic lines, constant volume, with lines of constant temperature Centigrade in the region of superheat. This diagram, which gives graphically the results of the tables, can be purchased separately.

It should be noted that table No. 2, which would be most often consulted—viz., "Properties of Saturated Steam in Terms of Pressure"—is given in kilogrammetre and foot-pound units, also Centigrade and Fahrenheit. The diagram, however, only gives total heat in Centigrade units or pound-calories, a term preferred by the author.

These tables should become the recognised standard in this country, and Prof. Callendar deserves the thanks of all who love numerical and scientific accuracy. A. J. M.

A First Course in Engineering Science. By P. J. Haler, B.Sc., and A. H. Stuart, B.Sc. Pp. viii.+191. (London: W. B. Clive). 2s. 6d.

This little book embodies both the material and the suggested treatment of that material laid down in a publication issued by the Board of Education under the title "Memorandum on the Teaching of Engineering in Evening Technical Schools," the portion of the subject dealt with by the authors being that assigned to the first year of the major course of "Engineering Science." The book is divided into two parts, of which the first is devoted to mechanics and the second part may be looked upon as introductory to the steam engine. Although certain of the matter is good, we are decidedly of the opinion that the elementary student would do better to obtain separate books on applied mechanics and heat engines (of which there are several really excellent ones already on the market) and work carefully through these. The authors advise students to provide themselves with sketch books and to make good detailed sketches of different types of engines and boilers. They observe that text-book illustrations help. Many of the illustrations in their book are not only very badly executed but in addition are faulty in detail. Since young students attach a good deal of importance to the printed page, we should advise authors and publishers of elementary books on engineering to insist on a uniformly high standard of excellence for all illustrations.

Continuous and Alternating Current Machinery Problems. By W. T. Ryan. Pp. vii. ; 37. (London: Chapman & Hall). 2s. 6d. net.

This little book of problems was prepared to be used for a short elementary course on electrical engineering intended for civil and mining engineers. In general the problems are very closely related to actual engineering practice and are so made up as not to be mere mathematical puzzles. The ground covered includes the elementary laws and principles of continuous currents and alternating currents; continuous and alternating current generators and motors; efficiencies; transformers and polyphase power. The student will find helpful the author's notes on many of the problems, and to some the absence of answers to the problems will be disappointing. The book is well printed, and will, no doubt, serve the purpose for which it is intended.

ENGINEERING COLLEGES AND THE WAR.*

BY R. MULLINEUX WALMSLEY, D.SC., AND C. E. LARARD.

On the outbreak of the war it was inevitable that the work of the technical colleges should be put upon its trial, and that the colleges should be asked to prove that the large sums of money spent on their equipment and staffing were justifiable from the practical engineering point of view.

The object of this Paper is to deal more especially with what is being and can now be done by the technical colleges in assisting the country.

For convenience of reference, the Paper is divided into the following three sections: (1) Munitions work in technical college workshops; (2) training of munition workers and war workers generally; (3) other engineering war work in technical colleges.

Munitions Work in Technical College Workshops.

Equipment Available.—Many of our best technical colleges have well-equipped workshops provided with valuable modern tools of precision. Where such equipment is available there can be no doubt that the best use to which it can be put is in the manufacture, either directly for Government departments or the local Munitions Committees, of munitions of all kinds.

As regards the amount of equipment available of one type or the other, it may be noted that the number of technical colleges and schools in the United Kingdom comprised in the membership of the Association of Technical Institutions is 96. Altogether, not fewer than 112 educational engineering workshops or sets of workshops are in existence, and of them about 25 are more or less well equipped with modern tools.

Personnel: Staff, Students and Others.—As regards personnel, there are on the staffs of many of these engineering colleges and schools skilled instructors and workmen. There are also large numbers of skilled and semi-skilled engineering students who may be employed, and these may be and are in many cases supplemented by any outside skilled workmen obtainable.

Conditions of Utilisation.—The question of immediate importance is under what conditions and how the workshops of our engineering colleges can be made of use. Where there is already a collection of modern tools of precision as well as of the other tools suitable for roughing out and finishing, the best course to pursue is to organise the workshop as a factory workshop, and staff it under the direction of the well-trained staff, employing also such students as are available and are likely to be useful in the work. In addition, skilled workmen should, whenever possible, be imported from the outside.

An alternative method in large centres would be to assemble under one organisation a selection of tools from the different colleges in the area rather than to distribute the work amongst the colleges. The object of this centralisation would be the carrying on of the best type of work mentioned in the next sub-section.

Where, owing to the unsuitability of the equipment or for other reasons, the technical college authorities are unable to engage in the manufacture of munitions or to employ suitably the tools under their charge, they should be required to hand over such tools, either on loan or purchase, to Government Departments or "controlled" munitions works urgently requiring them.

Munitions Work which can be undertaken by the College Workshops.—Taking first the college workshop equipped with modern tools, machines, gauges and standards, perhaps the most useful work at the present time is the manufacture of gauges, for which there is a very pressing need. Then, again, numerous details are wanted for gun and small-arms work requiring not only the use of capstan lathes and operators, but of the higher type of workman able to use gauge and micrometer in milling, screw-cutting, grinding, &c., and for this kind of work also the well-equipped college workshop can be and is being made use of.

Turning next to somewhat poorly-equipped workshops, these can be utilised provided the necessary tools of the ordinary type are available, with students to work them. They can be employed on rough machining and on many other operations requiring only somewhat crude workshop skill. Experience, however, up to the present has shown that this roughing work is difficult to obtain from the sources indicated, for reasons given by the authors.

It is here that the Local Munitions Committee, or the Local Education Authority in the case of large areas with several technical colleges properly organised, can be of use even if it be considered undesirable to develop a centralisation scheme such as has been recommended above. Orders for finished units of work in quantities should be freely placed with these authorities by the Government departments. The authorities acting as distributing and collecting agencies would then place orders and material with the various technical colleges for specific operations.

In an appendix to the Paper the authors have scheduled the chief particulars which should be ascertained as a basis for the decisions to be arrived at. It is one of the sacrifices demanded by the stringency of the present crisis that at least some of the educational work, and from the conditions that of the higher type, has to be set aside for the present, so that the personnel, both students and instructors, as well as the material equipment, may be freed for national service. It being granted that only full-time work is contemplated, it is essential that it should be organised in accordance with the practice which in some form or other now obtains in the best workshops.

In the first place, a reliable system of cost-keeping is essential, and although the various institutions will, perhaps inevitably, adopt

* Abstract of a Paper read before the Institution of Mechanical Engineers

methods suitable to their particular circumstances and differing in details, yet it is important that each institution should start on a clearly-defined system. As an illustration of how this may be done, the method adopted in the workshops of the Northampton Polytechnic is described.

In connection with the question of the extent, if at all, to which the salaries of the engineering teaching staff should be charged to munitions work, we are glad to note that the governing bodies of some institutions feel it their duty to allow their staff, in time not urgently required for other work, to engage upon munitions work without charge to the cost of the work. If this were not done, the utmost that could be properly charged to munitions work, where the staff are engaged on this work, would be workshop value of the individual on similar work in a modern engineering factory. The simplest solution, and the one to which least objection can be taken, appears to be to allow engineering teachers in public institutions to engage upon munitions work without any charge for their services being made against the cost of such work. Exception may be made, however, where overtime is worked, for which the proper workshop value should be paid to the teacher. This procedure will simplify matters and avoid the cumbersome business of transfer and readjustment of grants.

Munitions Work actually undertaken in the College Workshops.—The authors propose next to give some indication of the munitions work which is at present being done in the engineering workshops of the different technical colleges, together with some idea of the actual conditions under which such work is being undertaken. Dealing with the London educational institutions first, and, in this section only, with munitions work, by far the most important of the work undertaken is the manufacture of numerous types of gauges which require to be finished with a very high degree of accuracy. In addition, numerous details are being manufactured for naval and military work of various kinds. The particular type of work undertaken in any institution depends, as has just been shown on its equipment and the conditions under which the work is organised and carried out.

An important question is the cost to the country at which this work is being done. Some institutions will no doubt be able to show that they can manufacture at a price which compares favourably with that of the outside manufacturer. In other institutions the cost price may well, because of the conditions, be greater than the proper market value, but it must be borne in mind in this connection that the work is very urgent, and that it is impossible at present to produce the goods required in sufficient volume to meet the imperative requirements. On that account extra cost may be faced without misgiving, provided it is not unreasonable, as it is output which matters first and cost afterwards. It cannot be disputed that, if a college workshop can turn out work up to specification in sufficient quantities at a reasonable market price, then that workshop is doing good work under difficult conditions, and that if it be possible for one good workshop with good facilities to do such work, it is possible for others under proper organisation to do likewise.

The conditions under which work has been accepted at the Northampton Polytechnic, whether that work is done for a Government department or for the local Munitions Committee, is practically the cost price to the governing body of the work done, over and above any outgoings which would have been incurred if the work had not been undertaken. Hitherto, orders have not been accepted from private firms, and it is proposed not to accept such orders so long as the necessary work is forthcoming from the Metropolitan Munitions Committee or one or other of the Government departments. Technical colleges undertaking work for private firms must necessarily agree at the very commencement with respect to the financial conditions under which the work is undertaken. In some instances contracting parties have agreed on a definite price for each piece of work to be done. In other instances the cost price, with or without establishment charges, has been agreed to, but the conditions vary considerably in relation to the many technical institutions which have undertaken munitions work.

The authors have endeavoured, from statistics available, to form a rough idea of the extent to which technical colleges are dealing with the munitions problem, and have estimated that about one-third are employed on the manufacture of munitions in some form; another third have been training munitions workers; and some of the remaining technical colleges have dealt with the problem by the supply of their workshop tools to munitions factories.

Training of Munitions Workers and War Workers Generally.

Summary of what is being done at present in Technical Colleges.—A fair number of technical college workshops are being utilised for the training of munitions workers, and the training given depends essentially on the type of workshop equipment, as well as upon the technical or teaching staff which can be set aside to deal with this work. The instruction courses given are remarkably varied, both in relation to the duration of the course and the quality of the work dealt with. Comparatively few institutions are prepared to offer any guarantee of subsequent employment to those being trained, and it is believed that only a very small proportion of workers so trained at the outset ever saw the inside of a munitions factory. A "certificate of proficiency" in munitions work may therefore mean little or much, and the proficiency certified requires to be very specifically defined. Better considered courses of instruction are, however, being offered and taken advantage of at technical colleges in London and in the provinces. Apart from the instruction which is being given to inexperienced workers, a good deal is being done in connection with the supplementary training of skilled and semi-skilled workmen. Courses of instruction are offered to skilled mechanics, fitters, turners, &c., some of whom are members of trade unions. We find at one large provincial centre a complete plant for the turning out of shells. Another prominent institution, acting under the local Munitions Committee, has received thousands of names of persons, many of whom are semi-skilled and many unskilled, who wish to receive instruction in the use of modern machine-tools and measurements for shells and gun manufacture. Then again, more than one institution is combining instruction work with a certain amount of munitions manufacture.

It has recently been proposed by certain of the educational authorities to add to their present equipment certain modern machine-tools of a very elaborate character with a view to training selected mechanics or others in the use of these particular tools. It is very doubtful whether such tools can be obtained from the manufacturers under present conditions in time to be of any use, and even if they could be so obtained, whether this is the best way to utilise them.

Training carefully selected Hands on the direct Production of Munitions under Manufacturing Conditions.—There are, we believe, in the United Kingdom thousands of men with some workshop training, and these men have received their training and experience in the old-fashioned type of shop of the non-specialised kind.

The general trend of recent years has been to replace costly hand-finishing and the costly work done on the older types of English tools by machines which in time have become more and more automatic, with greater accuracy of the work done and with greatly increased output. Hence the developments in the manufacture of the many types of milling machnes, jig work for increased and accurate productions, and the use of limit gauges, instead of micrometers and callipers, have led to the development of special tool-makers' machines and the modern tool-room equipment.

Thus it is found that in the highly organised and equipped factory there is little requirement for the ordinray type of skilled workman trained on the older workshop methods referred to above; and yet these developments are so recent that thousands of workshops are still of the non-specialised kind, and are still training the older type of skilled workman accustomed to receive good wages. Thousands of such workmen were, we believe, quite recently available for employment on munitions if they could be brought into use. At the moment the problem is to utilise this skilled labour in the production of the munitions which are so urgently required. The partial solution which has presented itself to the authors is not to establish instruction courses for such men, but to find work for some of them on munitions in the lower type of technical college engineering workshop, where they would find the tools with which they are familiar, and in the use of which some of them, at least, are expert.

There is next a class of men which should be utilised, and which consists of men with some practical engineering training, but who have for a longer or shorter period been following other types of employment, and have not been in contact with practical mechanical work for some time. Even if years have elapsed since their contact with practical work, skill gained is never lost, and two or three weeks at a factory should be quite sufficient to enable such men to regain their manipulative skill with ordinary tools, either hand or machine. For such work no special training in the schools ought to be required, nor should the time of the schools be spent on them

Since the above was written a scheme has been drawn up for training semi-skilled munitions workers in technical schools. This scheme has been drafted by the Ministry of Munitions in co-operation with the Board of Education, the Scottish Education Department and the Labour Exchanges. In a Memorandum* issued by the Ministry of Munitions special emphasis is laid on the condition that the training to be given must be thoroughly practical, and that purely educational ideals must be subordinated to utilitarian methods. In fact, the training, from an educational point of view, is to be pure

* An abstract of this memorandum is given as an appendix to the Paper.

"cram" work in engineering workshop practice of a strictly limited type.

Whether, and under what circumstances, the direct Manufacture of Munitions is preferable to Training Munitions Workers.—The first point to settle in each case will be as to whether it is better to arrange for the direct production of munitions or for the training of munitions workers. In connection with all such schemes, however, there arises the important and complicated question as to whether it is justifiable to set on one side specialised machine tools for instruction purposes when they are so urgently required for the direct production of munitions. The schemes also involve the absorption of the time of skilled instructors who might otherwise be employed on productive work. There should, therefore, be seriously considered in connection with the value of this work—

(*a*) The diversion of large numbers of useful machine tools and highly-trained mechanics (workshop instructors and teachers) otherwise directly employable in the manufacture of munitions.

(*b*) The proportion of men so trained who afterwards find effective employment on munitions work.

(*c*) The effect on the acceleration or retardation of the production of munitions by the employment of large bodies of short-trained, and therefore only at the best semi-trained, workers.

Other Engineering War Work.

It may be of interest to summarise very briefly the types of work, other than the direct production of munitions and the training of munitions workers, which has been undertaken by the colleges:—

1. The testing of war materials.
2. The testing of new constructional details for military and naval purposes.
3. All kinds of chemical and metallurgical analyses.
4. The testing of the numerous optical appliances which form so important a feature in modern warfare; also the working out of designs to meet new requirements.
5. General experimental work of various kinds in connection with the numerous committees which have been and are being organised.
6. The requisitioning of individual members of the staff to give technical advice on subjects in which they are specialists.
7. The training of drafts for the new armies in intensive short courses of special work.

DISCUSSION.

The discussion was opened by a Labour Official, who requested the Press not to report his remarks.

Dr. Wm. Garnett (educational adviser of London County Council) said, coming face to face, as they had recently done, with the production of highly specialised work, they had learned that in some measure the engineering schools required development. He did not think much could be done with the automatic tool in the schools, because it was too productive and too highly specialised; but the capstan lathe might quite properly be introduced for the purpose of teaching tool setting. Formal training, as the educationalists called it, would not suffice, because there was not enough "transfer" from one tool to the other. They seemed to be rapidly approaching the time when, for the ordinary work of the shops, there would be demand for only two types of workers, the highly-skilled tool maker, tool setter and precision worker, who was quite at home with 1/10,000th of an inch, and the unskilled tool minder, who could learn his job in an hour or two in the shop, but was, nevertheless, all the better for some preliminary training in vice and lathe work. This time had not yet fully come, even in munitions work, for in most munition shops the demand was today for plain turners, and tools could profitably be used in the hands of semi skilled workers at low wages for work for which very different tools would be employed under normal conditions. Nevertheless, the most striking feature of the present labour market was the large number of men who, a few years ago, would have passed as skilled fitters and turners who are now unable to obtain employment at ordinary trade wages. The extent to which teaching could be advantageously combined with production in the engineering schools had not been definitely determined. The distribution has settled itself for better or worse, more or less permanently in London, and the institutions possessing well-equipped shops have been used almost exclusively for production, and in some cases extra tools had been transferred from smaller institutions to those workshops where there was room. The authors asked about the result of this teaching work. The great majority on joining the classes had no experience of engineering work, and the course extended over six weeks, and included 144 hours of actual work. Of 518 completing the course, 357 had been placed in munition works. The Board of Education suggested a period of not under 30 and not over 100 hours. In those provincial institution in which the course had been reduced to 10 hours no pretence had been made at a course of training. The 10 hours had served simply to introduce the pupil, if a novice, to the workshop atmosphere, and, for the purpose of a test, enabling the authorities to observe how the pupil shaped, and thus to be in a position to recommend him to would-be employers as first, second or third class. But even where the training extended to 100 hours or more the most that could be done with the novice was to teach him to perform certain operations in the hope that if he was young he might, when the war was over, study engineering.

Mr. H. G. Taylor said it was quite impossible in a Paper of this kind to escape the educational aspect. In his opinion, the best method was to teach students to be useful in as short a time as possible. Since the beginning of last July he had been in charge of a class for training munitions workers. Although practically every profession and calling had been represented amongst these workers, in most cases they had turned out successfully. At least 90 per cent. of the men trained had become satisfactorily established in munitions factories, and many of them were doing remarkably well. At the outset his college was approached as to the advisability of training tool setters, and they got into contact with a firm particularly wanting tool setters, who asked that a course of training should be given and that the best men should be sent along. A course of about 140 hours was decided upon, and on an average there were about seven students per instructor. In the majority of cases the men had had no previous training or workshop experience. The factory found these men very satisfactory, and kept asking for more; in fact, quite one-fifth of the students had gone to this particular works. He visited the factory recently, and found that some of the men had got so advanced that they were training the incoming men as tool setters. The manager of the works thought the college could not do better than proceed with the course of training adopted, and to continue to teach the students their ABC, as it were, after which the works would teach them how to spell. He himself had come to the conclusion that this was the best. His experience was that those men who were mechanics before the war had not proved satisfactory, and all that could be done was to recommend them to some firm where they could do a little tinkering like that to which they had been accustomed. Mr. Taylor concluded his remarks with a brief demonstration of the course of training given at King's College.

An Official of the Ministry of Munitions said that the general knowledge acquired in some six weeks' training was of necessity somewhat superficial, and students could only do the simplest operations after such a course. It was important that students should not get the idea that they had acquired a considerable degree of skill, as they would then be more difficult to teach than men who came with an open mind who stated that they knew nothing, and had therefore not to unlearn. As the output of shells was the chief consideration, he strongly urged that the training be confined as far as possible to a single operation, that the capstan lathe should be introduced as much as possible, and that all idea of training of an engineering course should be abandoned for the time being. If that particular class of training necessary to fit men to go into the factories and turn out work passable by the authorities was given the training would have been successful. Already a substantial number of students were employed, which gave the idea that the work had been satisfactory. In regard to the capabilities of the students, he had heard them described as wonderful, and also as total failures. It all depended upon the management and the ability to apply the training to the best advantage. There should be closer correspondence between the managers of factories and the technical schools. If a factory was going to get men from a neighbouring college, the manager and the college authorities should meet occasionally and find what class of workers were required, and, if possible, arrange for them to do that particular work. This plan had been tried in a certain provincial centre and had worked very satisfactorily.

Prof. G. J. Wells said there was one general remark which he was tempted to make in reference to the conflict, or supposed conflict, between professors and the shop. The statement was made in the Paper that "Many practical engineers, and some engineering professors, have in the past looked with disfavour, almost with contempt, on the college workshop, and had doubted whether any serious work or instruction of real value can be given in it from a practical engineering point of view." A little of that difficulty should have been dealt with by the various committees, because if the authorities required educational training, if the institution required the chief of the department to have a B.Sc., it was unreasonable to suppose it could be got from a workshop training. If the authorities in the first place had recognised the need of teaching engineering, there would have been no conflict between the two. An engineer must teach engineering. Then the authors thought that the educational authorities should take charge of the proposed centralisation. He was disposed to think that the central organisation should be taken charge of by qualified engineers. The work carried out at East London College had come before him in the following way: Early in the war the question was raised as to what the college could do. Two courses were open, either to train munition workers, or to supply the skilled workers they possessed to suitable places where their special skill could be utilised. The Government decided that the latter course should be adopted, and so the college lost the whole of its trained skilled workers. It was then thought the college might do something more, and they took up testing, and not only physical but commercial tests were being done. Then the college possessed some antiquated tools, and it was necessary to decide the course best fitted for the work in hand, and he was glad to say that the line taken some months ago had proved quite correct. They started a course consisting of a great many exercises, and it was at once obvious that what we wanted was not men who were neither fish, flesh nor fowl, but somebody who could supply workers to the shops. All educational routine was thrown overboard, and they were trying to make each man fit to do the job for which he was going to be engaged.

Mr. C. E. Larard, in reply, said that the chief object in writing the Paper was to enable discussion to take place on matters of vital importance to the country at the present time. He agreed that general training was entirely out of the question at the present time. What was wanted in connection with unskilled labour was to train the workers to

perform one simple operation ; but of course, in technical schools, where they had students and others able to do more than one operation, something more was necessary. He doubted whether the course of simple instruction outlined by Mr. Taylor was of any value in a munitions factory. Reference had been made to combined teaching and manufacture, and he understood Dr. Garnett to say that this could be done successfully. He had had practical experience in connection with munitions and instruction work combined, and the latter had had to go finally. If they had to organise munitions work for the greater part of the day, and then bring in a body of unskilled men on to the same tools, the settings were damaged and time was wasted next day in getting the tools right again. If the machines were kept separate it would, of course, be all right.

COLLECTIVE POWER FOR BRITISH MANUFACTURING.

On Wednesday evening, the 15th inst., another informal dinner was held by the British Electrical and Allied Manufacturers' Association, at which a discussion took place on "Collective Power for British Manufacturing," the subject being introduced by Mr. T. C. Elder, honorary secretary of the British Association of Trade and Technical Journals. Owing to the indisposition of Mr. Davenport, the chair was taken by Mr. P. Rosling.

Mr. ELDER remarked that there were optimists and pessimists in business just as there were optimists and pessimists in the war. He personally was an optimist, but it was necessary to be an active optimist. He proceeded to enunciate what he described as a "negative creed." The Board of Trade, for example, was of no value to industry, and there was no question that there ought to be a Ministry of Commerce. He did not believe much in the talk of a business Government, nor did he believe in professional politicians. There was an old Wessex proverb to the effect that "This and better will do ; this and worse won't," and there was a good deal of truth in the saying. It was better not to waste time in trying to get political help, but to act for ourselves. There was no doubt that British engineering had made a most wonderful effort since the war began, and the question he wished to consider was, What could be done with the margin of engineering capacity when the war came to an end ? The output that was possible at the present time was enormous, owing to the laying down of huge engineering works ; but there would be a staggering effect on engineering when peace came. The questions were : What would the Government do ? What would the manufacturers do ? What would labour do ? Further, what would the Government do to keep our engineering industry ahead of that of Germany ? In his opinion, engineering firms should gain the confidence of the workers and of the voters. A new organisation should be formed to take measures for the advantage of all concerned—for example, by influencing the buyer and increasing the turnover. If chaos came with victory, it would not be the fault of the Government, but of the engineers themselves.

Mr. P. MARSHALL thought we must depend on ourselves, and not on other people. The proposed association seemed the best way of impressing the Government with the needs of the engineering industry. The idea of most British firms seemed to be on the lines "We have a good thing, let us try to sell it," whereas foreign competitors went to see what people wanted and then tried to make it. He did not see why we should not try to manufacture cheap articles as well as the higher class articles, provided they were good. In his opinion, wages would still remain higher after the war than before, owing to the high wages that had been earned during the war. Consequently, our methods would have to be improved to enable us to pay these higher wages.

Mr. LEE MURRAY was of the opinion that we must depend more on individual effort than upon other people. So far, manufacturers had been too busy upon new work. The general idea was that, in order to capture German trade, it was necessary for us to send men into foreign countries and have catalogues in foreign languages, give long credit and change patterns as often as desired. Also, according to Mr. F. W. Wile, the Germans would carry on their business in all sorts of dishonest ways. Actually, however, these were not the German methods. The Germans had built up business because they had earned it, and the success of their methods depended upon two facts. Firstly, they selected men who knew the market, and, secondly, men who knew the stuff they were selling. The British manufacturer often made the mistake of doing only one of these things, with the result that his efforts were wasted.

Mr. F. W. WILE, after dealing humorously with the remarks of the last speaker, emphasised the fact that there was not a neutral market at the present time that was not being vigorously exploited by the Germans. In China, for example, they got so far as to print catalogues in English, German and Chinese, of which he handed round a copy, enumerating cinematograph films showing the progress of German arms in the present war. These films were being exhibited on a large scale in order to educate the Chinese. He thought it would be well, according to a suggestion made by Mr. C. Colton, that the association should have a dinner, at which they invited labour men to express their opinions. If there was a chance of conflict between capital and labour, as many speakers thought there would be, after the war, it would be much better for the representatives of employers and labour to meet beforehand to discuss their respective points of view,

Mr. P. ROSLING, the chairman, said that before the war unemployment amounted to only 3·5 per cent. in the engineering trades. It would, therefore, be difficult to increase our output materially after the war unless trade union restrictions were removed. If the workers would only realise that they would have better times by the removal of these restrictions they would no doubt be removed. He thought the Press might be able to do something in this direction.

Mr. BRIGHTEN said that he had lived for many years in China, and he thought that unless action were taken in China to recognise the new Emperor without delay there would be a set back for British engineering, just as there was through the early non-recognition of the Chinese Republic. German competition had been difficult to meet over there. As an example he might mention that, some years ago, material was supplied c.i.f. in China by Germany cheaper than could be manufactured in this country. The limitation of output on the part of trade unions was due to a fear of reduction in piece rates. If employers and labour would only come together he thought the problem of these restrictions might be solved.

Mr. D. N. DUNLOP (secretary of the Association) remarked that any successful co-operation depended upon individual initiative. The B.E.A.M.A. might do something in fostering co-operation, but this would not supplant individual effort. Works must be laid out in such a way as to be able to deal with orders. There were numerous small firms quite successful, but not suitably laid out for dealing with export. Such firms might well group themselves together for capturing foreign markets and for taking advantage of the information that would be supplied to them by the Association. In the past we remained inactive while the German was active. In his opinion, business men should not shrink from controversial subjects. Unless we had a tariff we should not be able to treat our friends any better than our enemies after the war.

Mr. B. LONGBOTTOM thought we must organise. Both the Lords and the Commons must do their share, and he thought that a working committee might be appointed from both sides of the House to consider the question of a Ministry of Commerce. He thought that the days of restricted output had gone, and that working men would not go back to those methods after seeing the advantages of disregarding them. If employers would only organise they would be able to influence the Government.

The CHAIRMAN, in bringing the meeting to a close, remarked that Germany and the United States had often been said to be ahead of us in technical education. This education had given them tariffs which enabled them to protect their industries.

CORRESPONDENCE.

SOME PROBLEMS OF ELECTROMAGNETIC INDUCTION.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS : In reply to Mr. Biedermann's letter (p. 356) I wish to say that I quite understood that his objection to "the two different physical conceptions of one and the same phenomenon" applied to what he calls "my two different conceptions of the cause of the phenomenon." I do not see, however, that the movement of a conductor in a magnetic field, and the variation of the field near a conductor, need be considered as "one and the same phenomenon," merely because they both produce electric force. In one case we move ponderable matter, whereas in the other we change the condition of the ether, and these two causes are so fundamentally dissimilar that I see no reason for demanding a common explanation.

With regard to the water rotating in a bucket, I must say that the difference between a ponderable liquid and the condition of the ether which we call the magnetic field is too great to give one any weight as an analogy for the other. Had Mr. Biedermann asked whether the temperature rotated when the water rotated I think he would have suggested a closer, but still very crude, analogy.

With regard to the quotation from Sir J. J. Thomson's "Electricity and Magnetism," I quite agree that one can earmark, trace the movement and speak of the velocity of any want of uniformity in an electric or magnetic field ; one can go further, and speak of the velocity of the field, meaning thereby the velocity of a point with respect to which the distribution of the field appears to be invariable. The term "velocity of the field" is commonly employed in this sense, but cannot be so employed in the case of the cylindrical bar magnet, where no change in the distribution is produced by the alleged rotation of the field.

When I spoke of "endowing the field with any new characteristics over and above those postulated in Maxwell's theory" I did not mean to suggest that Mr. Biedermann had done any-

thing which had not been done previously by other people ; by "new" I mean "additional." It is true that Sir J. J. Thomson speaks of the tubes of force as if they were concrete entities moving and cutting conductors, but this is merely a convenient mathematical device, as is rather suggested by his opening remark, "Let us now introduce the view that the magnetic force is due to the motion of the Faraday tubes." I presume that one of the most up-to-date and masterly expositions of the Maxwell-Lorentz electromagnetic theory is Abraham's "Theorie der Elektricität," and the idea of E.M.F. being induced in a piece of wire by the lines of force moving and cutting it is never suggested from beginning to end.

An electron is a *thing* which can be moved about, but the magnetic or electric field is a *condition of space*, which, at any point, may be varied in magnitude and direction. Although this condition can be represented graphically by lines or tubes, these are, so far as we know, mere mathematical fictions, and, in my opinion, although it may be thereby correctly *calculated*, no physical phenomenon can be *explained* by the movement or velocity of a mathematical fiction which has no more real existence than the square root of minus one, which Sir J. J. Thomson also freely employs.

I am sorry to see from Mr. Biedermann's closing paragraph that he felt that any part of my reply was sarcastic ; it was certainly not intended to be so, and on reading it through again I fail to find any justification for the tone he adopts. The brevity with which I treated his case in which there was cutting of lines by a circuit, but no change of flux through it, was due to the fact that the fallacy of this example had been already pointed out by others (very fully by Emde in "Elektrotechnik und Maschinenbau," Heft 46-51, Vol. XXVI., 1908).

I will not attempt to unravel the tangle of error in the central paragraph of Mr. Biedermann's letter with its amazing exclamatory climax, "But whoever heard of closed loops of electric force." I think I may safely reply : Everybody who has read or even peeped into any book on electromagnetic theory or radiotelegraphy during the last 30 years. I should have thought that anyone who could quote Sir J. J. Thomson would have at least some inkling of the work of Clerk Maxwell and Hertz. One could hardly turn over the pages of Hertz's "Electric Waves" or Fleming's "Electric Wave Telegraphy" without catching sight of such diagrams as those on p. 144 in the former, or plate VI. in the latter, showing electric fields of closed loops of force. Mr. Biedermann says "I have always understood that the lines or tubes of an electric field must have their origin on positive charges, and their ends on negative ones," to which I can only say that when I replied to his letter I did so under a complete misapprehension as to his acquaintance with the elements of the electromagnetic theory.*

I feel as an astronomer might, who, after a lengthy argument with someone whom he has taken quite seriously, finds the ground suddenly swept from under him by the naive rejoinder, "But I always thought that the earth was flat." In these circumstances I do not think that any useful purpose would be served by my discussing the matter further with Mr. Biedermann.

In answer to Mr. Maccall, I should like to express my regret that I unintentionally suggested that my answers to Mr. Biedermann were also answers to any points which he had raised. One small matter on which I disagreed with Mr Maccall I have already dealt with above. My principal objection to his suggestion to leave both hypotheses side by side and use one or the other as may be convenient, is based on my figure on p. 323, in which the line-integral of the electric force around the dotted loops must be equal to the rate at which the magnetic flux through the loops is changing. This accounts fully for the E.M.F. induced in the coil, and, to my mind, leaves no room for the other hypothesis. I can see no escape from this argument without throwing over the fundamental equation.

$$\text{Curl } E = -dB/dt.$$

If the rotation is maintained there is a constant (with respect to the poles) distribution of electric force in the space between the poles and the armature and in the surrounding space, but the ultimate source of this is the want of uniformity near the pole tips, as can be seen by considering the initial movement with the resultant electromagnetic wave-front radiated from the pole-tips with the velocity of light.

I will not enter here into a discussion of the effects which arise when the conductor and poles are rigidly connected and suddenly moved from rest, although it is a very interesting point.—I am, &c.,

South Kensington, Dec. 17. G. W. O. Howe.

[This correspondence is now closed.—Eds. *E.*]

* Mr. Biedermann's confession serves to emphasise the truth of Ebe's remark on p. 467 of his "Lehrbuch der Elektrizität," that "Es macht allerdings Anfangern immer etwas Schwierigkeit sich die Existenz dieser eigentumlichen elektrischen Felder vorzust Eber, weil sie auftreten ohne dass elektrische Ladungen da sind von welchen sie ausgehen." (Beginners always find some difficulty in picturing these peculiar electric fields, since they occur without any electric charges being present from which to originate.)

ELECTRIC LIFTS.*

BY H. MARRYAT.

Leaving on one side a number of special and eccentric designs, and taking no account of an equal number of monstrosities, lifts may be broadly divided into two classes ; that is to say, sheave driving lifts and drum driving lifts.

Each of these classes may be again divided into top gear lifts and bottom gear lifts ; that is to say, lifts in which the gear is situated at the top of the well, immediately over the car, and lifts in which the gear is placed elsewhere, for although with bottom gear lifts the machine is usually situated at the foot of the well, it is not necessarily so placed, but for convenience may be fixed upon any floor, and for special reasons it is sometimes placed more or less remote from the lift well, the ropes being lead from the driving sheave or drum to the car and counterweight, by means of guiding sheaves.

All these lifts work upon the see-saw principle. Not only are the car and the attendant, if any, fully counterweighted, but also a proportion—usually 40 per cent.—of the maximum load. Under these conditions, the lift descending empty, will take almost as much power as when ascending fully loaded, and exactly the same power as when ascending with 80 per cent. of full load. On the other hand, with an average load of 40 per cent. of full load it will take practically no power either ascending or descending. It is this system of counterbalancing part of the load which secures for the electric lift its extraordinary efficiency. Comparing electric with hydraulic lifts, the first cost is very much the same. A completely automatic electric lift may cost a little more than an ordinary hydraulic lift, but no attendant is required with the automatic lift, whilst one is needed in the other case.

In the running costs the electric lift, properly constructed, costs less all the time. With a hydraulic lift, the quantity of water used is the same, whether the car be fully loaded or quite empty ; but, as we have seen, an electric lift will carry its average load at practically no cost.

Table indicating the number of journeys averaging two floors of travel, performed by push-button automatic electric lifts per unit of electric current consumed.

Description.	Period.	No. of journeys.	B.O.T. units.	Journeys per unit.
6 cwt. passenger lift	162 days	46,474	462	100
.. ..	151 ..	8,432	119	71
.. ..	162 „	6,662	75	89
.. ..	130 ..	23,513	168	140
4	181 ..	2,222	10	222
6 cwt. hospital bed lift .	188 „	42,565	369	115
10 cwt. goods lift	146 ..	3,336	46	72
.. ..	28 ..	259	8	32

As further corroboration of the extraordinarily low running cost of electric lifts, the chief engineer of the Westminster Electric Supply Corporation, Ltd., informs the author that in respect of 50 electric lifts operating in their district, the current consumption for the past 12 months has been 53,000 units, or only 1,060 units per lift per annum. The car lights, taking a considerable amount of energy, are usually included with the energy cost for the lift.

With regard to the important item of maintenance cost, the balance is again in favour of the electric lift. A hand-rope or car-switch lift

* Abstract of Paper read before the Association of Supervising Electricians.

operated by an attendant, which is the only type of lift which may be fairly compared with a hydraulic lift, will cost 25 per cent less to maintain than its hydraulic equivalent. A completely automatic electric lift will cost no more to maintain than a hydraulic one, with the additional economy of the attendant's salary, which, in itself, will be about five times the total maintenance cost.

When a hydraulic lift has to be taken out of a building for any reason, its scrap price will hardly pay for the cost of removal, whereas, on the contrary, in the case of an electric lift, there is no difficulty in adapting it for another position.

The best place for a lift gear is at the top of the well, immediately over its work. Here the maximum of efficiency is attained and the number of parts to be maintained is reduced to a minimum. In this position the length of the ropes is only one-third that of the ropes for a similar lift, if the gear be fixed at the foot of the well. As rope renewals form the most expensive part of the upkeep of a good lift, this is a matter well worthy of consideration.

In calculating the horse-power capacity required by a motor to drive such lifts as I am speaking of, it is usual to allow $2\frac{1}{2}$ times the actual theoretical maximum load. The theoretical load is the amount in pounds that the lift is out of balance when fully loaded, multiplied by the speed in feet per minute at which the lift travels. This figure, divided by 33,000, gives the theoretical load in horse-power. This is no more than is sufficient for comfortable working.

The author next deals with balancing, and illustrates the saving effected by adopting correct principles.

Worm gears are fully discussed, and it is pointed out that the rim of the worm wheel sometimes gets free on its centre, a source of great danger, since, with the exception of the car dog grips, all the safety devices are cut out.

The three methods of control, viz., hand-rope, car-switch and push-button, are considered, and also safety appliances. An excellent query form (as used by the author's firm), to be filled up by lift inspectors, was passed round at the meeting.

LEGAL INTELLIGENCE.

Osram Lamp Works (Ltd.) v. Pope's Electric Lamp Co. (Ltd.)

As announced in our last issue (p. 396), the Court of Appeal dismissed on the 15th inst. this appeal of plaintiffs from a judgment of Mr. Justice Joyce dismissing their action for alleged infringement of patent. In delivering judgment, Lord Justice BANKES said that at the suggestion of the Master of the Rolls, the argument upon the question of infringement had been heard first, upon the understanding that, if necessary, argument could be addressed to them later upon the other points in the case. Having regard to the conclusion to which all the members of the Court had come, that would not be necessary. Having briefly dealt with the subject matter of the patent in question and outlined the methods of making carbon and metallic filaments, he said he had no doubt that Welsbach had the features of the process of making carbon filaments in his mind when (in 1908) he described the mixture he proposed using as "viscous" and the forcing process as "squirting." Welsbach's discovery consisted in the fact that he found that by making use of the known reaction between steam and carbon he could, in the presence of hydrogen, burn out the carbon from the material forming the filament, leaving a coherent filament consisting of pure metal. The discovery which was intended to be protected by plaintiffs' patent was the discovery that Welsbach's process could be successfully applied to the metal tungsten. Defendants manufactured pure tungsten filaments by a process which they alleged was essentially different from that employed by plaintiffs, but which plaintiffs alleged was an infringement of their patent. Defendants' case was that they arrived at a pure tungsten filament by employing, not only a process entirely different in kind from that of the plaintiffs, but that they made use of a different reaction to get rid of the carbon—namely, the reaction between oxygen and carbon. In the case of Marconi v. British Radio Telegraph Co., Mr. Justice Parker (as he then was) stated the law applicable to a case like the present in the following words: "It is a well-known rule of patent law that no one who borrows the substance of a patented invention can escape the consequences of infringement by making immaterial variations." In the present case he was satisfied that infringement, if infringement there were, was not deliberate or intentional. In order to succeed, plaintiff must establish that defendants' process was substantially the same as that described in their specification and claim. The simplest way of seeing whether that was so or not appeared to be to ascertain, first, what defendants' process was, and then what plaintiffs' process was, and to contrast the two. Defendants' process was fully and accurately described by Dr. Passmore. The only point upon which he had not been able to find any evidence was as to the exact height of the iridium furnace. In defendants' process the first step in dealing with the material after mixing was to calender it, which consisted in placing it under rollers moving in opposite directions. At that stage the material was in the form of a hardish paste containing about 12 per cent. of carbonaceous matter, or potential carbon. The paste was next forced by hydraulic pressure through a fine orifice in a diamond die, and received on a card by an operator, who, by movements of the card, shaped the filaments into the required form, so that after cutting they were in hairpin shape. In that form they were hung in bundles, introduced into an oven and dried at a temperature of about 120 deg. At that stage of their manufacture the filaments contained about 2 per cent. of carbonaceous matter. The next step was that the filaments (in bundles of 300 or 400) were hung upon a kind of hook which was introduced into the bottom of an iridium tube or furnace of about $1\frac{1}{2}$ in. to 2 in. in diameter, which was heated at the upper end to a temperature of 950°C. The hook on which the filaments hung was moved by mechanical means up the furnace at the rate of about $1\frac{1}{2}$ in. to 2 in. per minute, and after about 6 to 10 minutes spent in the hot zone was moved down again. The whole time occupied in travelling up and down was about 30 minutes. During the whole time that the filaments were in that furnace a rapid stream of dry hydrogen was being passed down the furnace from the top. After being allowed to cool the filaments were removed from that furnace, when they were found to contain about 2 per cent. of carbon. The next step consisted in placing the filaments in an oven which was gradually heated up to 220 deg., and in which the filaments were allowed to remain for an hour or thereabouts. After being removed from that oven the next and last step was that they were placed in a second tube or furnace, into which hydrogen was introduced as before, and which was heated at its upper end to 1,850 deg. The filaments are moved up that tube by hand quite rapidly, the operation taking from a few seconds to a few minutes, depending upon the size of the filaments. Defendants' second process was in all respects identical with the one described, except that the first furnace was dispensed with and the filaments were heated to 950°C. in a vacuum. In regard to plaintiffs' specification, regard must be paid to the state of knowledge at the date of the application, which was November, 1904. The process consisted really of two separate treatments, the first comprising the composition and treatment of the material down to its carbonisation, and the second what might be called the decarbonising and the unification treatment. It was the first of those two latter which was claimed to be the real invention, on the ground put by Dr. Passmore when he said that what was not before known was that steam and hydrogen having removed the carbon, the tungsten filament would be left intact. He had no doubt whatever that what the framer of the specification intended to describe by the "usual manner" of forming filaments was not the mere mechanical process of "squirting," but the squirting of a material pressure to force it through the appropriate orifice. He came to that conclusion not only because he was satisfied on the evidence that the usual process in 1904 was the process spoken of as the soft paste process, but also because of the inclusion of unification as a necessary part of the process and of denitration being also necessary when nitro-cellulose was used as part of the binding medium. With regard to the first part of what he had called the second treatment, it was not disputed that the process described included heating the filaments by passing current through them and introducing them into a previously prepared atmosphere of steam and hydrogen. So far as the claim was concerned he could not read the second claim as anything different from the first, so far as the process claimed was concerned. The main points on which defendants' process differed from plaintiffs' process were then dealt with. His Lordship said that in the first place the composition and condition of the material were different. In defendants' process it was hard, requiring tons of pressure per square inch to pass it through a diamond orifice. In plaintiffs' it was soft, and could be squirted through an orifice made of glass. In the second place in plaintiffs' process carbonisation was done separately, and before any attempt was made to decarbonise. In defendants' the carbonisation and practically the whole of the decarbonisation were done at one and the same time in the first furnace or in the vacuum, as the case might be. In the third place, the heat necessary for the decarbonisation in plaintiffs' process was produced by passing an electric current through the filaments. In defendants' it was applied externally. In the fourth place, defendants' filaments were not exposed to a previously prepared atmosphere of steam and hydrogen. Defendants said in their process they did not carbonise at all, and that the material used, other than tungsten metal, was not used as a binder, but as a lubricator. He did not attach much importance to those points. It was quite true that they emphasised the difference between the material used in the two processes, but carbonising was a chemical process and might be used for creating a quantity of pure carbon, or in order to convert a small quantity of carbonaceous matter into carbon as a step in getting rid of it altogether. In either case the process was carbonising, so also with regard to the binding material employed. One man might so carry out his process as to require, or might use, though he did not require, a considerable quantity of binding material. Another man might require and use very little. In the present case he considered the differences between the two processes on those two points as differences in degree rather than in kind, and he thought that the material used by defendants did in the very early stage of the process and before the calendering act as a binder; and he could not find any evidence upon which he could accept the suggestion that the 2 per cent. of carbon found at the end of the first furnacing was not a residue at all but was caused by the absorption by the metallic tungsten of gases given off during the passage of the filaments up the furnace. There remained, however, the question whether defendants' process as a whole, and having regard particularly to the four points indicated above, was substantially the same as the process said to have been infringed. In his opinion it was not. In his opinion, the difference passed the border line which separated a difference in degree from a difference in kind, and defendants' process as a whole was, in his opinion, substantially different from the one described in plaintiffs' specification. If the test to be applied was

the commercial value of the result there could be no question on that point, as the one process enabled the filaments to be made in bulk, whereas the other required each individual filament to be separately handled before the electric current could be passed through it. It was contended that, though defendants' process might to the eye appear different, and might contain various improvements, yet defendants had taken the substance of the plaintiffs' invention, and applied it to the manufacture of their filaments. It was said that the real principle, or substance of the invention was the application of the known reaction between steam and carbon to get rid of any carbon in the filament while leaving the tungsten metal unaffected; that the use by defendants of tungsten oxide in their mixture rendered it impossible for them to carry out their process without making use of the steam-carbon reaction, because when the filaments reached the required degree of heat, steam was produced, either from the small quantity of water contained in the material of the filament or from the oxygen in the tungsten oxide combining with the hydrogen introduced into the furnace, and that steam reacted with the carbon in the filament and dispersed it. A number of experiments were given in evidence with the view of proving that, and the two main points endeavoured to be established were (1) that the reaction between oxygen and carbon which defendants claimed to be the agent by which they expelled the carbon from the filament did not take place below a temperature variously given at 1,000°C. to 1,030°C.; (2) that much below that temperature the carbon was found in defendants' process to be in course of being expelled, or, in other words, that before a temperature was reached at which the oxygen-carbon reaction could take place, the filaments had passed through a temperature at which the steam-carbon reaction must have taken place. In his opinion it was not enough for plaintiffs, in the peculiar circumstances of the case, to say that. It was not disputed that the oxygen-carbon reaction would at the appropriate temperature disperse any carbon in the filaments, and the question, therefore, must be not only whether the filaments had passed through the range of temperature appropriate to produce the steam-carbon reaction, but whether that reaction had to any appreciable extent dispersed any of the carbon in the filaments. To do so to a merely negligible extent could not constitute an infringement of plaintiffs' patent. On that question the time during which the filaments were in course of passing through the material range of temperature appeared to him to be important, but he could find no evidence directed to that point. The material facts on that question appeared to be as follows: Defendants' mixture or paste, after calendering, contained about 12 per cent. of carbonaceous material; that was reduced by the first ovening process to 2 per cent., and it was in that condition that the filaments were introduced into the first furnace in which the infringement was alleged to take place. When taken out of the furnace the filaments contained 2 per cent. of carbon. The difference between those two quantities had, therefore, been dispersed during the 30 minutes or thereabouts during which the filaments had been in the furnace. By what agency had that been done? The first material point to establish in that connection appeared to be the temperature at which the steam-carbon reaction commenced to operate, because nothing which occurred in the furnace below that temperature could amount to a taking of plaintiffs' invention. On that point he found a great want of certainty in the evidence. At first the temperature was stated to be 600°C.; then it rose to 700°C.; later from 700° C. to 800° C., and later still to 800° C. In order to ascertain what was going on in the furnace plaintiffs made an experiment at which they interrupted the process at 500° C. Why that interruption took place at that stage was not explained, except that it was a sort of half-way house. It was ascertained that at that stage of the process the filaments contained 6 per cent. of carbon, that was to say, that the difference between 2 per cent. and 6 per cent. had by that time been dispersed by some agency which could not be any infringement of plaintiffs' patent. What occurred in the furnace during the time that the filaments were travelling from the point at which the temperature was 500° C. to the point, be it 700 deg. or 750 deg. or 800 deg., at which the steam-carbon reaction commenced, there was no evidence to show, and it was quite consistent with the evidence that the carbon had been reduced from 6 to 2 per cent. before the filaments reached that point. No evidence was given as to the time occupied by the filaments in passing through the material range of temperature. In his opinion, so far as plaintiffs' evidence on that point was concerned, it fell short of proof, and so far as that experiment and others intended to support it were concerned, they had failed to satisfy him that any carbon in defendants' filaments was to any appreciable extent dispersed by the steam-carbon reaction. What he had said with regard to the first furnacing in defendants' process applied with equal or even greater force to the second furnacing. The conclusion at which he had arrived as to the first furnacing applied also to the vacuum process, where the alleged infringement was said to take place by the accidental presence of water vapour, which defendants could not prevent, and which was said to be the agent which released the necessary hydrogen to form the steam and hydrogen atmosphere which constituted the alleged infringement. In regard to the other point, mainly relied upon by plaintiffs, namely, that the oxygen-carbon reaction could not take place at a temperature below 1,000° C. He had carefully considered the evidence and the arguments of Counsel, and as a result he was not convinced that in defendants' process as carried out the oxygen-carbon reaction did not commence at a temperature lower than 950° C. The general conclusion, therefore, at which he had arrived was that plaintiffs had failed to establish their case from whichever point of view it was to be regarded, and the appeal, therefore, failed, and must be dismissed with costs.

Lord Justice WARRINGTON also delivered a judgment dismissing the appeal, in the course of which he said there were in defendants' process two chemical factors tending to produce the desired result. The evidence was insufficient to determine the precise part played by each, and he thought the Court was justified in holding under those circumstances that plaintiffs had not proved that the carbon was removed substantially as described in the specification. But if he was wrong about that, he should still be of opinion that defendants' process, taken as a whole, did not infringe the substance of plaintiffs' invention. It started from a different standpoint; the several steps in it were different in nature and had different aims and results, and these variations were not merely colourable alterations. The result was that, in his opinion, the appeal ought to be dismissed.

Lord Justice BANKES said the Master of the Rolls (who was absent from indisposition) desired him to say that he concurred in the judgment delivered by Lord Justice Warrington and himself.

Lord Justice BANKES said they would not grant a stay.

Effect of War on Contracts.

Mr. Justice Shearman recently delivered an interesting judgment in the case of Greenway Bros. (Ltd.) v. S. F. Jones & Co. Plaintiffs claimed £513. 7s. 6d. damages for breach of contract to supply a quantity of "G.O.B. virgin spelter" to be delivered at plaintiffs' works on or before July 31, 1914. By a further contract the parties further agreed for the purchase and sale of another 50 tons of G.O.B. virgin spelter to be delivered on or before Aug. 31, 1914. Defendants failed to deliver the whole of the spelter as agreed, and plaintiffs bought other spelter at an increased price. Defendants pleaded that plaintiffs had agreed to extension of time for delivery, and that plaintiffs could have bought at the same price in the market, and also that, in any event, there was a provision in both contracts which said that "delays en route or other contingencies beyond our control to be sufficient excuse for any delay traceable to these causes," and in view of the outbreak of the war that clause relieved defendants from liability.

Counsel for defendants submitted that, according to a trade understanding, "G.O.B. virgin spelter" meant spelter from oversea, and not spelter which could be obtained in this country. That being so, as the war had prevented spelter from reaching this country from abroad, defendants were excused owing to contingencies beyond their control. He also submitted that the English Government had interfered with the acquisition of spelter at the material date without a permit.

For plaintiffs it was argued that "G.O.B. virgin spelter" was not confined to spelter obtained from the Continent. The condition relied on only excused delay; it did not excuse non-performance. In construing the condition the principle of ejusdem generis must be applied, and war was not a matter which had been in the contemplation of the parties at all. The condition was intended to provide against strikes, railway accidents and similar contingencies; it was merely a demurrage clause. And even if the clause did include the contingency of war, the contract was one for the delivery of goods generally, not specific goods, and it would have been possible to perform the contract in spite of the war. Mere difficulty in getting the goods would not be an excuse; there must be a practical impossibility.

Mr. Justice SHEARMAN, in giving judgment, said that the real difficulty was how to construe the clause relied on. It was an ordinary one, and was known as the strike clause. It was common in charter-parties and building contracts, and it was now finding its way into contracts for the sale of goods. The contract was for the sale of G.O.B. spelter. That simply meant spelter of good ordinary brand, and no doubt the course of business had been such over a number of years that a contract to supply G.O.B. spelter was generally fulfilled by supplying spelter from the Continent. At the same time, he had no doubt that there was spelter in England at the time which was available for those willing to pay the price of it, and when the dispute under the contract arose it was not impossible, though it might have been difficult, to procure the spelter required. Defendants really had made a sub-contract for the goods with German firms, and when the difficulty arose all that they did was to press the agents for delivery. Finally they wrote to plaintiffs saying that they would deliver when they could obtain spelter under normal conditions, which meant at a normal price. That was a clear repudiation of the contract unless the strike clause relied on was a protection. Whether the breaking out of war was a contingency within the contemplation of the clause was arguable: on the whole he thought that it was, but it was unnecessary to decide that question. Assuming that the war was a contingency ejusdem generis as those contemplated in the clause, defendants had failed to satisfy him that the delay in delivery was traceable to the war. He knew of no case which said that where there had been a rise of price owing to unforeseen circumstances a vendor was excused from delivery until he could get the goods at a low price again. There must, therefore, be judgment for plaintiffs.

A stay of execution was granted.

Electric Supply Undertakers' Obligations.

On Friday last Mr. Justice Neville granted an interim injunction to restrain electric supply undertakers from cutting off the supply of electrical energy to a foundry.

Mr. O. THOMPSON (for plaintiffs) said his clients, who carried on business as foundry proprietors, on November 13, 1912, entered into an agreement with the undertakers for the supply of electrical energy for power to plaintiffs' works at a pressure of 460 volts for five years from June 25, 1912, and plaintiffs agreed to receive and pay for such supply at a certain price per unit, the aggregate payment not to be

less than £266 a year, and plaintiffs agreed to take and pay for 80,000 units as a minimum quantity of energy per annum. Plaintiffs' foundry was not a controlled establishment, but work was being carried on there night and day, the business largely consisting of the making of rolls and cartridge metal. They employed 300 workmen, 88 of whom had been attested, and the rest of them were munition workers and exempted from Lord Derby's scheme. Plaintiffs had fulfilled their part of the agreement, and were now using electrical power at the rate of 200,000 units per annum ; but on Dec. 6 last the undertakers wrote to plaintiffs, pointing out that the cost of generating electricity had greatly increased owing to the considerable rises in the cost of coal, labour, &c. Owing to the war and the work which plaintiffs were doing their demand for electricity had greatly increased all anticipation, and it had necessitated the purchase of fuel over and above that contracted for and further enhanced the cost of generation. The price of electricity had already been increased by 20 per cent., and was now being increased by a further 15 per cent. for ordinary power consumers. The committee in charge of the undertaking felt that plaintiffs should bear some proportion of all that increased cost, and they proposed to advance the price of electrical energy supplied to plaintiffs by 20 per cent. on the contract prices, such advance to come into operation in respect of all electrical energy supplied during the current quarter. If the firm were not willing to agree to the advance in price, the Committee would either reduce the amount of energy supplied or cut off the supply altogether, as may be most convenient to them. In reply, plaintiffs said that they would hold defendants to their agreement, but defendants then wrote (on Dec. 20) that they would curtail plaintiffs' supply by cutting them off from 4 p.m. to 6 p.m. each day. Thereupon plaintiffs issued a writ claiming an injunction to restrain defendant undertakers from discontinuing or curtailing during any period of the day or night the supply of electrical energy for power to their works in breach of the agreement.

His lordship granted an interim injunction extending over Christmas until the first Friday of next sittings.

Shrimpton v. Northern Power, Light & Coal Co.

This action came before Mr. Justice Peterson last week. Plaintiff asked for a declaration that the company had no power to issue further prior lien bonds, and also an injunction restraining defendants from borrowing on the security comprised in plaintiffs' bonds. The question was raised as to whether the resolution extending the company's borrowing powers (purporting to have been passed at a meeting held at Dawson City on Sept. 18, 1911, at which three shareholders were present) was valid. His lordship held that a resolution passed by a two-thirds majority of the subscribed stock of the company present at the meeting was valid, and dismissed the action with costs.

Kingstown Provisional Order Arbitration.

At Dublin last week Mr. Justice Barton was asked to make an order directing the Taxing Master to tax the costs of the Dublin Southern District Electric Supply Co. in the recent arbitration with Kingstown Council (referred for taxation under order of the Court in March last) under the scale provided for by the Acts for taxation of Parliamentary costs, or, in the alternative, that the costs be taxed as Chancery costs on the higher scale as between solicitor and client, or for such order as the Court might deem reasonable. Counsel for the company referred at length to the history of the Kingstown Provisional Order. The Council had acquired the company's order, and what the Court had to deal with was the costs of the arbitration which was held in London in January last. To put their case properly before the arbitrator expert evidence was given by Mr. H. F. Parshall and Mr. R. Hammond. Kingstown Council had got their precious undertaking, but they had never stirred hand or foot to the extent of striking a lucifer match to provide Kingstown with light. The costs of the arbitration were forced on the company, which made a demand of £4,000. The costs of the arbitration were cut down by the taxing master from £1,259 to £600. 16s. The fees of counsel and costs of witnesses were reduced from £887. 15s. 7d. to £317. 18s. 4d. The arbitrator had allowed £3,600, and every shilling of that was out of pocket expenses, so that Mr. Murphy stood to lose something like £900. Now Kingstown Council wanted him to lose another £900 over the arbitration, so that he should be at a loss of £1,800 for making Kingstown a present of an electric lighting order. There was no principle to prevent the taxing officer from giving Mr. Murphy every shilling of his just expenditure, as that was not contentious business.

For the Council, it was pointed out that it was Parliamentary costs merely that had been dealt with by the arbitrator (Mr. Brown), and all the costs and expenses of the company had been paid up to the time of the arbitration. It was contended that the Taxing Master was right, and that no order should be made on the application.

In delivering judgment, his LORDSHIP (after reciting the facts) said the Taxing Master for the taxation of the costs had taxed them as High Court Chancery costs as between party and party. The questions were whether he was right. Costs ordered to be taxed simpliciter were to be taxed as between party and party. The High Court had power to order costs as between solicitor and client to be paid by an opposite party, and the arbitrator (under similar jurisdiction) had like power. Under the power which this arbitrator had there was nothing to prevent him from awarding costs as between solicitor and client, or giving all the expenses incurred by the company. He did not do so, but merely awarded the costs incidental to the arbitration, and he (Mr. Justice Barton) had no power whatever to enlarge his order. On the question as to whether he could construe them as Parliamentary costs, he said the costs with which they were concerned were not costs of obtaining a provisional order, but costs awarded by the arbitrator, who was appointed under the provisional order after it had been obtained and passed into law. He would declare the company entitled to indemnifying costs if he had the power to do so. If he had any discretion in the matter he would exercise it in favour of the company. The arbitrator gave costs simpliciter as between party and party, and he could not give to it a wider meaning.

Workmen's Compensation.

In the Bow (London) County Court last week his Honour Judge Smyly, K.C., gave his considered decision in the case of Attwell *v.* West Ham Corporation. The case occupied the Court for eight days. Attwell was engaged by the electricity department of the Corporation, and his duties consisted in cleaning out transformer chambers. When at work on one of these there was an unexplained explosion and the man was severely burned. He said he was engaged as a labourer, and did not understand anything technical about electricity, and he was also quite positive he was not provided with gloves to use at his work. For defence it was alleged that not only was he supplied with gloves, and told it was against the rules not to wear them, but a few minutes after the accident the foreman was on the scene and found the gloves in the man's bag on a chair. They denied any liability, saying the man was engaged as a man who understood electricity, and if he had taken ordinary precautions nothing would have happened. The jury gave a verdict for plaintiff for £350 damages. A new trial was applied for, on the ground that the verdict was against the weight of evidence and the legal arguments lasted two days. On Wednesday Judge Smyly delivered judgment. He said he failed to find any ground for interfering with the verdict of the jury. There might be a lot to be said about the gloves, but the jury had had the evidence before them, and, having decided, his Honour could see no reason to upset the verdict. There was a suggestion that the jury were not impartial, as they had showed signs of impatience, but he saw nothing of it, and thought they displayed marvellous patience. Therefore he ordered the verdict to stand, but granted leave to appeal.

S. Segar v. G. Isaacs.

Last week, by a majority, the Court of Appeal dismissed plaintiff's appeal from the decision of Mr. Justice Bailhache dismissing his action against Mr. Godfrey Isaacs for alleged breach of an oral agreement to take certain shares or pay the difference between their purchase price and the sale price, namely, £8,655. Plaintiff alleged that the consideration for the agreement was forbearance on his part to bring an action against defendant for misrepresentation and for misfeasance as managing director of Marconi's Wireless Telegraph Co. Mr. Justice Bailhache, whilst holding that the agreement was made, came to the conclusion that the true consideration consisted of improper, indirect threats, and that the action was a blackmailing one.

Lord Justice SWINFEN EADY now said he had great difficulty in believing that the agreement alleged by plaintiff was come to, or that there was anything more than what the parties called an understanding, the effect of which they were not agreed upon. He was perfectly satisfied that plaintiff's claim was a blackmailing claim, and that the action was a blackmailing action. The appeal would be dismissed, with costs.

Lord Justice PHILLIMORE, who dissented, said the agreement did not seem to be an improbable one, and he was driven to the conclusion that such an agreement was made. He was unable to agree with Mr. Justice Bailhache that it was a blackmailing action. He thought plaintiff was entitled to judgment.

Lord Justice PICKFORD concurred with Lord Justice Swinfen Eady, and by a majority of the Court the appeal was dismissed, with costs.

Liability for Meters Destroyed by Fire.

At Mortlake Police Court, on the 8th inst., Barnes Urban Council summoned a consumer (Mrs. Emmins) for the recovery of £6, the value of two electricity meters which had been destroyed by fire.

Mr. W. T. GOODALE (clerk to the Council) said that he had decided not to refer to the various Acts of Parliament, but simply to rely upon a clause in the Barnes Electric Lighting Order, which provided that the Council might let for hire apparatus for the supply of electricity on such terms as to secure the repair and safety of the apparatus until the return to the undertakers. The clause also provided that the charges could be recovered as a civil debt in a court of summary jurisdiction. He relied entirely upon that clause for the recovery of the £6 for the meters, which were supplied under two separate agreements which were signed by defendant, and provided that she was to make good any loss or damage.

The CHAIRMAN said that the case had since the last hearing been most exhaustively gone into by the clerk, and he came to the conclusion that they could proceed under the clause mentioned in the Barnes order. The Bench, however, thought Mr. Goodale was wrong in his contention that reference to two justices (in the Railway Clauses Act) was equivalent to a court of summary jurisdiction.

Mr. GOODALE said he relied on the clause of the electric lighting order.

Mr. C. S. DAVIDSON (electrical engineer to the Council) gave evidence as to the signing of the agreements by defendant in respect to the two meters. The Fire Brigade reported that on arrival they found that the

fire was being extinguished by buckets of water behind the door. That led him to believe that the cause of the fire was there. Subsequently he inspected the premises, and found the greatest damage was done there. He could not say how the fire originated, and the brigade reported that the cause was unknown. He had reason to suppose that the fire was not caused by the Council's electricity supply. There was no leakage recorded prior to the time of the fire, but after the brigade had turned out a leakage was shown on the recorder at the station. It was a requirement of the Board of Trade to keep a leakage recorder at the station, and when a leakage was recorded to go out and ascertain where it was. The chart produced showed the hours and amount of leakage in the current. After the outbreak of the fire there was a distinct leakage shown.

Sir JAMES SZLUMPER thought the onus of showing that the outbreak was due to the meters was on defendant.

Mr. GOODALE agreed, but as defendant had suggested at the last hearing that such was the case he wished to show that it was not due to the Council's installation.

Continuing, Mr. DAVIDSON said that both meters were destroyed beyond repair. He had rendered an account amounting to £7. 14s. After the account was sent in defendant told him she had not been insured, and that she had been very hardly hit over the fire. On that account he reduced the claim to £6. Defendant agreed to that figure, and to pay it at the rate of £1 per month.

DEFENDANT said she wished to prove that the only part of the shop destroyed was near the meters. There was only one costume saved, which was on a stand near the door. She asked for an adjournment, as, owing to illness, her solicitor could not attend that morning.

Mr. GOODALE could not see any reason for an adjournment as the claim had been admitted.

DEFENDANT gave evidence, and said there was only one garment saved from the fire, and that was on a stand near the door. The outbreak was near where the meters were. There was no match on the premises and it must have been the electric light. The insurance agent had told her to fight the case, and an engineer who had examined the meters told her that fire "caught on the company's side."

Mr. EMMINS said that on the night of the fire the costume was on the stand behind the door, and the stock near the meters was most burnt.

In answer to the Bench, Mr. DAVIDSON said nothing had been deducted from the cost of the meters, and he considered that after three months' use their value would not depreciate, as they would last 25 years.

The Bench found that the Council had made good their claim, but they reduced the amount to £4. 10s., including costs.

PARLIAMENTARY INTELLIGENCE.

TRADING WITH THE ENEMY.

The Trading with the Enemy (Extension) Bill passed through the Committee stage in the House of Commons on the 17th inst. The Home Secretary (Sir J. Simon) again explained the objects of the Bill. Under the Bill a pro-German firm in a neutral country was put on a black list, and British customers would not be able to trade with it without incurring a penalty. The reason was because they wanted to do all they could to prevent a suspected firm, say, in South America, from assisting the enemy. Where a firm was within the jurisdiction the right thing was not to penalise people who traded with it, but to attack the firm itself. Firms in this country which were suspected of having enemy associations were already dealt with by existing legislation, but it was said that such firms ought not to be allowed to continue to carry on business. There were many cases in which the existing practice was the right one to adopt, but that was no reason why, if there were cases that should be dealt with in a different way, the Government should not take power to do so. In the shortest possible time an independent bill would be presented which would give the Board of Trade power, by some proper procedure, where the national interests required it, instead of authorising a business to go on to make provision for the business to stop.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PEYER, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

20,146 LANDIS & GYR S. A. Prepayment electricity meters. (25/4/13. Addition to 18,464/14.)

22,927 SIEMENS & HALSKE AKT.-GES. Apparatus for operating electrical devices at a distance. (21/11/13.)

Comprises apparatus for electrically controlling or causing determinate operations at a distance with the use of synchronously running contact systems at the transmitting and receiving stations, in which the synchronism is produced by means of pendulums or swinging mechanisms which are caused by the transmitting station to swing out simultaneously, and which, after a short fixed non-varying period of oscillatory movement, are again stopped automatically.

22,950 ALLGEMEINE ELEKTRICITATS-GES. Cooling of turbo-dynamos and like electric machines. (21/11/13.)

23,072 B.T.-H. Co. & WHEAT. Illumination of surfaces.

23,113 TERRY. Electric incandescent lamps.

23,122 B.T.-H. Co. (G.E. Co.) Vapour electric devices.

Consists in the provision of an insulating seal having a section of mineral insulation united respectively to an electrode and a metal container, a metal body adjacent to the mineral insulation having substantially the same coefficient of expansion.

23,236 HARRY W. COX & Co. & DONNITHORNE. X-ray apparatus.

23,321 ELECTRIC & ORDNANCE ACCESSORIES Co. & ETCHELLS. Control of switches for electric lighting or heating systems.

1915 SPECIFICATIONS.

1,173 BASSANESE. Tilting electric furnace for melting and refining metals.

1,609 ROBERT BOSCH (FIRM OF). Electric regulating devices. (Addition to 27,961/12.)

1,715 W. SANDERS & Co. & SANDERS. Incandescent electric lamps.

1,740 MAJESTIC ELECTRIC DEVELOPMENT Co. Electric radiator. (3/2/14.)

2,386 B.T.-H. Co. (G.E. Co.) Electric Switches, circuit-breakers, and the like.

Consists in furnishing the stationary or movable or both arcing contacts with a piece of magnetic material which is arranged to give a magnetic field partly embracing and surrounding the contact and extending "into the space between the two arcing contacts when they separate."

2,883 OATES. Conduits for electric cables and the like.

3,984 DIXON. Controlling systems, particularly applicable to the control of a telegraph strip. (16/3/14.)

5,629 BOBROFF & UNIVERSAL INDICATOR Co. Electric signalling apparatus or indicators.

5,673 SIMPSON. Contact-breakers for magneto-electric machines. (15/4/15.)

5,943 GILES. Electric switches. (24/4/14.)

8,458 UREN & GAMBLE. Means for joining up the ends of electrical conduits. (18/6/14.)

9,158 JACKSON ELECTRIC STOVE Co., GRIESBACH HOLMES, SMITH & WILLIAMS. Electric cooking.

10,957 SAMUEL, SLINGO, GUNTON & DOUGLAS. Electric railway systems. (Addition to 14,984/14.)

10,958 SAMUEL, SLINGO, GUNTON, POWELL & KINGSTON. Electric railway systems. (Addition to 15,539/14.)

12,267 RENAULT. Electric controller and circuit making and breaking device having a closed field. (26/8/14. Addition to 24,121/14.)

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions When complete Specification accompanies application an asterisk is affixed.*

November 23, 1915.

6,502 MAYOR & COULSON & LAWRENCE. Electric switch appliances.

16,508 LEON. Insulation system for cells and batteries.

16,516 BEAUMONT. Electric batteries.

16,524 WHEELER. Machine for instruction in reading Morse code.

16,535 FALK, STADELMANN & Co. & BEAUCHAMP. Lamp shades or screens.

16,540 MARKS. (Interstate Electric Novelty Co., U.S.) Electric batteries.*

16,550 ALEXANDER. Telegraph or telephone line insulator.

6,562 BUTTERFIELD & ASHWORTH. Production of tungsten from scheelite.*

November 24, 1915.

16,565 SCHOLEFIELD. Clamps or supports for coils or windings when used on electric circuits.

16,569 DEWHURST. Electric lamp holders.

16,591 B.T.-H. Co. (G.E. Co., U.S.) Systems of radio communication.

16,602 COCHLOVIUS. Electric furnaces. (24/11/14, Switzerland.)*

16,614 ETABLISSEMENTS DE DION-BOUTON SOC. ANON. Magneto-electric generators. (17/6/15, France.)*

November 25, 1915.

16,640 ELECTROMOTORS LIMITED & GREENHALGH. Dynamo-electric machinery.*

16,643 JENKINS & C. I. SYNDICATE. Electrolytic cells.

16,647 COCKRELL. Electrical connection.

16,671 JAMES. Electrodynamic brakes for use in connection with printing machines. (Addition to 596/15.)*

November 26, 1915.

16,687 DYER. Mine signalling apparatus.

16,692 SMITHSON & CALLENDER'S CABLE & CONSTRUCTION Co. Winding drums for electric wires, cables and the like.

16,694 & 16,695 RAILING & ANGOLD. Arc lamps.

16,719 CALDWELL. Substance for use in connection with X-ray work in human and other bodies.

16,721 B.T.-H. Co. (G.E. Co., U.S.) Vehicles.

16,730 PERREUR-LLOYD. Electrolytic production of zinc, copper or other metals. (Addition to 4,681/15.)*

16,731 VANDERVELL. Portable battery lamps.

November 27, 1915.

16,753 HARVEY. Galvanic batteries.

16,754 HARVEY. Manufacturing the elements of electric batteries and performing like operations.

16,765 G. D. PETERS & Co., HIBBERD & KING. Electrically lighting railway and other vehicles.

November 29, 1915.

16,779 MORGAN. Train-signalling devices.

16,780 WESTWOOD. Switches for electric cycle lamps. (Divided application on 7,909/15. May 28.)

16,781 MURDOCH. Electric generator or motor.

16,797 MARKS. (Interstate Electric Novelty Co., U.S.) Casings for portable electric flashlights.

November 30, 1915.

16,814 HYDE. Electric steel and alloy making and refining processes.

16,836 CANTON. Electromagnetic driving or transmission gear.*

16,846 BROOK & BISHOP. Electric switches.

16,853 LAKIN. Terminals for the flexible cables of medico-electrical apparatus.

16,854 WALKER. Dynamo-electric machines of the commutator type.

16,865 GIBSON & BENNS. Portable electric lamps.

16,866 CONNER. Hunting or copying switch arrangements, and electrical range-finding systems embodying such arrangements.

December 1, 1915.

16,898 ELLEFSEN. Alternating-current motor starters.

16,900 BOWDEN & THOMPSON. Cables for the distribution of electrical power. (Divided application on 4,585/15. March 24.)

16,928 GIRARDEAU. Dynamo-electric machines. (Addition to 16,107/15. 2/12/14. France.)*

16,933 PIERES & PIERES. Rotary converters.*

16,934 JACKSON. Intercommunication telephones.

December 2, 1915.

16,961 CRUIKSHANKS. Railway signals and the like.

16,992 PIERCE. Switching gear.

16,993 INTERNATIONAL ELECTRIC Co. & LE NOIR. Electrical signalling systems or annunciators, chiefly for hotels.

16,993 INTERNATIONAL ELECTRIC Co. & LE NOIR. Switches.

16,994 BERRY. Electrical heat radiators.

17,000 INTERNATIONAL ELECTRIC Co. & LE NOIR. Audible signal devices.

December 3, 1915.

17,032 AKTIEBOLAGET ELEKTRISKA UGNAR. Electric furnaces. (16/12/14, Sweden.)*

17,033 DELLER. Electric lamp fittings.

17,034 SMITH. Means for laying and collecting field telephone wires.

17,035 LATHAM & GRAHAM & LATHAM. Mirrors or reflectors.

17,036 GRAHAM & GRAHAM & LATHAM. Signalling devices.*

December 4, 1915.

17,062 PIERES. Connection between electric incandescent lamps and holders.

17,063 GEBAUER & EICHELBERG. Electric furnaces.

17,092 BAKER. X-ray photography.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	437	Mather and Platt Progress	83
Imports and Exports of Electrical Manufactures	438	Standard Ironclad Panels. Illustrated	84
Educational Notes	438	The New Glasgow Showrooms. Illustrated	85
Business Notices	438	New "Benjamin Electric" Lists. Illustrated	86
Bankruptcies, Liquidations, &c.	438		
Electricity Supply	438	Tenders Invited	441
Traction Notes	440	Tenders Received & Accepted	442
Empire Notes	440	Municipal Accounts	442
Miscellaneous Notes	440	Companies' Meetings and Reports	442
The Round Table	79	New Companies, &c.	443
Corrosion-Proof Wiring. Illus.	80	City Notes	443
Royal Ediswan "Pointolite" Lamp. Illustrated	82	Electrical Companies' Share List	443
"Rugby" and "White Star" Lamps	83		

COMMERCIAL TOPICS.

American Foreign Trade. There was recently incorporated in the State of New York the American International Corporation, with a capital of $50,000,000, in order to establish trade relations with foreign countries and thus create a market for American products, and also to finance and protect developments in foreign countries undertaken by American engineers and manufacturers, and to assist in financing the rehabilitation of industries in foreign countries. The company will not engage in a direct banking business, but will have very broad powers. Of the capital, $49,000,000 will be in common stock and $1,000,000 in managers' shares. If dividends above 7 per cent. are paid, one-fifth will be divided among the managers' shares and the remaining four-fifths among the holders of the common stock. Managers' shares can be held only by those actively engaged in managing properties under the direction of the company, and must be sold back to the corporation at their value when connection with the corporation is severed. One-half of the common stock has been offered to the stockholders of the National City Bank of New York, and no public offer of the stock will be made; that which is not subscribed for by the bank's stockholders, together with the remainder of the stock, will be placed with firms having interests abroad. Mr. Charles A. Stone, head of Messrs. Stone & Webster, is president of the new corporation, and while he will not sever his connection with the engineering corporation, he will devote all his time to the new venture. Mr. R. P. Tinsley, treasurer of the Standard Oil Co., is secretary and treasurer, and an influential board of directors includes the following: Messrs. J. Ogden Armour, Charles A. Coffin, William E. Corey, Joseph P. Grace, James J. Hill, Otto H. Kahn, R. S. Lovett, Ambrose Monell, Hy. S. Pritchett, Percy A. Rockefeller, John D. Ryan, C. H. Sabin, Wm. L. Saunders, Jas. A. Stillman, Chas. A. Stone, F. A. Vanderlip, Theo. N. Vail, Edwin S. Webster and A. H. Wiggin.

* * * *

Utility of Showrooms. A good illustration of the utility of showrooms was given at a recent meeting of Burton-on-Trent Council by Ald. Lowe, chairman of the Gas and Electricity Committee. Having supplied details of the cost of equipping the electricity and gas showrooms, Ald. Lowe gave instances of the results of the showrooms. He said that, though there were but 11 electric fires when the electric showrooms were opened, there were about 163 at the present time, which indicated increased revenue. Nearly all gas concerns in this country had showrooms, and found the necessity for enlarging and developing them. The placing of gas fires commenced two years ago, and since then between 600 and 700 had been fixed.

* * * *

Charges for Electric Heating. During the course of the last of his series of six lectures on the subject of electric heating and cooking, given recently at University College, Dr. J. A. Fleming remarked upon the raising of the rates for electrical energy for heating and cooking purposes, more or less as a result of the war. He strongly expressed the view that the charges for lighting only should have been increased, and the existing rates for cooking and heating maintained. He pointed out that these rates under normal conditions are sufficiently high, and although they have contributed towards the increased popularity of electric fires and other apparatus, they do not justify increases which range from 15 to 25 per cent. Having regard to all the circumstances, we cannot but agree with Dr. Fleming in his criticism. We appreciate that central station engineers are labouring under difficulties arising from shortage of labour, and are also operating with coal and other supplies at increased cost, but having regard to the amount of energy which can be consumed during off-peak hours by cooking and heating apparatus, it might reasonably be expected that steps would be taken which would not discourage this class of consumer, nor tend to militate against the increased sale of domestic electric appliances. The grievance is most pronounced where the lighting and heating are charged for at separate rates and the respective energy is measured by separate meters. It is amongst this class of consumer that there will be a marked falling off in the use of electric heating and cooking devices, particularly if gas is still available as a standby. We realise that it may be inexpedient to discriminate as between one class of consumer and another, and that there might be a risk of something in the nature of a strike among lighting consumers who do not use cooking apparatus and who would feel aggrieved that they are bearing more than their share of the increased charges for electrical energy. It is perhaps a little early yet for central station engineers who have made heavy increases in the rates to note exactly what effect the new charges have had upon the undertaking. If there is any truth in Dr. Fleming's suggestion that the increased charges will militate against the use of electric cooking and heating apparatus, or even occasion its discontinuance, then central station engineers may take action to adjust the prices and place them on a more equitable basis.

* * * *

Wiring Improvements. Many of the books which are written on the subject of electric light wiring, and which profess to be practical guides to wiremen and electrical contractors, are sadly lacking in information on the subject of breakdowns and repairs. From what we can gather, the average electrical contractor is a long-suffering person, and rather than exchange views with his confrères upon the work in which he is engaged, he prefers to maintain silence. Probably he thinks that in so doing he is keeping secret information which would be damaging to his interests and those of his industry if it were published. For example, we believe that perpetual difficulties have presented themselves in the wiring of premises in which there is free moisture or an atmosphere charged with corrosive fumes. A typical instance is to be met with in the wiring of stables. Not infrequently this class of work may come into the hands of a small contractor with limited experience. He discovers that after wiring the premises with perhaps half-a-dozen different systems, the installation always breaks down owing to the presence of ammonia fumes. It will be noticed from our Supplement pages this week that a method has at last been devised which has proved, after extensive practical experience, to be suitable for the installation of electric lighting and power in chemical works, breweries, cold storage plants, manure works, stables, &c. The secret of the success of this system appears to be due to the use of solid rubber insulation as the outer protective covering for the wires, and the design of the fittings from which joints are made and the connection established between the branch circuits and lampholders and switches. The details of this method of wiring will, we feel sure, be followed with the utmost interest. The makers claim that the system is a complete solution of the problems of wiring in the class of premises to which we have referred. It is gratifying to note that it is an essentially British product and is entirely distinctive from anything which has previously been introduced.

* * * *

Indian Shareholders and Income Tax. It is announced that shareholders on the Indian register of the Bombay Electric Supply & Tramways Co. recently held a meeting to consider means of obtaining relief from English income tax. The chairman (Sir David Sassoon) said legal opinion was to the effect that the only means by which the company could escape from liability to pay the English tax was by transferring the management to Bombay. Resolutions, providing for alterations in the constitution of the company, were adopted.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

For the week Dec. 13, 1915, *to* Dec. 18, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

GOOLE.—*France:* Elec. [illegible]

LIVERPOOL.—*U.S.A.:* Elec. [illegible]; Unenumerated, 151 pgs.

LONDON.—*U.S.A.:* Elec. machinery, £925; carbon candles, £30; telephone materials, £65; lamp parts, £170; wire and cable, £297; Elec. lamps, £757; unenumerated, £5,599 [illegible]; Holland: Elec. lamps, £3,617 [illegible]; £390; Elec. machinery, £125; unenumerated, £430 *France:* Elec. lamps, £400; Elec. machinery, £292; [illegible]; Denmark: Elec. [illegible], £9,237. *Italy:* Elec. machinery, £310. *Canada:* wire and cable, £190. *Switzerland:* elec. machinery, £376; unenumerated, £173.

MANCHESTER.—*U.S.A.:* Unenumerated, 265 pgs.

EXPORTS.

To Australasia—*Auckland:* Elec. [illegible]. *Melbourne:* Elec. machinery, £140; unenumerated, £1,258. *Sydney:* Elec. machinery, £647; Elec. glow lamps, £353; wire and cable, £172; unenumerated, £554. *Wellington:* Elec. glow lamps £324; elec. machinery £401; unenumerated, £364. *Brisbane:* Wire and cable, £76; unenumerated, £39. *Dunedin:* Wire and cable, £252; unenumerated, £187. *Lyttelton:* unenumerated, £142. *Adelaide:* Wire and cable, £44; unenumerated, £221. *Fremantle:* Unenumerated, £36. *Perth:* Unenumerated, £160. *Christchurch:* Unenumerated, £400. *Invercargill:* Wire and cable, £472; unenumerated, £54.

AFRICA.—*Durban:* Wire and cable, £45; unenumerated, £725. *Port Elizabeth:* Wire and cable, £1,182; unenumerated, £39. *Cape Town:* Wire and cable, £496; telegraph material, £102; unenumerated, £718. *East London:* Unenumerated, £200. *Zanzibar:* Unenumerated, £25.

E[illegible]—*Alexandria:* W[illegible]; *Port Said:* Unenumerated, £46. *Suez:* Telegraph material, £3,575.

SOUTH AND CENTRAL AMERICA—[illegible]; Elec. [illegible]; £1,103 [illegible] cable, £4,250 [illegible]; £[illegible]

U.S.A.—*New York:* Elec. machinery, £43

HOLLAND.—*Amsterdam:* Unenumerated, £58. *Rotterdam:* Elec. machinery, £22.

PORTUGAL.—*Lisbon:* Unenumerated, £112.

SPAIN.—*Barcelona:* Wire and cable, £27; unenumerated, £283.

ITALY.—*Genoa:* Unenumerated, £300.

NORWAY.—*Christiana:* Wire and cable, £2,064; Elec. machinery, £74; unenumerated, £329.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Unenumerated, £[illegible]; *Calcutta:* Elec. [illegible], £[illegible]; *Madras:* Unenumerated, £258. *Ceylon:* Unenumerated, £205. *Karachi:* Unenumerated, £[illegible]; *Port Sudan:* Unenumerated, £[illegible]

CHINA.—*Shanghai:* Elec. machinery, £79; wire and cable, £104; unenumerated, £227.

JAPAN.—*Yokohama:* Unenumerated, £695. *Kobe:* Unenumerated, £1,239.

JAVA.—*Batavia:* Wire and cable, £1,460.

WEST INDIES.—*Barbados:* Unenumerated, £172. *Demarara:* Unenumerated, £34. *Grenada:* Unenumerated, £[illegible]

GIBRALTAR.—Wire and cable, £69.

MOROCCO.—*Rabat:* Unenumerated, £77.

FRANCE.—*Dieppe:* Unenumerated, £75. *Paris:* Unenumerated, £820. *Calais:* Unenumerated, £[illegible]; *Havre:* Unenumerated, £[illegible].

FOREIGN GOODS (duty paid and free).

Auckland: Unenumerated, £829. *New York:* Unenumerated, £1,003. *Dunedin:* Unenumerated, £[illegible]; [illegible]; £97. *Calcutta:* Unenumerated, £60. *Cape Town:* Unenumerated, £[illegible]; [illegible]; *Java:* Unenumerated, £[illegible]; *Japan:* Unenumerated, £[illegible]; £32. *Sydney:* Unenumerated, £225.

IN TRANSIT.

Cape Town: Elec. [illegible]; *Natal:* Elec. [illegible]; Elec. [illegible]

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL NOTES.

Sheffield University.—As a result of the war, a department has been opened at this university for the scientific teaching of glass making. A lecturer and a demonstrator have already been appointed, and it is to be hoped that the efforts to develop a well-known Yorkshire industry will be successful.

Northampton Polytechnic Institute.—At the annual prize distribution the Principal referred to the educational, social and recreative work of the Institute. During last session 1,748 students were enrolled, as against 2,107 the previous session. The student hours fell from 70,6 to 48, showing the drain caused by enlistment. The Optical Society had contributed a considerable sum in support of the optical classes. The certificates awarded by the City and Guilds Institute were 67, as against 101 the previous session. Twenty two members of the staff, 226 students and 119 members of the Institute had joined the Colours. The Roll of Honour gives the names of seven killed and six injured in their country's service.

Classes have been formed in field telephony, range finding, plane table work and map reading for artillery divisions. Experimental work has been done for the Government. Finally, the ordinary day [illegible] of the engineering college was closed, and the workshops organised as a factory from July 1. Students and staff, with some extra assistance, continue this work. In order to allow this work to proceed the [illegible] in the day engineering college are not being run this session. The Principal expresses his keen appreciation of the effective and loyal assistance given to him by the staff.

BUSINESS NOTICES.

Mr. Alan Williams, M.I.E.E., has removed to 5, Chancery-lane, London, W.C., where he continues to represent the Anderston Foundry Co. and the British Electric Plant Co. In addition he will continue his electrical and general engineering business. Telephone No., 2367 Holborn; and telegrams, "Alnwilms, Fleet, London."

After the 1st prox. the address of Mr. Arthur T. Cooper, consulting engineer, will be 3, Clement's Inn, London, W.C. Telephone: Holborn 6369.

Magnetic Appliances (Ltd.) has removed to 159, Westminster Bridge-road, London, S.E. Telephone: "Hop 4703."

The partnership between Fredk. Wm. Bowen and Thos. Jenkin (trading as the South Wales Electric Welding Co.), Glantawe-chambers, Wind-street, Swansea, has been dissolved. Debts by Mr. Bowen, who continues at the same place and under the same style.

Herbert D. W. Lewis and Randell H. Fletcher, consulting engineers, Prudential-buildings, St. Mary-street, Cardiff, have dissolved partnership. Debts by Mr. Fletcher.

Plant for Sale.—An advertiser has for disposal two 250 kw. rotary converters with transformers and switchgear, suitable for 6,600 v. three-phase, 50 ∾, supply; generating at 440 v. d.c. three-wire.

Plant Wanted.—Messrs. Easton, Gibb & Son (Ltd.), H.M. Dockyard, Rosyth, advertise for two shunt-wound motors or generators of about 400 kw. each at 500 volts d.c.

Patent Development.—The proprietors of patent No. 28,617/1909, relating to "An improved process of homogeneously uniting metal bodies by heat," desire to negotiate for the sale of the patent rights or for the grant of licences. Inquiries to Messrs. D. Young & Co., patent agents, 11 & 12, Southampton-buildings, London, W.C.

Christmas Holidays.—It is announced that the Siemens lamp and supplies department, 38-39, Upper Thames-street, E.C., will be closed from Friday evening, the 24th inst., until Wednesday morning, the 29th inst.

For stocktaking the department will be also closed on Thursday, Friday and Saturday, Dec. 30 and 31, and Jan. 1, 1916, but in order to meet customers' urgent requirements the counter will be open on Wednesday and Thursday the 29th and 30th inst.

The British Thomson-Houston Co. announce that Mazda House will be closed on Saturday, Dec. 25, and Monday, Dec. 27, and for the purpose of stocktaking on Friday, Dec. 31, and Saturday, Jan. 1. The counter will, however, be open for business on Friday, Dec. 31.

BANKRUPTCIES, LIQUIDATIONS, &c.

An application for the discharge of Jas. P. K. Clark, electrical and mechanical engineer (lately trading as Geo. Driver & Sons), Hythe-road, Willesden Junction, London, N.W., will be heard on Jan. 12 at Bankruptcy-buildings, London, W.C.

An application for the discharge of Herbert Page (trading as Smeeton & Page), electrical engineer, 63, Queen Victoria-street, London, E.C., and 32, Marlborough-road, Chiswick, will be heard on Jan. 11 at Bankruptcy-buildings, London, W.C.

The Parana Power Synd. (Ltd.) is being wound up voluntarily, and Mr. L. Maltby (Messrs. Deloitte, Plender, Griffiths & Co.), 5, London Wall-buildings, London, E.C., has been appointed liquidator. A meeting of creditors will be held at the office of the liquidator on Dec. 30.

ELECTRICITY SUPPLY.

EXTENSIONS.

Derby.—The L.G. Board have authorised the Council to borrow £2,043 for motors and £1,927 for mains.

Hammersmith (London).—The Finance Committee recommends the Borough Council to apply for sanction to borrow £3,000 for the electricity undertaking, including extensions of mains for giving supplies (or additional supplies) of energy to a number of factories, the total cost of which will amount to £3,216.

Councillor Stamper has been appointed chairman and Ald. Johnson vice-chairman of the Electricity Committee.

Huddersfield.—At the last meeting of the Corporation the Electricity Committee reported on future extensions.

The committee resolved that additional supplies be given for lighting provided that extensions of mains are not necessary. Electrical energy for heating or cooking will be supplied to consumers only on the consumer undertaking to pay for any apparatus, alterations or extensions of mains. Small motors will be connected where such connection does not entail additional capital expenditure.

It was agreed to ask the Finance Committee to make provision for £10,000 capital expenditure.

The committee passed a resolution of sympathy with the family of Councillor J. W. Lawton, chairman of the committee, who died suddenly on Dec. 1.

Kingston-on-Thames.—An inquiry was held last week into the Council's application for sanction to a loan of £16,792 for the electric supply undertaking, of which £11,000 was for new works and £5,792 excess expenditure on previous loans.

The borough electrical engineer (Mr. J. E. Edgcome) stated, in reply to the inspector (Mr. P. M. Crosthwaite), that in anticipation of the sanction to the £11,000 loan £507. 6s. had been spent.

The INSPECTOR said he could not understand why the Corporation did not apply for sanction to the excesses as they occurred, instead of leaving them to accumulate. Such sanctions were given by the Board every day.

Mr. EDGCOME explained that it was running expenditure to take consumers as they applied. He gave detailed evidence showing how the excess expenditure was made up, and the various items making up the loan of £11,000 for new expenditure. The efficiency of the new oil engines came out very high indeed. For the complete year ended March 31 last, the figures for coal worked out at 1·802d. per unit sold, whereas the fuel oil cost was only 0·424d. per unit. In other words, it cost four times as much to generate by coal as it cost to generate by oil. In 22 years they had only had nine breakdowns, which was a very good record. They put on about 100 new customers every year, and the loan was intended to cover the next four years. They were at the present time connecting one firm which was to work night and day. After going over the items absolutely necessary, the Inspector said he made out the total to be £3,682, plus the excess expenditure, which of course must be provided for.

London County Council.—On Tuesday the following loans for electricity purposes were sanctioned: Islington B.C., £985; St. Pancras, £15,000; and St. Marylebone, £3,800.

Redditch.—The Urban Council have decided to borrow a further sum of £12,542 for extensions of electricity supply undertaking.

Southend-on-Sea.—The L.G. Board has sanctioned the raising of the necessary loan for the purchase of the machinery for the Leigh and Thorpe Bay sub-stations on the understanding that the Corporation would endeavour to dispose of same and not fix it without the Board's consent. The Light Railways Committee has, therefore, invited offers for the purchase of the plant.

The Committee has had before them correspondence which passed between the electrical engineer (Mr. R. Birkett) and Messrs. Carricks, of Edinburgh, the contractors for the supply of the overhead travelling crane for the Leigh sub-station, from which it appeared that, owing to the inability of the Corporation to accept delivery at an earlier date in consequence of the withholding by the L.G. Board of their sanction to the raising of the money for the equipment of the station, they were unable to supply a crane in accordance with the original specification, but that they could supply a crane with heavier girders at an additional cost of £36. The Committee has accepted this offer.

Stafford.—At the last meeting of the Council it was reported by the Gas and Electricity Committee that the time had come when they could not safely continue with their present plant, and they had had under consideration at a special meeting the question of extending the electric generating plant. They were hoping at the earliest possible moment to submit a comprehensive scheme.

Walthamstow.—Having considered a report of the electrical engineer (Mr. G. R. Spurr) as to the demand upon the generating station, the Lighting Committee has directed him to communicate with the proper department of the Government as to extensions of the plant and mains.

GENERAL.

Barnes.—Mr. Whitworth, shift engineer at the electricity works, has resigned, and the filling of the vacancy has been left to the chairman of the Lighting Committee and the electrical engineer, with power to make a temporary appointment at £120 a year.

B.E.A.M.A.—The following firms have recently been elected members of the B.E.A.M.A.: Messrs. Cole, Marchent & Morley, Hick, Hargreaves & Co., and the Edison & Swan United Electric Light Co.

Bermondsey (London).—In consequence of enlistment of permanent shift engineers the Electricity Committee decided to appoint a number of temporary engineers at £2. 2s. per week.

It has been found, however, that this sum is not sufficient to attract or retain suitable men, and the Committee has authorised the appointment of two temporary engineers at £3 per week. As Mr. Jackson, third engineer-in-charge, is in receipt of a salary of £120 per annum, and Mr. Stone, temporary engineer-in-charge, is receiving £2. 2s. per week, the Committee recommends that for the duration of the war they should be paid at the rate of £3 per week.

Brighton.—The proposal to increase the charges for electric current, referred to in our last issue, caused considerable discussion at the meeting of the Council last week.

Ald. COLBOURNE said that before the war freight to Shoreham Harbour was 6s. a ton, now it was 20s.; but if coal was 14s. or 15s. before the war why should it be 43s. now? He moved that the Committee's recommendations be referred back with instructions to submit a report on the subject by the engineer, together with their recommendations.

This amendment, having been seconded, was carried by 18 votes to 15.

East London Linking-up Scheme.—Poplar Electricity Committee has approved the draft agreement for giving effect to the proposals for linking up with Hackney Borough Council's undertaking.

Poplar will lay and maintain two 0·15 three-core cables, pilots and telephone communication to Hackney boundary, and Hackney will lay and maintain two 0·15 three-core cables, pilot and telephone connections to the Hackney-Poplar boundary. Poplar will provide switchgear and cable protection gear for linking up the mains, cost being borne equally by Poplar and Hackney. Each party will have the use of the other party's spare plant without any kilowatt charge, and will be entitled to supply from the other party's spare generating plant at a minimum charge of 0·25d. per unit, measured at the supplying Council's switchboard. Supply will be given at between 6,000 and 6,600 volts three phase alternating current at 50 periods per second. So far as practicable, each party to give to the other equal supplies of energy, and the agreement is to remain in operation for 20 years unless terminated by mutual agreement, and provision is also made for the revision of the charges.

In order to give effect to the scheme it will be necessary to lay mains from the northern sub-station to Hackney boundary at a cost of £2,000, and an extra £350 for e.h.t. panels and switchgear. The Finance Committee recommends the borrowing of the £2,000, the £350 being paid for out of revenue.

Foots Cray.—A notice from the local electricity supply company, intimating that it was proposed to make a charge of 1s. per metre per quarter, has been referred to the Lighting Committee by the Urban Council.

Gillingham.—Last week the Council were recommended to again increase the cost of electric current by 10 per cent.

The Chairman of the Electric Light Committee (Ald. Holmes) gave the big increase in the cost of coal as the reason for the advance. With the 10 per cent. added, electric current would be quite as cheap as gas.

The Town Clerk read several letters from consumers of current, most of whom were not prepared to agree to any alteration of existing arrangements.

Eventually it was decided to refer the matter to the Committee, with power to act.

Halesworth.—The Urban Council have decided not to offer any opposition to the proposal of the Halesworth Electricity and Engineering Works to establish electricity supply works and to use overhead cables.

Hove.—At the recent Council meeting, on the presentation of the minutes of the Lighting Committee Ald. Clark pointed out that two consumers would not consent to change from the 110 to 220 volts supply

He said they were the only two, and to keep them on the lower voltage would involve great expense. It, therefore, became necessary to apply to the Board of Trade to authorise the change to be made. The Committee hoped, however, that the two consumers would not make such a step imperative, but gracefully consent to the change.

Islington (London).—The Finance Committee has reported on the proposal of the Lighting Committee to increase the price charged for electrical energy.

The committee report that they had a statement prepared by the Deputy Borough Treasurer, showing the estimated expenditure and income of the electricity undertaking for the year ending March, 1917, from which it appeared that, owing to the increase in the cost of production (due mainly to the price of coal showing an advance of nearly 70 per cent. on previous prices) a large deficiency would result if the present charges were continued. An increase of 15 per cent., commencing with the March quarter, would approximately meet such deficiency.

Loftus-in-Cleveland.—The Urban Council has made a grant to Messrs. Pease & Partners, who were responsible for the electric lighting arrangements, in respect of the reduced revenue owing to street lighting restrictions. £200 is to be taken for the full year, and a sum apportioned according to the number of times lamps have not been lit.

Portsmouth.—Last week the Corporation adopted a recommendation of the Electric Light Committee to increase the charge for electric current for power, heating and lighting by 15 per cent. as from Dec. 31, the minimum charge remaining as at present and no alteration being made in the case of prepaid slot meter consumers.

In moving the adoption of the report, Ald. F. G. Foster said he was sorry that such a resolution had had to be brought forward, but the committee had a big deficit. There had been a large increase in the cost of coal, the estimated increase in the outlay for which this year being £8,000. The decrease in revenue was £3,200 and the increase in the sinking fund £1,000. They had saved £1,000 in wages, but the net loss for the year would be about £9,300. The 15 per cent. might enable them to make both ends meet.

Councillor H. R. PINK pointed out that he doubted whether the 15 per cent. increase was enough. A great deal would be lost through the shorter hours of business in public-houses, who were very large consumers.

Tynemouth.—The electrical engineer (Mr. C. Turnbull) reports that in many cases the consumption of current by motors was much less than was expected, and he recommends that the 1½d. rate be not charged unless the consumers, along with any lighting on the same service, take current to the value of £1 in a quarter.

The Electricity Committee proposes to make a minimum charge of 5s. per quarter in respect of supplies to garages, this being in addition to meter rent.

The Borough Surveyor has been authorised to consult an expert as to the condition of the Tynemouth Traction Co.'s tramways.

Ulverston.—It was announced at the Rural Council last week that the High Furness Committee had reported that Coniston Parish Council had agreed to the erection of poles and also the laying of certain underground cables in connection with the electric lighting scheme, and they recommended that a clause be inserted in an agreement to be made between the promoters and the Rural Council giving the latter an option of purchase of the proposed works. The matter was, however, referred back for further consideration.

Yarmouth.—After Dec. 31 the price of electric current will be increased from 5½d. to 6d. per unit, but the charge to churches, chapels, schools and hospitals will be 5d. per unit.

TRACTION NOTES.

Birmingham.—The Board of Trade inquiry into the tramway accident which occurred on Nov. 12 took place on Saturday.

GEO. L. OWEN, motorman in charge of the car, described what took place on the morning of the accident. It was raining heavily at the time, and on nearing Lichfield-road he found he could not stop his car at a request stop, so he applied his brakes, but they took no effect; the car gained speed and ran off the rails in Lichfield-road. It went across the road, turned on its side and struck an electric-light standard, against which it leaned. He was thrown on his side by the accident.

In reply to the Inspector (Col. Druitt), he could not say why the brakes refused to act, unless there was an open circuit or a bad rail.

The INSPECTOR: It could not have been a bad rail with that heavy rain.

The conductor of the car gave evidence, and mentioned that a passenger was able to jump on to the car at Pugh-road, so it could not have been going at a great pace there.

Mr. R. H. DICKINSON, engineer to the Corporation tramway department, said the magnetic hand brakes were tested after the accident and they worked all right. When he first saw the car the sand pedal was not in working order. The driver could not have pulled himself up by it, as he stated, because there were no nuts at the bottom of the pedal, which, if taken hold of, would have come clean away. The car had only recently been re-wheeled and was thoroughly overhauled in November 1914. Cars were examined in the sheds every day. He thought the driver must have been going at too high a speed, and threw his magnetic brake right over, instead of notching it in the ordinary way, and there being no sand to use that had the effect of picking up the wheels, which went over on to the roadway. At the speed at which the car was said to be travelling by Owen, it should have turned the curve all right if the wheels had been allowed to rotate.

Evidence of the testing of the brakes and of their being in order was given, and the inquiry concluded.

Bradford.—Last week the Corporation decided to employ women conductors as an experiment, but all women will be dispensed with at the conclusion of the war on the return of their own employees, or immediately sufficient male labour can be obtained.

Up to the present 689 men have joined H.M. Forces and of the remainder (818) of military age 550 have been attested under the Derby scheme.

There will be tramcar service on Sunday, Dec. 26.

L.C.C. Tramways.—On Tuesday an emergency report was submitted to the L.C.C. by the Highways Committee recommending capital expenditure of £4,500 for doubling certain sections of the existing tramways between Nile-street and Abbey Wood. The recommendation was carried.

Tramway Breakdowns.—Replying to Mr. Gilbert, Mr. Hume said that there was no agreement with the South London Electric Railway in regard to providing additional travelling facilities in the case of a breakdown of the tramways in South London, but in such an event it was the practice to telephone to the company so that they could provide for additional traffic.

Middlesex Tramways.—The employees of the Metropolitan Electric Tramways (Ltd.) have been granted an increase of 2d. a day on their wages maximum, and an addition of 1s. a week war bonus to men earning between 30s. and 40s. a week.

Railway Rates.—Under the Railway & Canal Traffic Act, 1888, the following increases in rates will come into force on Jan. 1, 1916:—

Dublin, to and from English and Welsh stations, carriages and motor cars 3s. 6d. each, and all other goods traffic (with certain exceptions, such as grain, beer, ale, cattle, sheep, &c.), at station-to-station rates, 5d. per ton, or, including cartage, 11d. per ton.

Interior Irish stations, to and from English and Welsh stations, goods traffic at station-to-station rates, 5d. per ton, or, at rates including collection or delivery, 11d. per ton.

Walthamstow.—The Commissioner of Police has advised the Tramways Manager that it would be inadvisable to provide flash lamps for the use of conductors on the tramcars.

EMPIRE NOTES.

Australasia.—We have received from Mr. W. G. T. Goodman, the chief engineer and general manager, a card with Christmas and New Year greetings on one side and exhaustive statistics relating to the undertaking of the Adelaide Municipal Tramways Trust on the other.

The statistics include all that is usually included in the annual accounts of municipal trading undertakings, and give the comparative figures from 1909 to 1915. This handy form of accounts will doubtless be preferred by many persons to the usual volume form.

Gisborne (N.Z.) Council has decided to submit proposals to the ratepayers for raising loans for electricity works (£10,000) and tramways (£30,000).

The electrical engineers of the Wellington (N.Z.) tramways and lighting departments have been requested to report fully on the subject of the supply of electrical energy to outlying districts. The general manager of the tramways department advises that consideration should be given to the possibility of a hydro-electric scheme being adopted.

H.M. Trade Commissioner in Australia (Mr. G. T. Milne) reports that the Federal Attorney-General, at the close of a meeting of the metal conference on Oct. 14, stated that arrangements had been completed whereby the whole of the copper output of Australia suitable for electrolytic treatment could be dealt with in the Commonwealth. The problem the conference had considered was how to make provision for refining copper. The electrolytic process might now be regarded as settled, and as to the fire refining method, he was confident that the arrangements made by the conference in regard to it would be sufficient to treat all Commonwealth copper ore not treated electrolytically. The policy of the Government had been to make provision for treating copper ores so that they should afford employment for capital and labour within the Commonwealth. The export of copper matte and blister copper would not in future be permitted unless it could be clearly shown that facilities for refining were insufficient. Only one further step remained to be taken—namely, the manufacture from metallic copper of all copper and brass goods consumed within the Commonwealth. The Federal Attorney-General hoped soon to be able to announce that this problem also had been satisfactorily solved.

MISCELLANEOUS NOTES.

Inquest.—The inquest on the three victims of the recent tramcar accident at Birmingham was concluded on the 15th inst.

GEO. LEE OWEN, the driver of the tramcar, said that on the morning of Nov. 12 he left Witton depot at 5:18. On the journey he tested the brakes twice and they were in order. The car was stopped at the compulsory stop at Park-road, and on receiving the signal the journey was resumed. Witness left the hand brake off, gave the controller a couple of notches to start the car, and then shut off power, and the car went along impelled by its own weight. He applied the hand brake at the crossing in order to steady the car, and afterwards put on the magnetic brake and dropped some sand. He continued doing so, but found the magnetic brake would not act. He then applied the hand brake, but that failed to hold the car. Near Pugh-road he dropped more sand, shut the controller to the off, and reversed the key from the backward to the forward position. He applied the magnetic brake to the top notch, and also the hand brake. Witness then heard the wheels crunching over the sand, and the next thing he knew was that the car had left the rails. It overturned while crossing the uphill track in Lichfield-road. The whole three of the brakes failed to act. He tried the magnetic brake first, he then tried to stop at Pugh-road with the hand brake, but that did not stop the car; and then he reversed the key. He could not suggest why at that particular time they should not act, unless it was a bad rail. He commenced to apply brake power immediately after passing Pugh-road.

The Coroner summed up, and the jury returned a verdict of "Accidental death," adding a rider that in their opinion the driver misjudged the distance for applying the brakes.

Interesting Private Munitions Plant.—Sir James Horlick, Bart., who has two sons serving at the front, has found yet another outlet for his patriotism by the conversion of his motor repair shops into a miniature munitions works.

Sir James Horlick possesses a first-rate electrical plant, and, as may be expected, electricity plays an important part in the driving of the three screw cutting lathes, drilling machines, &c., with which these works are fitted. Sir James has placed his engineer (Mr. A. S. Taylor) in charge of the shops. We are aware that it is not every country estate that has

facilities for the making of war material, but we are bringing the above splendid effort to the notice of our readers as we feel sure that there must be many lathes and other machines lying idle throughout the country which, even if they could not be used in position, could be put to most useful purpose elsewhere, and all in possession of such would do well to get into touch with Messrs. Rawlings Bros. (Ltd.), who will be pleased to give inquirers the benefit of their experience, as they were favoured with instructions from Sir James Horlick for the equipment and general arrangements of the works, or to Mr. W. Reason, the energetic secretary of the local Munitions Committee.

Munition Case.—At Blackburn Munitions Tribunal last week an electrician alleged that a firm had unreasonably withheld his certificate.

He said he had had extra work to do since the war and contended he was not properly remunerated; he was also over-worked.

The Chairman said it was rubbish to say he was over-worked. He did not know what they were coming to when men complained because they had to walk from one works to another. The firm said the man was single, was 25 years of age and had not attested.

The certificate was refused.

Prohibited Exports.—By an Order in Council, issued on Tuesday last, the exportation of the following is prohibited :—

Hematite pig iron and iron and steel smelting scrap to all destinations; bichromate of soda, solid drawn steel tubes and material for wireless telegraphs, to all destinations other than British possessions and protectorates.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during November, 1915, and (*b*) the aggregate figures from Jan. 1 to Nov. 30, with the increases or decreases compared with the corresponding periods of 1914 :—

Electrical machinery, (*a*) £110,109 (including generators and motors other than for aeroplanes, motor cars and cycles, £17,589, and electrical machinery unenumerated, £92,520) (decrease £28,623), (*b*) £1,394,861 (including generators and motors other than for aeroplanes, motor cars and cycles, £240,637, and electrical machinery unenumerated, £1,154,224) (increase £41,010); telegraph and telephone cables, submarine (*a*) £180 (decrease £724), (*b*) £311 (decrease £1,588); other than submarine, (*a*) £2,140 (increase £851), (*b*) £28,285 (decrease £18,538); telegraph and telephone apparatus, (*a*) £29,896 (increase £14,777), (*b*) £108,994 (decrease £84,982); other electrical wires and cables, rubber insulated (*a*) £3,741 (increase £2,174), (*b*) £86,520 (decrease £144,093); with other insulations, (*a*) £526 (increase £179), (*b*) £43,862 (decrease £15,779); carbons, (*a*) £15,797 (increase £8,987), (*b*) £134,397 (increase £20,148); glow lamps, (*a*) £10,182 (increase £4,755) (*b*) £133,650 (increase £19,904); arc lamps and electric searchlights, (*a*) £136 (increase £81), (*b*) £2,800 (decrease £414); parts of arc lamps and searchlights (other than carbons), (*a*) £6,012 (decrease £425), (*b*) £79,127 (decrease £5,239); primary and secondary batteries, (*a*) £35,895 (increase £25,369), (*b*) £144,014 (increase £62,088); meters and measuring instruments,* (*a*) £4,435, (*b*) £28,680; switchboards,* (*a*) £185, (*b*) £5,449; electrical goods and apparatus unenumerated, (*a*) £21,609, (*b*) £187,842. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £131,334 (increase £68,509), (*b*) £984,231 (decrease £167,786).

* Not enumerated separately in previous years.

Exports.—The exports of electrical machinery, material, &c. (*a*) during November, 1915, and (*b*) from Jan. 1 to Nov. 30, with the increase or decreases compared with the corresponding periods of 1914, were as follows :—

Electrical machinery, (*a*) £1,302,869 (including railway and tramway motors, £7,777, generators and motors other than for aeroplanes, motor cars and cycles, £76,668, and electrical machinery unenumerated, £32,768) (increase £3,523), (*b*) £1,302,869 (including railway and tramway motors £107,010, generators and motors other than for aeroplanes, motor cars and cycles, £640,420, and electrical machinery unenumerated, £555,439 (decrease £737,709); telegraph and telephone cables, submarine (*a*) £59,967 (increase £25,065), (*b*) £353,361 (decrease £120,132); other than submarine, (*a*) £60,632 (increase £31,587), (*b*) £405,365 (increase £113,850); telegraph and telephone apparatus, (*a*) £30,587 (increase £14,669), (*b*) £202,063 (decrease £31,251); other electrical wires and cables, rubber insulated, (*a*) £73,471 (increase £46,887), (*b*) £332,557 (increase £15,478); with other insulation, (*a*) £60,257 (increase £30,485), (*b*) £468,675 (increase £88,094); carbons, (*a*) £1,058 (increase £611), (*b*) £8,203 (increase £896); glow lamps, (*a*) £15,130 (decrease £1,156), (*b*) £146,346 (increase £19,696); arc lamps and searchlights, (*a*) £2,826 (increase £2,622), (*b*) £6,961 (decrease £5,888); parts of arc lamps and searchlights (other than carbons), (*a*) £1,088 (increase £898), (*b*) £20,764 (decrease £1,488); primary and secondary batteries, (*a*) £16,509 (decrease £461), (*b*) £181,189 (increase £20,022); meters and measuring implements,* (*a*) £14,466, (*b*) £139,935; transformers,* (*a*) £7,714, (*b*) £61,738; switchboards,* (*a*) £3,717, (*b*) £54,898; electrical goods and apparatus unenumerated, (*a*) £58,488 (decrease £7,137), (*b*) £539,962 (decrease £267,163). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £405,910 (decrease £169,967), (*b*) £2,922,017 (increase £88,687).

* Not enumerated separately in previous years.

TENDERS INVITED.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23. Tender forms, specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W. *See advertisement.*

In reference to the invitation of tenders by DURBAN Corporation for (1) Telephone Apparatus and Materials; (2) Underground Cables (paper insulated, armoured, silk and cotton covered, &c.); and (3) 540 Cast-iron Pipes, 9 ft. in length, for the cables, it has been arranged that firms who tendered by the date originally announced (Dec. 1) may amend their figures and send them to Messrs. Webster, Steel & Co., 5, East India-avenue, London, E.C., by Dec. 31.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Coal-Handling Plant.

DARLINGTON Corporation require tenders by Jan. 12 for supply and erection of Coal Bunkers, Elevators, &c., at their electricity works. Specification from Borough Electrical Engineer.

Power House Extension.

ST. PANCRAS (London) Council require tenders by noon Jan. 10 for Steel Constructional Work of extension of power house. Drawings can be seen at 57, Pratt-street, Camden Town, N.W.

Electric Power Plant.

Tenders will be received at the Negociado Quinto de la Segunda Sección (Material) del Estado Mayor Central de la Armada, Ministerio de Marian, Madrid, until Jan. 26, for the Construction and Installation in the Cadiz Naval Arsenal of an Electric Power Plant. Conditions of tender may be seen at the above-mentioned Negociado. Tenders (in Spanish), on paper bearing a 1 peseta stamp, must be accompanied by specifications and plans. A provisional deposit of 20,000 pesetas (about £800) is required to qualify any tender. Local representation is necessary.

Electrical Supplies, &c.

TOXTETH PARK Guardians require tenders by noon Dec. 29 for three months' Electrical and Engineers' Supplies, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

HAMPSTEAD (London) Council require tenders by 4 p.m. Jan. 6 for one or three years' supply of Electrical Engineers' Stores, Oils, Ironmongery, &c. Forms of tender from the Town Clerk, Town Hall, Haverstock Hill, N.W.

Wiring and Fittings.

BISHOP AUCKLAND Urban Council require tenders by Dec. 28 for Electric Lighting of new Engine House at West Mill. Specifications can be seen at the Waterworks Manager's Office.

Electrically-operated Pumps.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1,301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fish-plates Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

Electrification of Cranes.

Tenders will be received until Jan. 6 at the offices of the Junta de Obras del Puerto, Alameda de Mazarredo, 3, Bilbao, for the Electrification of Seven Movable 3-ton Steam Cranes and One Fixed 25-ton Steam Crane on the wharves at BILBAO. Local representation is necessary.

TENDERS RECEIVED AND ACCEPTED.

VALENCIA (SPAIN).—The Port Authorities have awarded a contract for supply and erection of four electric cranes to the Sociedad La Maquinista Marítima y Terrestre, of Barcelona, at about £7,780.

LONDON COUNTY COUNCIL.—The following tenders have been accepted for the supply of insulating materials :—

L. Andrew & Co., Robert W. Blackwell & Co., Geo. Hattersley & Sons, Geo. MacLellan & Co., Micanite & Insulators Co., and Siemens Bros. & Co.

BRISTOL.—The Docks Committee has accepted the tender of Siemens Bros. & Co. for supply of 425 yds. of triple concentric paper insulated cable.

Government Contracts.—The following tenders were accepted by the British Government Departments during November :—

War Office.—Craypark Electric Cable Co. and Macintosh Cable Co., cables, &c.; Alperton Rubber Co., India Rubber, Gutta Percha & Telegraph Works Co., and Siemens Bros. & Co., rod and sheet ebonite ; Hancock & Rexin, electric light and power installation in fabric shops, South Farnborough ; C. Cooper & Co., electric lighting, New Camp, Grantham, and Prisoners of War Camp, Alexandra Palace; Pinching and Walton, ditto, Prisoners of War Camp, Dorchester ; Mann, Egerton & Co., ditto, Royal Flying Corps Camp, Norwich.

Post Office.—Siemens Bros. & Co., telephone apparatus submarine cable and battery cells ; Western Electric Co., protective apparatus ; Telegraph Construction & Maintenance Co., submarine and telephone cable : Callender's Cable & Construction Co., W. T. Glover & Co. and W. T. Henley's Telegraph Works Co., telephone cable ; Everitt & Co., Liverpool, manganese chloride ; Taylor, Tunnicliff & Co., fuse mountings ; T. Bolton & Sons, British Insulated & Helsby Cables, Shropshire Iron Co., and F. Smith & Co. (Inc. in London Electric Wire Co. & Smiths), bronze wire.

Ship Lighting.—The tender of Siemens Brothers Dynamo Works has been accepted for the supply of Wotan, Tantalum and carbon lamps to the Aberdeen Line for the year 1916.

The tender of Siemens Brothers Dynamo Works has also been accepted for the supply of Wotan and Carbon filament lamps to the Royal Mail Steam Packet Company during 12 months from January 1, 1916.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Gravesend.—The accounts of the electricity undertaking (exclusive of Northfleet extension) for the year to March 31, show capital expenditure £84,419 (increase £9,968), of which £28,343 has been repaid.

Revenue was £13,298 (against £12,708 for previous year), total costs were £7,727 (£6,628), gross profit was £5,571 (£6,080), interest required £1,972 (£1,959) and repayment of loans £3,022 (£2,906), and £200 (£100) was carried forward, the net profit being £827 (£1,158). Average price obtained was 2·03d. (2·12d.) and total costs (other than capital charges) were 1·180d. (1·104d.). Units generated were 2,114,056 (1,940,002) and sold 1,570,895 (1,441,482).

The capital spent on the Northfleet section, which takes current from the Gravesend works, is £12,564 (£11,069), of which £3,010 has been repaid. Revenue was £1,709 (£1,542), gross profit was £715 (£712) and, after meeting capital charges, the net result was a profit of £17 (£19). Units purchased were 345,327 (200,227) and sold 286,186 (205,911).

Leeds.—The revenue account of the electricity department for the half-year to Sept. 30, which was presented to the Electricity Committee on Monday, shows a gross profit of £36,294 (compared with £30,723 in corresponding period of 1914), and a net deficit of £15,251 (£11,686).

Income from sales of current was £70,572 (against £64,262), total revenue was £70,697 (£64,277) and working expenses were £34,402 (£30,723). £3,643 (£5,737) was contributed to capital expenditure, and interest redemption and income tax required £47,902 (£39,502). Units sold were 19,849,021 (18,626,358). Power units increased from 9,985,583 to 12,164,564. Average price obtained for all purposes was 0·85d. (0·83d.)

In his report the city electrical engineer (Mr. C. N. Hefford) says the increase in the output took place without any endeavour to obtain new consumers, and in face of restrictions upon extensions of mains and services. Allowing for the transfer of a number of consumers to the class taking residential bulk supplies on the rateable value system, the consumption of energy for private lighting has been very slightly more than in the previous corresponding half year, which may be considered very satisfactory in view of the lighting regulations. The output for street lighting was less than one-sixth of that for the previous corresponding half-year. The supply of energy to motors has shown what may be considered about a normal increase (21·8 per cent.), the use of electric motors in connection with engineering works, &c., having fully counterbalanced any falling off in other directions. Electric heating has shown an unsought increase of 71 per cent. When the committee are free to take measures for the development of this branch of the business, the improved apparatus now available and the low price of energy should result in a large increase in electric heating. A higher average price had to be paid for coal, and this factor will become more serious when existing contracts expire. Labour has been more expensive, apart from the payment of £968 during the half year in allowances to dependents of officials and workmen serving in H.M. Forces. There is nothing abnormal in the fact of a deficit for the summer half of the year, this having been, indeed, the invariable experience from the commencement of the undertaking.

COMPANIES' MEETINGS AND REPORTS.

India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.)

The 52nd ordinary general meeting of this Company was held on Wednesday, Major LEONARD DARWIN (Chairman) presiding.

The SECRETARY (Mr. A. P. Crouch) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN, in moving the adoption of the report (abstracted in our last issue) and the declaration of the dividends set out therein, referred to the absence of one of their directors (Col. Weston Jarvis), who was Colonel of a London Yeomanry Regiment, and his brigade received orders to go to the East in April last. The Board gave him leave of absence whilst on military service. They called no half-yearly meeting in June of this year, their last gathering being a year ago, when he ventured to express a hope that their main troubles were things of the past. That hope had been justified by the year's working. Both their factories had been occupied with Government work, whilst they had been able to execute a portion of their ordinary work without interfering with the Government demands, which, of course, had first call on their resources. That had increased their yearly turnover to a considerable extent, and although the Government orders did not in themselves carry as large a profit as their ordinary business, the increased turnover had automatically decreased the percentage of their standing charges and thereby increased their profit. During the year they had had to meet many difficulties in the ever changing costs of labour, material, transit and fuel, and they were glad to think that their anticipation and action in the past with these unknown factors before them had been justified by the final results of the year's trading. Their foreign branches had nearly all shown a distinct improvement on the previous years' records, partly due to more economical methods being adopted, and also to some extent to an increase in the volume of business. Their factory at Persan had done very well, having transformed what had been a loss for some years into a profit. That change had been due to a great extent to an improvement in methods of buying, manufacturing and selling goods and a more accurate knowledge of costs of production. Their ship "Dacia" had been employed on important work, which she had completed in a most satisfactory manner. With reference to the future, he should not venture to prophesy. As long as the war continued they hoped to be able to fill their works and keep all the available labour employed, especially on Government requirements ; but when the war finished and there was a falling off in the demand for war supplies, it would be necessary to some extent to re-build that portion of their business which they had been unable to maintain owing to war conditions. It had been the aim of the directors, amongst other things, to be prepared to produce in their factories such work as had hitherto been produced in Germany and supplied to England and France, in order that when Government work was no longer required they should be in a position to compete with the German suppliers in these markets. They anticipated that there would be difficulty in doing that, but on the whole, they hoped to be able to maintain a satisfactory condition of profit. In the early part of the coming year they would have to deal with the question of the redemption or renewal of their

debenture bonds. They looked forward to the future in the belief that their organisation and methods would enable them to deal successfully with the unknown conditions after the war, and they thought that the company would maintain its old record in the possibly altered circumstances arising out of it.

Mr. C. H. GRAY (joint managing director) seconded the resolution.

The CHAIRMAN stated, in reply to questions, that there had been some years in which the cable ships probably had not paid, but he should say that, on the whole, in recent years they had paid. The Board thought there would always be a future for cable work. They looked forward fairly confidently to being able to do a good deal of work in that direction. They had now only two ships, having lost one about a year and a half ago. One of their ships, as he had stated, had been doing a very important bit of work which would show a certain amount of profit and a very considerable amount of credit.

Mr. W. E. GRAY (joint managing director) said he had not the exact figures, but about 450 employees had joined the Colours and they had allowed them half their pay. About the same number of women had been engaged.

The report and accounts were then adopted and the dividends approved.

The retiring Director (Major Leonard Darwin) was re-elected and the auditors (Messrs. Turquand, Youngs & Co.) were re-appointed.

On the motion of a shareholder, a resolution of sympathy to the Board and to the relatives of the late Mr. Matthew Gray was carried unanimously, and a vote of thanks to the chairman, directors and staff closed the proceedings.

FULLER ACCUMULATOR CO. (LTD.)—At the meeting on Tuesday the directors reported that for the year ended Oct. 31 the working had been satisfactory. The sales of the block accumulator continued to increase both at home and abroad, and there was sufficient work on hand to keep the factory busy for months to come. A new patent had been acquired which enhanced the value of the existing patent. The balance of preliminary expenses (£600) had been written off. The net profit of the year's trading was £9,960. 9s. 3d., which, with £3,343. 14s. 8d. placed to reserve last year, made a total of £13,304. 3s. 11d. It was decided to pay a dividend on the preference and ordinary shares at rate of 10 per cent. per annum (including interim dividend already paid), to place to reserve fund £1,656. 5s. 4d., which (added to £3,343. 14s. 8d. placed to reserve last year) makes a total reserve of £5,000, leaving to be carried forward £2,304. 3s. 11d.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The directors have declared a dividend of 7 per cent. on the preference shares and an interim dividend of 5 per cent. on the ordinary shares (less tax) on account of the current year. The directors express regret that they have not yet been able to obtain from Government departments a basis of settlement in respect of either remuneration or compensation for services rendered, for the use of their stations since the commencement of the war, nor in respect of other matters in which the Government is indebted to the Company. However, without taking into account the considerable sums which are estimated to be due to the Company in respect of these matters, the business actually completed for the current year has been satisfactory, and justifies the directors in declaring the above dividends.

MARCONI WIRELESS TELEGRAPH CO. OF CANADA (LTD.)—The report states that message traffic to and from ships, which forms an important source of their revenue, and which prior to the war was showing a gratifying increase, has been adversely affected by the severe censorship imposed, the general dislocation of passenger traffic and the placing of important stations at the disposal of tde Government. The directors have submitted appropriate claims to the Naval authorities for compensation in respect of the reduced revenne of the various coast stations as compared with the corresponding period anterior to the war. The matter is still in abeyance, but the directors have reason to believe that an equitable settlement will be arranged.

VENEZUELA TELEPHONE & ELECTRICAL APPLIANCES CO. (LTD.)—The report for the year ended June 30 shows a profit of £17,644, to which must be added £10,433 brought forward. After providing for interest on prior lien, first and second debentures, and for payment of income tax, the balance is £20,401, out of which it is proposed to pay a dividend of 30 per cent., amounting to £2,580 (less tax) on the cumulative preference shares, thus discharging arrears of dividend to Dec. 31, 1906, to place £6,000 to reserve for renewals and depreciation, and to carry forward £11,821. The sum of £6,191 was spent on capital account during the year.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES

ANGLO-RUSSIAN ENGINEERING CO. (LTD.) (142,379)—Reg. Dec. 11, capital £5,000 in 4,000 10 per cent. preference shares of £1 each and 20,000 ordinary shares of 1s. each, to carry on the business of electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in electrical apparatus, &c. Private company. First directors are T. J. Edwards, E. C. Hoegersteedt, J. S. Aplin and J. B. Webb. Reg. office, 78, Turnmill-street, E.C.

COPPER DEPOSITING & GENERAL ENGINEERING CO. (LTD.) (142,418) Reg. Dec. 16 capital £1,000 in £1 shares, to carry on business of copper depositors, refiners and workers of copper and other metals by electric or any other process, makers and suppliers of copper or other metal depositing apparatus, machinery and plant, &c. Private company.

MORTGAGES AND CHARGES.

ARDEE ELECTRICAL CO. (LTD.)—Debentures reg. Dec. 15 (by order of Court) amounting to £2,000. General charge on company's undertaking and property.

W. SANDERS & CO. (1915) (LTD.)—Particulars of £1,000 debentures, created Dec. 1, 1915, have been filed, whole amount being now owing. Property charged: Company's undertaking and property, present and future. No trustees.

RECEIVERSHIP.

APPARATUS & ACCESSORIES (LTD.)—G. E. Corfield, 119, Finsbury-pavement, E.C., ceased to act as receiver or manager on Nov. 24, 1915.

CITY NOTES.

MEMORANDA (Dec. 22).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58¼. Consols Pay Day, Jan. 5. Stocks and Shares Ticket Days Dec. 29 and Jan. 12. Pay Days Dec. 30 and Jan. 13. Price of silver, 26 1/16d.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Dec. 3: Auto-Electric Vacuum Drying Synd., Boudjah Electric Lighting Co., Chapman Motor Starter Synd., East Kent Electric Supply Co., Filaments, Inventors, Radiographic Processes, Small Power Dynamo & Motor Co., United Sherardizing, Wolf Engineering Co.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 21. The greatest care is taken in compiling the e figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Dec. 21.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 9 4	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅛	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs...	83¼†	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 9 9	..
5	5%	Do. Ord.	3 1/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	3¼	6 0 0	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90†	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	10	6 0 0	Feb, Aug
St.	4½%	Do. 1st Deb.	90½	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	77	5 16 11	July
5	9%	Kensington and Knightsbridge Ord. ..	6 1/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 1/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½†	5 6 4	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2⅛	7 10 11	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/32	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7⅝	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 3/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations..	1⅛	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	[illegible]	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3⅝	5 16 2	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80[illegible]	6 4 7	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	[illegible] 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	70	5 14 3	..
St.	4%	Do. do. Assented Def. Ord. ..	68	5 [illegible] 8	..
St.	4½%	Do. 4½% Pref.	99¼	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅞	5 11 4	May, Nov
St.	5%	Do. Pref. 1886	80	6 5 0	Feb, Aug
10	⅝%	London Electric Ry. Ord.	1 1/16	4 0 0	Jan, July
St.	4%	Do. 4% Pref.	58	6 17 11	Mar. Sept
St.	4%	Do. 4% Debs.	85†	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24[illegible]	4 10 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb Aug
St.	3½%	Do. 3½% Convertible Pref.	74[illegible]	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82¼	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83[illegible]	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15[illegible]	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 [illegible] 0	May, Nov
St.	4½%	Do. 4½% First Pref.	[illegible]	6 15 10	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109¾†	5 9 4	Jan, July
St	4%	Do. 4% Debs.	72[illegible]	5 11 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	73†	5 9 7	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅜	..	..
1/0	..	Do. A Ord.	[illegible]	..	..
St.	6%	Do. 6% Inc. Debs.	105	5 14 3	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shares	Last Dividend	Name.	Price, Tues., Dec. 21.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways	—*cont.*		
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	76⅞	7 15 6	Mar, Sept
..	4½%	Do. 4½% Bds.	100½	4 9 6	Jan, July
5	..	Yorkshire W. Riding Ord.	¼	..	March
5	6%	Do. Pref.	4⅛	6 19 6	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2¹½	5 19 6	Apl, Oct
1	6%	Do. 6% Pref.	1¹⅝	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 9 9	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	⅞	7 2 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10¹⅞	7 2 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅛	5 14 3	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅞	8 0 0	April
100	6%	Do. 6% Prior Lien Debs.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅜	7 4 7	Jan, July
5	2/6	Do. 5% Pref	4⅛	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kel'ner	3	6 13 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅜	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	62½	6 8 6	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅝	7 4 6	Jan, July
St.	4%	Do. 4% Debs	72½	5 10 4	Jan, July
..	10%	General Electric Ord.	10⅞	9 11 1	July
10	6%	Do. 6% Pref.	9⅛	6 3 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	⅞	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	9⅛	5 9 7	Feb, Aug
10	5%	Do. Pref.	7½	6 13 4	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34½	7 1 0	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅝	4 10 7	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	83⅛	4 15 4	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99¼	4 10 3	Jun, Dec
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	101	5 19 0	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	2⅞	6 11 10	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70	5 14 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅞	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅛	6 9 4	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½	5 9 10	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80⅞	4 18 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 11	Feb, Aug
10	7%	Do. Ord.	12⅝	5 13 2	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8.	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	48⅜	6 13 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅞	5 6 6	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅛	9 8 3	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 5	May, Nov
10	7%	Western Telegh. Co.	12½†	5 12 0	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99½	4 10 5	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	134⅜	5 18 9	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 9 3	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101	4 9 0	May, Nov
1	10%	*Oriental Telephone Ord.	1⅜	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79½	5 0 8	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 5 11	Jan, July
5	8%	United River Plate Ord.	5⅛	6 14 9	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10½†	5 17 1	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10²†	5 15 9	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	8⅝†	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68½†	5 17 3	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	80	6 5 0	Jun, Dec
St.	4½%	Do. 4½% Debs	77½	5 18 10	Jan, July
St.	4%	Do. 4% Debs.	75	5 6 8	Jan, July
5	2/9	Do. 5½% 1st Pref.	4⅛	6 15 5	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅜	8 0 0	Jan, July
100	2%	Brazilian Traction Ord.	92½	7 12 5	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	91½†	6 11 0	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅝	6 8 0	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62½	6 16 0	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅛	7 15 1	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	90½	5 10 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅞	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	42	..	Fb,M,Aug,N,
..	5%	Do. 5% Bds	49½	10 12 4	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94½	4 15 3	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 5) yr. Bds	79	6 6 7	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	95	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10⅛	5 19 3	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4⅛	5 17 8	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	122½	5 14 4	Ja,Apl,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	93	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29⅛	..	J, A, J, O
..	..	Do. Pref.	34⅛	..	May, Nov
..	5%	Do. 5% Bds.	43	13 5 1	Jan, July
..	5%	Shawinigan Water & Power 5% Bds.	104½	4 15 5	Jan, July
..	6%	Do. Cap. Stock	141	4 5 1	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 8	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	80	5 12 6	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	⅛	..	Jan, July
—	5½%	Do. 5½% 2nd Mort. Debs.	92⅛	5 18 7	Jan, July

* And 13⅓% Bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 21, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	14½d.	English Lead	£28 17 6
Solid Drawn Copper Tubes	14½d.	Antimony	Nominal.
Brazed Copper Tubes	14½d.		
Brazed Brass Tubes	16½d.	**Old Metals.**	**per ton.**
Brass Wire	13½d.	Clean Scrap Copper	£79 0 0
Copper Wire	13⅝d.	Braziery Copper Scrap	£72 0 0
Rolled Brass	13½d.	Clean Scrap Brass	£59 0 0
Brass Sheets	13⅝d.	Old Lead	£23 0 0
		Old Zinc	£50 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£112 0 0	Black Pewter	£80 0 0
Spelter	£88 0 0	Gun Metal	£63 10 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec 20, the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£125 0 0	Old Lead	£24 0 0
Clean Mixed Brass	£59 0 0	Tea Lead	£22 0 0
Clean Copper	£75 0 0	Old Zinc	£56 0 0
Braziery Copper	£69 0 0	Hollow Pewter	£115 0 0
Gun Metal	£70 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 15	1,670	+ 153	28	51,034	+ 2,740
Anglo-Argentine	,, 16	51,874	+ 240	28	2,555,023	− 132.741
Ashton-under-Lyne	,, 11	427	+ 49	37	17,725	+ 1.297
Ayr Corporation	,, 18	237	+ 16	31	12,531	+ 675
Birkenhead Corporation	,, 19	1,378	+ 114	38	51,781	+ 4,115
Birmingham Corporation. Trams	,, 11	15,850	+ 3,636	37	520,377	+ 73,663
Birmingham Corporation. Buses&c.	,, 11	814	+ 184	37	31,144	+ 18,068
Blackburn Corporation	,, 15	1,026	− 10	38	48,440	+ 299
Blackpool Corporation	,, 16	642	+ 101	38	67,405	+ 1,638
Blackpool and Fleetwood	,, 18	259	− 11	50	38,313	− 351
Bolton Corporation	,, 19	2 606	+ 164	38§	101.249	− 1,579
Bournemouth.... Trams	,, 15	1,694	− 41	37	78,906	+ 3,751
Bournemouth.... Buses	,, 15	7	..	37	906	− 100
Bradford Corporation	,, 18	6.530	+ 863	37	245,213	+ 10,378
Brighton Corporation	,, 19	850	+ 20	38§	42,956	+ 339
Bristol Trams Trams	,, 17	5,022	+ 678	50	236,159	+ 5,723
Bristol Trams Buses,&c.	,, 17	5,100	+ 983	50	244,936	+ 45,007
Burmah E. Trams & Ltg.	..	..	..	..	..	..
Burnley Corporation	,, 18	1,526	+ 174	11	27,564	+ 2,138
Burton Corporation	,, 20	271	..	38	10,698	− 409
Bury Corporation	,, 19	1,216	+ 83	38§	51,205	− 415
Calcutta Tramways Co.	,, 18	R67,012	+ R4,465	..	..	..
Camborne-Redruth	..	..	..	..	..	..
Cardiff Corporation	,, 11	2,594	+ 176	36	98.774	− 2,583
Cork Electric Trams Co.	,, 16	432	− 17	50	24,961	+ 24
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	,, 18	988	+ 46	38‖	39.490	+ 1.260
Dover Corporation	,, 11	276	+ 47	36	11,542	+ 2,087
Dublin & Lucan Railway	,, 17	105	− 9	24	3 594	+ 66
Dublin United	,, 17	5,714	− 136	50	304,499	+ 10,875
Dundee Corporation	,, 15	1,264	+ 48	31§	41,791	+ 2,195
East Ham Council	,, 18	1,339	+ 128	37‖	48,960	+ 5,437
Exeter Corporation	,, 17	320	+ 4	37	14,255	+ 791
Glasgow Corporation	,, 18	21,807	+ 1.715	29‡	624.070	+ 44.065
Glossop Trams	,, 18	123	+ 22	51	6,396	+ 368
Gloucester Corpn.	,, 15	293	− 3	37	12,402	+ 120
Halifax Corpn. Trams	,, 14	1,798	− 32	37	83,089	+ 879
Halifax Corpn. Buses	,, 14	36	− 5	37	1,828	− 4
Hastings Elec. Trams Co.	,, 16	721	− 36	50	88,031	− 264
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	,, 18	3,176	+ 145	37	115,105	− 2,425
Ilford District Council	,, 18	616	+ 22	37	24,368	+ 2,949
Ilkeston Corporation	,, 15	128	+ 11	37	4,996	+ 184
Ipswich Corporation	,, 18	466	+ 68	36	20,765	+ 3.344
Isle of Thanet Co.	,, 18	217	− 36	11¶	2.901	− 919
Kilmarnock Corporation	,, 18	153	+ 9	31	5,227	+ 137
Lanarkshire Trams Co.	,, 16	2,007	+ 334	50	98,964	+ 5.809
Lancashire United	,, 15	1,519	+ 60	50	86,328	+ 5.220
Leeds Corporation	,, 18	8,641	+ 638	38	336.960	+ 25.968
Leicester Corporation	,, 18	3,137	+ 264	51	153,402	+ 9.471
Leith Corporation	,, 18	706	+ 79	31	23.898	+ 1,496
Lincoln Corporation	,, 18	135	+ 17	38	5,302	+ 607
Liverpool Corporation	,, 11	13,382	+ 936	49¶	655,247	+ 10,028
Llandudno&Colwyn Bay R.	,, 17	173	+ 14	2‖	423	+ 15
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	,, 16	185	+ 26	37	8,241	+ 255
Manchester Corporation	,, 18	17,709	+ 647	37	671,822	+ 21.574
Nelson Corporation	,, 18	171	+ 30	37‖	7,339	+ 300
Newcastle-on-Tyne Corpn.	..	..	..	..	..	..
Newport (Mon.) Corpn.	..	..	..	..	..	..
Northampton Corporation	,, 17	631	+ 39	37¶	27,238	+ 4,748
Nottingham Corporation	,, 16	3,580	+ 369	37	139 131	+ 9.938
Oldham Corporation	,, 19	2.131	+ 181	39	88,732	+ 3,908
Portsmouth Corporation	,, 11	2.030	+ 27	37	92.849	..
Preston Corporation	,, 15	1.000	− 194	37••	35.996	+ 1.386
Rochdale	,, 18	1.542	+ 94	38¶	64.209	+ 2.886
Rotherham Corporation	,, 15	1.199	+ 251	37	43,353	+ 5.113
Salford Corporation	,, 20	5,133	+ 371	38‡	196.594	+ 7,458
†Sheffield Corporation	,, 19	9,416	+ 1.360	37‖	345,418	+ 47.846
Southampton Corpn.	,, 15	1,416	+ 177	37	56,109	+ 6.102
Southend Corporation	,, 15	547	− 29	37	31,356	− 7.936
South Shields	,, 11	737	+ 72	36‖	29,256	+ 1,188
St'lyb'dge,Hyde,&c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	,, 19	1,472	+ 106	38	56.711	+ 667
Sunderland District	,, 15	572	+ 123	7	3.761	+ 250
Swindon Corporation	,, 15	179	+ 6	37	7,336	+ 643
Tyneside Tram Co.	,, 8	467	− 50	23	13,941	− 623
Wallasey Corporation	,, 18	1,144	+ 78	37‖	48.545	+ 644
Walsall Corporation	,, 18	784	+ 105	51	37,652	+ 5 619
Walthamstow	,, 18	750	+ 30	38	34,109	+ 3,373
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	,, 16	3.006	+ 229	37	115,555	+ 10,027
Widnes Corporation	..	..	..	..	..	..
Wolverhampton Corpn.	,, 15	1,156	+ 134	11	11,947	+ 1 083
Yorkshire W.R. Trams	,, 19	1,460	+ 135	51	80,203	+ 6.656

(a) These comparisons are with the corresponding period last year. * Partly electrical.
† Includes omnibuses, &c. ‡ Minus 2 days. § Minus 3 days ‖ Plus 3 days.
¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 445
Arrangements for the Week .. 448
Electric Traction on the Giovi Line. Illustrated 449
Diesel Engines for Generator Drive. By Charles Legrand 452
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated. *Continued* 453
A Study of the Surges Caused on Switching off Asynchronous Motors. By Reinhold Rudenberg. Illustrated .. 455
Electrical Railways. By H. M. Hobart 457
The Electrically-Propelled Battleship "California." By W. L. R. Emmet. Illus. .. 458
Semi-Automatic Lifts on the "Underground." Illus. .. 459
Provisional Electric Lighting Orders 460
Patents Expiring in 1916 461
SOME ELECTRICAL EVENTS OF 1915 462
Tentative Standards of Transmission. Illustrated 464
CORRESPONDENCE 466
Development in Radiotelegraphy and Telephony During 1915 (Lee De Forest).
Earth Resistance (O. S. Peters).
The Standardisation of Loaded Telephone Lines. By Dr. F. Breisig 468
Construction, Maintenance and Cost of Overhead Contact Systems. By F. Zogbaum. 469
Variable-Speed Pumping Plant for a Drainage District. Illus. 469
The "Electrician" Commercial and Industrial Section .. 471–482

NOTES.

Training of Munitions Workers.

As long ago as last July it was announced that arrangements were proposed whereby certain technical colleges would provide short courses of training for suitable unskilled workers, so as to enable them to be of greater use in the making of munitions. There are some 112 such colleges in the country, and, if properly organised and equipped, each of these could train, on an average, 10 men per week, making 1,120 per week in the aggregate. In the House of Commons, on the 20th instant, Mr. LLOYD GEORGE said that for the new munitions factories 80,000 skilled men and 200,000 to 300,000 unskilled men were required in order to alter the proportions substantially of orders in favour of this country, and consequently reduce the cost of the war by scores of millions of pounds in the course of a single year. As far as the skilled artisan class is concerned, no material assistance can be given by the colleges and schools, but 1,120 men (and women) of the semi-skilled artisan class can be trained per week. The short courses of training for the quarter of a million workers required by the Ministry of Munitions would, therefore, extend over a period of no less than four years. By working day and night, seven days per week, the period would be halved. It is well not only that the Minister of Munitions should know the limitations of the colleges and schools as training centres for munitions workers, but also that the people of the country should know the facts.

BEFORE attempting to offer a solution of the problem, it is advisable that we should endeavour to give some idea of the magnitude of the task which confronts the Ministry of Munitions. From figures obtainable at any Public Library, it appears that of the 17,000,000 occupied persons in Great Britain in normal times approximately 8 per cent., or 1,360,000, are employed in the whole of the engineering trades. Assuming that 10 per cent. of these men have enlisted, we get about 1,250,000 as the number of pre-war engineering artisans available. A quarter of a million is a conservative estimate of the number of men actually engaged on work of vital importance (other than the manufacture of munitions and other war material) at the present time. This leaves in round numbers a million artisans and other workers in the engineering trades. Taking into account the men engaged upon work for the Navy, which work must, of course, continue without interruption, it is possible to make a fair estimate of the number of men available who were actually engaged in engineering work 18 months ago. Of this number, the ratio of skilled to unskilled will in all likelihood be higher than when war was declared, on account of the higher percentage of semi-skilled and unskilled men likely to have been drafted into the Army. No useful purpose would be served by attempting to give the number of men and women either actually engaged in or immediately available for the manufacture of munitions, but it is generally known that since war was declared the number of skilled men cannot have been increased to any appreciable extent. On the other hand, the number of semi-skilled and unskilled workers has been materially increased. For the new munitions factories 80,000 skilled men and 200,000 to 300,000 unskilled men are required.

The 12 areas into which the country has been divided are covered by 40 local Munitions Committees, and the probable skilled and unskilled labour requirements, immediate and prospective, of each of these Committees are, therefore, known. The eligible men must of necessity be prepared to serve in the Army, and it is, therefore, to the women of the Empire that we must look for furnishing the semi-skilled labour in the munitions factories. We venture to think that a "Derby call" to the women would put to shame the men who are "waiting to be fetched." The training of the vast number of munitions workers is a less serious matter than might at first be supposed. In a relatively short time the technical colleges could be equipped for the training of instructors. At the end of a month the colleges would be able to furnish instructors to the various Munitions Committees at the rate of 1,000 per week, and in about eight weeks 5,000 instructors would be available. Certain of the machines standing idle in the munitions works would be used for a period of six weeks for the training of the unskilled workers, and in less than three months every one of the quarter of a million "unskilled" workers would have been given instruction sufficient to make her a highly skilled worker on one job. Incidentally, the "rolling snowball" method of training briefly outlined above would in a very short time enable a large number of unskilled male workers to be freed for the Army. To ensure success it would be necessary for the Ministry of Munitions properly to equip the college workshops.

At the end of eight weeks such equipment could be handed over to the local Munitions Committees, and the colleges would be free to train in adequate numbers potential leaders in industry. When peace comes we hope that many of the machine tools now being used for the manufacture of munitions will be handed over to the Education Authorities for the purpose of founding trade schools, as distinct from technical schools.

The James Forrest Lecture.

THE James Forrest lecture before the Institution of Civil Engineers was this year assigned to an electrical engineer, and the choice fell upon Mr. H. M. HOBART. In the very lengthy address, to which a large audience listened on December 14th, and which was delivered in abstract by Mr. J. A. F. ASPINALL, in the absence of the author, there was a great deal of interest. If, however, we may venture a word of criticism, we were a little surprised that Mr. HOBART introduced so much descriptive matter, apart from results, referring to three examples of electrification—namely, the Butte, Anaconda & Pacific, the Chicago, Milwaukee & St. Paul and the Norfolk & Western Railways; and we were even more surprised that he introduced the very contentious subject of single phase *versus* continuous current. Mr. HOBART has from time to time played a prominent part in the discussions on this question, and for him to introduce it in the James Forrest lecture, which we think ought to deal with principles broadly, is rather taking advantage of those who disagree with him, and who are not given the opportunity of replying. Apart from this criticism, let us say at once that the lecture contained a mass of very interesting information. For example, the comparisons made between steam and electric locomotives will appeal to all, more particularly as the figures given are the results of actual experience gained on the Butte, Anaconda & Pacific Railway.

ALTHOUGH the first cost of an electric locomotive is about £80 to £90 per ton, as compared with the much lower cost of £30 in the case of the steam locomotive, yet the net result is in favour of the electric locomotive on account of the better utilisation of weight and the higher speed that is obtainable. The cost of electrical energy per locomotive mile is only 7d., compared with the outlay of 19·9d. for coal on the steam locomotive. It must be borne in mind, however, that the price of coal here is 19s. per ton, and that the price of electrical energy is at the unusually low figure of 0·265d. per kilowatt-hour. Nevertheless, even if the price of electrical energy were 0·4d., the outlay per locomotive mile would still be only 10·5d. Further, owing to the increased speed, there is a considerable saving in the number of hours of service by engine crews, with corresponding less cost of running; and it is gratifying to see such figures as 15·1d. for annual expenditure per locomotive mile in the case of the electric locomotive, as compared with 37·5d. per locomotive mile in the case of steam locomotives. Owing to the greater tractive effort of the electric locomotive the conclusion is reached that, for the same ton-miles of service, the higher price is not a handicap, fewer locomotives being required than with steam. Another point of interest is that of regenerative braking. In the case of mountainous country the economy to be effected by this method has been found to be very marked, not merely through the return of energy to the line, but also on account of the great saving in wear and tear of brakes and brake rigging. Mr. HOBART carries the matter a step further, and suggests that regenerative braking is well worth consideration in the case of short lines with dense traffic. In the days when reliance was placed upon natural ventilation, the increase in the size of the electrical equipment necessary to permit of electric braking might have been sufficient to neutralise any economies in electrical energy so obtained, but with forced ventilation the case seems to be very different.

AT the end of his lecture, Mr. HOBART dealt with the relative merits of single phase and continuous current in electric traction. We quite admit that the three-phase generator has marked advantages over the single-phase machine, and that the single-phase locomotive is somewhat heavier for the same power than the continuous-current locomotive; but we should like to see further figures of actual maintenance on both types of railway before admitting that Mr. HOBART's contention is fully proved. It is interesting to note the calculations made by Mr. HOBART as to the cost of electrical energy at the locomotive when supplied (1) by continuous current, transformed by motor generators from three-phase generation; (2) by single phase, similarly transformed, from 60 cycle transmission; and (3) by single phase delivered from single phase, 25 cycle generators, through transformers. The result is reached that the total cost of the energy in the second case is 6 per cent. higher, and in the last case is 2½ per cent. lower, than that of the first. Mr. HOBART stated finally that the outlay for electrical energy may be taken as about the same on the three systems, thus leaving the single-phase system handicapped by the greater inherent cost of single-phase locomotives. Thus it would seem that, after all, the continuous-current system does not show so very much to advantage—at least to such a preponderating extent as to make other systems not worth consideration.

Electric Propulsion of Battleships.

THE decision of the Navy Department of the United States to equip two further battleships of the largest and most powerful class with electric propelling machinery has created a good deal of interest in the engineering world, the more so since it follows closely upon the placing of orders for the equipment of the electrically-propelled battleship "California" now under construction in the New York Navy Yard. As our readers are no doubt aware, the latter vessel will be the first battleship in which electricity is used as a motive power. It is significant that electric propulsion was decided upon as the result of two years' experience with the electrically-propelled 20,000-ton collier "Jupiter," and after a long campaign of education in which the "Jupiter" was an incident. Although the test results have not been made public, from the figures which have been published it appears that the steam consumption of the main drive of the "Jupiter" is 30 per cent. better than that of reciprocating engines installed in ships of the same class. At the laying of the "California's" keel it was stated that the combination of electric drive and oil fuel would enable this vessel at a speed of 10 knots to steam for nine days' longer than a coal-burning Dreadnought, which meant that she could cruise more than 2,100 miles further. The "California" is a vessel of 32,000 tons displacement, with a maximum speed of about 22 knots and a shaft horse-power of 37,000. From the general particulars given elsewhere in this issue it will be noted that the generators are bi-polar alternators, and that the motors are so arranged as to be connected either as 24-pole or 36-pole machines. For economic cruising at 15 knots or less, one generator will be used with motors on 36-pole connection, and for higher speeds the 24-pole connection will be used. Speed variation with either motor connection will be effected as in the "Jupiter" by change of turbine speeds through the agency of variable-speed governors. The work has been entrusted to the General Electric Co., Schenectady, and its progress will be followed with lively interest by those concerned. We look forward with every confidence to the time when the equipment will be put through the acceptance tests.

Expiring Patents.

THE list which we publish in another column of the patents expiring in 1916 is less interesting than usual. In fact, it only contains one patent of outstanding importance—namely, No. 10,245, due to Mr. MARCONI, for his well-known magnetic detector. This detector has been largely used, not so much on account of its sensitiveness, but owing to the fact that it is robust, and serves its purpose extremely well. Another patent, No. 9,488, by Mr. A. W. BEUTTELL, relates to reflectors for tubular lamps, and is the patent under which the Linolite Company has for some years put upon the market the convenient system known by the names of Linolite and Tubolite. Lastly, we may mention Prof. A. BLONDEL'S patents, Nos. 17,406 and 23,262, referring to the making of carbons for flame arc lamps. These carbons are provided with "wicks" of various minerals which may take up from one-third to one-half the total cross-section, and such that the speed of combustion of the wick is adjusted to that of the carbon. The materials used include various compounds of strontium, magnesium, aluminium and other metals, combined with regulating substances, chiefly in the form of borates.

Measurement of Decrement.—To the current issue of "Wireless World" Mr. W. H. Nottage contributes a well-illustrated article on this subject. Descriptions are given of Marconi long-wave decremeters and wavemeters, and reference is made to other well-known types.

Perkin Medal Award to Dr. Baekeland.—The Perkin Medal Committee, consisting of representatives of the different chemical societies of the United States, has awarded the Perkin medal for 1916 to Dr. L. H. Baekeland. According to established custom, the presentation of the Perkin medal to Dr. Baekeland will be made at the January meeting of the Society of Chemical Industry in joint session with the American Chemical Society and the American Electrochemical Society.

Motor Control.—At a meeting of the American Institute of Electrical Engineers, held on the 10th inst., a Paper entitled "The Principles and Systems of Electric Motor Control" was read by Mr. C. D. Knight. The author described several types of resistors, and explained the various forms of magnetic control in vogue for both alternating-current and direct-current motors. The characteristics of contactor or magnet switch design were also considered. We shall give an abstract of this informative Paper in an early issue.

Solenoid and Electromagnet Windings.—An informative Paper on this subject, read by Mr. G. L. Hedges at the Los Angeles Section of the American Institute of Electrical Engineering, was published in the November issue of the "Proceedings." The author derives a new and shorter method for the design of the most efficient windings for continuous or intermittent service, and gives formulæ which eliminate the usual cut and try methods of design. Charts, plotted from the formulæ, reduce to a minimum the calculations necessary in designing a winding.

Liverpool Overhead Railway.—At a recent meeting of the Liverpool Engineering Society, Mr. E. J. Neachill dealt in a Paper with the Liverpool Overhead Railway. He stated this was the first overhead railway in the world to be operated electrically. Electricity was adopted chiefly on account of its freedom from fire risks to the warehouses and sheds on the docks estate. The total length from Dingle to Seaforth Sands is 6½ miles. On week days the service is operated for 19 hours, and on Sunday for 13 hours. The average number of trains run during the past year was 845,765, and 4½ million workmen were carried during that period.

The Mersey Railway.—Mr. James Shaw at the same meeting of the Liverpool Engineering Society dealt with the Mersey Railway. In 1900 Parliamentary powers were obtained in order to adopt electric traction, and the conversion was effected without interfering with traffic. From the date of its electrification this railway had a new lease of life. The increase in railway passengers was 760,200 per annum. In 1902 the last year of steam traffic there was a deficit of £4,087, while for 1913 the surplus was £48,977, and the net result is an increase of £37,000 per annum.

Electric Waves in Transmission Lines.—To the current issue of the "General Electric Review" (U.S.A.) Mr. J. M. Weed contributes the first of a series of articles on "Theory of Electric Waves in Transmission Lines," devoted to a theoretical study of the behaviour of transmission lines and connected apparatus with respect to the travelling waves which result from switching operations, arcing earths and short circuits. The present article presents a theoretical conception of the propagation of these waves and of their reflection from the open end of the line. The fundamental voltage, current and energy equations are developed, and also those for the velocity of propagation and for the natural frequency of oscillation of the line.

OBITUARY.

HERBERT ARNAUD TAYLOR.—We have to record with great regret the death of Mr. Herbert Taylor, of the firm of Messrs. Clark, Forde, Taylor & Erskine Murray, which occurred at his residence in Melbury-road, Kensington, early on Thursday morning, the 23rd inst. Mr. Taylor, who was 74 years of age, had been in failing health for some time past, but he only became seriously ill a week before he passed away. Mr. Taylor was destined for a military career. He was educated privately, and having passed into the Royal Military Academy, Woolwich, he obtained his commission as Lieutenant in the Royal Engineers in June, 1862, when nearly 21 years of age. He resigned his commission, and became a pupil of the late Mr. Latimer Clark in 1867. Thus began the introduction to telegraph and submarine cable engineering to which his whole life was devoted. Mr. Taylor, up to the time of his demise, was a partner in the firm of Clark, Forde, Taylor & Erskine Murray, the termination of his partnership occurring at his own request at the end of the present year. During Mr. Taylor's pupilage and whilst acting for Mr. Clark as his chief assistant engineer, a large amount of useful work was carried out by him, notably in connection with the series of experiments which resulted in the production of the well-known Clark standard cell, and the determination of its E.M.F. in absolute measure, &c. In this work Dr. Alexander Muirhead was also associated, both acting for and under Latimer Clark's direction. We may also mention the experimental work on the effect of temperature on the electrical resistance of gutta percha covered conductors, which was carried out by Mr. Taylor on behalf of Mr. Clark. The first important cable work upon which Mr. Taylor was engaged was the Persian Gulf cable of 1868, Latimer Clark being the engineer appointed by the Government to carry out the laying operations. On the voyage out to Bombay on the P. & O. steamer "Carnatic," the ship struck the Shadwan Reef in the Red Sea, many lives being lost. Mr. Taylor, though in imminent danger, happily escaped by swimming to the reef, on which some days were spent before relief came. The greatest trouble, however, was the loss of the whole of the testing instruments, but this difficulty was one that he was pre-eminently adapted to overcome, and with improvised apparatus, sought for and constructed by himself, he made the loss sufficiently good to ensure the proper testing and control of the electrical part of the work during the laying of the cable. In 1872 Mr. Taylor entered into partnership with Latimer Clark, H. C. Forde and Charles Hockin, thus forming the firm known as Clark, Forde & Taylor, who during the past 40 years have acted as consulting engineers to all the great submarine cable companies, and whose name is intimately associated with the development and progress of submarine telegraphy. Beginning with the laying of the 1873 and 1874 Anglo-Atlantic cables and in the succeeding years, Mr. Taylor acted as engineer on expeditions too numerous to record, including many of the lines of the Eastern group; indeed, tens of thousands of miles of cable were laid in all parts of the world under his personal supervision. The last foreign work undertaken by him was in connection with the laying of the British Pacific Cable, upon which project he gave evidence before the Committee appointed to report upon the proposal, and for which subsequently his firm were appointed engineers. As senior partner Mr. Taylor was responsible for the specifications to which the cable was manufactured and laid; indeed, to this work he devoted his whole time and thought in order to bring its establishment to a successful issue. Mr. Taylor was a man of sound and deliberate judgment, whose opinion on all matters connected with cables was sought and valued, particularly with respect to the electrical side of the subject, in which he was always most deeply interested. Beyond taking part in his firm's engineering work, he,

in association with the Muirhead brothers, solved the problem of duplex working on submarine cables, and thus doubled the earning power of many millions of capital invested in such undertakings. The introduction of automatic transmission of signals on cable circuits was also in no small degree due to his efforts. The construction of highly sensitive relays was engaging Mr. Taylor's attention when in 1898 Mr. S. G. Brown approached him in order to obtain his assistance in developing certain ideas relative to cable working, and this partnership resulted in the invention of the drum cable relay and magnetic shunt, which have proved of such great benefit to the numerous cable companies which have adopted the system. Such a record impresses upon us the services rendered to telegraphy by Herbert Taylor, whose many patents bearing on cable enterprise are evidence of his activities. Mr. Taylor was a member of the Institutions of Civil and Electrical Engineers, and he served on the Council of the latter for some years. As a member of the Sub-committee on Cables appointed by the Engineering Standards Committee, with his exceptional knowledge of copper conductors, he assisted materially in their deliberations. Unfortunately, Mr. Taylor's natural reserve and dislike of publicity led to a large amount of interesting experimental work done by him not being published. We mention, however, Papers on "The E.M.F. of Mercury Alloys" (Hockin and Taylor) and "Temperature Coefficients of Conductivity Copper" (Clark, Forde and Taylor), the latter having been adopted by the Engineering Standards Committee. Experiments upon the current-carrying capacity of copper wires in air and in vacuo occupied months of careful research; the results, however, did not satisfy Taylor's idea of thoroughness, he could accept no approximation, and as the determination of the proportionate loss of heat by radiation and that by convection were incomplete he abandoned the idea of publication. Those who knew Mr. Taylor admired him for his personal gifts and ever courteous manner. A staunch friend and modest to a degree, he never had what might be called the "business instinct." Disinterested and ready to assist any and all who came to him for help and advice on whatever matter it might be, assistance was rendered with a graciousness that left him no enemies but many friends, who will sincerely feel their loss in the death of this loyal gentleman to whom meanness of thought or idea was absolutely foreign and unknown. We tender our sympathy to his family in their sorrow.

William Cross.—The death is also announced of Mr. William Cross, who was for some years clerk in charge of the Anglo-American Telegraph Co.'s station, 63, Old Broad-street, London. Mr. Cross, who retired from the company's service some five or six years ago, was 59 years of age.

Killed in Action.—We regret to announce the death of Second-Lieut. W. O. Garrett, who was for some years in the service of Siemens Bros. Dynamo Works at Madras. Mr. Garrett left at the end of October, 1914, having obtained a commission in the Queen's Own 3rd Sappers and Miners, and after a short training in Bangalore left for the front in Mesopotamia, whence he is now reported to have been killed in action.

APPOINTMENTS VACANT AND FILLED.

The Borough of Swindon Education Committee invite applications for the permanent appointment of head of the engineering department of the technical institution. Commencing salary £200 per annum, rising by increments of £10 to £250. Further particulars from the Principal, to whom immediate application should be made, at the Technical Institution, Swindon. *See advertisement.*

A fully qualified electrician is required to take charge of all electrical equipment in large airplane works on the south coast. *See advertisement.*

An advertiser requires a capable cable operator, with knowledge of repairing and testing cable instruments, &c.

Mr. R. Allan Brown has been appointed burgh electrical engineer at Falkirk in place of Mr. Herold Ransom, who recently resigned in order to join H.M. forces. For over four years Mr. Brown has acted as chief assistant engineer at Falkirk.

INSTITUTIONS AND SOCIETIES.

Diesel Engine Users' Association.—At the December meeting of the Diesel Engine Users' Association the proceedings were mostly of a formal nature, dealing with the election of President, Members of the Committee, &c., for the ensuing year. Mr. Geoffrey Porter, borough electrical engineer to the Worthing Corporation, was elected President. Messrs. C. O. Milton (Middlesbrough), C. Gould (Letchworth), and H. Leslie Dixon (Leatherhead) were elected members of the Committee to take the place of other members retiring at the expiration of their terms of office. Mr. Percy Still (Chelsea) was elected as Honorary Secretary. The acting Hon. Secretary for the current year stated that there had been an increase during the year of 19 members, the total membership to date being 48, and representing 104 Diesel engines, having a total horse-power of 23,984. Further applications had been received for election to membership during the coming year.

During the year 1915 a work of considerable importance has been accomplished in drawing up a standard form of policy of insurance against breakdown specially applicable to Diesel engines. Under an arrangement with Lloyds, preferential terms are granted to members of the Association, or to the undertakings for which they act, and in granting this preference the underwriters are influenced by the assumption that in view of the interchange of the results of experience and of the general circulation of information on the subject of Diesel engine practice, the risk of trouble with engines under the control of members of the Association is likely to be considerably reduced. The scheme also provides for inspection of engines and full reports by engineers who have made a special study of Diesel engine plant. The subject of income tax assessment and of the allowance made for depreciation by the Inland Revenue Authorities has also received careful consideration. The Association has made arrangements with Messrs. Humphreys-Davies & Co. to take action to endeavour to obtain more favourable treatment for Diesel engine plant in this connection. In view of the present high rate of income tax, and of the possibility of a still higher rate in the future, this question is now of very great importance to a large number of concerns using Diesel plant. Discussions of considerable interest have taken place on the subjects of the breakdown of a Diesel engine at Oxford, the use of various fuel oils, the lubrication of Diesel engines, cracked and seized pistons, increased price of fuel oil, &c., and a considerable amount of information on these subjects has been circulated.

Before the conclusion of the meeting, the retiring President, Mr. J. E. Edgcome, referred to the rapid growth of the Association from small beginnings, and spoke of the useful work carried out, which had been not only for the benefit of users of Diesel engines, but which they were glad to be informed had also proved to be useful to engine makers and others interested in the industry.

ARRANGEMENTS FOR THE WEEK.

ROYAL INSTITUTION.

Meetings at Albemarle-street, Piccadilly, London, W. Six illustrated lectures adapted to a juvenile auditory on "Wireless Messages from the Stars," by Prof. H. H. Turner, D.Sc., D.C.L., F.R.S.

Saturday, Jan. 1st.

3 p.m. Lecture III.: First Message, "We are very far away."

Tuesday, Jan. 4th.

3 p.m. Lecture IV.: Second Message, "Some of us are Giants and some are Dwarfs."

Thursday, Jan. 6th.

3 p.m. Lecture V.: Third Message, "But we all behave much as you do."

Saturday, Jan. 8th.

3 p.m. Lecture VI.: Fourth Message, "And, in fact we are your Blood Relations."

TUESDAY, Jan. 4th.

The Röntgen Society.

8.15 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C., the following Papers and demonstrations will be given: "Some Observations in the Occurrence of Uranium," by the President, Dr. J. H. Gardiner, followed by some demonstrations.

WEDNESDAY, Jan. 5th.

Royal Society of Arts.

5 p.m. Juvenile lecture (with experiments) on "Crystallisation," by Prof. J. M. Thomson, LL.D.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

The following orders have been issued for the week commencing Jan. 3, 1916:—

Drills, 6.25 to 7.25; 7.25 to 8.25 p.m.

Monday, Jan. 3.—Sections 1 and 2, technical; sections 3 and 4, squad; signalling sections and recruits.

Tuesday, Jan. 4.—School of Arms with Architects' Corps, 6 to 7.

Thursday, Jan. 6.—Sections 1 and 2, shooting.

Friday, Jan. 7.—Sections 3 and 4, technical; sections 1 and 2, squad; signalling sections and recruits.

Orders of the week.—Monday, Jan. 3, 1916, to Saturday, Jan. 8, Mr. L. C. Hughes Hallett.

Platoon on Duty.—Monday, Jan. 3, to Saturday, Jan. 8, No. 1 Platoon.

Platoon on duty to provide a picquet for H.Q. of one N.C.O. and three men, and also one N.C.O. for instructing recruits.

Sections for technical parade at Headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for shooting practice at ranges.

Uniforms are now ready for all recruits at Chenies House.

Members who have not yet been measured for uniforms must call at once at Chenies House, Endsleigh Hill, as soon as possible. Payment for uniforms to be made to the Adjutant.

ELECTRIC TRACTION ON THE GIOVI LINE.

Very interesting are the results of the electrification of the Giovi section of the Italian State Railways. An account of them was recently given in the "Revista Tecnica delle Ferrovie Italiane," in a Paper by MM. F. Santoro and L. Calzalori, reproduced in "La Lumière Electrique." From this source and from "Le Génie Civil," which has given an excellent description of the locomotives and the Chiappella station, we have obtained the information in this article. Some of the graphs are reproduced from the "Electric Railway Journal" of America.

The line from Pontedecimo to Busalla is a very difficult one to work. The gradients are severe; there is one of 1 in 37 of a length of 10·4 km., with maximum gradients of 1 in 34 in a tunnel and 1 in 28 in a cutting; the line is, moreover, serpentine in course, in places with a radius of 400 metres. There are also numerous tunnels, of which the longest is the Giovi tunnel, 3,258 metres long. There is very heavy traffic over the line, joining as it does the principal towns of Northern Italy, and it helps to carry almost the entire trade leaving the port of Genoa. It is partly supplied from a steam central station at Chiappella, which until last year was the sole source of power. Now, however, most of the energy comes from the hydro-electric stations of a private company through a sub-station at Sampierdarena. Both the current from these and from Chiappella is taken to four sub-stations on the line at Rivarollo, Pontedecimo, Montanesi and Busalla.

It was in 1910 that electric traction was introduced on the three-phase system, the line volts being 3,300 at $16\frac{2}{3}$ cycles. The amount of traffic then was considerably increased; a speed of 45 km. an hour (28 miles per hour) was thought to be suitable, having regard to the gradients on the line, and half this speed was adopted for certain goods trains. The regenerative system was adopted as a rule; all the descending trains were hauled by two locomotives, working on the regenerative principle. This arrangement was very convenient, seeing that two locomotives were needed on the ascending gradient. Thus greater speed was possible, the journey between Pontedecimo and Busalla being reduced by 16 minutes. Similarly, it also became possible to reduce the distance between successive trains, and to increase their number, and a larger amount of traffic was handled without increase in the number of the locomotives. The speed of the trains was also regulated to a more uniform standard owing to the recuperative method, and there was also the additional advantage of greater economy in power. Neither were the brake shoes worn out to the same extent as before, and the wear on the rails was correspondingly reduced.

Double Traction and Regenerative Working.

The Giovi line has solved the problem of what may be called double traction—*i.e.*, the haulage of trains with an engine in front and in rear. It has been found to be possible to distribute the load equally between the two, and this can be done whether the wheels are of the same or of different diameters. It was intended in this case to use a multiple controller, operated from a distance, there being a communicating cable between the two locomotives. In actual work this was found to be cumbersome, and, indeed, unnecessary; it was, therefore, abandoned. There was also good ground for doubting the possibility of distributing the load equally between two locomotives which had wheels of different diameters. The question seemed likely to be rather complicated, and it was desired, moreover, to find some solution capable of general application.

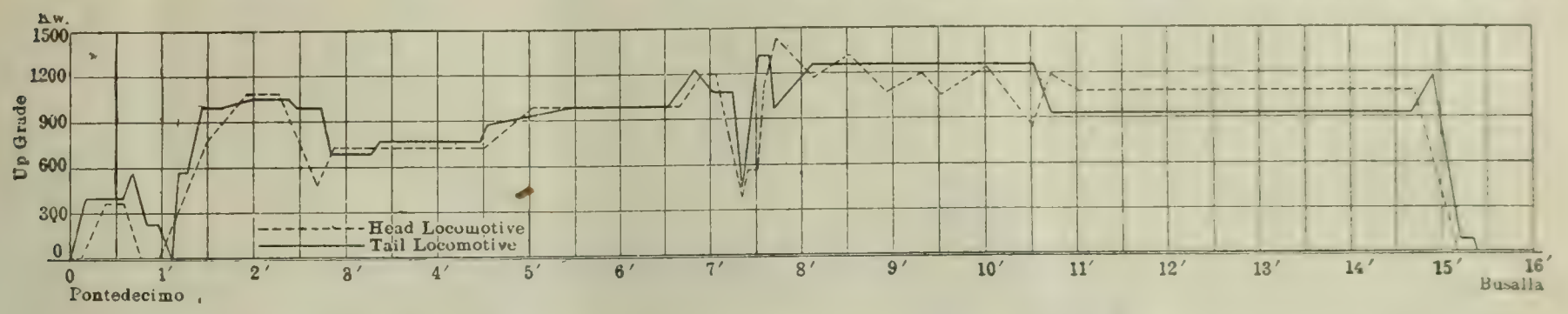


Fig. 1.—Regulation of Load Obtained on Two Locomotives with Difference of Wheel Diameter 1·41 in.

Thus it was considered desirable to be able to effect this equality of distribution of load whether the locomotives were receiving energy from the line or were working on the regenerative principle. This was found to be possible by a simple arrangement, which consisted of the insertion of adjustable resistances in the secondary circuits—*i.e.*, in the rotors of the motors of one of the locomotives. This would be the engine with the larger wheels when climbing a gradient and that with the smaller when running down and regenerating. The same liquid rheostat was used as served for the starting of the motor, and in order to adjust its value under the new conditions, it was found possible to utilise exactly the same apparatus as was used for starting the train, and which will be described later. Without this means of adjustment, it was found in a particular case that the division of the load was unequal. The front engine, with wheels of a diameter of 1,060 mm., had a load with the rotors on short-circuit of 140 kw., whereas the back engine, with wheels of a diameter of 1,070 mm., had a load under the same conditions of 254 kw. If the load had been equally divided, each would have had about 194 kw., the excess of load on the back locomotive being, in fact, about 29 per cent. A test was then made with the locomotives joined up under the altered conditions. The diameters of the wheels with their difference of 10 mm. remained as before, and they were coupled to a train, the one in the front and the other in the rear; the rotors of the locomotive with wheels of the smaller diameter were put on dead short-circuit, while those of the other were short circuited through the adjustable liquid resistance. A diagram of the consumption of energy was then taken. It was found that the distribution of load

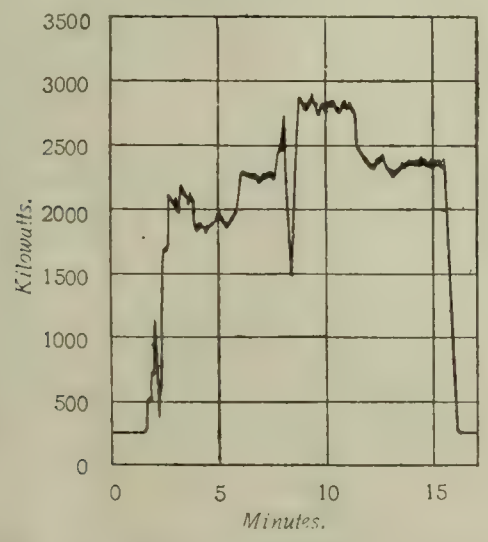


Fig. 2.—Station Load Curve during the Ascent of a 500-ton Train.

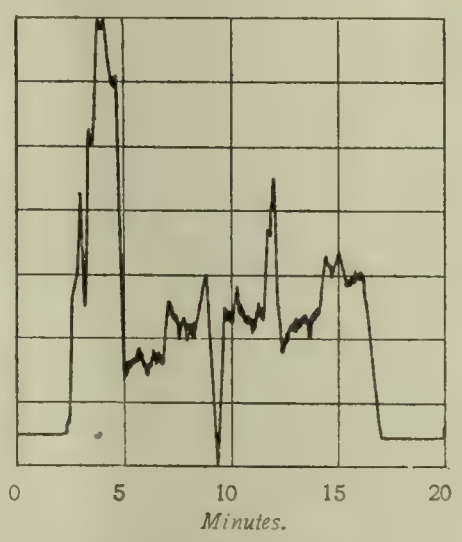


Fig. 3.—Station Load Curve during the Running of Two 500-ton Trains, one ascending and the other descending.

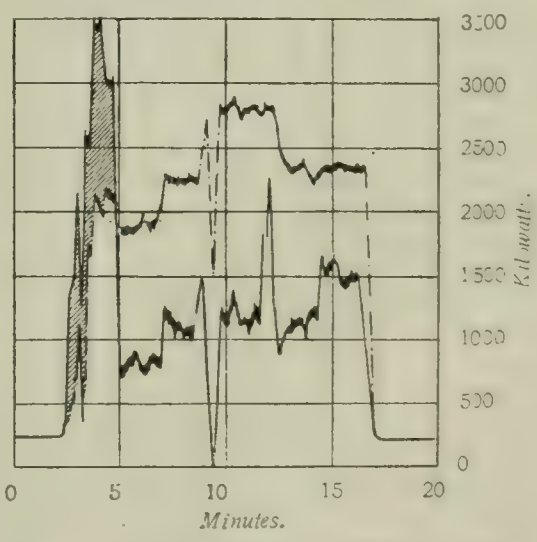


Fig. 4.—Superposition of Figs. 2 and 3, showing the Energy Saved.

was almost exactly equal; the power absorbed by the one with the smaller wheels was 207·13 kw., whereas that taken by the other was 210·92 kw. The difference in this case was less than 1 per cent. of the mean load.

This close approach to equal loading is shown in Fig. 1, where the energy consumption for two engines having a difference of wheel diameter of 1·41 in. is plotted against time. Figs. 2, 3 and 4 are records of energy taken from the central station, showing (Fig. 2) the energy required for the ascent of a train of 500 tons (Fig. 3), the energy taken when one such train is ascending while another is descending and (Fig. 4) the two curves superposed, giving the energy saved. The regenerated energy amounts to 47 and 46 per cent. of that taken when ascending for trains running at 28 and 14 miles per hour respectively. When two locomotives are used this is increased to 54·5 per cent., or more than half what is required for going up is given back on running down.

MM. Santoro and Calzalori in their original Paper give a lengthy examination of the economies effected in the working expenses owing to the adoption of electrical methods of traction in place of steam. Without reproducing all their figures it may be said briefly that at first glance the working expenses, including interest on capital outlay, would appear to have gone up by about 50 per cent., but this has been more than counterbalanced by a considerably increased traffic, which has gone up in a still greater ratio. It may be said that besides obtaining an increased output from the line, and thus being enabled with the existing facilities in the way of rails, rolling-stock, &c., to obtain means of dealing with a larger volume of business, from which necessarily a greater profit is to be expected, this has been obtained with a decreased cost per ton-kilometre, an economy which has resulted from the marked gradients on the line. This has allowed the management to avail itself of certain special advantages, and notably to improve the ratio between the dead weight and the load hauled. A table is also given showing the capital expenditure at the central station and the sub-stations together with the cost of transmission lines, trolley wires, alterations to telegraphic and telephonic circuits, installation of signalling apparatus, and also the cost of electric locomotives. This is to be set off against the value of the steam locomotives, which are stated to be worth a sum almost exactly equal to that of their electrical substitutes. There are also tables relating to the working costs at the central station, and to the working expenses more properly charged to the working of the traffic of the line.

It may, therefore, be said that the electric traction on the line has abundantly justified itself. There are, of course, certain variations in the voltage of the line; but the Tirrill regulator, which is used in the central station at Chiappella, reduces them to such limits that the motors on the locomotives work with absolute regularity. During the period under consideration there have been only five occasions on which there was complete interruption of current for more than 10 minutes, and only one occasion on which the supply was cut off for more than an hour.

Features of the Locomotives.

The locomotives have been supplied by the Società Italiana Westinghouse. One of the latest types (E550), the outcome of much study and experience, has a total length of 9·52 metres, and weighs 60 tons. A drawing of the locomotive is given in Fig. 5, from which it will be seen that all the weight is used for adhesion, there being five pairs of driving wheels all coupled and of 1·67 metres diameter. There are two motors working without gearing, but coupled directly to the centre axle by means of triangular coupling rods.

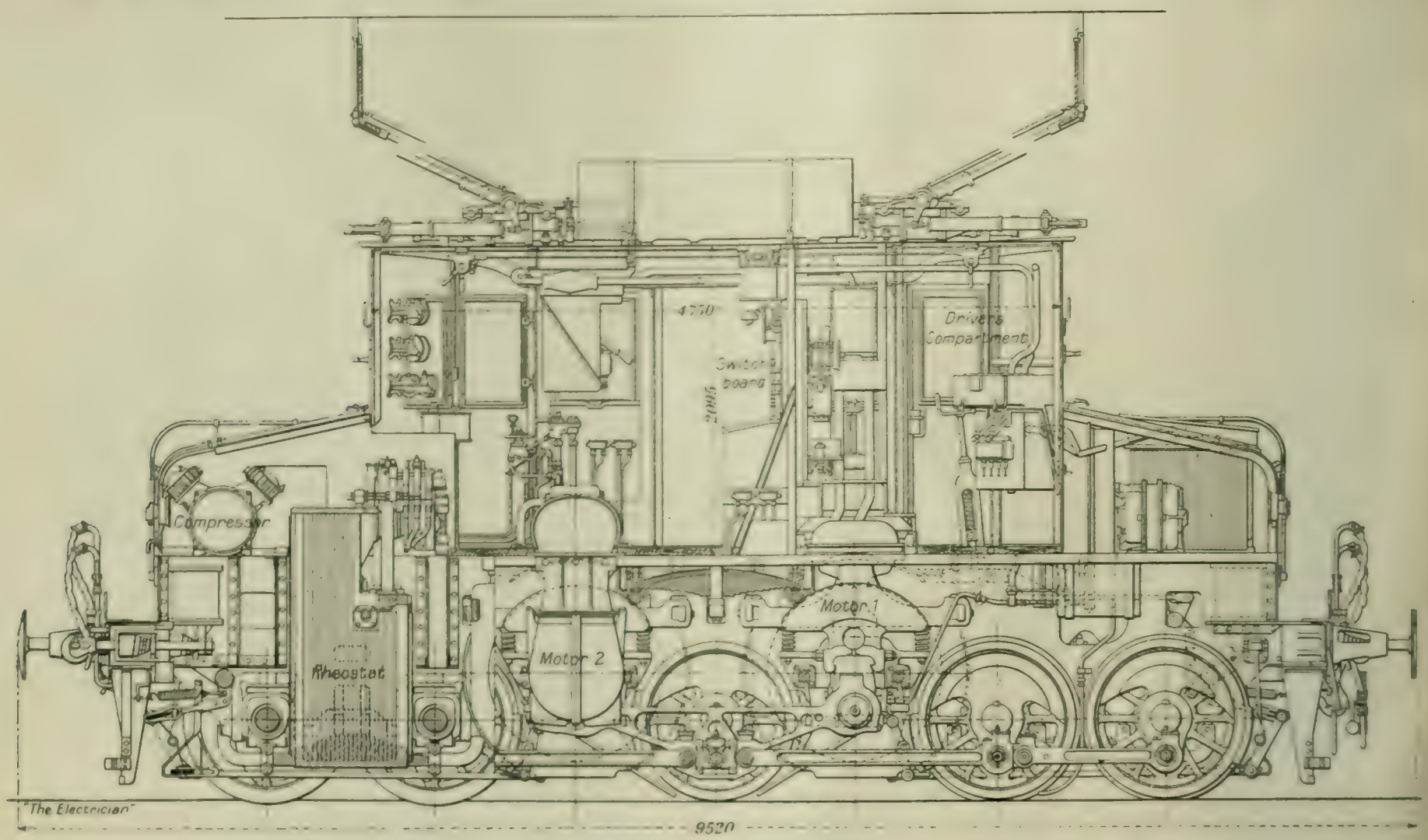


Fig. 5.—Sectional Elevation of Electric Locomotive, Type E 550.

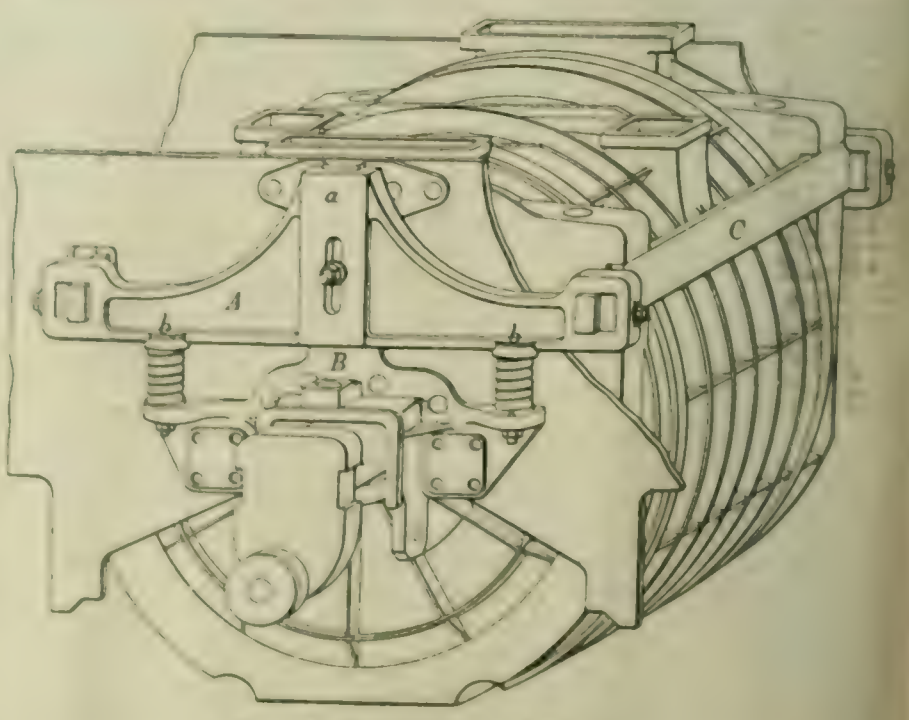


Fig. 6.—Suspension of Motor.

A [illegible] B Motor [illegible] C Transverse beam a Guide b Spring

For each motor there are two inside bearings that keep the rotor in position in the stator and two outside that hold the axle in the framing. The weight of the stator is taken by four springs marked *b* in Fig. 6, which shows the suspension. Guides *a* allow of a vertical movement of the motor within the frame. Vertical play is also allowed at the bearing of the crank pin of the central axle.

The engine is the same each end, and has two controllers, one for each direction of travel. Besides the braking by regeneration, the ordinary Westinghouse air brake equipment and a hand brake are provided.

The 3,300-volt three-phase current is provided by two overhead wires and the running rails. There are two trolleys, each carrying two collecting bars, one for each wire; the distance between the trolleys is sufficient to cover any dead portion between sections of the line, so that no interruption of the current occurs. Fig. 7 shows the connections to the motors. After being brought within the locomotive in metal tubes, the cables from the trolleys are taken through choke coils to a double-pole oil circuit-breaker, and thence to the and between these coils and the main switches lightning arresters are fitted.

The two motors work on the full line voltage, and at the frequency of 16⅔ cycles have a synchronous speed of 250 revs. per min. They are eight-pole induction motors with wound rotors and slip-rings. To obtain two running speeds of 25 km. and 50 km. per hour (15·6 and 31·2 miles per hour) they can be connected in parallel or in cascade. For this purpose one of the motors (No. II in the drawings) has the ends of the 12 coils of its stator winding brought out to the speed-controller, which is fixed to the top of it. This is of the drum type, and is only operated when the circuits are dead to change from the cascade connections to the parallel. The other motor (No. I.) has its coils connected permanently four in series for each phase as an ordinary star winding. The winding of the rotors is a delta arrangement for both machines, and is connected to three slip-rings which are mounted on an extension of the axle supported by a return crank outside the main bearing. This arrangement allows of easy access to the brushes, which are 12 in number for each phase.

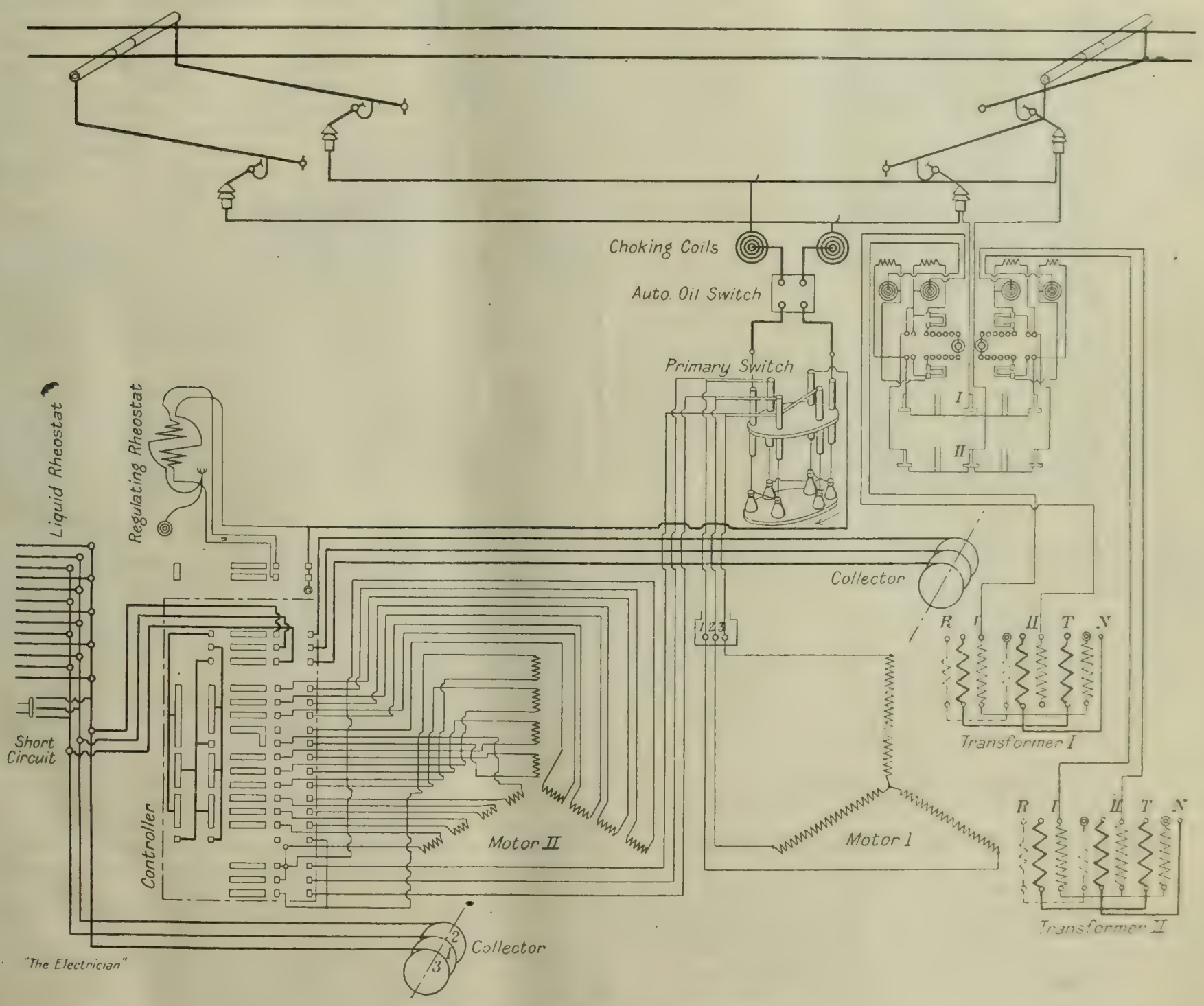


FIG. 7.—DIAGRAM OF CONNECTIONS.

main oil switch. This consists of two discs one above the other, the top disc, which is fixed, holding six contact pieces, three of which are connected to the motor terminals, and the other three to the mains (*i.e.*, one to each of the trolley cables and one to the frame of the engine). Six corresponding contacts on the bottom disc are so connected that when brought against those above by the lifting of the disc current is given to the motors for running in one direction, but when the disc is first turned through 60 deg. and then raised two phases are crossed, so that the motors will run in the opposite direction. By giving the switch, both vertical and rotary movements in this way it serves as a reversing device as well as a main switch.

There is also a set of auxiliary circuits taking current to two small 12 kw. transformers for working all the low-tension apparatus on the engine. Choke coils bring the primary voltage down to 3,000 volts,

When running in cascade the stator of No. I. motor is connected to the line while current from its rotor is taken through the speed controller to the stator of No. II. motor, which in this case has all the coils of each phase connected in parallel, and the three phases star-connected. The current from the rotor of No. II. motor is taken to a liquid starting rheostat. In parallel running both stators are connected to the line, and the two rotors in parallel discharge their current into the rheostat. The stator of No. II. motor has then, of course, all coils on each phase in series, so that the winding is similar to that of the stator of No. I. motor.

The rheostat (Fig. 8) consists of a vessel having two compartments (A and B), in one of which are the plates for the three phases, while compressed air can be admitted to the other. A very dilute soda solution is used, and the level of this is raised around the plates

by the pressure of the air in the other compartment. When the plates are completely submerged they are short-circuited.

All the high-tension apparatus is enclosed in metal casing, the inspection doors of which can be opened by a special key. This key is kept within the apparatus for raising the trolleys, and it cannot be taken out until the arc are lowered. When it is removed the valve for raising the trolleys is locked, and another safeguard provided is by so constructing the locks of the inspection doors that the key cannot be withdrawn from the locks until they are properly closed.

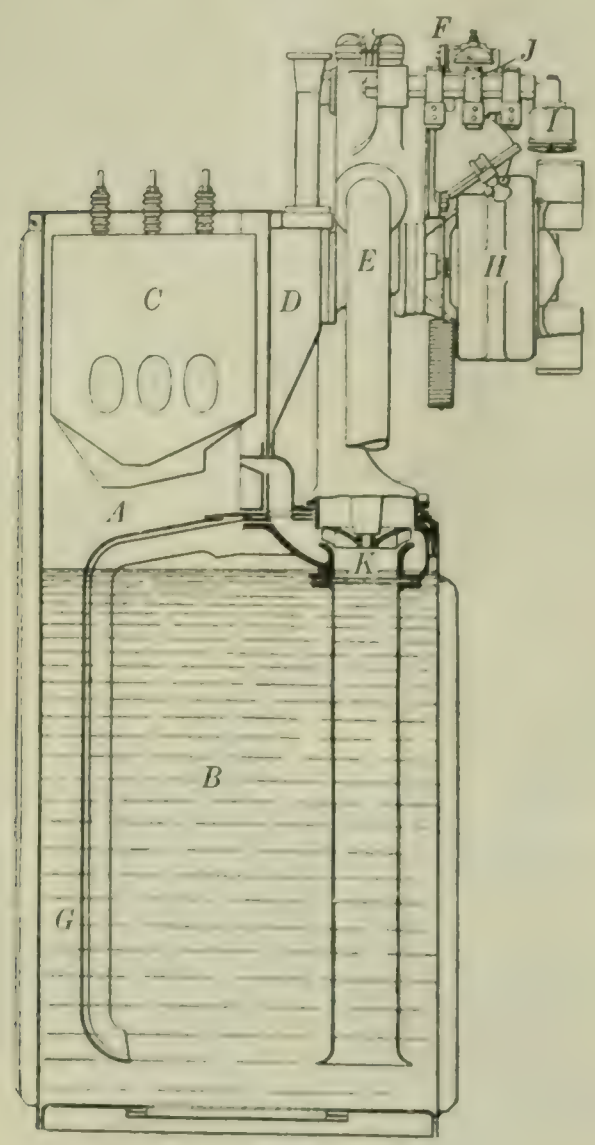


FIG. 8.—STARTING RHEOSTAT.

A, Compartment for plates; B, Compartment for compressed air; C, Plates; D, Float chamber; E, Compressed-air pipe; F, Balance for Controlling air-valves; G, Diaphragm separating compartments A and B; H, Wattmeter regulator; I, Relay; J, Short-circuiting contacts; K, Centrifugal circulation pump.

(To be concluded.)

DIESEL ENGINES FOR GENERATOR DRIVE.*

BY CHARLES LEGRAND.

Summary.—The author describes some investigations made in Europe on Diesel engines of large capacity, with a view to their suitability for driving generators of 500 kw. to 1,000 kw. capacity under conditions prevailing in mining camps in the south west of the United States.

In 1912 the writer investigated the suitability of Diesel engines for driving generators of 500 kw. to 1,000 kw. capacity under conditions generally prevailing in mining camps in the south west. At that time no American-made engines of sufficient size were available, and the investigation was carried on in Europe, mostly in Belgium.

Four-cycle engines of 175 effective B.H.P. per cylinder had been in use for several years, and the results of their operation known. Cylinders of 250 effective B.H.P. were made, but I did not see any.

Two-cycle engines of 250 effective B.H.P. per cylinder had been in operation for a short time, but no data as to maintenance or repairs was available. Engines with cylinders of 600 effective B.H.P. were under construction after shop experiments had been carried on with one single cylinder of that size. One cylinder of 1,000 effective B.H.P. was being experimented upon, and builders were ready to take orders for engines using this size cylinder. All of the above cylinder ratings were for sea-level conditions. The four-cycle engines inspected had trunk pistons air cooled. The two-cycle engines had water-cooled pistons with cross-head and slides.

All engines used forced lubrication for cylinders. Both types were used successfully to drive alternators in parallel, the generators being equipped with damping windings. For a given number of cylinders the four-cycle engine required a heavier flywheel. Heavy oils could be used in both types with proper arrangement for heating the oil and using a light oil at start and finish of a run.

The fuel consumption per brake-horse-power of a four-cycle engine is from 7 to 10 per cent. less than that of the two-cycle engine, depending on the load, and for both types is practically independent of the size of the engine.

The four-cycle engine is simpler, having no scavenging pump or moving water connections to the piston.

The two-cycle engine has no exhaust valve, the exhaust taking place through ports in the cylinder wall; this is an advantage when using oil containing sulphur, as the exhaust valve is principally affected when sulphuric acid is formed in the cylinder and condenses on the seat of the exhaust valve, requiring frequent grinding of this valve.

The scavenging pump is an advantage on engines to be used at high elevations, as by increasing the size of this pump the pressure in the cylinders at the beginning of the stroke can be increased above atmospheric pressure and restore sea-level conditions, if found advisable, at a comparatively small increase of fuel consumption. This could be done on four-cycle engines by the addition of an air pump, but would complicate this type of engine.

The lubricating oil consumption of four-cycle engines is higher per horse-power than that of the two-cycle engine. The total consumption of lubricating oil of a 525 H.P. three-cylinder four-cycle engine in actual practice being approximately 5 gallons per brake-horse-power-year of engine rating, while that of a five-cylinder two-cycle engine of 1,250 B.H.P. is 2·5 gallons per brake-horse-power-year, both being on sea-level rating of engines and for continuous service.

The proportion of cylinder oil to engine oil used in the two-cycle type seems to be greater than in the four-cycle. In the four-cycle, the cylinder and engine oils used are about the same, according to builder's statements, while in the two cycle the cylinder oil is approximately twice the engine oil from actual practice during three months.

The four-cycle engine takes a little more room and is heavier than the two-cycle engine of the same power.

Briefly stated, the advantages of the four-cycle engine were: well-established type with known maintenance and repair costs, smaller fuel consumption, greater simplicity; those of the two-cycle engine were less lubricating cost, steadier running, less liability of trouble from sulphur in fuel oil, greater output per cylinder, less cost per horse-power, especially at high altitudes.

After due consideration, the company with which I am connected decided to try the two-cycle engine in actual practice, and two five-cylinder engines rated at 1,250 B.H.P. at sea level, direct connected to 815 k.v.a. 6,600-volts three-phase 180 revolution generators were installed. One of them has been in operation since December, 1914, and the other since March, 1915. The load at present is so small that only one engine is operated at less than 25 per cent. capacity, and it is too early to give any results of operation; however, from the numerous tests which we have made parallel operation is quite easy.

The exciters are direct connected to the engines and run in parallel on the regulator.

Before paralleling the generators, the exciters were run in parallel for half an hour, one engine having a slightly variable load of 90 kw. and the other no load. The variation of load on the two exciters did not exceed 10 amperes from the average of 90 amperes.

The two generators were then paralleled on a total load of 90 kw., and the variation of load between engines could hardly be seen on indicating wattmeters. After a sufficient length of time to satisfy ourselves that there was no difficulty in parallel running, we cut off the fuel supply on one cylinder of one engine, then on two cylinders. With one engine running on three cylinders and the other on five cylinders the load varied approximately 30 kw. between the two engines after the governor had been adjusted to divide the load about equally. This test was then repeated after increasing the total load to 200 kw., with the same results. Later on the two engines were connected in parallel, then the fuel supply was cut off altogether on one engine, running its generator as a motor; the fuel supply was then put on again, but we have been unable to make the generators fall out of step, and they behave much better than any compound steam engines with which the writer has had experience. The cur-

* Paper read before the American Institute of Electrical Engineers.

rent readings were too small to get reliable data on interchange of current between generators.

The engines use California crude oil of about 16 deg. B gravity, heated to 120°F. by means of the circulating water of the engines, except at start and finish of a run, when a lighter oil is used so that it will flow when cold.

The writer hopes to be able to publish some operating data after the engines have been operated for a few months more.

Regarding cost of installation as compared to a steam plant, this has to be figured for each particular case. The character of the load has an important bearing on the total capacity of generating machinery to be installed.

With a steady load the total capacity of the units is practically the same, as both have the maximum efficiency at rated load.

With a variable load subject to high peaks the Diesel engine plant would require a greater capacity than the steam plant, as, like all internal combustion engines, the Diesel engine has little overload capacity.

With conditions prevailing generally in Arizona, on rated capacity of plant installed for total power between 1,000 kw. and 2,500 kw., the cost of a Diesel engine plant compares favourably with a high-grade steam plant using condensing Corliss engines, with a superheater and economiser in the boiler plant.

In designing a Diesel engine plant it is well to remember that the fuel consumption per effective brake-horse-power is practically independent of the size unit used, that an engine can be started and put under full load in a very short time, so that a greater number of units can be used if it suits the load conditions better.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Continued from page* 348.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

Section IV.

Flank Dispersion.—This is the name usually applied to the dispersion caused by the magnetic lines which either link with the end connections of the stator winding, without linking with the rotor winding, or else link with the rotor end connections but not with the stator winding. This source of leakage is the most difficult of all to calculate, as it depends on so many factors of which it is not easy to take account; for instance, the particular shape of the end connections and their disposition relative to the stator, or rotor, and housing. In fact, it would not be too much to say that it would be impossible to calculate this part of the dispersion from first principles alone, as has been done for the main and peripheral dispersion. At any rate, if not actually impossible, the expression of the result would contain so many factors that it would be much too cumbersome for any practical purpose.

It is, however, quite possible to deduce from first principles the *form* which the expression must have in terms of the principal dimensions of the machine.

By comparison with observed results it may then be seen whether the effect of the various quantities which do not enter into the expression is sufficiently invariable to warrant the substitution of some mean value as a constant. It is on these lines that the estimation of σ_3 will be made.

The coefficient of self-induction of a coil of given shape and size may be expressed as An^2l_m, where l_m is the mean length of a turn and n the number of turns. Now the back and front end connections, considered alone, together form a series of coils, and the coefficient of self-induction of these coils is the magnetic linkage due to the unit current in them. There will be a certain amount of mutual induction between the coils of the stator winding and those of the rotor, and also between the coils of different phases of either winding. All these coefficients of mutual induction can, however, be expressed in the form above.

Now, $\sigma_3=(l_3+l_3')$ L, where l_3 is that part of (L$_s$—M) and that part of (L$_r$—M) due to linkage of magnetic lines with the end connections. Thus, l_3 is of the form

$$\{A_1(nS)^2l_m+B_2(nS)^2l_m+B_3(nS)^2l_m\}\ldots C(nS)^2l_m,$$

where B_2, B_3 refer to the mutually inductive effects of stator phases 2 and 3, on phase 1, and C to the mutually inductive effect of all stator phases on a rotor phase.

The above may be written simply $A(nS)^2l_m$ or $A(nS)^2\tau$, since l_m is approximately proportional to the pole-pitch. Similarly, l_3' varies as $(nS)^2\tau$.

In the section on peripheral dispersion we saw that L, reckoned per unit axial length, was proportional to $(nS)^2\frac{\tau_i}{\delta}$, so that L is proportional to $(nS)^2\frac{\tau_i l_i}{\delta}$, where l_i denotes the axial length of stator or rotor, *excluding air-ducts*.

$$\therefore\quad \sigma_3\propto\frac{\tau}{\frac{\tau_i l_i}{\delta}}=k\,\frac{\tau}{\tau_i}\,\frac{\delta}{l},$$

where k is to be determined by comparison of calculated with observed results.

The values of k obtained by this method vary considerably, but a large part of this variation is only due to the errors inherent in this method of determining k, for, in addition to errors of construction and observation there will be some error in our calculation of the main and peripheral dispersion, and *every one* of these errors will be included in the value of k so obtained.

For motors with wound rotors k appears to have a value of about 4. For motors with squirrel-cage rotors the value should, therefore, be about 2, since there is but little leakage round the end rings of a squirrel-cage rotor. Possibly the value should be rather greater than 2, owing to the fact that there can also be no mutual induction between the end connections of the stator and rotor, which would increase the stator leakage, but only to a small extent.

Section V.

Comparison of Calculated Values with Observed Results.—The general formula for σ as developed in the preceding pages is

$$\sigma=\sigma_1+\sigma_2+\sigma_3=0{\cdot}004+\frac{B}{S^2}+\frac{26P\delta}{S\tau_i}+k\,\frac{\tau}{\tau_i}\,\frac{\delta}{l_i},$$

where S=number of slots per pole (mean of stator and rotor).

τ=pole-pitch.

τ_i=pole-pitch reduced by slot openings or thin parts of slot bridges (mean of stator and rotor).

l_i=axial length of stator or rotor, less ventilating ducts.

δ=radial length of air-gap.

k is about 4 for motors with wound rotors and about 2 for squirrel-cage motors.

B is a constant given in Table II.

P is the slot permeance.

For semi-enclosed slots $P=\left(\frac{c}{v}+\frac{1}{3}\frac{h}{b}\right)$.

For totally enclosed slots $P=\left(\frac{4}{3}\frac{c\mu}{v}+\frac{1}{3}\frac{h}{b}\right)$.

where $\mu=1+11{,}500\,\frac{v\sqrt{\sigma}}{qw}$,

q=amp. conductors per cm. periphery.

w=slotch-pitch (mean of stator and rotor).

(μ lies between 1·5 and 6).

Where the numbers of slots per pole per phase in both stator and rotor are whole numbers, $\sigma_1 \left(=0{\cdot}004+\frac{B}{S^2}\right)$ may be taken from Table I. (*See* THE ELECTRICIAN, Oct. 29, p. 134.)

Examples of Calculation of σ—

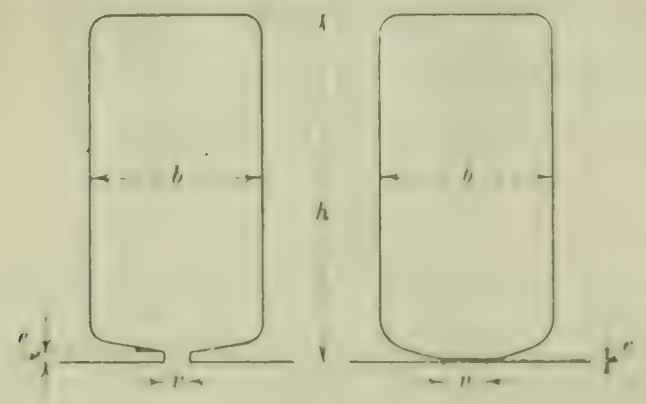
1. Six-pole slip-ring motor with semi-enclosed slots:
Diameter=90 cm.
Axial length (less ducts)=23 cm.
Air-gap length=0·1 cm.
Number of stator slots=144.
Number of rotor slots=180.
Stator slot width=1·2 cm.
Rotor slot width=0·9 cm.
Depth of stator and rotor slots=3·5 cm.
Width of slits=0·15 cm.
Thickness of slits=0·1 cm.

$\therefore \quad \tau = 17{\cdot}2 \qquad \tau_1 = 13{\cdot}2$

$S_1 = 24 \qquad S_2 = 30 \qquad \therefore \quad S = 27$

$P_1 = \left(\frac{0{\cdot}1}{0{\cdot}15}\cdot\frac{3{\cdot}5}{3\cdot 1{\cdot}2}\right) = 1{\cdot}7 \qquad P_2 = \left(\frac{0{\cdot}1}{0{\cdot}15}\cdot\frac{3{\cdot}5}{3\cdot 0{\cdot}9}\right) = 2{\cdot}0$

$\therefore \quad P = 1{\cdot}85 \qquad k = 4$



From Table I.:

$$\sigma_{1\ mean} = 0{\cdot}0068$$

$$\sigma_2 = \frac{26 P \delta}{S \tau_1} = \frac{26 \times 1{\cdot}85 \times 0{\cdot}1}{27 \times 13{\cdot}2} = 0{\cdot}0041$$

$$\sigma_3 = \frac{4\tau\delta}{\tau_1 l_1} = \frac{4 \times 17{\cdot}2 \times 0{\cdot}1}{13{\cdot}2 \times 23} = 0{\cdot}0190$$

$$\therefore \quad \sigma = 0{\cdot}0299$$

2. The same motor with a squirrel-cage rotor having 120 totally enclosed slots:
Width of rotor slot=1·2 cm.
Depth of rotor slot=2 cm.
Width of thin part of slot bridge=0·2 cm.
Thickness of same=0·02 cm.
We shall assume $\mu=3$, so that

$$P_2 = \left(\frac{4}{3}\frac{c\mu}{\tau} + \frac{1}{3}\frac{b}{b'}\right) = \frac{4}{3}\cdot\frac{3\cdot 0{\cdot}02}{3{\cdot}5} + \frac{1}{3}\cdot\frac{2}{1{\cdot}2}$$
$$= 0{\cdot}4 + 0{\cdot}56 = 0{\cdot}96;\ \text{say } 1{\cdot}0$$

P_1 (as before) $= 1{\cdot}7 \qquad \therefore \quad P = 1{\cdot}35.$

$\tau = 17{\cdot}2 \qquad \tau_1 = 13{\cdot}4$

$S_1 = 24 \qquad S_2 = 20. \qquad \therefore \quad S = 22.$

σ_1 has now to be determined by means of the formula

$$0{\cdot}004 + \frac{B}{S^2}$$

where B is to be obtained from Table II. (THE ELECTRICIAN, Nov. 12, p. 205.)

It should be mentioned that, so far as the determination of σ_1 is concerned, S_2 is to be regarded as representing the larger number of slots per pole, whether this occurs on the stator or rotor.

Thus, in our case, $\tau_2=3$, $\tau_1=2$: not $\tau_1=3$ and $\tau_2=2$.

From Table II., B=2·05.

$$\therefore \quad \sigma_1 = 0{\cdot}004 + \frac{2{\cdot}05}{22^2} = 0{\cdot}0082$$

$$\sigma_2 = \frac{26 \times 1{\cdot}35 \times 0{\cdot}1}{22 \times 13{\cdot}4} = 0{\cdot}0037$$

For squirrel-cage motors $k=2$.

$$\therefore \quad \sigma_3 = \frac{2 \times 47{\cdot}2 \times 0{\cdot}1}{43{\cdot}4 \times 23} = 0{\cdot}0094$$

$$\therefore \quad \sigma = 0{\cdot}0213$$

Comparison of Calculation with Observation.—In Table V. are set out the particulars of a number of motors given in the Paper by Dr. Behn-Eschenburg, already referred to.*

The observed values were all taken at the position of maximum σ, so that in calculating the values of σ by the above formula the maximum values of σ_1 have been used. Where the number of slots per pole per phase is not a whole number the second method of winding described in Section 1 has been assumed. While in one or two instances the discrepancy between calculated and observed values, expressed as a percentage of the latter, approaches 20 per cent., yet on the average the error is only some 7 per cent. The particulars of the slot dimensions not being complete, a depth of 3 cm. has been assumed for a diameter of 30 cm., increasing to 4 cm. when the diameter is 150 cm. The width of slots has been taken about 0·6 of the slot pitch. Any error in these assumptions can entail but relatively small differences in the results. The thickness of the tooth-edge was mentioned in the Paper as being in all cases about 0·1 cm.

At the bottom of the table are the particulars of five motors with totally enclosed slots. In one instance here the discrepancy between calculation and observation is as large as 17 per cent., but on examining the dimensions of this machine it will be seen that while it has a diameter of 94 cm. the gap length is only 0·04 cm., which is exceptionally small. Under these circumstances the reluctance of the main paths will be greater than six-fifths of the gap reluctance, which was the proportion assumed in calculating σ_2, and also k will have a proportionately greater value, so that our estimation of both σ_2 and σ_3 will necessarily be somewhat low.

In the four other cases the agreement is on the average quite as good as that obtained with the motors having semi-enclosed slots, which would seem to confirm the approximate correctness of the estimation of the leakage over the iron bridges. A value of $\mu=3$ was assumed in calculating σ_2, but with the very thin slot bridges employed in these motors, this part of the leakage is so very small that the result differs but little whatever value we take for μ between its limits 1·5 and 6.

In Table VI. are given complete particulars of a few motors mostly taken from Hobart's "Electric Motors." The values of σ are here the mean values. It will be seen that, using the same value of k, namely 4, the agreement is as close on the average as when the values of σ were the maximum values, though in one case there is a comparatively large percentage error, possibly due to an error of observation.

The fact that on the average the same value of k gives equally good agreement between calculation and observation, whether the comparison be made for the mean values of σ or the maximum, would seem to show that the variation in σ with the position of the rotor relative to the stator is caused entirely by the variation of the main dispersion, or, at least, that any variation in the flank dispersion is of a negligible amount. Further, it confirms the correctness of the method of calculating σ_1.

Relative Accuracy of Estimation of the Three Components of the Dispersion Coefficient.—It is probable that the degree of accuracy to which the three components σ_1, σ_2, σ_3 can be estimated, is greatest for σ_1 and least for σ_3. In the first place σ_1 does not depend on the measurement or construction of any small dimensions such as the air gap, and the slits in semi-enclosed slots. In the second place, it is entirely, or, at any rate, very nearly independent of the ratio $k=\frac{\text{Reluctance of main paths}}{\text{Reluctance of air gap}}$, which depends on the relative lengths of gap and iron circuit, and on the degree of saturation existing in the latter.

Both σ_2 and σ_3, however, depend directly on this ratio.

* "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Behn-Eschenburg. "Journal" of the I.E.E., Vol. XXXIII., Part 2, April, 1904.

Table V.—*Comparison of Calculated with Observed Results.*

No.	d	l_i	δ	p	τ	τ_i	S_1	S_2	w_1	w_2	b_1*	b_2*	h_1*	h_2*	v_1	v_2	e_1	e_2	P_1	P_2	P	σ_1	σ_2	σ_3	σ	σ obs.	Diff.	%diff.†
1	29	10·0	0·065	4	22·8	20·7	18	24	1·27	0·95	0·7	0·5	3·0	3·0	0·10*	0·10*	0·1	0·1	2·4	3·0	2·7	0·0132	0·0105	0·0287	0·0524	0·060	−0·0076	−12·7
2	29	10·0	0·065	6	15·2	13·8	12	16	1·27	0·95	0·7	0·5	3·0	3·0	0·10*	0·10*	0·1	0·1	2·4	3·0	2·7	0·0210	0·0236	0·0287	0·0733	0·090	−0·0167	−18·5
3	29	14·5	0·065	4	22·8	20·7	18	24	1·27	0·95	0·7	0·5	3·0	3·0	0·10*	0·10*	0·1	0·1	2·4	3·0	2·7	0·0132	0·0105	0·0198	0·0435	0·045	−0·0015	−3·3
4	29	14·5	0·065	6	15·2	13·8	12	16	1·27	0·95	0·7	0·5	3·0	3·0	0·10*	0·10*	0·1	0·1	2·4	3·0	2·7	0·0210	0·0236	0·0198	0·0644	0·075	−0·0106	−14·1
5	38	24·0	0·07	6	19·9	17·8	9	12	2·21	1·66	1·5	1·0	3·1	3·1	0·20	0·20	0·1	0·1	1·2	1·5	1·35	0·0280	0·0132	0·0130	0·0542	0·054	+0·0002	+0·4
6	38	24·0	0·07	6	19·9	17·8	18	24	1·10	0·83	0·75	0·5	3·1	3·1	0·10	0·10	0·1	0·1	2·4	3·0	2·7	0·0132	0·0132	0·0130	0·0394	0·039	+0·0004	+1·0
7	49	19·0	0·07	8	19·25	18·05	9	15	2·14	1·22	1·2	0·7	3·2	3·2	0·10	0·10	0·1	0·1	1·9	2·5	2·2	0·0253	0·0185	0·0158	0·0596	0·064	−0·0044	−6·9
8	49	19·0	0·07	4	38·5	36·1	18	30	2·14	1·22	1·2	0·7	3·2	3·2	0·10	0·10	0·1	0·1	1·9	2·5	2·2	0·0125	0·0046	0·0158	0·0329	0·034	−0·0011	−3·2
9	49	19·0	0·08	6	25·66	24·06	12	20	2·14	1·22	1·2	0·7	3·2	3·2	0·10*	0·10*	0·1	0·1	1·9	2·5	2·2	0·0189	0·0119	0·0180	0·0488	0·050	−0·0012	−2·4
10	49	19·0	0·08	8	19·25	18·05	9	15	2·14	1·22	1·2	0·7	3·2	3·2	0·10*	0·10*	0·1	0·1	1·9	2·5	2·2	0·0253	0·0211	0·0180	0·0644	0·063	+0·0014	+2·2
11	49	28·0	0·08	6	25·66	24·06	12	20	2·14	1·22	1·2	0·7	3·2	3·2	0·10*	0·10*	0·1	0·1	1·9	2·5	2·2	0·0189	0·0119	0·0122	0·0430	0·042	+0·0010	+2·4
12	49	28·0	0·08	8	19·25	18·05	9	15	2·14	1·22	1·2	0·7	3·2	3·2	0·10*	0·10*	0·1	0·1	1·9	2·5	2·2	0·0253	0·0211	0·0122	0·0586	0·056	+0·0026	+4·6
13	58	24·0	0·09	8	22·8	21·3	12	18	1·90	1·27	1·1	0·7	3·2	3·2	0·10*	0·10*	0·1	0·1	2·0	2·5	2·25	0·0188	0·0165	0·0160	0·0513	0·054	−0·0027	−5·0
14	58	30·0	0·07	8	22·8	21·05	15	20	1·52	1·14	0·9	0·6	3·2	3·2	0·10	0·10	0·1	0·1	2·2	2·8	2·5	0·0163	0·0124	0·0101	0·0388	0·042	−0·0032	−7·6
15	58	30·0	0·07	4	45·6	42·1	30	40	1·52	1·14	0·9	0·6	3·2	3·2	0·10	0·10	0·1	0·1	2·2	2·8	2·5	0·0100	0·0031	0·0101	0·0232	0·022	+0·0012	+5·5
16	90	17·0	0·10	12	23·6	21·6	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·15*	0·15*	0·1	0·1	1·7	2·0	1·85	0·0198	0·0165	0·0257	0·0620	0·067	−0·0050	−7·5
17	90	23·0	0·10	12	23·6	21·6	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·15	0·15	0·1	0·1	1·7	2·0	1·85	0·0198	0·0165	0·0190	0·0553	0·067	−0·0117	−17·4
18	90	23·0	0·10	6	47·2	43·2	24	30	1·97	1·57	1·2	0·9	3·5	3·5	0·15	0·15	0·1	0·1	1·7	2·0	1·85	0·0110	0·0041	0·0190	0·0341	0·033	+0·0011	+3·3
19	90	32·0	0·10	12	23·6	21·6	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·15	0·15	0·1	0·1	1·7	2·0	1·85	0·0198	0·0165	0·0136	0·0499	0·060	−0·0101	−16·8
20	90	32·5	0·11	12	23·6	18·9	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·35	0·35	0·1	0·1	1·3	1·6	1·45	0·0198	0·0162	0·0169	0·0529	0·060	−0·0071	−11·8
21	90	40·0	0·10	12	23·6	21·6	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·15*	0·15*	0·1	0·1	1·7	2·0	1·85	0·0198	0·0165	0·0109	0·0472	0·046	+0·0012	+2·6
22	150	28·5	0·10	14	33·7	31·7	12	15	2·81	2·25	1·6	1·3	4·0	4·0	0·15	0·15	0·1	0·1	1·5	1·7	1·6	0·0198	0·0097	0·0150	0·0445	0·046	−0·0015	−3·3
23	150	28·5	0·14	14	33·7	31·7	12	15	2·81	2·25	1·6	1·3	4·0	4·0	0·15	0·15	0·1	0·1	1·5	1·7	1·6	0·0198	0·0136	0·0209	0·0543	0·055	−0·0007	−1·3
24	58	24·0	0·09	8	22·8	19·8	12	18	1·90	1·27	1·1	0·7	3·2	3·2	0·2	0·2	0·1	0·01	1·15	1·75	1·45	0·0188	0·0115	0·0173	0·0476	0·045	+0·0026	+5·8
25	90	32·5	0·11	12	23·6	20·9	12	15	1·97	1·57	1·2	0·9	3·5	3·5	0·2	0·2	0·1	0·01	1·15	1·45	1·3	0·0198	0·0131	0·0153	0·0482	0·058	−0·0098	−16·9
26	94	40·0	0·04	12	24·6	22·5	9	12	2·73	2·05	1·6	1·2	3·5	3·5	0·2*	0·2*	0·1*	0·01*	0·9	1·1	1·0	0·0280	0·0044	0·0044	0·0368	0·040	−0·0032	−8·0
27	94	40·0	0·10	12	24·6	22·5	9	12	2·73	2·05	1·6	1·2	3·5	3·5	0·2*	0·2*	0·1*	0·01*	0·9	1·1	1·0	0·0280	0·0110	0·0110	0·0500	0·054	−0·0040	−7·4
28	150	22·0	0·15	16	29·5	27·4	9	12	3·28	2·46	2·0	1·5	4·0	4·0	0·2*	0·2*	0·1*	0·01*	0·8	1·0	0·9	0·0280	0·0123	0·0294	0·0697	0·075	−0·0053	−7·0

* Assumed. † Average (arithmetical) per cent. difference 7·1.

Table VI.

No.	d.	l_i.	δ.	p.	τ.	τ_i.	S_1.	S_2.	w_1.	w_2.
1	21·5	8·35	0·05	4	16·9	13·1	12	15	1·41	1·13
2	32·2	20	0·075	6	17·0	14·4	9	12	1·89	1·42
3	50·2	28	0·10	8	19·7	17·1	9	12	2·19	1·64
4	88	33	0·15	12	23·1	18·1	15	18	1·54	1·28
5	130	40	0·125	14	29·2	25·9	12	21	2·44	1·39
6	300	75	0·175	30	31·4	26·8	15	24	2·09	1·31

No.	b_1.	b_2.	h_1.	h_2.	v_1.	v_2.	e_1.*	e_2.*	P_1.	P_2.	P.
1	1·1	0·65	2·2	2·2	0·3	0·27	0·1	0·1	1·9	1·5	1·25
2	1·4	0·8	3·6	2·5	0·3	0·2	0·1	0·1	1·19	1·54	1·36
3	1·63	1·03	4·5	3·5	0·3	0·2	0·1	0·1	1·25	1·64	1·45
4	1·05	0·8	2·5	2·15	0·3	0·2	0·1	0·1	1·12	1·22	1·17
5	1·3	0·75	5·2	2·3	0·2	0·2	0·1	0·1	1·83	1·52	1·68
6	1·3	0·7	5·7	2·2	0·3	0·2	0·1	0·1	1·79	1·55	1·67

No.	σ_1.	σ_2.	σ_3.	σ.	σ_{obs}.	Diff.	P.c. diff
1	0·0148	0·0092	0·0310	0·0550	0·060	−0·0050	− 8·3
2	0·0220	0·0175	0·0177	0·0572	0·055	+0·0022	+ 4·0
3	0·0220	0·0210	0·0165	0·0595	0·060	−0·0005	− 0·8
4	0·0112	0·0153	0·0232	0·0497	0·052	−0·0023	− 4·4
5	0·0128	0·0128	0·0141	0·0397	0·050	−0·0103	−20·6
6	0·0099	0·0145	0·0110	0·0354	0·036	−0·0006	− 1·7

which may vary considerably in different motors, sufficiently, indeed, to cause an error in σ_2 and σ_3 of 15 per cent. or more.

In the section on peripheral dispersion the value 1·2 was taken for k_z. If it is known from the data of design (such as an exceptionally small air-gap, or high flux densities) that k_z is likely to be more than 1·2, σ_2 and σ_3 should be increased in the proportion of the estimated value of k_z to 1·2.

Lastly, σ_3 is liable to even greater error than σ_2, because k must depend to a certain extent on dimensions not taken into account at all. Any discrepancy between the observed and calculated values of σ, which are not due to errors of observation or construction, are, therefore, most probably to be ascribed to incorrect values of k and k_z, and, in lesser degree, to error in the estimation of P, the slot permeance.

(*To be concluded.*)

A STUDY OF THE SURGES CAUSED ON SWITCHING OFF ASYNCHRONOUS MOTORS.†

BY REINHOLD RUDENBERG.

It has lately been noticed on many occasions that the windings of asynchronous motors have been destroyed by the effects of surges. This happened when the rotor circuit was opened through the starting resistance in order to be able to disconnect the motor from the network by opening the main switch. The discharges could be avoided if the reverse course of action was adopted—*i.e.*, by disconnecting the motor from the network and then opening the circuit of the starting resistance. The switch has in the latter case to break a much larger current, which amounts to the total current taken by the motor; but the surges, which are produced, are much less serious. It is well to consider the cause of the surges which arise on switching out an asynchronous motor with an open secondary circuit, and which are much more serious than those caused on switching out a transformer. This is due to the fact that the energy in the magnetic field of the motor is much greater than that in a transformer, owing to the fact that in the one case there is a considerable air-gap, which is the main site of the magnetic energy, while in the other case there is a practically closed iron path. The magnetic energy stored up in the motor is transformed into heat, but if the switching is carried out very quickly it causes very high voltages in the windings on account of the rapid changes in the field. Take the other case where, on switching out, the rotor winding is closed or short-circuited; then the magnetic field of the motor is linked with the short-circuited winding, and is not so suddenly destroyed. It does not need to discharge its energy through the spark at the contacts. Even if the stator is switched off quite suddenly, the field remains for an instant at its full strength, seeing that it is maintained by currents which are

* Assumed. Average (arithmetical) per cent. difference, 6·6.

† Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 15, 1915.

formed in the rotor. The polyphase field remains attached to the rotor winding and rotates with it, dying out gradually in accordance with the values of the time-constants. The field energy is not rapidly dispersed in the spark caused by switching out the stator, but is slowly dissipated in the resistance of the rotor winding. If the rotor winding is not short-circuited, but contains a considerable resistance, then the field of the motor is discharged more quickly in conformity with the smaller time constants. If the rotor circuit has a high resistance, then surges are likely to be caused in the stator owing to the rapid change of the field. In actual practice, it is impossible to switch out the stator suddenly. There is always an arc formed at break, which acts as a resistance between the stator and the network and causes the disappearance of the field to take place more slowly. Part of the field-energy is no doubt dissipated in the arc, and this tends to decrease the surge. The effects produced in and by the arc are not to be studied very exactly owing to their very nature, but it is possible to calculate what would be the extreme limit of the surging phenomena, if we could suppose the arc to be extinguished very quickly. The author proceeds to do this mathematically, and arrives at a formula from which he deduces the



Fig. 1.

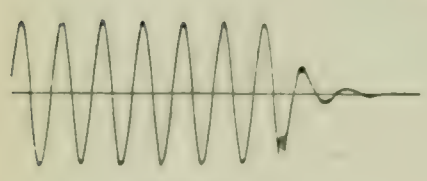


Fig. 2.

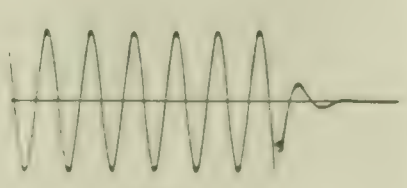


Fig. 3.

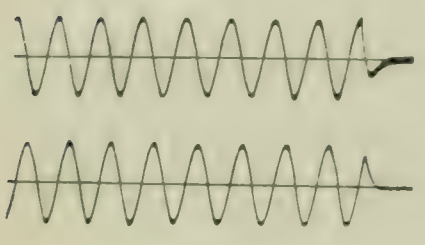


Fig. 4.

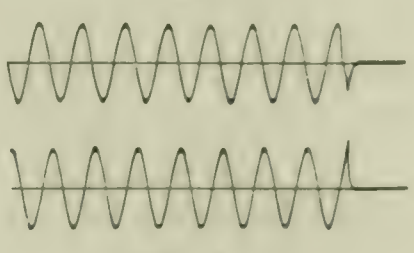


Fig. 5.

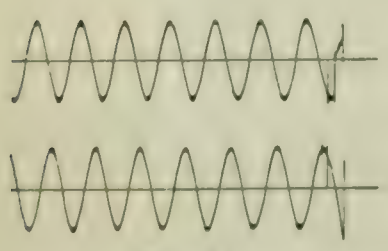


Fig. 6.

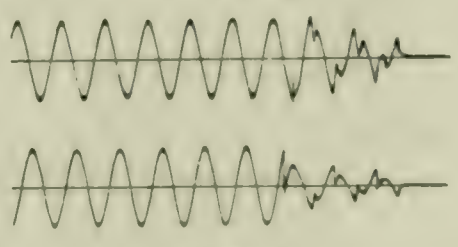


Fig. 7.

Figs. 1 to 7.—Diagrams showing the Voltage-wave on Switching-out Asynchronous Motors with Varying Resistances in the Rotor Circuit.

following results. The surges which arise on switching out the motor, die away gradually in accordance with the time-constants of the rotor circuit. Their amplitudes in the different phases of the motor are greater in proportion as the magnetising current bears a larger ratio to the normal working current. This means that the surges depend on the amount of the stored-up magnetic energy, and they increase in proportion as the resistance in the rotor circuit at the moment of switching off is greater than the normal running resistance. The danger to the insulation of the motor arises not so much from the absolute height of the surge as from the suddenness with which the surge can spread itself through the motor winding. The arc at the contacts can easily cause heavy voltage-surges, which might destroy the windings of the motor, especially those on which they first impinge.

But all these calculations have only a theoretical interest, and show the extreme limits. It is, perhaps, more to the point to study some oscillographic records, showing what actually takes place. An ordinary motor used for driving a crane was taken; it had a large magnetising current, and gave 50 H.P. at 600 revs. per min. on 500 volts. This motor was taken as being suitable for a normal and moderate voltage, in order to avoid any possibility of a breakdown during the tests. The oscillogram in Fig. 1 was taken when the motor was switched out during normal running with a short-circuited rotor. The voltage is seen to die away gradually at a rate corresponding to the large time-constants of the rotor winding, the process occupying less than one-fifth of a second. There is here no sign of any surge. The oscillogram in Fig. 2 shows the dying away of the voltage when the motor is in series with about half its starting resistance. There are here several very marked and rapid jags in the voltage-wave. In Fig. 3 the rotor circuit includes about two-thirds of the starting resistance, the voltage dies away more quickly, and the jags are more marked. At the moment of switching out, the voltage rises slightly, but not to any dangerous extent. In oscillogram in Fig. 4, the resistance in series with the rotor was about one-third more than the normal starting resistance; the voltage dies away still more quickly, almost aperiodically. Fig. 5 shows the rise and the sharply-pointed tip in the voltage wave when the resistance in series with the rotor is four times the normal starting resistance. And, finally, Fig. 6 shows the effect produced when the rotor circuit is opened, and thus the resistance in series with it is infinite. The rise of the voltage above the normal is not so remarkable, but rather the very sudden variations of the voltage which seems to pass unsteadily from positive to negative values. These sudden variations seem to suggest surges of considerable extent, which are known to be very dangerous to the insulation of high-tension motors. These tests were not carried out with a good switch, the three contacts of which opened at the same instant, but an old oil switch was used, in which the contacts were badly burnt, and in which the three contacts were by no means opened at the same instant. But this caused no difference in the oscillograms. Fig. 7 on the other hand shows the effects produced when an air switch with copper-

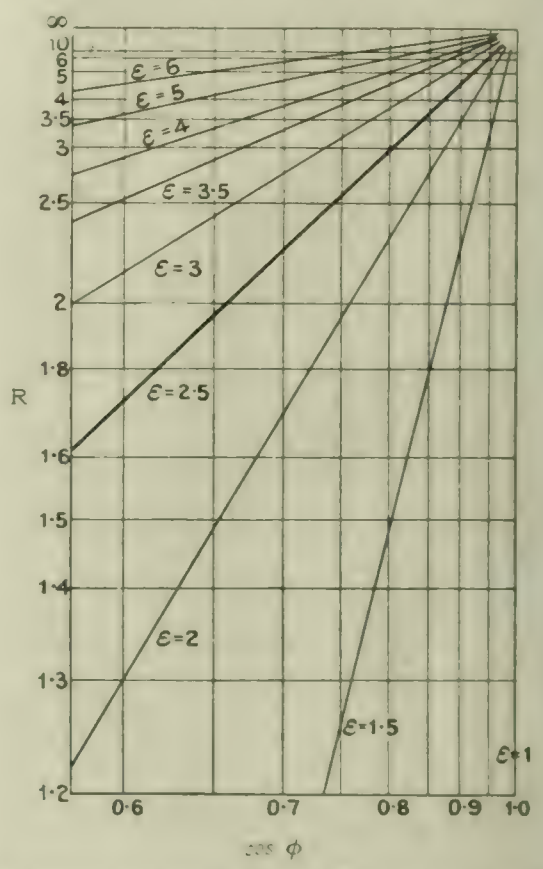


Fig. 8. The relation between the Power-factor, Rotor Resistance, and Surge-ratio on Switching-out Asynchronous Motors.

carbon contacts was used. The process seems to go much more steadily, although the rotor circuit was opened. This was because an arc was formed which lasted through several periods until the whole energy of the motor field was dissipated. Here, too, one notices the sudden jumps in the voltage-wave, which might be very prejudicial to the windings. A table is given showing the limiting theoretical values of the voltage-surges as deduced from mathematical considerations. In Fig. 4 the observed surge in the voltage-wave is little more than half the theoretical maximum; there are no very marked jumps or sharp tips; the motor appears in no wise endangered. But it would probably be risky to do frequently as shown in Fig. 5, where the theoretical maximum is much higher. The insulation would doubtless suffer, not because the observed surge was 34 per cent. above the normal voltage, but because the sharp tips in the oscillogram undoubtedly mean surges. Anything much beyond that shown in Fig. 4 is probably dangerous.

It is practically more convenient to leave the magnetising current out of account, and to take the known power factor of the motor as the basis of the calculation. We can at the same time take account of the fact that not only does the energy of the main field of the motor become dissipated at the moment of switching off, but also that of the stray fields. Both of them give rise to surges. There are slight differences according as the motor has its full load when switched off or is only partially loaded. To take, however, the most unfavourable case, we may suppose it to be fully loaded, and calculate accordingly.

Thus, the author again on theoretical grounds arrives at a fresh formula, from which the results shown in Fig. 8 are obtained. Here the ordinates are the total resistance in series with the rotor, and the abscissæ are the power factors. The curves, or rather straight lines, correspond to the maximum permissible surge—*i.e.*, the ratio of the surge to the normal working voltage. Therefore, if the power-factor of a motor is known, we can at once obtain the resistance which may be in series with the rotor, if the surge is not to exceed a certain predetermined limit. Practically, as aforesaid, it is well to keep below the line $\epsilon=2{\cdot}5$—*i.e.*, below a maximum surge limit of rather more than twice the working voltage.

ELECTRICAL RAILWAYS.*

BY H. M. HOBART.

After giving figures showing the growth of electric traction on railways in the United States and Canada the author passes to the decrease in cost of electricity during recent years. Fifteen years ago a 3,000 kw. set cost about £30,000, or at the rate of £10 per kilowatt, whereas a 30,000 kw. turbo set can be obtained for less than £60,000. In other words, a set with 10 times the output now costs less than twice the old price.

Curves are given in the original Paper showing the costs of electrical energy obtained from steam, electric and hydro-electric stations respectively. From these it appears that the curves of the total cost cross at a 20 per cent. station load-factor, the hydro-electric station then showing lower costs than the steam station.

Taking as a basis a station of 150,000 kw. capacity equipped with five three-phase turbo sets of 30,000 kw. at unity power-factor, the author gives figures of running costs with fuel of 14,000 B.Th.U. per ton and a load-factor of 50 per cent. It is shown that with coal at 4s. per ton the total cost per kilowatt-hour is 0·228d., and with coal at 12s. per ton it is 0·302d.; thus increasing the price of fuel three-fold only increases the cost of electrical energy by 33 per cent.

The Butte, Anaconda and Pacific 2,400-volt Railway.

Prior to the summer of 1913 the trains on the Butte, Anaconda & Pacific Railway were hauled exclusively by steam locomotives. The railway comprises 114 miles of single track, of which some 70 miles is in yards and sidings. There is very little tangent track in the course of the entire 114 miles. For the 12 months preceding June, 1913, the traffic aggregated about 760,000 locomotive-miles. This traffic was handled with 27 steam locomotives, giving an average of 28,000 miles per steam locomotive per year. The steam locomotives were of three types, the weight with loaded tender being 138 tons, 145 tons and 115 tons respectively, and the weight on the drivers being 74 tons in the first two types and 54 tons in the third.

The annual coal-consumption for these 27 locomotives amounted to 67,000 British tons. This reduces to 197 lb. of coal per locomotive-mile. The price of the coal delivered at the bins of the railway company was 19s. per British ton. This works out at a fuel cost of 19·9d. per locomotive-mile. The fuel is lignite, and has a calorific value of 12,250 B.Th.U. per lb. (3·60 kw.-hours per lb.).

Ninety-one miles of single-track of this system have now been equipped for electric operation, and all but four of the 27 steam locomotives have been withdrawn from service. At present the annual traffic is slightly greater than during the last year of "all-steam locomotive" operation. This traffic is handled with 17 electric locomotives, and the four steam locomotives above mentioned. The 17 electric locomotives are at present accounting for 700,000 locomotive-miles per annum. This is an average of 41,000 miles per electric locomotive per annum. The energy consumed by the 17 electric locomotives requires the supply to the sub-stations of 18,500,000 kw.-hours of electricity per annum, or 26·3 kw.-hours per locomotive-mile. The electricity is delivered to the sub-stations at a price of 0·265d. per kilowatt-hour. Consequently the expenditure for electricity per locomotive-mile amounts to $(26{\cdot}3\times0{\cdot}265=)$7d. Thus the outlay for electricity per locomotive-mile is only 7d. as against an outlay of 19·9d. for coal per steam locomotive-mile. Too much significance, however, should not be attached to this ratio, since it is largely dependent upon local conditions. For the same price (0·265d. per kw.-hour) for electricity, but with coal of the same quality—at, say, 8s. per ton—the outlay for fuel per locomotive-mile would only have been $(8/19\times19{\cdot}5=)$8·2d. per steam locomotive-mile. Furthermore, notwithstanding the gradual decrease in the cost of manufacturing electricity, conditions will usually make it quite out of the question to obtain electricity at so low a price as 0·265d. per kilowatt-hour. Had it been necessary to pay a 50 per cent. higher price for the electricity—namely, 0·40d. per kilowatt-hour—the outlay for electricity per locomotive-mile would have been 10·5d.

Each of the 17 electric locomotives weighs 72 British tons, and the entire weight is on the drivers. The weight per axle is 18 tons. Fifteen are employed in freight service and two in passenger service. A type of motor, known as the G.E. 229–A, is employed both on the freight and passenger locomotives, the only difference relating to the gear ratio, which for the freight locomotives is (87 : 18=) 4·83, and for the passenger locomotives is (80 : 25=) 3·20, the passenger locomotives thus having a 51 per cent. higher speed for a given speed of the armature. The locomotives receive 2,400-volt direct-current electricity from overhead conductors by means of roller pantograph trolleys. Each of the four motors constituting the equipment of a locomotive is wound for a working pressure of 1,200 volts, and the winding is insulated for a pressure to ground of 2,400 volts. The motors are permanently connected in pairs of two in series. By series-parallel control the two pairs can be operated in series or in parallel with one another. The maximum free-running speed of the freight locomotives is about 35 miles per hour. Each freight locomotive is capable of developing continuously a tractive effort of 25,000 lb. at 16·2 miles per hour, the corresponding output at the drivers being 1,080 H.P.

At starting, the locomotive provides a tractive effort of 40,000 lb. for a coefficient of adhesion of 0·25, and 48,000 lb. for a coefficient of adhesion of 0·30. The thermal characteristics are such as to permit of the development of a tractive effort of 48,000 lb. for five minutes, starting cold. This five-minute rating provides a valuable margin for the slow acceleration from rest of long freight trains on heavy grades; in other words, it provides liberal emergency capacity. Another occasion when this five-minute rating is utilised is when a very long freight train is headed by one locomotive and pushed by another. The electrical equipment of the locomotive weighs 60,000 lb., or 55·5 lb. per horse-power of continuous output at the rims of the drivers. Conversely expressed, the locomotive is capable of delivering continuously at the drivers an output of 40·5 H.P. per British ton of weight of electrical equipment. The motors are cooled by the circulation through them of air supplied from a motor-driven blower.

The traffic on the Butte, Anaconda & Pacific Railway has, up to the present, consisted chiefly of transportation of ore. Owing to the increase of traffic four tractor trucks have been added to the rolling-stock equipment. A locomotive with its tractor truck carries six motors and the combination weighs 108 tons,* The control is so arranged that the six motors can be operated either all in series or in two parallels of three in series. A locomotive with one of these tractors is capable of exercising a tractive effort of 37,500 lb. at 10·8 miles per hour.

With regard to comparisons, it is difficult to arrive at a satisfactory basis. The locomotive-mile is unsatisfactory for this purpose, owing to the variable amounts of switching mileage and non-revenue and special mileage. In this case these quantities are given in Table I. :—

Table I.

Kind of locomotive-mileage.	Percent. of total annual locomotive-mileage.	
	With 27 steam locomotives.	With 4 steam and 17 electric locomotives.
Switching	40·5 p.c.	32·9 p.c.
Non-revenue and special	9·3 „	4·3 „
"Switching" plus "Non-revenue and special"	49·8 „	37·2 „

The data in the above table afford evidence of the superiority of the electric locomotive for switching work and of the relatively small amount of non-revenue mileage associated with its use. The net ton-mileage of freight carried annually by the railway is at present some 170 million ton-miles.

In the days of all-steam locomotive operation the weight of a train was about 1,600 tons, but with electric traction this has been increased 35 per cent., to about 2,100 tons. The speed of two 72-ton electric locomotives when hauling trains of 4,300 tons up a 0·3 per cent. gradient is about 16 miles per hour, or over twice as great a speed of the lighter trains formerly hauled by steam locomotives.

The author then discusses at some length the "drivers-to-draw-bar" efficiency of locomotives—*i.e.*, the ratio of the draw-bar pull to the tractive effort of the locomotive at the rims of the drivers.

* Abstract of the James Forrest Lecture, 1915, delivered before the Institution of Civil Engineers on Dec. 14.

* All tons here given are British.

Figures are given of the power consumption of a west-bound and east-bound trip. Some detailed figures are also given in regard to the consumption of hauling trains from East Anaconda up to the Washoe Smelter, a distance of seven miles with a ruling gradient of 1·1 per cent. When electric traction was first inaugurated two 72-ton electric locomotives were used in hauling 16-car trains. They made the trip in 22 minutes, as against 45 minutes with the steam locomotives. At present the trains have been increased to 25 cars, and the running time is 26 minutes. The figures in Table II. give the results so obtained, the vertical lift being 380 ft. and friction being assumed as 6 lb. per ton.

Table II.

Designation of run.	1	2	3	Average.
Number of cars in train	18	21	25	21·3
Gross weight of train in British tons	1,270	1,410	1,710	1,460
Gross ton-miles	8,900	9,900	12,000	10,300
Schedule speed in miles per hour ...	16·1	16·2	14·2	15·5
Total consumption in kw.-hours.....	580	560	746	629
Watt-hours per ton-mile	65·1	56·5	62·2	61·5
Kilowatt-hours per train-mile.....	...	...	...	90·0

Table III.

	Efficiency of electrical equipments.	"Drivers-to-drawbar" efficiency.	"Pantograph drawbar" efficiency of locomotives.
West-bound trip of 3,700-ton train of loaded ore cars from Rocker to East Anaconda at a schedule speed of 20 miles per hour.....	84·0 p.c.	97·0 p.c.	81·5 p.c.
East-bound trip of 1,190-ton train of empty ore cars from East Anaconda to Rocker at a speed of 20 miles per hour	83·3 ,,	95·0 ,,	79·2 ,,
Seven-mile trip up Smelter Hill with two 72-ton locomotives hauling 1,316 tons of loaded ore cars, the total train weight being 1,460 tons	83·0 ,,	92·8 ,,	77·0 ,,

In Table III. are given the efficiency figures obtained, the "pantograph-to-drawbar" efficiency being the product of the electric efficiency of the equipment into the "drivers-to-drawbar" efficiency.

The author then discusses figures that have been given by Mr. L. R. Pomeroy and by Mr. C. P. Kahler in regard to the small proportion of time spent by locomotives in the useful work of actually hauling trains. He gives figures showing that the "coal-to-drawbar" efficiency of the steam locomotive is of the order of 3 per cent., whereas the actual working efficiency of electric locomotives from the coal in the electricity supply station to the rims of the drivers on the locomotive is over 6 per cent. This higher efficiency is obtainable irrespective of the density of the traffic.

In regard to coal consumption, laboratory tests of locomotives may show a consumption as low as 30,000 B.Th.U. per indicated horse-power hour, but it is rare that a railway operates with less than 80,000 B.Th.U. per indicated horse-power-hour. In electricity supply stations 13 per cent. from the coal pile to the outgoing cables represents a typical value of the annual overall efficiency of a large modern station with a good load-factor, say, 50 per cent. With coal of 14,000 B.Th.U. per lb., this means 1·9 lb. per kilowatt-hour of output.

(To be continued.)

THE ELECTRICALLY-PROPELLED BATTLESHIP "CALIFORNIA."*

BY W. L. R. EMMET.

The new electrically-propelled battleship "California," which is being built at the New York Navy Yard, is of the largest and most powerful class which has been adopted by the United States. Her displacement is 32,000 tons and her maximum speed is to be about 22 knots, requiring about 37,000 shaft H.P. The contract with the manufacturer of the electrical equipment covers two turbine driven generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, &c., two turbine-driven exciting units, and a complete equipment of condensing auxiliaries and ventilating blowers, all driven by motors from the exciting units.

Each of the auxiliary units is of 300 kw. rating, with a 240-volt continuous-current generator geared to a high-speed non-condensing turbine. These turbines will exhaust into the heaters, into the main turbines, or both.

The award of this contract for the "California" was the result of a very long campaign of study, in which the equipment of the U.S. collier "Jupiter" was an incident. The "Jupiter" has now been in commission for two years and has proved an unqualified success. The steam consumption of the main drive with 190 lb. pressure, dry steam, and 28·5 in. vacuum is 11 lb. per horse-power-hour delivered to the propeller shafts, which is at least 30 per cent. better than is done by reciprocating engines in ships of the same class. There is also evidence of further saving in the "Jupiter" incident to the fact that her large low-speed propellers are turned with a perfectly uniform angular motion and with entire freedom from racing, conditions never heretofore achieved.

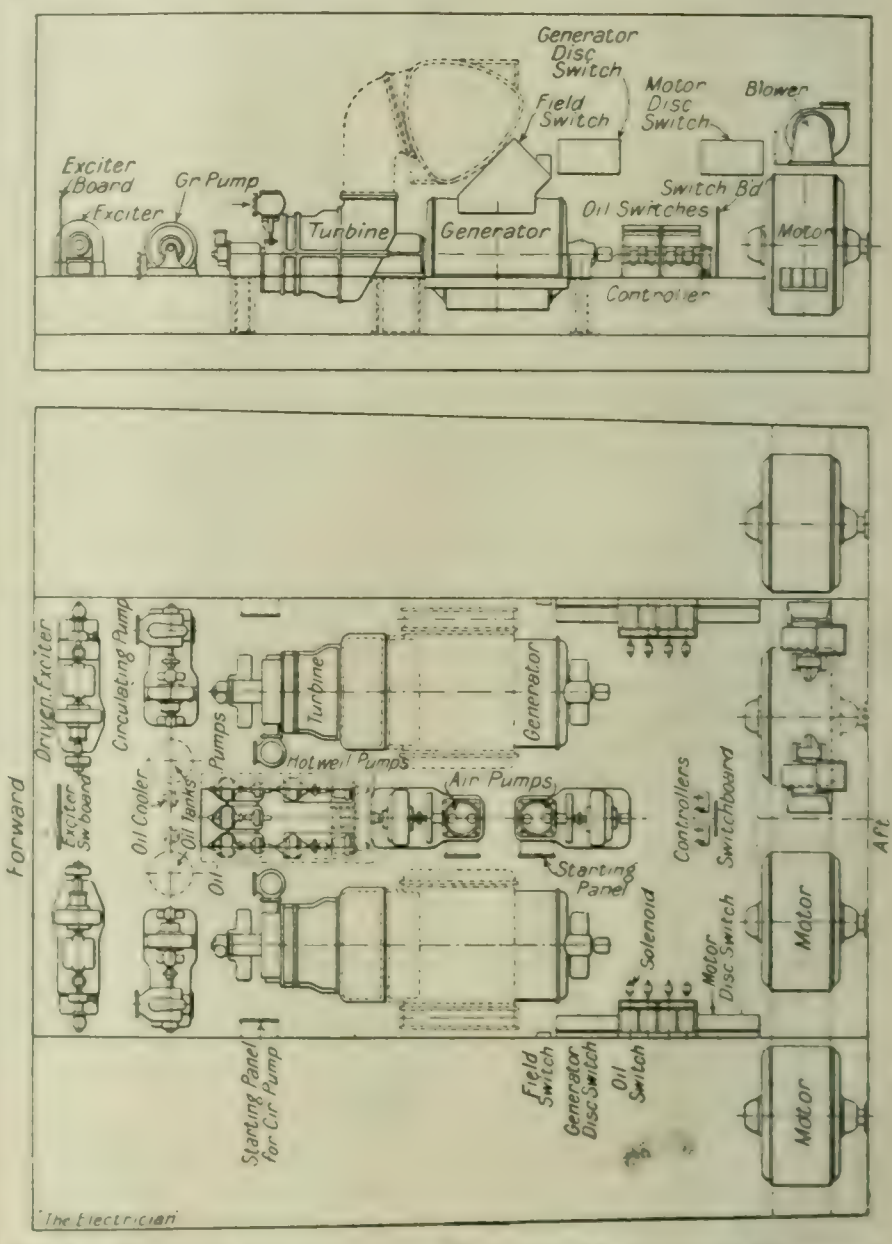


FIG. 1.—PROPOSED ARRANGEMENT OF ELECTRIC PROPELLING MACHINERY ON THE UNITED STATES NEW BATTLESHIP "CALIFORNIA."

The generators for the "California" are bipolar alternators, and the motors are arranged to be connected for either 24 or 36 poles. For economic cruising at 15 knots or less one generator will be used with motors on 36-pole connection. For higher speeds the 24-pole connection will be used. The ship will be capable of operating at a speed of about 18·5 knots with one generator.

Speed variation with either motor connection will be effected by change of turbine speeds through the agency of variable-speed governors designed to hold automatically any desired speed within usual ranges. This arrangement, which is also used in the "Jupiter," entirely prevents racing and makes it convenient to hold a fixed speed irrespective of variations in sea, weather or steam conditions. It is thought that this feature will be valuable in fleet formations.

The steam consumption guaranteed on the "California" covers the total steam required for the main turbines and engine-room auxiliaries as described above. The conditions are 250 lb. gauge pressure, dry steam, with such vacuum as can be produced under trial conditions.

Very heavy penalties are imposed in case these guaranteed consumptions are exceeded in trials, £5,000 per pound for the two lower speeds and £4,000 per pound for the two upper speeds.

* Abstract of a Paper read before the Society of Naval Architects and Marine Engineers. From the "Electrical World."

At full speed the "California" propellers will make 175 revs. per min., this being about the lowest speed of propellers which is practicable within the space. The propeller speeds proposed for the sister ships with Parsons turbine drive is 240 revs. per min., and comparisons by Dyson's method indicate that this speed difference will give the "California" an advantage of about 9 per cent. in propeller efficiency.

Table I.—*Pounds of Steam to Main Engines per Hour per Engine Horse-power.*

	12 knots.	15 knots.	19 knots.	21 knots.	Proportional to speed of 21 knots.
"Florida"	31·8	...	24·0	23·0	328
"Utah"	28·7	...	20·3	21·0	323
"Delaware"	22·0	...	18·7	21·0	122
"California"	17·3	15·2	15·0	16·4	175

In Table I. is given a comparison of steam consumption per effective horse-power between the "California" as guaranteed, the "Florida" and "Utah," which are driven by Parsons turbines, and the "Delaware," which is driven by reciprocating engines. These figures are taken from the published records of trials. Fig. 1 shows the engine-room arrangement of the "California" suggested in the General Electric Co.'s proposal, although a somewhat different arrangement will actually be used.

SEMI-AUTOMATIC LIFTS ON THE "UNDERGROUND."

The London Electric Railway Co. are now equipping many of the lifts at their stations with semi-automatic control. From the commencement of their installation all these lifts had limit switches actuated by the movement of the cars to bring them automatically to rest at the landings, and, further, the attendant in the lift could put the gate controlling lever to the open position while the car was moving and the gates would then open of themselves by pneumatic power when the landing was reached. The elaboration of this system that is now being used consists of the control of the lift and gates from the landings, no attendant travelling with the lift. This system was devised by Mr. W. A. Agnew, mechanical engineer, and Mr. Graff-Baker, assistant in charge of the lift section, who has kindly supplied us with particulars. The original type of switchboard for this control has a set of plungers, grouped as shown in Fig. 1. Two of these boards are installed for each lift, one at the top and one at the bottom landing. The labels beside the plungers explain their functions. The four in the centre control the gates of the car and the landing doors opposite them. Pressing the "down" plunger at the top landing starts the lift down, and when it arrives at the bottom of the shaft it is automatically put under the control of the lower board, when pressing the correct plungers will open the "exit" gates as required. The attendant may further expedite matters by having his "exit open" plunger ready pressed in, when the gates will open as soon as the lift has stopped at the landing. Pressing the "up" plunger on this bottom board will cause the lift to ascend and come again under the charge of the top attendant. The "up" plunger at the top and the "down" plunger at the bottom are sealed up and only used in emergency, as it would obviously be dangerous to start a lift from the distant landing.

The emergency plungers marked "stop" and "reset" are painted red, and intended for use when it is desired to stop the car in the middle of its travel. Pressing the "stop" plunger does this by cutting off the current and applying the brakes. Afterwards by pressing first the "reset" plunger and then the starting one the lift can be made to continue its journey. The switch marked "indicator" is for cancelling the illuminated sign which shows when the lift is approaching the landing.

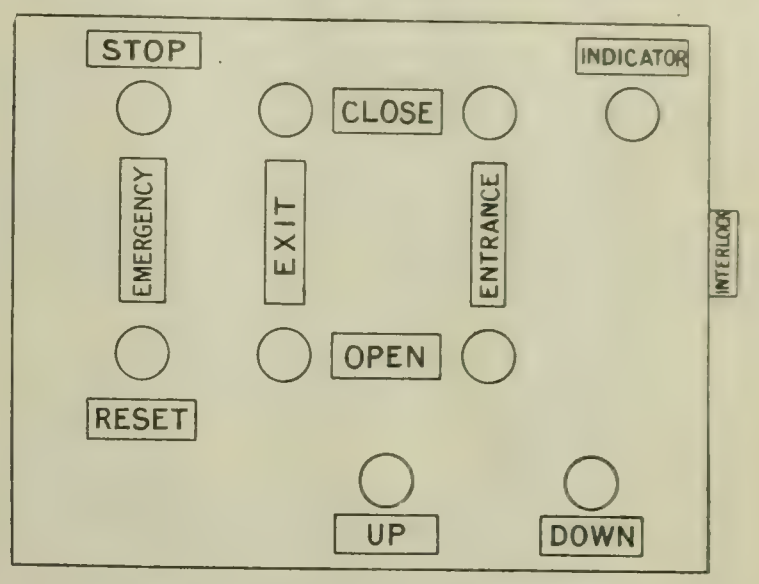
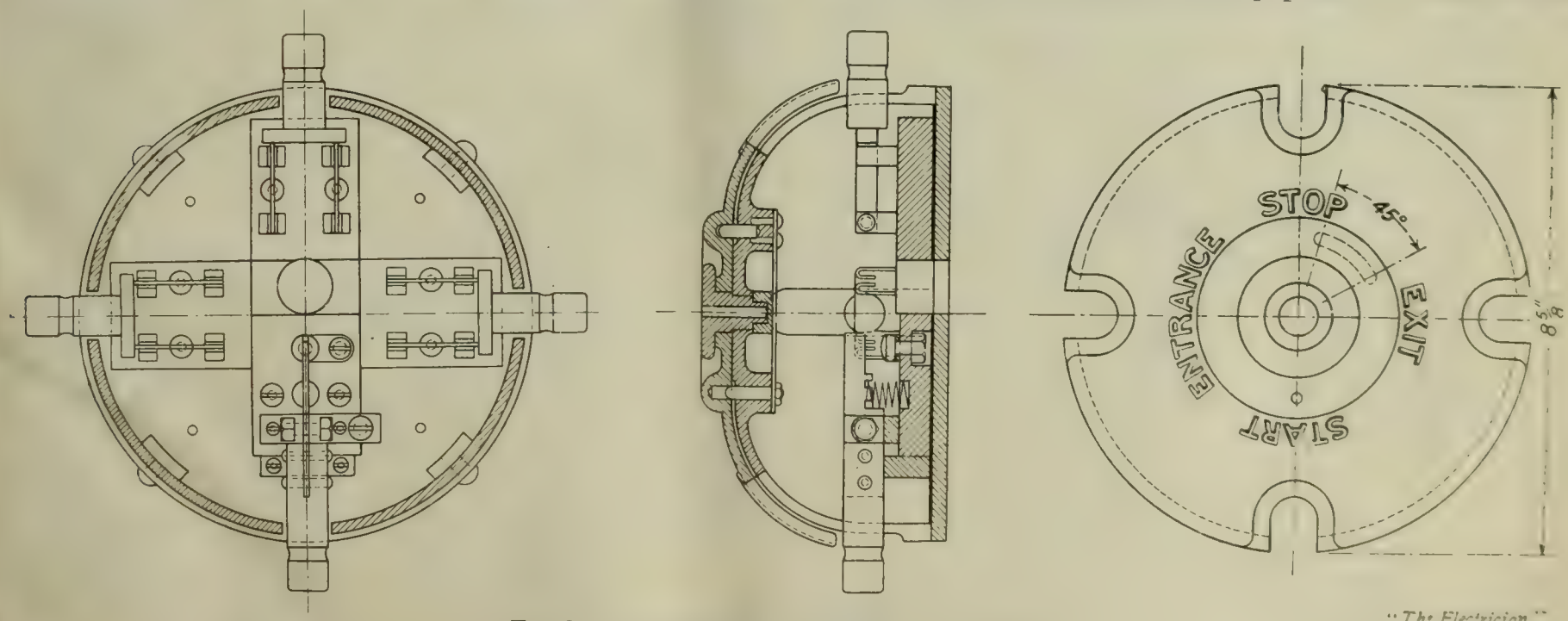


FIG. 1.—DIAGRAM OF CONTROL BOARD.

Provision is also made for working the lift from inside. When it is desired to do this the gates are all opened and the control-board locked by a key fitting on to the "interlock" nut shown at the side. The motion of the lift is then controlled from the ordinary controller inside. Above this controller is a board with four plunger switches for the gates and an emergency switch for stopping while making a journey.

The installation of these control boards on 10 lifts is now completion. Plans are made also for the equipment of 41 more lifts on the same principle, but with the type of controller shown in Fig. 2. This consists of four switches at right angles, the handles of which project from the circumference of a dome-shaped cover. As will be seen from the drawing, the starting switch is not a knife switch like the others, but consists of a lever, which, on being pulled out against the action of a spring, touches a contact, closing the circuit of the starting relay. This relay will then remain excited though the lever is released. The construction of the relay is shown in Fig. 3. It contains two separate mechanisms, the currents in the coils of which are controlled by the starting switches at the top and bottom landings respectively. Each coil closes three circuits by bringing down a bar on to four contacts, one of which forms a common return. A link



"The Electrician."

FIG. 2.—ARRANGEMENT OF LANDING CONTROL BOX.
Scale: 3″=1 foot.

encloses two bars connected one to each of the relay armatures, thus ensuring that both units cannot go in together.

The new type of controller enables a very convenient system of locking to be employed. When it is desired to operate from inside the lift all four switches must be returned to their normal positions, and the cover is then turned through an angle of 45 deg., so that the switch handles are no longer beneath the slots cut in the cover to receive them, and therefore cannot be moved. The cover is then held in this position by a catch pressed into engagement by a flat spring on the inner cover. To release this for the purpose of rotating the cover back again a key is inserted in a central opening to press back the spring.

For the control of the lift gates and for keeping them closed when the car is not at the landings, there have to be at the top and bottom of the shaft contact pieces making electrical connection with appropriate contacts on the car when this has reached the landing. On the original equipment these take the form of brass strips fixed at the landings in pairs. Each pair forms a V, the central bottom portion of which is an insulating block, to which the strips are fixed, their upper ends being free. A couple of projecting bars on the lift on rising embrace this V, bending the strips towards each other, their spring giving a good contact pressure. It is found, however, that

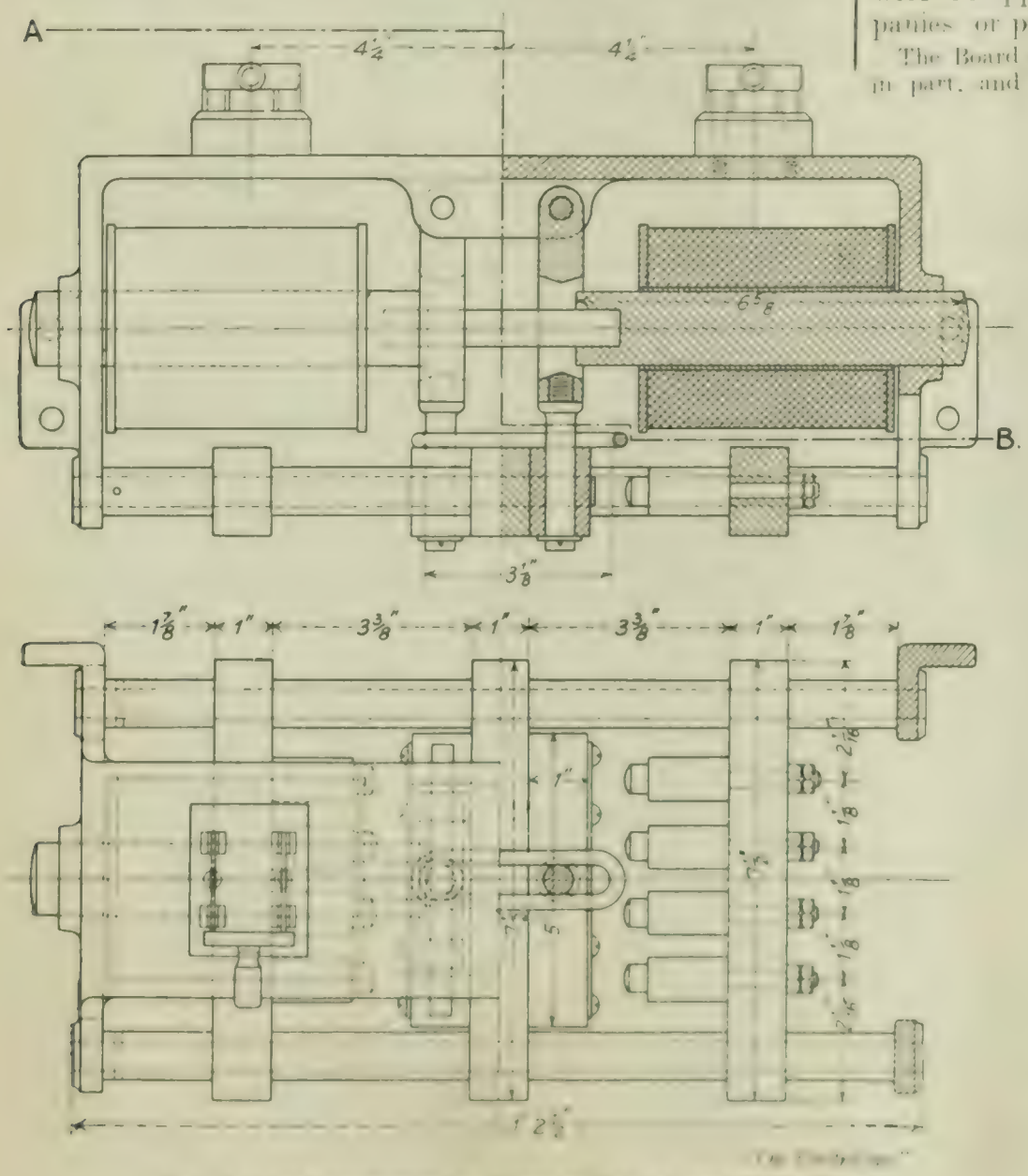


Fig. 3. Arrangement of Duplex Relay for D B Type Landing Control. Plan and Section on A B

the brass strips suffer from the shock involved in this arrangement so the lifts with the new control will be provided on the roof with metallic cups which will receive at the top landing the ends of chains hanging above them. These cups are offset from the car and carry chains in turn which engage with cups supported from the side of the pit at the lower landing. Experiments with this system have proved it to be thoroughly efficient for dealing with the small relay currents of about 1 ampere that are employed.

The landing doors not being transparent, a safety feature is used by which the controller switch puts directly into operation only the lift gate closing mechanism, and not until these gates are closed is the circuit completed for closing the landing doors. The operator can thus see that no one is caught by the closing gate. Also when a lift arrives at the landing, arrangements are made by which the operator who is on the "entrance" side will, by pushing home his "exit open" switch, cause not only the exit lift gates and landing doors to open, but also the entrance doors (on his own side), thus affording him a clear view of the passengers leaving the lift.

The semi-automatic control does not reduce the number of attendants, as two operators are still required for every two lifts, one at each landing, but the fact that the attendant need not leave his position at the controller board which is convenient for ticket inspection and collecting, eliminates much of the delay due to heavy traffic.

In all these installations depth indicators are fitted at both landings above the lift entrances. These consist of cubical lanterns moving vertically on guides through a distance of about 3 ft., in accordance with the motion of the lift.

PROVISIONAL ELECTRIC LIGHTING ORDERS.

The report by the Board of Trade respecting the applications to and the proceedings of the Board under the Electric Lighting Acts, 1882 to 1909, during the past year states that there were 31 applications, 20 by local authorities and 11 by companies or persons.

The Board of Trade granted 27 of the applications, either wholly or in part, and four were refused. Altrincham Electric Supply (Ltd.) applied for an Order to authorise the transfer of its electricity powers to a new company; the local authorities for the districts in the area of supply objected to the transfer, and from the information supplied to the Board by the promoters, it was observed that the effect of the transfer would have resulted in the watering of capital, so that the nominal capital would not have been represented by assets or expenditure. The Board of Trade refused to be a party to this, and decided not to grant the Order.

The application of Mr. G. Allom for Chipstead and district was granted for the whole of the area scheduled, except the portion of the Parish of Coulsdon, and the area of supply in the Order of the Urban Council of Connah's Quay was confined to the urban district. The Order applied for by East Grinstead Urban Council was opposed by some ratepayers, and after holding a local inquiry the Board decided to grant the Order. In regard to the application of the Ely Gas and Electricity Co. for Ely urban district, the promoters failed to produce evidence of the consent of the local authority, and there was also opposition by ratepayers and owners of property, and the Board decided not to grant an Order. Harrogate Corporation applied for an extension Order, but they decided not to proceed with the application in regard to the rural districts of Wetherby and Wharfedale. Knaresborough Rural Council gave their consent (except four parishes), and Pateley Bridge assented in respect of all the parishes within their district included in the application, and the Board issued an Order for the area to which the two Rural Councils had given their consent.

Keighley Corporation also applied for an extension Order, and they produced evidence of the consents of the Urban Councils of Oakworth and Oxenhope and the Rural Council of Keighley, and the Order was granted in respect of these districts with the exception of a part of the township of East West Morton in Keighley rural district, which the promoters withdrew from their application. The promoters decided not to proceed with their application for the supply of electricity in Haworth urban district, but they required authority to carry their mains through Haworth in order to supply Oxenhope. The Urban Council of Haworth refused their consent, but on consideration of the circumstances the Board of Trade dispensed with their consent and inserted in the Order a clause empowering the breaking up of certain specified streets in Haworth for the purpose of supplying electricity in the urban district of Oxenhope.

In regard to the application of Messrs. Christy Bros. & Co. for the Mid-Somerset Electric Lighting Order, the promoters failed to produce evidence of the consent of the Glastonbury and Wells Corporations and Wells Rural Council. After considering the representations made the Board decided not to proceed with the application as regarded those districts, but they granted the Order in respect of the urban district of Street and the parishes of Compton, Dundon and Somerton, in Langport rural district, the title of the Order being altered to the Street and District Electric Lighting Order.

The Reading Electric Supply Co. applied for an extension Order, and had obtained the consent of the Rural Council of Henley, but had failed to secure the consents of Henley upon Thames Corporation and Wokingham Rural Council. The promoters withdrew the Borough of Henley-upon-Thames from the application and requested the Board to dispense with the consent of Wokingham Rural Council. Reading Corporation,

who have special powers to purchase the existing electricity undertaking of the company, opposed, and the promoters subsequently agreed to a special clause under which the Corporation would have similar powers to purchase the undertaking within the proposed added area. As, however, the promoters failed to produce evidence that the local authorities for the districts within that area (the Rural Councils of Henley and Wokingham) consented to the Corporations' taking those special purchase powers, the Board decided not to proceed with the application.

With regard to the Tunbridge Wells (Extension) Order, the Corporation produced the consent of Southborough Urban Council, but the Rural Councils of Tonbridge, Sevenoaks and Ticehurst refused their consents. The promoters withdrew Sevenoaks rural district from the application, and the Board decided not to proceed with the application as regards the rural district of Ticehurst. Tonbridge Rural Council lodged objections to the application, but subsequently withdrew them, although they refused to give a formal consent. Under the circumstances the Board dispensed with the consent of Tonbridge Rural Council, and granted the Order in respect of the Urban District of Southborough, and the part of the Tonbridge rural district included in the application.

In regard to the application of the County of London Electric Supply Co. for Woodford and district, failure to produce evidence of the consents of the local authorities caused the Board not to grant the Order.

Since the date of the previous report the Board have approved deeds of transfers in 10 cases, and they have also given their consent (under sec. 2 of the Electric Lighting Act, 1909) to the construction of 10 generating stations. Nine orders were made for the supply of electricity in bulk and 25 undertakers also obtained authority under section of the 1909 Act to give a supply of electrical energy to certain specified premises outside their areas of supply.

PATENTS EXPIRING IN 1916.

The following is a list of patents of interest to electrical engineers which, unless extended by the Privy Council, will expire during 1916. This list does not include any patent granted in 1902 which has since for any reason become void :—

No.	Date. (1902).	Name of Patentee.	Subject of Patent.
362	Jan. 6	E. R. Johnson	Phonograph-telegraph Apparatus.
1,061	Jan. 14	F. G. Creed & W. A. Coulson	Telegraph Receiving Apparatus.
1,359	Jan. 17	F. R. Simms & R. Bosch.	Magneto - Electric Machines for Igniting in Explosion Engines.
2,736	Feb. 3	G. Honold	Magneto - Electric Machines for Igniting in Air.
4,754	Feb. 25	R. Lundell	Field Magnet Frames.
5,104	Feb. 4	Soc. G. et P. de Mestral...	Arc Lamps.
5,812	Mar. 8	J. H. Wooliscroft	Rheostats.
6,666	Mar. 18	J. H. St. H. Mawdsley....	Preventing Sparking Field Magnets.
6,884	Mar. 20	A. Graham	Telephone Apparatus Casings.
7,689	Apr. 1	J. B. Struble	Relays.
7,995	Apr. 5	G. Langbein & Co.	Metals, Depositing.
8,558	Apr. 12	Brit.Thomson-Houston Co	Switches.
9,488	Apr. 24	A. W. Beuttell.....	Incandescent Lamps, Supports.
9,803	Apr. 28	M. Wildermann	Obtaining Alkalies.
10,181	May 2	O. J. Lodge & A Muirhead	Wireless Apparatus.
10,204	May 3	J. Hargreaves, J. W. Stubbs & J. Kearsley	Electrodes.
10,245	May 3	G. Marconi & Marconi's Wireless Telegraph Co.	Wireless Receiver.
10,452	May 6	De Forest Wireless Telegraph Co.	Wireless Receiver.
10,652	May 9	E. A. Claremont & J. Stratton	Cables, Armouring.
11,085	May 14	Stothert & Pitt & E. Evans	Motors, Controlling.
12,554	June 2	Siemens Bros. & Co.....	Automatic Telephone Systems.
12,706	June 3	C. D. Ehret	Wireless Telegraph Apparatus.
12,796	June 4	C. F. Boehringer & Söhne	Cells and Receptacles.
13,287	June 11	Submarine Signal Co.....	Submarine Telephony.
13,521	June 14	Sir O. J. Lodge, A. Muirhead & E. E. Robinson	Wireless Telegraphy Apparatus.
14,126	June 21	W. A. Gorman & A. Graham	Telephones, Connecting.
14,133	June 21	H. Baker & Castner-Kellner Alkali Co.	Couplings, Electrodes.
14,135	June 21	H. Baker, A. T. Smith & Castner-Kellner Alkali Co.	Obtaining Alkalies and Chlorine.
14,136	June 21	W. A. Gorman & A. Graham	Couplings.
14,286	June 24	F. J. Sprague & E. R. Carichoff.	Switches.
14,373	June 25	Lancashire Dynamo & Motor Co. & R. S. McLeod	Distributing, Regulating Transformers.
14,386	Jan. 8	P. L. E. Lederlin.....	Obtaining Chlorates and Perchlorates.
14,430	June 25	F. H. Higgins.....	Telegraphic Printing Receiver.
14,774	July 2	Vickers, Sons & Maxim, A. D. Williamson & C. L. Simpter	Switches.
14,790	July 2	Johnson Lundell Electric Traction Co.	Armatures, Commutators.
14,857	July 3	L. Lohner & F. Porsche...	Dynamo, Regulating, & Motors, Controlling.
15,095	July 12	F. Conrad	Testing.
16,041	July 18	A. C. Revrolle	Resistances.
16,495	July 24	J. E. Bousfield.....	Working Metals by Electricity.
16,529	Dec. 14	M. I. Pupin	Resistances, Improving Conductors.
16,923	July 30	General Electric Co.	Incandescent Lamps.
17,406	Aug. 7	A. Blondel	Arc Lamps.
17,703	Aug. 12	R. A. Fessenden	Controlling Electromagnetic Radiating.
17,705	Aug. 12	R. A. Fessenden	Wireless Signalling.
17,706	Aug. 12	R. A. Fessenden	Wireless Signalling.
18,328	Aug. 20	Brit.Thomson-Houston Co	Switches.
18,747	Aug. 26	Strowger Automatic Telephone Exchange	Telephone Systems.
18,786	Aug. 26	H. Bremer	Arc Lamps.
18,817	Aug. 27	Brit.Thomson-Houston Co	Switches, Motor Controlling.
18,821	Aug. 27	Brit.Thomson-Houston Co	Switches, Motor Controlling.
18,872	Aug. 28	H. W. Cox	Switches, Motor Controlling.
19,272	Sept. 2	A. W. W. Miller.....	Incandescent Lamps.
19,562	Sept. 6	General Electric Co.	Switches.
20,084	Sept. 13	Electrochemische Werke Ges.	Obtaining Calcium.
20,755	Sept. 23	Sprague Electric Co.....	Motors, Controlling.
21,799	Oct. 7	E. R. Johnson & W. N. Dennison	Phonographs, &c.
21,914	Oct. 8	General Electric Co.	Dynamos, Regulating.
22,712	Oct. 18	V. A. Fynn.....	A.C. Motors, Controlling.
23,262	Oct. 24	A. Blondel	Arc Lamps, Electrodes.
23,288	Oct. 24	G. Winter & F. Eichberg	Transformers.
23,642	Oct. 29	W. Trantom.....	Purifying Electrolytes.
23,756	Oct. 30	F. W. Howarth	Electric Furnaces.
24,770	Mar. 25	G. H. Hill.....	Motors, Controlling.
25,023	Nov. 14	G. A. E. Kohler.....	Switches.
25,027	Nov. 14	G. A. E. Kohler.....	Motors, Controlling.
25,524	Feb. 28	Soc. G. et P. de Mestral...	Arc Lamps.
25,658	Nov. 21	Marconi's Wireless Telegraph Co. & C. S. Franklin	Wireless Apparatus.
26,395	Nov. 29	A. Artom	Wireless Apparatus.
26,552	Dec. 2	R. A. Fessenden	Wireless Apparatus.
26,553	Dec. 2	R. A. Fessenden	Wireless Apparatus.
26,868	Dec. 5	A. Wright.....	Quantity Meters.
27,769	Dec. 16	General Electric Co.....	Cutouts, Switches.
28,167	Oct. 10	A. G. Brown	Cutouts, Switches.

BOOKS RECEIVED.

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"Wireless Telegraphy," by Dr. J. Zenneck. Translated from the German by A. E. Seelig, E.E. (London : Hill Publishing Co.) Pp. xx. +443. 17s. net.

"Life Jottings of an Old Edinburgh Citizen." By Sir J. H. A. Macdonald, P.C., K.C.B. (London : T. N. Foulis.) Pp. 502. 10s. 6d.

"Mechanical World" Pocket Diary and Year Book for 1916. (Manchester : Emmott & Co.) Pp. 428. 6d. net.

"Year Book of the American Institute of Electrical Engineers," 1915. (New York : American Inst. of Electrical Engineers.) Pp. 393.

"La Elettrificazione delle Ferrovie." By Aldo Righi. (Bologna : Nicola Zanichelli.) Pp. vi.+112.

"A Course of Modern Analysis," by E. T. Whittaker D.Sc., F.R.S., and G. N. Watson, M.A. (Cambridge : University Press.) Pp. 560. 2nd edition. 18s. net.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Displayed Advertisements not for proof before first insertion can be taken until NOON ON WEDNESDAY, and Official Announcements, Auctions and "Smalls" of all kinds of which no proofs are required before insertion can be accepted up to FIRST POST THURSDAY MORNING.

SOME ELECTRICAL EVENTS OF 1915.

In reviewing the course of events during the last year we are, of course, faced with entirely abnormal conditions. These had set in during the last six months of 1914 when the British Empire was faced with the greatest crisis in all its history, and it was necessary to take drastic steps in order to meet the needs of the moment. Since then, however, the nation has settled down to an existence under the conditions of war, and although many people thought a year ago that the conflict could not continue for long, owing to commercial and financial reasons, there is no such marked feeling at the present time.

Due to the fact that all warfare depends very largely upon the efforts of engineering, the manufacturing resources of this country have been increasingly taxed during the past year and there has consequently been a certain kind of prosperity ; but in many ways this prosperity is delusive. When war broke out there was much talk about capturing German trade, and our manufacturers were expected to take steps with a view to attaining this laudable object. As time goes on, however, it is becoming increasingly necessary for the manufacturing resources of the country to be put to the manufacture of munitions of war, and, consequently, it is impossible for any considerable export trade to be maintained. This state of affairs has led to a serious decrease in exports just at a time when the export trade is of importance in order to maintain British credit and to balance the large imports of war material.

At the present moment there are conflicting calls for engineers to join the Colours and to engage in munitions work. Obviously, there must be a need for engineers in the engineer units of the Forces, but apart from this it is a wrong policy to induce engineers at the present time to join the Colours if they are not going to be engaged in engineering

work in so doing. In Mr. LLOYD GEORGE'S recent speech in the House of Commons on this subject he stated that he required a large number of skilled and unskilled mechanics for the manufacture of munitions, and it need scarcely be said that the supply of munitions is quite as important as, or even more important than, the supply of men in the fighting line. This surely has been one of the lessons which the German method of fighting should have taught us by now. But so far there has been a great lack of discrimination in allowing those men to join the Colours who would have been more useful in other directions. This remark applies also to technical students. Our supply of third-year students should be maintained if possible, owing to the fact that their services will be required later on in the commercial developments that will follow the war. By this we do not mean that every effort should not be made to bring the war to a successful and speedy conclusion. It may yet happen that every able-bodied man will have to join the Colours, or else be engaged in Government work. But that time has not yet come, and meanwhile it is a mistake to shut down the technical colleges, stopping their normal functions and converting them into munition factories, for which purpose we think they must be somewhat inefficient.

Among the national problems with which we have been confronted during the past year, trade unionism has loomed large, and by no means always for the national good. Even at the present time the deadly nature of the struggle in which we are engaged does not seem to be realised by the bulk of trade unionists, and rather than that this country should put forth the maximum effort in the manufacture of munitions, it would seem that many trade unionists would prefer to imperil our existence by maintaining the old traditions, preventing the use of unskilled labour and restricting the output. We trust that this appalling lack of appreciation of the seriousness of the position will not continue, or it may be that the enormous expenditure of valuable lives will prove of small avail.

Among the trade problems that have been somewhat acute during the past year has been the supply of dyes in this country, due to the fact that in the past we have been chiefly dependent upon Germany for these materials. After much delay, a company with the title of British Dyes, Limited, was formed for the manufacture of dyes in this country on a large scale. The initial scheme met with considerable criticism, and this was not altogether eliminated in the final scheme, owing to the lack of technical and scientific representation upon the Board. To some extent this has been remedied by the appointment of a technical committee under the chairmanship of Dr. M. O. FORSTER, F.R.S., and a research department under Dr. G. T. MORGAN. Further, they appointed a technical committee of a number of well-known chemists, under the chairmanship of the late Prof. R. MELDOLA, F.R.S. The weakest point from the financial point of view is the fact that the Company has no guarantee against Continental competition at the close of the war. The Government has been unwilling to guarantee any protection of this kind, although a large grant has been made for the purpose of research.

The question of technical research generally is also one which has exercised the minds of many during the past year, with the result that a joint deputation from the Royal Society and the Chemical Society attended on the President of the Board of Education on May 6th. The deputation was favourably received, and later it was announced that a sum of £25,000 would be placed at the disposal of the Board of Education for the purpose of research. A scheme has been drawn up by the Board, according to which the matter was placed in the hands of a Committee of the Privy Council with a small advisory committee, consisting mainly of scientific men and others engaged in industries dependent upon scientific research. Recently the various universities, colleges and learned societies have been asked to send in applications for grants in aid of researches, and we understand that many applications have been so made.

Akin to research is the utilisation of invention in the waging of war. Something is now being done in this direction. An Inventions Board was formed by the Admiralty in July, with Lord FISHER as chairman, and in August an Inventions Branch was formed by the Ministry of Munitions. Nevertheless, we doubt if as much is being done as might be done in this direction, largely because very few people know what is really required.

Although we now hear much less about the capturing of German trade we are glad to note that there is a greater tendency to consider organisation with a view to the expansion of British trade after the war, and the meeting of German competition. The British Electrical and Allied Manufacturers' Association has taken the matter seriously in hand. Arrangements are being made to obtain commercial information from abroad with a view to fostering our trade, such information being placed in the hands of British manufacturing firms. The issuing of catalogues in foreign languages, the meeting of local needs, and many other matters of that kind have been under consideration. The whole question has also been further discussed by the Engineers' Club of Manchester, and it has been suggested by the Committee of this Club that a large association should be formed which would deal with all questions relating to British trade, industry and education on the broadest possible basis. The Board of Trade has taken steps to exhibit from time to time articles of enemy manufacture which it is desirable to make in this country. The Board also initiated a British Industries Fair, which was held in London in May, and there seems to be a good prospect that this will now become an annual event. Individual efforts have been made by Mr. G. H. ANTOINE and by Mr. R. STEYLAERS to organise our resources so that we may be able to take advantage of the trade that must inevitably arise when the Germans are driven out of Belgium.

In electricity supply there is not very much to record in the way of advance, owing to the special conditions under which work has been carried on. In Parliament, for example, contentious Bills have been dropped, and thus no progress has been made in any power scheme for unifying electricity supply in the London area. In passing, it may be said that the London County Council District Electricity Bill was severely criticised by a committee of the London local authorities, particularly on the question of capital charges. There has been some linking up of power supply stations in the case of Hackney, Poplar, Shoreditch, Stepney, Battersea, Fulham, Hammersmith, Woolwich and the South Metropolitan Company, and throughout the country the main feature has been the great increase in the use of electrical energy for power purposes. Similarly, the Bill of the Incorporated Municipal Electrical Association in regard to municipal wiring and hiring out of plant has been dropped for the time being, although there is no question that some such measure is badly required. It would be a great advantage if the Incorporated Municipal Electrical Association and the Electrical Contractors' Association were able to promote a non-contentious Bill upon the subject. The Power Bill of the Yorkshire Electric Power Co., which would have been a boon to many districts, failed to obtain

the approval of a Select Committee of the House of Lords, not so much through the opposition of certain local authorities as through the antiquated attitude of the Board of Trade.

Apart from legislation the most important factor in electricity supply has been the shortage of coal. In May a joint conference was called of the electricity supply authorities and the gas undertakings, at which it was decided to represent to the Government the seriousness of the position. In due course this was done, and a deputation waited on the Coal Exports' Control Committee. There was an insistent demand for control, but export was not prohibited until August, and prices were not regulated until even later. The good of any such steps, however, have been largely counteracted by the tardiness with which they were taken. At the present moment the position cannot by any means be considered satisfactory.

During the present year the Institution of Electrical Engineers has, like many other societies, maintained its programme of technical meetings. Mr. C. P. SPARKS has succeeded Sir JOHN SNELL in the presidency, and although not much publicity has been given to the work of the Council recently, we believe that there has been considerable activity in connection with Government questions.

At a time like the present it is only natural that there should be very few new developments to record : in fact, the new Ediswan lamp seems to be the only outstanding feature of the kind in this country, but in the United States the work of LANGMUIR and of YENSEN has been remarkable. On the other hand, we have been able to record from time to time considerable progress in such matters as electric winding, and the electric propulsion of ships.

In the electrical industry we have to mourn the loss of Prof. GRYLLS ADAMS, Mr. ROBERT HAMMOND, Mr. THOMAS PARKER, and Mr. C. E. P. SPAGNOLETTI, all well-known pioneers. Also Sir J. C. LAMB, at one time secretary to the Post Office, Mr. H. A. MAVOR, and Dr. F. S. PEARSON. In chemistry there are the names of Prof. R. MELDOLA and Sir HENRY ROSCOE, while in physics there is Sir ARTHUR RÜCKER. On the Continent, the most prominent of those who have passed away is Dr. E. RATHENAU.

TENTATIVE STANDARDS OF TRANSMISSION.*

Recommended by the Independent Telephone Association of America.

In January of 1915, Mr. H. D. Currier read a Paper on the subject of "Operating Responsibility," before the Independent Telephone Association of America.

At the several meetings of this committee which have been held, the manufacturers and colleges where telephone engineering is taught have beeen invited to attend and participate in the work of the committee.

The subject considered has been "Telephonic Transmission as Applied to Central Office and Subscriber Station Equipment." The results of this work are set out below. The recommendations made are tentative. It is intended that they be tried out for a period of one year. If, during this time, any changes are found to be necessary, they will be made. As soon as practicable after the expiration of one year, a permanent set of standards will be adopted to serve until such time as the development of the art may require that they be changed.

Much in the way of betterment of service, improvement in transmission and economy of investment and operation will be realised if the standards are rigidly adhered to in practice as recommended by the Standardisation Committee.

TENTATIVE STANDARDS OF TELEPHONIC TRANSMISSION.

DIVISION "A." GENERAL.

1. *Scope.* The following recommendations constitute a set of tentative standards of telephonic transmission and are to be in force for a period of one year following Jan. 1, 1916, unless modified before the expiration of that time. As soon as practicable after the expiration of one year, a permanent set of standards, based upon the tentative standards, will be adopted.

2. *Object.*—This set of recommendations has for its object the provision of a set of standards by means of which the relative transmission efficiency of telephone apparatus may be determined accurately, thus enabling the operating man to select more intelligently his apparatus and thus to maintain a high quality of telephone service.

3. *Standard.*—In the interest of uniformity throughout the United States and until an official standard for the measurement of telephonic speech transmission (hereafter referred to as transmission) may have been established by the Government, all measurements shall be made taking as the basis of comparison, the transmission obtained between two subscriber sets, connected together through repeating coils and a variable length of standard artificial cable as shown in the circuit described in Fig. 1. The subscriber sets, repeating coils and other elements of the circuit should form a part of a large number of pieces of such apparatus specially selected for equality.

The transmission obtained with this circuit and that obtained with any other circuit with which comparisons are to be made, are made equal by adding to the circuit having the superior transmission, and, between the repeating coils or their equivalent, an appropriate mileage of standard artificial cable having a resistance of 88 ohms per loop mile and a capacity of 0·06 mfd. per mile. The difference in transmission in the two cases may, therefore, be expressed in terms of the loss in a given number of miles of standard cable. If the cable has to be added to the circuit adopted as a basis for comparison, the transmission in the circuit under test is said to be inferior by..... miles of standard cable. If it has to be added to the circuit under test the transmission of the latter is said to be superior by.....miles of standard cable.

It is, of course, obvious that, in selecting as a basis of comparison a circuit already in use by the American Telephone & Telegraph Co. and by the British Post Office Department, there is involved no question of comparative efficiency of the terminal apparatus, repeating coils, and other elements forming part of the circuit. In fact, independent apparatus in order to be approved by this Association, must give equal or greater transmission efficiency than that represented in the circuit adopted as the basis of comparison.

To avoid all possible question of dispute relative to transmission measurements, it is respectfully urged that the Bureau of Standards establish tentative standards by the aid of carefully selected instruments and apparatus in sufficient number to guarantee the constancy and permanency of such basis of reference, and it is further recommended that the efforts of the Bureau of Standards be directed to constructing, procuring and maintaining a transmission standard meeting all possible requirements of the art for universal use throughout the United States, and to provide facilities for the certification of transmission standards for all parties interested.

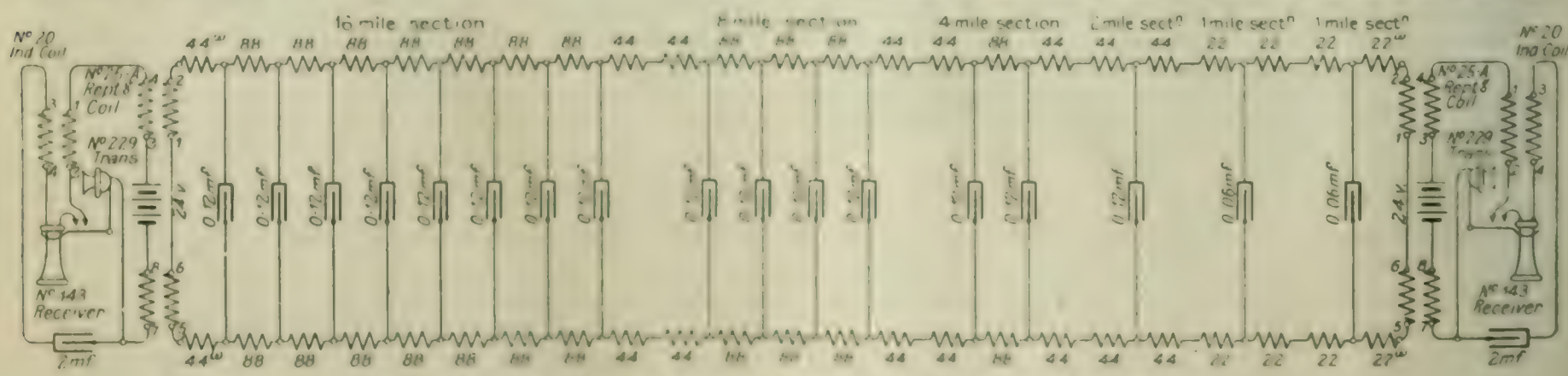


FIG. 1.—32 MILE STANDARD ARTIFICIAL CABLE—No 19 B & S. 0·06 mf. per mile.

(Connection and arrangement of Test Circuit. The arrangement [illegible] the [illegible] transmission conditions [illegible])

* Mr. Currier advocated the appointment of a Standardisation Committee, and, as a result, action was taken at the convention, authorising the appointment of such a committee. This committee was subsequently appointed and organised.

* From the "Telephone Engineer."

4. *Limit of Satisfactory Commercial Transmission.*—The limit of satisfactory commercial transmission has been fixed as the transmission obtained between terminal apparatus as specified in sec. 3, with 32 miles of standard artificial cable in the circuit. No connection should give transmission inferior to this.

5. *Transmission Equivalent of a Portion of a Circuit.*—The transmission loss in any part of a circuit is somewhat dependent upon the conditions in the remainder of the circuit, but, for purposes of specification the loss in each portion may be given separately. The standards recommended for central office equipment and subscribers' station equipment are for portions of circuits, but, ordinarily, the losses for the entire circuit may be taken as the aggregate of the losses of the parts, within a sufficiently close degree of accuracy. All recommendations deal with losses in non-loaded circuits only.

6. *Sources of Transmission Losses.*—Transmission losses occur from a decrease in the supply of current to the transmitter of the subscribers' set (hereafter called " battery supply loss ") and from an actual decrease in the high-frequency current propagated over the line or through the apparatus (hereafter called " high-frequency loss ").

7. *Use of Standard Artificial Cable.*—When the standard artificial cable circuit is to be used in making comparison tests, it is recommended that the entire circuit under test be made up of the component parts actually employed wherever this is possible. On account of the instability of the telephone transmitter as a means of varying the energy in the circuit, a sufficient number of changes from the circuit used for reference (Fig. 1) to the one under test should be made to eliminate error due to momentary changes in the transmitter. As far as possible the current supplied to the transmitter should not be interrupted or changed during the test. Both transmitting and receiving tests should be made and, when a difference exists, the direction giving the poorer transmission should be taken in stating the difference.

Division " B." Standards for Central Battery Switchboards.

8. *Current Supply of Zero Loop Resistance.*—The central office battery supply circuit shall supply not less than the following current values on local connections with subscribers' loops of zero loop resistance :—

Nominal Battery voltage.	Minimum Battery voltage.	Current supply With minimum voltage.
22 volts	20 volts	0·160 ampere
40 volts	36 volts	0·110 ampere
48 volts	43 volts	0·100 ampere
48 volts*	46 volts	0·095 ampere

If it is desired to obtain the current supply on zero loop for any battery voltage other than those given, the value may be obtained by assuming a minimum battery voltage of 1·8 volts per cell and a minimum current supply of 0·050 amperes at a loop resistance of 350 ohms (4 miles of standard cable). From these data the current supply on zero loop can be calculated.

[Note.—On account of the variation in resistance of subscribers' sets, the subscribers' set is omitted from these figures. In order to make a measurement to determine whether these values have been met, a connection should be set up as in a regular call and a measurement made with a milliammeter across the cable terminals of the line on the cable side of the main distributing frame.]

9. *High-frequency Loss in Local Connection.*—The total high-frequency loss in the central office between two local subscribers connected to that office shall not exceed 1·5 miles of standard cable. This shall include all losses from the terminal of one line on the cable side of the main distributing frame, through the heat coils, jumper and switchboard wiring, answering jack and one connecting cord circuit through the multiple jack (or answering jack if non-multiple), switchboard and jumper wiring and heat coils to the terminal of the second line on the cable side of the main distributing frame, the local lines having zero loop resistance.

10. *High-frequency Loss in Trunked Connection.*—The total high-frequency loss in the central office equipment on a local or inter-office trunk connection shall not exceed 1·5 miles of standard cable. This shall include all losses from the outgoing trunk multiple jack through the trunk circuit to the plug or jack in the position where the trunk terminates, the trunk loop having zero resistance.

Division " C." Standards for Local Battery Switchboards.

11. *High-frequency Loss in Local Battery Switchboards.*—The high-frequency losses in local battery switchboard equipment for connections between local subscribers' lines and for inter-office and local trunk circuits shall not exceed the allowable maximum for the same kind of connection or circuit in central battery offices as prescribed in secs. 9 and 10.

Division " D." Standards for Long-distance Switchboard Equipment.

12. *High-frequency Loss in Long-distance Connections.*—The total high-frequency loss in the long-distance switchboard equipment between two non-loaded open wire long-distance lines shall not exceed 1 mile of standard cable. This shall include all losses from the line terminal of one line on the main distributing frame through jumper and switchboard wiring, long-distance answering jack and one pair of long-distance connecting cords without repeating coil, through the long-distance multiple jack (or answering jack if non-multiple), switchboard and jumper wiring to the line terminal of the second line on the main distributing frame, the long-distance loops having zero resistance. If a repeating coil is used, it shall conform to the requirements of sec. 30.

* With voltage regulation.

13. *Current Supply in Long-distance to Local Connections with Zero Loop Resistance.*—The central office battery supply circuit on a circuit for connecting long-distance lines to local subscribers' lines shall supply not less than 0·225 amperes with the minimum battery voltage prescribed in sec. 8, to the local line on zero loop. This shall apply to all battery voltages and the test for same shall be made as provided in the " Note " under sec. 8.

[Note.—The use of battery of 40 volts or over for the battery supply to the local transmitter on long-distance connections is recommended and the use of 22 or 24 volt battery is not approved except in cases where there are no local lines having a greater resistance than 300 ohms.]

14. *High-frequency Loss in Long-distance to Local Connections.*—The total high-frequency loss in the central office equipment in a connection between a non-loaded open wire long-distance line and a local subscribers' line shall not exceed 2 miles of standard cable. This shall include all losses from the line terminal of the long-distance line on the main distributing frame, through the switchboard and jumper wiring, long-distance answering jack, long distance to local connecting cord circuit and long-distance switching trunk, through subscribers' multiple, switchboard and jumper wiring and heat coils to the terminal of the subscribers' line on the cable side of the main distributing frame, all loops having zero resistance. This does not include the losses in phantom coils where used.

15. *High-frequency Loss in Long-distance Switching Trunks.*—The total high-frequency loss in the central office equipment on a long-distance switching trunk circuit shall not exceed 1 mile of standard cable. This shall include all losses from the out-going trunk multiple jack on the long-distance switchboard through the trunk circuit to the plug or jack on the position where the trunk terminates, the trunk loop having zero resistance.

[Note.—This loss may be exceeded somewhat if the total loss in the connection from long-distance line to local subscribers' line is kept within the limits prescribed in sec. 14.]

16. *High-frequency Loss Due to Bridged Operators' Set.*—The high-requency loss in the long-distance connection due to the effect of bridging the operators' set for monitoring a long-distance connection or long distance to local connection shall not exceed 1 mile of standard cable.

Division " E." Losses in Subscribers' Station Equipment.

17. *Transmission Efficiency of Central Battery Subscribers' Station Equipment.*—The transmission efficiency of central battery subscribers' station equipment shall be such that no loss is introduced when two sets of the type under test are substituted for the two sets of the test circuit with 4 miles of standard cable in each subscribers' loop. Both transmitting and receiving tests shall be made. The receiving efficiency shall not be less than the sets used in the test circuit.

18. *Transmission Efficiency of Local Battery Subscribers' Station Equipment.*—The transmission efficiency of local battery subscribers' station equipment shall be such that no loss is introduced when two sets of the type under test are substituted for the two sets used in the test circuit with no battery flowing through the re eivers of the local battery sets. The local battery sets shall be equipped with the number of new dry cells specified by the maker of the set. Both transmitting and receiving tests shall be made.

Division " F." Standards for Private Branch Exchanges.

19. *Transmission Standards for Private Branch Exchanges.*—On account of the diversity of practice and the variety of local conditions to be met, it is difficult to draw specifications that will cover all cases in private branch exchange service. The recommendations in the following sections should be followed whenever all of the local stations connected to the private branch exchange switchboard are located near the switchboard or in the same building. Where the stations are located at some distance from the switchboard, it is recommended that the requirements for current supply and high-frequency losses for central offices as given in secs. 8 to 10 inclusive and secs. 13 and 14 be followed.

20. *Current Supply to Private Branch Exchange Local Lines for Local Trunk Connections.*—The current supply to the local lines of a private branch exchange for local trunk connections, where the loop resistance of the private branch exchange trunk does not exceed 300 ohms, should not be less than the current supplied to a regular subscribers' line of the same loop resistance as the private branch exchange trunk plus 25 ohms. For private branch exchanges having trunk lines with a greater resistance than 300 ohms, the current supplied to the local line should not be less than 0·040 ampere.

[Note.—In order to determine whether this requirement has been met a connection should be set up as in a regular trunked connection to the private branch exchange and a measurement made by placing a milliammeter directly across the terminal of the local line at the line side of the private branch exchange main distributing frame or cable terminal at the end of the private branch exchange switchboard cable. The receiver of the local terminal station should be left on the hook. If the current is supplied over a charging lead without the use of a battery at the private branch exchange, one-half of the total possible number of connections on the private branch exchange switchboard should be set up with the receivers of the local terminal stations on these connections off the hook.]

21. *Current Supply to Private Branch Exchange Local Lines for Long-distance Connections.*—The current supply to the local lines of a private branch exchange for long-distance connections where the loop resistance

of the private branch exchange trunk does not exceed 300 ohms should not be less than the current supplied to a regular subscriber's line for a long-distance connection, the subscriber's line having the same loop resistance as the private branch exchange trunk plus 25 ohms. For private branch exchanges having trunk lines with a greater loop resistance than 300 ohms the current supplied to the local line should not be less than 0·075 amperes. The measurement to determine if this requirement is met shall be made as specified in the " Note " under sec. 20.

22. *High-frequency Loss in Trunked Connections.*—The high-frequency loss in the private branch exchange switchboard on a trunked local or long-distance connection shall not exceed 1·5 miles of standard cable. This shall include all losses from the terminal of the trunk on the main distributing frame or cable terminal at the end of the private branch exchange switchboard cable through the protector if used, switchboard cabling, and wiring, trunk terminal on switchboard, connecting cord or trunk circuit, local line terminal, switchboard wiring and cabling, protector, if used, to the terminal of the local line on the main distributing frame or cable terminal at the end of private branch exchange switchboard cable.

23. *High-frequency Loss in Connection between Local Terminal Stations.* The high-frequency loss in a connection between two local terminal stations of a private branch exchange shall not exceed the amount specified for central office switchboards as given in sec. 9 of these standards.

DIVISION "G." AUXILIARY APPARATUS.

24. *Nature of Recommendations.*—The following recommendations cover certain points as to quality, arrangement and transmission losses of parts or auxiliary apparatus which have a more or less direct effect upon transmission efficiency. When losses are specified, they may be departed from somewhat if the part is a portion of a circuit and the circuit as a whole is covered by and conforms to the recommendations made in the preceding secs. 8 to 18 inclusive.

25. *Heat Coils.*—The resistance of a single heat coil should not exceed 7 ohms and the inductance should be negligible. Wire-wound coils should be wound non-inductively. In long-distance lines the heat coils should be so placed that they are between the line and the signalling apparatus, but not in the line to the answering jack on the long-distance switchboard.

26. *Switchboard Cords.*—Switchboard cords for use in long-distance connections shall not exceed a resistance of 1 ohm per conductor for a new 72 in. cord, and shall not introduce a transmission loss greater than 0·1 mile of standard cable per pair of cords. Switchboard cords for use in local connections shall not exceed a resistance of 10 ohms per conductor for a new 72 in. cord, and shall not introduce a transmission loss greater than 0·25 miles of standard cable per pair of cords.

[NOTE.—In general, switchboard cords having no other conducting material than steel do not meet the requirements for long-distance connections and should not be so used.]

27. *Switchboard Cable.*—The conductor size in switchboard cable should not be less than No. 22 Brown and Sharp gauge, and should have double silk and single cotton insulation. The use of No. 19 Brown & Sharp gauge, double silk and single cotton insulated conductor is recommended for all wiring in long-distance line talking circuits.

28. *Condensers.*—Condensers used in talking circuits or bridged across talking circuits shall have a capacity not less than the rated capacity of the condenser, which shall be measured with alternating current by bridge method. The insulation resistance shall be not less than 500 megohms and the condenser shall be tested for breakdown with 500 volts direct current. The rated capacity shall be marked on the case of the condenser.

29. *Bridged and Legged Impedances.*—The high-frequency loss in any impedance bridged across a line or legged from one side of a line to battery or ground shall not exceed 0·5 mile of standard cable.

30. *Repeating Coils.*—The high-frequency loss in a repeating coil shall not exceed 0·5 mile of standard cable. This shall apply to coils used in phantom as well as in other circuits.

31. *Transmitter Protection.*—As a protection for transmitters against excessive current when the operator is ringing on the line, it is recommended that a 15-watt tungsten lamp or similar protective device be cut in series with the generator supply leads in each position of the switchboard.

CORRESPONDENCE.

DEVELOPMENT IN RADIOTELEGRAPHY AND TELEPHONY DURING 1915.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: In the field of long-distance commercial telegraphy from high-power stations consistent progress is noted. The remarkable success of the American type of 150 kw. Poulsen Arc Station of the Navy at Darien has demonstrated beyond question the genuine practicability and good efficiency of this type of transmitter. The new Sayville installation, employing a moderately high-frequency 150 k.w. alternator with two successive steps of frequency doublers by means of asymmetric transformers, has now been in constant operation over a sufficient period fully to justify the faith of the German engineers who designed and erected the plant. The commercial success of this and the corresponding station at Nauen, together with that of the Tuckerton and Eilvese stations, should silence the last sceptic as to the ability of wireless to compete successfully with the cable in transatlantic service. Practically all commercial telegraph service between the United States and Germany is now exclusively handled *via* radio.

The success of the stations above mentioned surely demonstrates the electrical equality as well as the structural superiority of the umbrella and the triangular flat-top types of antenna over the expensive and far-stretching horizontal, so-called " directive " transmitter antenna.

I doubt if a solitary radio engineer now argues the relative merits of the continuous-wave transmitter and the spark type, whether quenched or rotary. The signal failure of the two gigantic spark-type radio stations, constructed ostensibly for trans-oceanic telegraph, has silenced their most persevering champion. The year has seen the adoption for long-distance telegraphy of the ultraudion type of receiver-detector, to the complete exclusion of all others. The commercial service above outlined would be a practical impossibility without this development of the audion. Our U.S. Navy has progressed far in its definite plan to displace other types of detectors in all its stations. For this decision the fast increasing use of continuous-wave transmitters is, of course, partly responsible.

Foremost of spectacular radio feats of the past year stands the recent long-distance telephone transmission from the Arlington Naval Station to Mare Island and Honolulu. Notwithstanding the attempt to veil the methods here used in corporate mystery, the radio profession now will recognise that this phenomenal work was done by means of a gigantic oscillating audion amplifier system at the transmitter, and with the audion detector and amplifier at the several receiving stations. A small microphone controlled the amplitudes of oscillation of a single audion amplifier. The amplified oscillations from this first circuit were impressed upon the grid circuits of a larger bulb. The output currents from the wing or plate circuit of this lamp led to the grid circuit of a bank of 12 to 20 large bulbs, connected in parallel, and the greatly magnified, high-frequency voice-modulated currents from the plate circuit of this bank led in turn to the final bank of from 300 to 550 bulbs. These latter drew their direct current supply from a 600-volt continuous-current generator, and delivered the final oscillating energy into the lofty Arlington antenna. In this way some 50 amperes of radio-frequency current were perfectly modulated by the small master-microphone. Under ideal meteorological conditions this radiated energy was sufficient to be picked up and amplified by audion detector-amplifiers over 4,000 miles distant—at night.

The readiness with which this audion radio telephone transmitter can be associated with a wire telephone system is obvious, and suggests great possibilities. As a commercial undertaking, however, the enormous upkeep expense of a high-power transmitter of this type, the prohibitive cost of bulb renewals, renders the method at present a colossal scientific experiment, chiefly of advertising value.

Nevertheless, the year of 1915 has demonstrated beyond all question immense future possibilities in the field of radio-telephony.—I am, &c., LEE DE FOREST.

[Practically all commercial telegraph service between the United States and Germany is now, for obvious reasons, exclusively handled *via* radio.—EDS. *E.*]

EARTH RESISTANCE.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: In view of certain statements concerning the resistance of earth connections made by Prof. E. W. Marchant in THE ELECTRICIAN of Sept. 17th, and subsequent comments thereon, it seems advisable to give the general formula for the resistance of an earth connection in terms of the resistivity of

the soil, and the position and dimensions of the metallic body forming the connection. This formula is the familiar one for flow of current in an infinite conductor, and is either derived or given in nearly all text-books on electricity and magnetism. For the purpose of this discussion, however, the formula may be derived as follows: Let (1) and (2) be two metallic bodies embedded at a distance from each other in an infinitely extended semi-conducting medium like the earth. Let it be supposed that body (1) is continuously maintained at a potential $+V_1$, and body (2) at a potential $-V_2$. The difference of potential between (1) and (2) will be $V=V_1+V_2$, and a current I will flow from (1) to (2) through the medium which offers a resistance R to the flow of current. Accompanying the difference of potential V between (1) and (2) there will be an electric intensity E at all points in the medium, which will correspond to a charge of static electricity $+Q$ on body (1), and $-Q$ on (2). Suppose a closed surface S of any form to be drawn about (1), but not including (2).

Let dS be an element of area of this surface,
n the direction normal to the surface,
E_n the normal component of the electric intensity at any point on the surface,
I_n the normal component of the current density at any point on the surface,
K the dielectric constant of the medium, and
ρ the resistivity of the medium.

By Gauss's theorem $\int\int E_n dS=\frac{4\pi}{K}Q$. Also $-\frac{\delta V}{\delta n}=E_n$.

By Ohm's law $-\frac{\delta V}{\delta n}dn=i_n dS\cdot\rho\frac{dn}{dS}=E_n dn$, or $\rho i_n dS=E_n dS$.

Integrating, $\rho\int\int i_n dS=\int\int E_n dS \quad \therefore \rho I=\frac{4\pi}{K}Q. \quad . \quad . \quad . \quad (A)$

Now $Q=C_1 . V_1$, where C_1 is the electrostatic capacity of the condenser formed by bodies (1) and (2), and by Ohm's law $I=V/R$.

Substituting for I and Q in equation (A), therefore,

$$\rho=\frac{4\pi}{K}C_1R=4\pi CR,$$

where C is the electrostatic capacity between (1) and (2) in a medium of dielectric constant equal to unity, supposing the relative positions of the bodies to be the same.

Hence, the resistance $R=\rho/4\pi C$.

It is obvious that this formula applies to either two bodies or one, that is, either to a case where current flows from one body to another, or to a case where current flows from a single body towards infinity, depending upon whether the electrostatic capacity C is calculated for the condenser formed by two oppositely charged bodies or for a single body in free space. To clear up this last statement it is only necessary to consider that (2) is a shell enclosing (1), and infinitely large. In this case V_2 becomes equal to zero, $V_1=V$, and the electrostatic capacity C becomes that of (1) in free space; consequently, R is made to refer to (1) only, and the current I is supposed to flow away from (1) towards infinity.

The formula just derived can be used to find the resistance offered to a flow of current either away from a single electrode buried in the earth or from one electrode to another in the earth, the electrodes being of any shape or disposition whatever, if the value of C and the resistivity of the earth are known. In order to do this for a single electrode it is necessary to represent the electrical field about an electrode buried in the earth by means of a similar electrode embedded near a dividing plane in the infinitely extended medium, with a second electrode of the same kind also embedded in the medium in such a way that the second electrode forms the image of the first in the plane. The electric fields corresponding to the two electrodes will then be symmetrical with respect to the dividing plane, and one-half of the medium can be imagined to be removed without disturbing the field in the other half. The remaining half of the medium will then represent the earth, and the electric field about an electrode buried in it for the reason that for practical purposes it may be assumed that the earth is a semi-infinitely extended conducting medium. With one-half of the medium removed the formula becomes $R=\rho/2\pi C$, since the resistance to flow of current is then twice as great, R referring to the resistance to flow of current away from the single electrode, while C refers to the combined electrostatic capacity in free space of the electrode and its image.

In the case where current flows from one electrode to another it is necessary to represent the electric field surrounding the two electrodes buried in the earth by means of a pair of similar electrodes embedded near a dividing plane in the infinitely extended medium with a second pair of electrodes of the same kind also embedded in the medium, in such a way that the second pair of electrodes forms the image of the first pair in the plane. The electric fields corresponding to the two pairs of electrodes will then be symmetrical with respect to the dividing plane, and one-half of the medium can be imagined to be removed as described in the preceding paragraph. In this case R, of the formula $R=\rho/2\pi C$, refers to the resistance offered to flow of current from one electrode to the other, and the electrostatic capacity C refers to the capacity in free space of the condenser, formed by one electrode and its image on the one hand, and the other electrode and its image on the other hand.

From the method of deriving the foregoing formula, it is evident that it is immaterial whether body (1) is a single piece of metal or several separate pieces as long as the surface S encloses all of them. The resistance to flow of current away from several electrodes in parallel, or from one set of electrodes to another can, therefore, also be found from the formula $R=\rho/2\pi C$, R referring to the resistance to flow of current, and C to the electrostatic capacity in the same manner as in the two preceding paragraphs, except that in calculating C and R all of the electrodes enclosed by the surface S must be treated as a single electrode.

Prof. Marchant's example of flow of current from one hemispherical electrode embedded in the ground with its plane surface flush with the surface of the ground to a similar hemispherical electrode at a great distance away from it may now be considered. In this case C refers to the condenser formed by the two spheres, of which the hemispheres just mentioned are a part, since the combination of each hemisphere and its image in the surface of the ground forms a sphere. The capacity of the condenser formed by the spheres becomes equal to one-half the capacity of one of them in free space, as they are moved away from each other to a great distance. In this case, therefore, $C=a/2$, where a is the radius of each of the spheres. Substituting in the formula, $R=\rho/2\pi\cdot\frac{1}{2}a=\rho/\pi a$. If current is supposed to flow away from one of the hemispheres towards infinity, $C=a$, and $R=\rho/2\pi a$, that is, R in this case is one-half that for current flow from one hemisphere to another.

The value of C is, therefore, a criterion of the effectiveness of an earth connection. For if two metallic bodies are buried in the same kind of soil, the one for which C is the greatest will have the least resistance. C can be calculated for a few simple cases. For a driven pipe it can be roughly approximated by using the formula for the electrostatic capacity in free space of an ellipsoid of revolution, of which the length of the major axis is great in comparison with that of its minor axis. This formula is $C=L/\{2\log_e(2L/d)\}$, where L is the length of the major axis and d of the minor axis. In calculating C, L is taken as twice the length of the driven pipe, and d as its external diameter, since C applies to the electrode and its image in the surface of the ground as pointed out heretofore.

In the discussion given by Prof. Marchant it is stated that a, calculated from $R=\rho/2\pi a=(\rho/2\pi a^2)a$, is a criterion of the effectiveness of an earth connection of hemispherical form. In this case a is the radius of the hemisphere, and $2\pi a^2$ is the area of the spherical surface in contact with the soil. This, of course, is true, because for a hemispherical electrode $C=a$. It is further stated, however, that if for an electrode of any form the surface A in contact with the soil is substituted for $2\pi a^2$, a value a may be calculated which can still be regarded as a criterion of the effectiveness of an earth connection. This

amounts to saying that $C=AR/\rho$, which is true only for the special case of the hemisphere.

Length of pipe in feet.	L in centimetres.	C in electrostatic units.	a.	R.
1	61·0	7·92	5·00	149·3
2	122·0	13·45	5·90	87·8
3	183·0	18·52	6·44	63·8
4	244·0	23·35	6·82	50·6
5	304·0	28·00	7·09	42·3
6	366·0	32·40	7·37	36·5
7	427·0	36·85	7·56	32·1
8	488·0	41·20	7·72	28·7
9	549·0	45·40	7·87	26·0
10	610·0	49·60	8·00	23·8

$\rho=7{,}400$ ohms per cm.^{2}.

To show the magnitude of the error which may arise from taking a, calculated from $R=(\rho/\Lambda)a$, as a criterion of the effectiveness of an earth connection of a form other than a hemisphere, the above table is given. In this table a is calculated from measured values of resistance to flow of current away from ¾ in. pipes driven in the ground to depths varying in steps of 1 ft. from 1 ft. to 10 ft., which have been corrected for non-homogeneity of the soil by using $R=\rho/2\pi C$ as an observation equation. The external diameter of the pipe was 2·6 cm. (1·02 in.), and the average resistivity of the soil, obtained by substituting measured values of R, and calculated values of C, for the different lengths of pipe in $R=\rho/2\pi C$, was found to be about 7,400 ohms per cubic centimetre. The values of C were calculated from the formula $C=L/\{2\log_e(2L/d)\}$, as indicated above. To facilitate comparison, C and a are given in parallel columns. It is seen that the values of C, and also of R, indicate that a pipe driven 10 ft. in soil of uniform resistivity is about six times as effective as one driven 1 ft., whereas the values of a indicate that a pipe driven 10 ft. is only 1·6 times as effective as one driven 1 ft. The magnitude of the error here is practically the same as shown by some of Prof. Marchant's own measurements, in which he finds a to be 0·51 and 0·63, while the actual measured resistances are 6·1 and 42 ohms respectively.—I am, &c.,

O. S. Peters.

United States Bureau of Standards,
Washington, Dec. 8.

THE STANDARDISATION OF LOADED TELEPHONE LINES.*

BY DR. F. BREISIG.

Since one of the objects of loading telephone lines is to enable speech to be transmitted over great distances, the problem arises of connecting such lines in different countries. These lines may be designed without any intention of connecting them ultimately in series with others, but it will be well to consider what steps should be taken in order that such connection may be afterwards made with the best results. Of the three principal constants of the line, the attenuation, the characteristic and the distortion, the former need not be considered; it will naturally be reduced as much as possible in every case. If the characteristics of two sections of a line are equal, there is no loss by reflection at the junction. If loaded, each section—*i.e.*, the line between two junctions—should consist of a number of similar units, each made up of a coil and equal lengths of line on either side of it. In other words, each section of the line should be divided exactly into a whole number of parts, and a loading coil inserted at the middle of each part. This may lead to slightly different spacing in different sections, but the difference in the characteristics thereby produced will cause much less loss by reflection than the want of symmetry near the junction which may occur if the spacing in each section be made the same.

Although the best value for the characteristic depends on the constants of the line and loading coils, it is rarely that one finds values lower than 1,000 or higher than 2,000 ohms; any improvement gained by going outside these limits would probably be lost by reflection on joining the line in series with another. The value usually lies between 1,400 and 1,800 both for overhead lines and cables, and it would be advisable to keep within these limits for any lines which may ultimately be connected through those of other countries.

With respect to the number of loading coils per mile, Hayes states that American practice is to make the wave-front pass through 7,000 coils per second, while, according to Hill, English practice is to make (C in mfds. per mile)×(the distance between the coils in miles) ×(the inductance of each coil in millihenries) not greater than 25. In Germany the natural frequency of a coil, together with its half section of line on either side, is made at least equal to $16{,}000/2\pi$. All these rules may be expressed in the same way; their result is that if the German rule gives 100 coils in a given line, the English gives 79 and the American 87·5. The distortion—that is, the difference between the attenuation constants for different frequencies, depends very largely on two factors which are frequently overlooked, viz., the variation of the leakance and of the effective resistance of the coils as the frequency is varied. The leakance is approximately proportional to the frequency, and the effective resistance of the coils per kilometre of the line may be expressed as follows:—

$$\rho=\rho_0(1+a\omega-b\omega^2),$$

where ρ_0 is the resistance to continuous currents and $\omega=2\pi f$; a and b are constants depending on the hysteresis and eddy-current losses.

Actual tests gave the values in the accompanying table:—

Type of line.	λ.	ρ_0.	$a\times10^3$.	$b\times10^7$.
3 mm. cable	0·0895	0·765	0·328	0·0184
2 mm. cable	0·1424	2·35	0·174	0·0110
4·5 mm. overhead	0·020	0·220	0·165	0·0298

λ is the inductance of the coils per kilometre of line. The distortion may be conveniently expressed as follows:—

$$\Delta=1{,}000\frac{d\beta/\beta}{d\omega};$$

that is, it is the ratio of the relative change in the attenuation constant β to the change of frequency, multiplied by $1{,}000/2\pi$ to give a convenient figure. It will depend on the frequency, and it is preferable to fix upper and lower limits of frequency and find the average value of Δ over this range; thus

$$\Delta_m=\frac{1}{\omega_3-\omega_1}\int_{\omega_1}^{\omega_3}\Delta d\omega=\frac{1{,}000}{\omega_3-\omega_1}\log\frac{\beta_3}{\beta_1}.$$

Suitable values for ω_1 and ω_3 are 3,000 and 7,000 respectively, and then

$$\Delta_m=\frac{1}{4}\log_e\frac{\beta_3}{\beta_1}.$$

For an unloaded cable with a light conductor we can use the approximate formula

$$\beta=\sqrt{(\tfrac{1}{2}CR\omega)},$$

which gives $\Delta_m=\frac{1}{4}\log_e\sqrt{\frac{7}{3}}=0{\cdot}106.$

For a loaded cable we have

$$\beta=\tfrac{1}{2}[R-\rho(1+a\omega+b\omega^2)]\sqrt{\{C(L+\lambda)\}}+\tfrac{1}{2}\delta\omega\sqrt{C(L+\lambda)}.$$

The first term R in the square brackets is the resistance of the line itself, while the second is that of the coils, each reckoned per kilometre, while δ is the approximately constant value of the ratio

$$G:\omega C$$

where G is the leakance per kilometre.

From the formula

$$\Delta=\frac{1{,}000}{\omega_3-\omega_1}\cdot\frac{\beta_3-\beta_1}{\beta_2}$$

where β_2 is the attenuation for $\omega_2=5{,}000$, we get

$$\Delta=\frac{1{,}000\delta+a\rho\sqrt{C(L+\lambda)}-10^7b\rho\sqrt{C(L+\lambda)}}{2\beta_2}.$$

This is the distortion over the range $\omega_1=3{,}000$, $\omega_3=7{,}000$. On applying this to the three cases tabulated above we get 0·078, 0·063 and 0·023 respectively, whereas the ordinary rules for loaded cables would lead one to expect a distortion of only about 0·005. Experiments with speech confirm these results. It is probable that the spacing of loading coils should be considered for each case, taking into account the constants of the line and of the coils, instead of applying a single rule to all cases; but the data at present available needs to be considerably increased before the problem can be definitely solved.

* Abstract of article in the "Elektrotechnische Zeitschrift," Vol. XXXVI., p. 297. Originally intended for the International Telegraph Congress at Berne.

CONSTRUCTION, MAINTENANCE AND COST OF OVERHEAD CONTACT SYSTEMS.*

BY F. ZOGBAUM.

Summary.—This Paper gives a general review of the problems involved in the maintenance and the cost of an overhead contact system of the catenary type, carrying high-voltage propulsion currents. The subject treated is the catenary construction on the New York, Westchester & Boston Railway, which is purely an electrical line, having no steam whatever.

One of the most important matters pertaining to the maintenance of an overhead catenary system is the inspection of the contact wires and the transmission system, in order that possible failures may be forestalled, so that defects may be discovered and failures prevented. During such an inspection it is important always to note the condition of the contact wire with reference to its position to the track, and at all times to keep the wire as near the centre of the track as possible.

Although on some other roads it has been found advisable to stagger the contact wire in order to get the maximum wear on pantagraph shoes, it will be seen from figures that are presented here that it has not been found necessary in the case of this system to stagger the contact wire to the advantage of pantagraph shoe wear. In noting the position of the contact wire with reference to the track it is essential always to allow for the swaying movement of the locomotive or car carrying the pantagraph. This is especially important on curves, as trains running at high speed on curves of any sharpness over 1 degree will naturally swing the pantagraph towards the outside of the curve, making it necessary to have the contact wire outside the centre line of the track, whereas on tangents the wire is kept as nearly as possible directly over the centre of the track.

The line of the New York, Westchester & Boston Railway, the catenary system of which is treated herein, consists of 54·26 miles of contact wire and 181·29 miles of transmission lines, which include signal feeders and control line, or 109·17 miles of transmission lines for traction power only. The 54·26 miles of contact wire is suspended over 30 per cent. curve track and 70 per cent. tangent track, so that practically the only adjustment necessary is on 30 per cent. of the road, as the tangent contact wire remains in relatively the same position throughout the year, while the curve contact wire needs slight adjustments from time to time. Included in the catenary system are six sectionalising or anchor bridges and 77 high-tension oil circuit breakers, which are used for sectionalising the high-tension power. Also, it is considered on this line that the signal transmission lines are included in the electrical distribution or catenary system.

Inspections are made by means of a work train consisting of one gasoline electric locomotive and work car. The gasoline locomotive contains the working platform from which repairs are done to the contact system. Erected on the work car is a pantagraph collector, identical with those used on the regular coaches and locomotives. Also on the work car is an electric search light, which is used in inspection as well as when making repairs. During the day-time, approximately once each month, the contact system is given a general inspection from the head end of multiple-unit trains, and the pantagraph collector is watched during the entire run over the road, and any defects or any wire off centre are noted.

In 1913 there were 27,927 car-miles operated per one pantagraph failure, in 1914 there were 55,503 car-miles operated per one pantagraph failure, and for the three months ending March, 1915, there were 64,799 car-miles operated per one pantagraph failure. The usual cause for broken pantagraphs is due to wire off centre, low joints on running rails on curves, overhead frog on deflector out of adjustment and loose sleeves on contact wire.

All told, on the 54·26 miles of road, there are the following number of insulators: On the 11,000-volt lines there are 2,557 pin insulators, 1,949 safety strain insulators, 164 wood strain insulators, 2,004 catenary suspension insulators and 87 dead-end strain insulators; on the 2,200 volt signal lines there are 1,368 pin insulators and 971 safety strain insulators, making a total of 9,100 insulators.

Out of the total number of 2,339 insulators carrying the signal transmission lines there have been no insulator failures after approximately three years' operation, and out of the 6,761 insulators carrying the 11,000 volt lines there have been the following failures: One insulator failure on contact lines in 1913; seven insulator failures, six of which were on contact lines and one on the transmission line, in 1914; and one insulator failure on the transmission lines in 1915.

The actual wear on the contact wire from the rubbing effect of the shoe has amounted to about $\frac{1}{8}$ in. flat surface on the under side of the grooved steel contact wire. This wear has been uniform over the entire line and there seems to be no indication of more wear on the low wire than on the high wire, and the wear on curves, also, is about the same, so that at the rate of wear as noted at the present time, it should be not necessary to renew the steel trolley wire for six or seven years, at least, from the initial installation.

In 1913 there were 37, and in 1914 19 pantagraph failures. The mileage obtained by pantagraph shoes decreases in the winter months and increases in the summer months. This is due to the fact that it is necessary to raise the tension on the upward motion of the pantagraph in the cold weather, on account of the slight raising in the contact wire, caused by contraction.

The author gives details of the rules and regulations for employees in the electrical and other departments.

The accompanying table shows the costs of maintenance of the overhead contact system, and for a matter of comparison the figures are shown for October, 1912, shortly after the system was put into operation, and an average for the last six months ending December, 1914. Included in the cost per unit is the cost of miscellaneous electric line expenses, which includes sectionalising bridges, sectionalising equipment, time of men while on emergency duty, work train, and, in fact, all charges which cannot be placed actually against feeders and contact.

For a matter of comparison, the cost of electrical maintenance is given per car-mile for July, 1914, and December, 1914, as follows:—

Total maintenance per car-mile, July, 1914 ..... $0·0156
Total Maintenance per car-mile, December, 1914 ..... $0·0142

The above figures include supervision, transmission and contact system, miscellaneous electric line expenses, work train, &c.

It will be seen in reviewing the above paragraphs that the various difficulties, none of which was serious, and the costs involved in overcoming the same, have decreased as time progresses, and we would, therefore, assume that the inverted peak of the triangle has not as yet been reached.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Maintenance Electrical Costs.

Description.	Oct., 1912.	July, 1914.	Aug., 1914.	Sept., 1914.	Oct., 1914.	Nov., 1914.	Dec., 1914.	Total for six months.	Average per month for six months.
Feeders	$19·31	$58·51	$257·95	$98·06	$94·82	$8·67	$29·40	$547·41	$91·23
Contact	955·25	163·19	144·45	176·81	162·14	204·95	245·27	1,096·81	182·80
Miscellaneous elec. expr.	291·81	790·15	706·92	753·77	837·27	985·48	777·46	4,851·05	808·50
Supervision	240·00	384·87	399·24	394·17	372·66	360·79	263·49	2,175·22	362·53
Totals	$1,506·37	1,396·72	1,508·56	1,422·81	1,466·89	1,559·89	1,315·62	8,670·49	1,445·06

VARIABLE-SPEED PUMPING PLANT FOR A DRAINAGE DISTRICT.*

The pumping plant for the South Quincy Drainage and Levee district, Illinois, is designed to pump the drainage and seepage waters of a drainage district of approximately 6,000 acres, to which an additional 4,000 acres of hill drainage have to be added. This water is handled by two electrically-driven double-suction centrifugal pumps with 36 in. discharge openings. They have a capacity of 60,000 gallons per minute, and are operated by two 200 H.P. motors. The layout of the plant is shown in Fig. 1. The current is supplied from an 11,000-volts line, which is transformed to 440 volt.

This plant has to pump all water falling in the district, as no sluiceway is provided. The topography of the county is such that many lakes can be drained by an additional 2 ft. of lift, and since

* From "Engineering News," slightly abbreviated.

these would add about 1,000 acres of agricultural land it was considered best to do this. One of the special features of the pumping plant is the chain-drive arrangement. In order to get the greatest efficiency the manufacturer recommended that the pumps be driven at 219 and 244 revs. per min. for different stages of water. To bolt may be loosened, so as to allow of the sprocket being slid along the shaft. The split hub has a lock nut with a key running the full length of the shaft, and is secured permanently in place.

To change the chain from one pinion to another a thin plate is employed, which is inserted under the chain after the centre distance

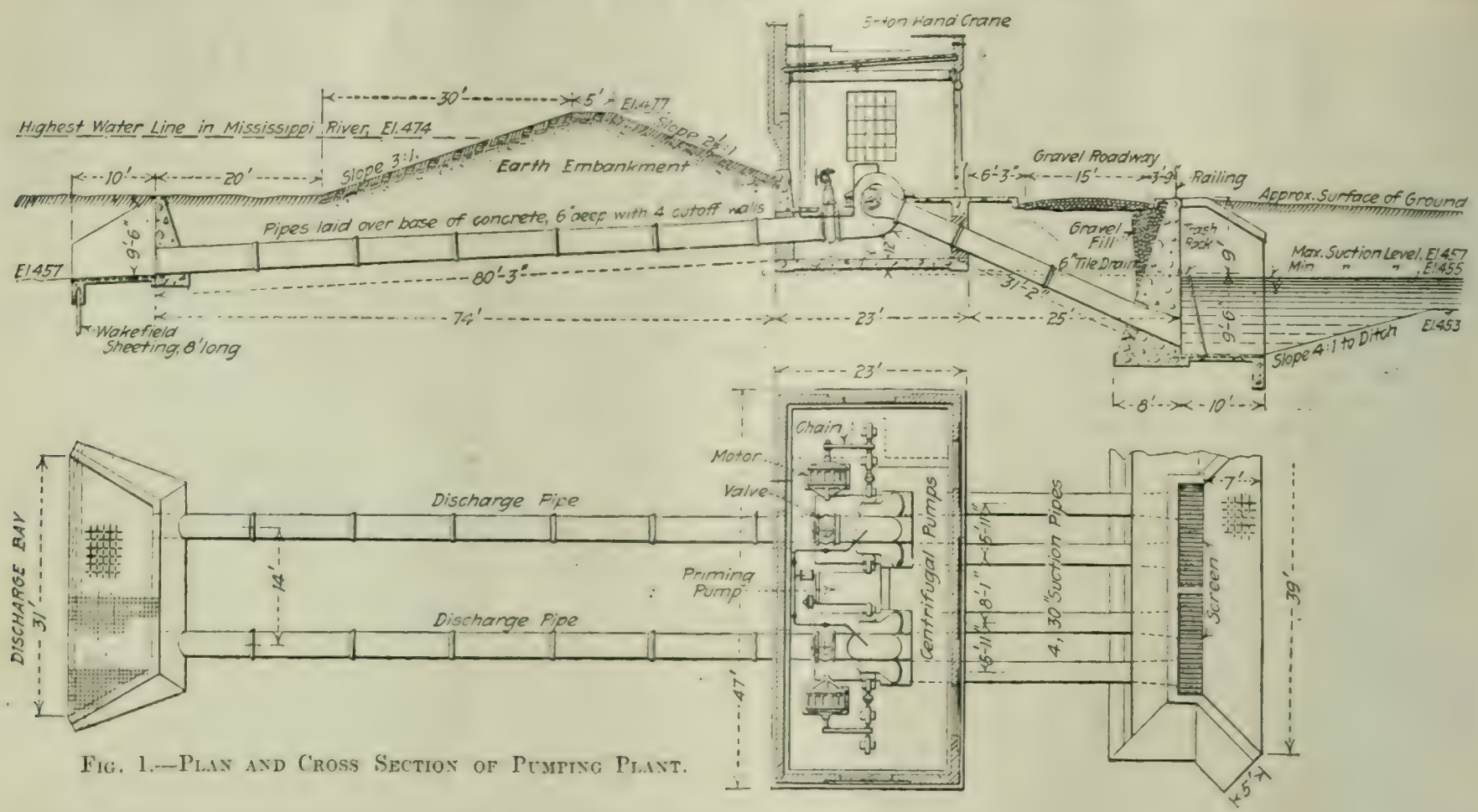


Fig. 1.—Plan and Cross Section of Pumping Plant.

accomplish this change of speed sprocket wheels of two different sizes are fitted to the motor shaft.

In some other plants of this kind the sprockets are slipped on and off the shaft as required. In this case, however, the two sprockets (with 30 and 27 teeth) are mounted permanently on the motor shaft,

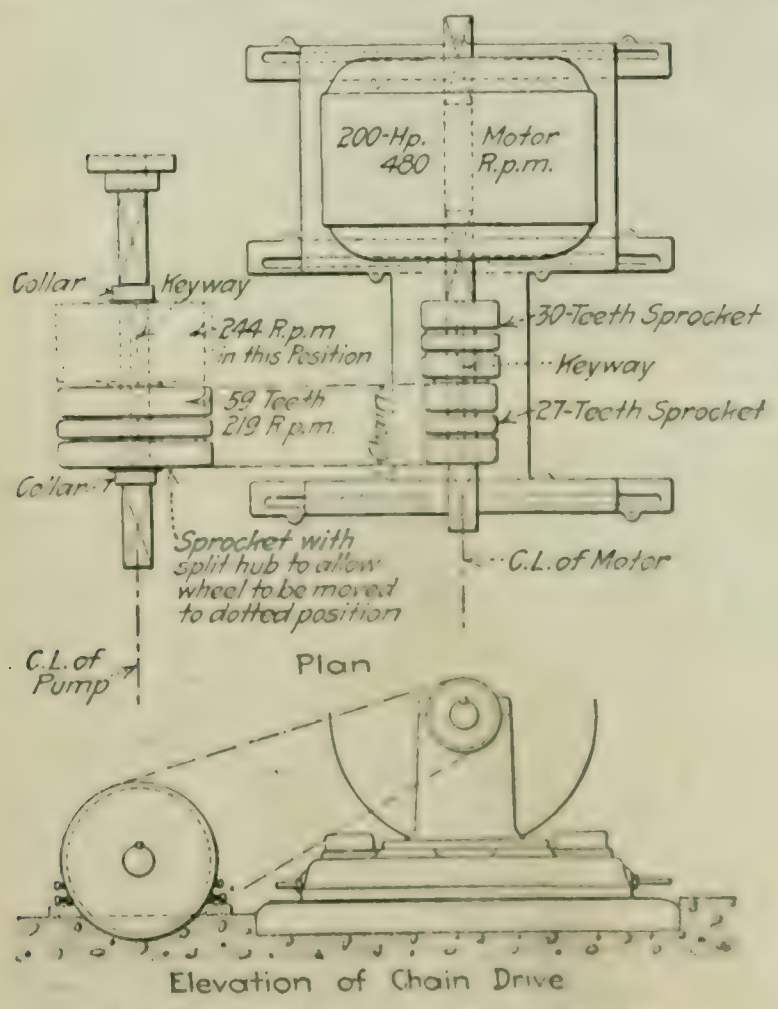


Fig. 2.—Variable Speed Chain Drive.

The two pinions are fixed permanently to the driving shaft, and the chain is moved from one to the other as required. The larger sprocket slides on the driven shaft

while the 59 tooth sprocket on the pump shaft is arranged to slide longitudinally, so that it can carry the chain for either one of the driving sprockets. This arrangement is shown in detail in the drawings in Fig. 2. The larger (driven) sprocket has a split hub. When shifting the chain from one driver sprocket to the other the is shortened. Then it is easy to push the chain from one sprocket to another. To facilitate the work of shifting the chain, a pulley is fastened to the wall and has two clamps fitting over the chain. The two clamps are fastened close to the small pinion and its upper side. As soon as the chain is pulled out so that its lugs are clear of the sprocket it is shifted to which ever side is desired.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

4,345 Soc. Marius Latour et Compagnie. Transformation of frequency of high-frequency alternating currents for wireless telegraphy and telephony. (20/2/13.)

19,045 Bruce & United Telegraph & Cable Co. Telegraphy.

23,171 Curtis, Short & Igranic Electric Co. Control of electric motors.
A control system for operating two electric motors at equal speeds wherein the field windings of the motors are connected in a common series circuit and in series with a controlling resistance, and the motor armatures are connected in parallel with a circuit comprising the field windings and any selected portion of the series controlling resistance.

23,641 Ballington & Shaw. Signalling and train-stopping apparatus. (Addition to 15,632/14.)

23,726 Bendixen & Mountain. Electric fire alarm apparatus.

23,749 Watson, Waters & Callender's Cable & Construction Co. Protective arrangements for electrical systems.

1915 Specifications.

112 B[illegible]n. (Siemens-Schuckertwerke Ges.) Galvanic batteries.

939 Imray. (Siemens & Halske Akt.-Ges.) Circuit arrangements for telephone systems.

1,612 Goby. Electric spark quenching apparatus.

1,684 Charlebois. Electromagnetic and vacuum lifters.

2,164 Marks. (Delany Foreign Co.) Telegraphic apparatus.

3,417 Siemens. Electric signalling systems.

3,433 Tesche. Rectifying switch. (Addition to 11,116/14.)

5,334 British Westinghouse Electric & Mfg. Co. Electric motor meters. (15/4/14.)
Relates to electric motor meters of the induction type, and particularly to motor meters for use in connection with alternating current circuits to give compensation for the [illegible] parallel with the load circuit, and a multipolar armature rotatably mounted in the field [illegible] a permanent magnet damping field and shaft armature for damping the rotation of the armature and for retaining the magnetic lines of force in the magnetic circuit.

7,271 Fahrney. Electric meters for the purpose of compensating for temperature variations.

8,303 McRae & Rowell. Insulating division plate or partition for a controller arc deflecting current breaker and the like.

8,376 Thomas. Safety devices for use with electrically-driven vehicles. (24/10/14.)

9,110 Dunham. Controlling electric transformers.

15,148 Soc. Générale des Compteurs et Appareils Electriques. Device for the protection of electrical [illegible] apparatus against excessive voltage. (26/10/14.)
Comprises at least one electrically controlled switch as well as an auxiliary resistance interposed in the [illegible] a protective electromagnetic device in series with the controlling [illegible] at the instantaneous rise of the latter cannot yet [illegible] as to avoid a short circuit, and is characterised by the fact that the resistance is adapted to be short-circuited by means of contacts controlled by the electromagnetic device in such a manner that they will come together as soon as the [illegible] at the condenser is almost formed, for the purpose of obviating the necessity of breaking a circuit through which [illegible] passes.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	471	Dust Truck with Tipping Body. Illustrated	3*
Imports and Exports of Electrical Manufactures	472	Brewers and Electric Trucks. Illustrated	4*
LEGAL INTELLIGENCE	472	"Cedes" Vehicle for Boots (Ltd.). Illustrated	4*
PARLIAMENTARY INTELLIGENCE	473	Ward Van Makes 733·7 Miles on 1,564 Ampere Hours. Illustrated	4*
Educational Notes	473	The Electric Taxicab. Illus.	5*
Business Notices	473	Electric Vehicles in Sweden. Illustrated	6*
Bankruptcies, Liquidations, &c.	474	Electric Vehicles in Use in Great Britain	6*
Electricity Supply	474		
Lighting and Power Notes	475		
Traction Notes	475		
Telegraph and Telephone Notes	475		
Empire Notes	475		
The Round Table	87	Foreign Notes	477
Complete Ferranti Catalogue. Illustrated	88	Miscellaneous Notes	478
Mather and Platt Progress	90	Tenders Invited	479
Whittle Belting. Illustrated	92	Tenders Received & Accepted	479
Electric Vehicle Progress Supplement—No. 23.		Companies' Meetings and Reports	480
The Electric Vehicle in Great Britain. Illustrated	1*	New Companies, &c.	480
		City Notes	481
		Electrical Companies' Share List	481

COMMERCIAL TOPICS.

Electricity Supply and Smoke Abatement.

A Local Government Board inquiry was recently held at Bradford into an application by the Corporation for a provisional order to extend the operation of the smoke abatement clause of the Corporation Acts (1910 and 1913), which expire at the end of this year. It was stated on behalf of the Corporation that for many years the atmosphere had been grossly polluted by smoke. A great deal of consideration had been given by the Health Committee to the subject of prevention of the atmospheric pollution and they considered it a matter of the utmost importance in regard to the general health of the population. The smoky atmosphere had contributed directly to the higher mortality from respiratory diseases, and it had a most deleterious effect on domestic hygiene. There were about 400 mill chimneys in the district and in some cases the chimneys served several boilers. It was estimated that 755 boilers (of 500,000 H.P.) were connected to those chimneys. The general powers under the Public Health Acts were ineffective against the smoke nuisance, as the small fines had no deterring effect on the owners. Their local acts of 1910 and 1913 gave them increased authority as to service of notices, inspection of boilers, &c., and they had a marked effect in lessening the smoke. The grit nuisance only arose with forced draught and automatic stokers. As a means for the practical prevention of smoke the increased use of automatic stokers and induced draught was advocated. The local mills when working consumed about 4,800 to 5,000 tons of coal a day and the other industries from 1,200 to 1,500 tons, while the amount used for domestic purposes probably did not exceed 1,400 tons a day. In Bradford the use of electricity and gas for domestic purposes was increasing yearly and it was anticipated that that, with the increased use of improved firegrates, would in time materially reduce any complaint from that cause. The Corporation had intended to promote a Bill in the 1915-16 Session for (inter alia) their powers in regard to smoke and grit nuisance to be continued indefinitely. We do not need to commend the objects of smoke abatement to the Bradford city electrical engineer, Mr. T. Roles, because the frequent extensions to his undertaking both in plant and mains point to a growth of the power and heating load in the district which will, if it continues, ensure the total abatement of the smoke nuisance in Bradford. The figures given above, however, indicate the task which lies before the electricity department in transferring the steam power load to the supply mains. No reference is made in the report to domestic heating, but we know that the sale and hiring out of electric fires is proceeding briskly in the area; indeed we believe that Bradford is regarded by the electric fire makers as quite a happy hunting ground. The present position of electricity supply in Bradford points to a considerable reduction in future of the smoke evil.

* * * *

British Industries Fair.

The announcement which the Board of Trade makes that it has completed its arrangements for the holding of a second British Industries' Fair will be read with considerable interest. The first Fair was held in May, 1915, at the Agricultural Hall, but the venue of the second will be the Victoria and Albert Museum, South Kensington, London, and the opening date is Feb. 21, 1916. The items of electrical interest should centre chiefly round the toy and electrical novelties business, a class of electrical manufacture and trade which had been allowed to drift into the hands of German firms. The fact that the German manufacturers have been so painstaking in this matter is proof conclusive that there exists a considerable demand for all kinds of electrical novelties, and that this demand can be met with lines which can be produced to yield good profits. The methods of cheapening production by the use of expensive punching and pressing tools are characteristic of German manufacturers, but they are the secret of their successes in this important industrial province. They were not afraid to lay down expensive plant, because they knew they could produce in vast quantities for a world market. Such action is in every way commendable, as displaying business acumen, but there is no monopoly of it held by any one of the nations. The lesson to be learned from an exhibition of this kind is the opportunity which it affords for starting to retrieve ground lost to Germans in the electrical novelty and toy trade. A danger exists of keen competition from America, for the catalogues of several of the electrical novelty firms in the United States are object lessons with which to illustrate the truth of the law of supply and demand. But even among the din of munition production we hear of genuine attempts being made to establish the British electrical novelty and toy trade upon an essentially indigenous basis.

* * * *

British Electrical Enterprise in Russia.

We are pleased to note that a group of well-known British manufacturing firms are combining to develop their business relations with Russia. As will be seen in another column of the present issue a new company, entitled the Electrical Manufacturers Co. of Great Britain (Ltd.), has been registered, with a nominal capital of £12,000 in £1 shares, to carry on business in Russia or elsewhere. This company is being promoted by Messrs. Bruce Peebles & Co., Crompton & Co., the Lancashire Dynamo & Motor Co., Allen West & Co., Brook, Hirst & Co., Eckstein, Heap & Co., and Whipp & Bourne. The first directors are Messrs. J. H. Bunting, E. R. Reeves, H. C. Siddeley, W. J. Moggridge, J. A. Hirst, A. Eckstein and S. Whipp, and these are the respective nominees of the promoting firms. We believe that there is a great future for the electrical industry in the vast and comparatively undeveloped country of our great Ally, but it is only by combination and by sound organisation that the best results can be achieved. The resources of the firms mentioned should be equal to the task of capturing much of the trade which has hitherto been in German hands. At all events, we wish them success with their project, which is being launched at an opportune time.

* * * *

Commercial Battery Vehicle Progress.

During the past year the number of commercial electric vehicles in use or on order in this country has been increased fourfold. The war may be said in some measure to be responsible for this marked development, but it cannot claim full credit for the achievement. An opportunity has been given to users of motor transport to test the modern commercial battery vehicle under everyday service conditions. This initial trial may be said to have been denied the vehicle to any great extent up to the period preceding the outbreak of war. The commandeering of horses and petrol motor vehicles threw the merits of the commercial battery vehicle, which had previously existed principally on paper, into bolder relief, and battery vehicle makers may have occasion to welcome the changes thus brought about by the war. The chief credit for the increase in the number of commercial vehicles may, however, be claimed by the manufacturers and salesmen of these machines. The Electric Vehicle Committee has done excellent work of an organising character, but it does not

necessarily function in the operating field. The spadework must of necessity be done by the manufacturers, their agents and representatives, and we feel sure that they will look back on the past year with feelings of considerable gratification. We have always argued that once the commercial electric battery vehicle was given a fair trial under service conditions it would substantially prove the claims which its advocates have for several years so persistently and so enthusiastically put forward. The modern machine with a modern battery is unquestionably a vast improvement upon its predecessors. The commercial battery vehicle is now being offered to motor transport users, many of whom have had a bitter experience of petrol and steam, and of their unsuitability to make good in a particular field of transport, that field which may best be described by the expression "short-haul frequent-stop" service, as essentially the province of the battery-propelled vehicle; and in proportion as the latter is employed for this purpose, so will automobile engineers generally come nearer to a recognition of its claims, and also of the limitations of petrol and steam as economical means of transport to the field of high speed and frequent stop service, for which they are exclusively suitable.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 20, 1915, *to* Dec. 22, 1915.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] *France:* Elec. [illegible] 12; [illegible]
[illegible] *Holland:* Elec. [illegible] 50; [illegible]
[illegible] *Denmark:* Elec. [illegible] 56; [illegible]. *France:* Unenumerated, 17; [illegible]
[illegible] *U.S.A.:* Unenumerated, 135 [illegible]
LONDON.—*U.S.A.:* Elec. machinery, £661; unenumerated, £663—205 pkgs. *Holland:* Elec. lamps, £2,173; unenumerated, £351. *France:* Carbon candles, £1,844; elec. lamps, £6[illegible]; unenumerated, £44. *Denmark:* Unenumerated, £4[illegible]

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £2,822; unenumerated, £306. *Melbourne:* Telephone cable, £2,883; wire and cable, £3,979; unenumerated, £151. *Sydney:* Wire and cable, £1,836; telegraph material, £90; unenumerated, £361. *Wellington:* Wire and cable, £77; telephone cable, £1,308; unenumerated, £169. *Lyttelton:* Elec. machinery, £45. *Adelaide:* Wire and cable, £242; unenumerated, £241. *Fremantle:* Wire and cable, £88. *Perth:* Elec. glow lamps, £99; unenumerated, £90. *Christchurch:* Wire and cable, £1,146; unenmerated, £296. *New Plymouth:* Elec. batteries, £260. *Wanganui:* Unenumerated, £44. *Napier:* Unenumerated, £27.
[illegible] *Durban:* Wire and [illegible] £73. *Cape Town:* Unenumerated, £110. *East London:* Unenumerated, £53. *Delagoa Bay:* Elec. machinery, £380. *Mombasa:* Unenumerated, £14.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £100; unenumerated, £115. *Puerto Colombia:* Telephones, £226.
HOLLAND.—*Amsterdam:* Wire and cable, £936; unenumerated, £687. *Rotterdam:* Wire and cable, £257; unenumerated, £37.
PORTUGAL.—*Lisbon:* Unenumerated, £66.
SPAIN.—*Cartagena:* Unenumerated, £226.
DENMARK.—*Copenhagen:* Unenumerated, £31.
RUSSIA.—*Vladivostock:* Unenumerated, £27.
[illegible] Wire and cable, £749; unenumerated, £187. *Calcutta:* Wire and cable, £3,928; unenumerated, £112. *Madras:* Wire and cable, £62. *Singapore:* Wire and cable, £12; unenumerated, £56. *Ceylon:* Unenumerated, £223. *Kilindini:* Unenumerated, £37.
[illegible]
CANADA.—*St. John's:* Elec. machinery, £151. *Toronto:* Unenumerated, £47
[illegible] *France:* [illegible]

FOREIGN GOODS (duty paid and free).

Cape Town: Unenumerated, £106. *Melbourne:* Unenumerated, £283. *Rotterdam:* Unenumerated, £61. *Sweden:* [illegible]

IN TRANSIT.

Melbourne: Elec. lamps, &c., £651.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Zinc Corpn. (Ltd.) v. A. Hirsch & Sohn.

Last week the Court of Appeal (Lords Justices Swinfen Eady, Phillimore and Pickford) delivered judgment on defendants' appeal from a judgment of Mr. Justice Bray, declaring that a contract for the supply to defendants (a German firm) of a large quantity of zinc concentrates was dissolved on the declaration of war. The facts were set out in THE ELECTRICIAN for Sept. 10 (p. 857).

Lord Justice SWINFEN EADY held that to carry out during the war any part of the contract would involve intercourse with the enemy and so would be illegal, and, therefore, the result was that the outbreak of war had dissolved the contract so far as regarded the future performance after Aug. 4, 1914. The remedy on either side of what had previously been carried out remained in abeyance until the termination of the war. The contract of 1910 not only provided that defendants should purchase plaintiffs' whole production, but that plaintiffs should not sell their concentrates to any other person. That negative stipulation remained in force, according to the tenor of the agreement, as well during a war as during a temporary strike or accident, or breakdown of machinery. Again, by clause 5 defendants had the right to leave 2,200 tons of concentrates on plaintiffs' floors, and 800 tons in their vats, at plaintiffs' risk for an indefinite period. Thus defendants could not take delivery, and yet plaintiffs could not sell their production elsewhere and must keep their premises encumbered with concentrates which they could not dispose of. The effect of such an agreement was to prevent the resources of the country from being developed and the value of the mineral from being utilised in the best interest of the country. Moreover, the result of preserving intact for defendants (as the agreement purported to do) all concentrates made ready by plaintiffs would be to enable defendants on the conclusion of peace to resume their trade as speedily and in as great volume as possible, and so to diminish the effect of the war on the commercial prosperity of the enemy country, which it was the object of this country during the war to destroy. To recognise such a contract and to give effect to it by holding that it remained legally binding on the contracting parties would be to defeat the object of this country in crippling the commerce of the enemy. Such an agreement was void, as tending to assist the King's enemies. To carry it out during the war, and to withdraw goods from commerce and preserve them for the enemy after the war was little removed from actually trading with the enemy. His Lordship expressed the opinion that the contract had become not suspended but dissolved by the war, and that the judgment of Mr. Justice Bray was right.

Lords Justices Phillimore and Pickford delivered judgment to the same effect and the appeal was accordingly dismissed, with costs.

Albion Electrical Co. (Ltd.) v. L.K.W. Synd. (Ltd.)

At Lambeth (London) County Court last week, plaintiffs sued the L.K.W. Synd. (Ltd.) to recover £58. 19s. 8d., balance of account for overhauling electrical installation at the Brixton Hall, and altering it so as to comply with the requirements of the L.C.C.

For plaintiffs it was said that on July 26 Mr. Chas. Lille, plaintiffs' manager, was approached by a Mr. J. P. Naylor, electrical engineer, to carry out certain alterations to the electrical fittings at the hall; he saw a Mr. Thos. H. Crosby, the secretary of the syndicate, and, as time was short, no estimate was prepared, Mr. Lille agreeing to carry out the work on the basis of being allowed 20 per cent. on the cost of material, 50 per cent. on the cost of labour and engineers' fees. The work was a "push job," but was completed, the hall being opened on July 27. He had great difficulty in obtaining payment, but eventually received a cheque for £5, signed by Crosby as secretary and manager of the syndicate. He still pressed for payment, until he received a letter from Crosby on Oct. 1, stating that he was not to hold the syndicate liable for the account, but was to look for payment to a Mr. Horace S. Laycock, promoter of the syndicate, and a director of the newly-formed L.K.W. Synd.

In his evidence Mr. C. LILLE said that throughout the whole of the transactions in dealing with Mr. Crosby he was under the impression the L.K.W. Synd. were liable for the account, and it was not until Oct. 1 that he received any intimation that he had to look to Mr. Laycock for payment.

For the defence THOMAS H. CROSBY, secretary and manager of the L.K.W. Synd., said that from Feb. 25 to July 28 he was acting as Mr. Laycock's manager at the hall but he ceased to be manager on July 28, when the syndicate came into existence, his salary being paid until the end of July by Mr. Laycock, and witness then becoming secretary and manager of the syndicate. The electrical arrangements were made by Mr. Naylor, and, as he was unable to carry out the work, he introduced him to Mr. Lille, who was to undertake it under the superintendence of Mr. Naylor. No figures were mentioned, but it was agreed plaintiffs should have a reasonable profit on work and materials sanctioned by Mr. Naylor.

Judge PARRY: Were you asked by anybody who was to be responsible for payment?—Witness: Not directly. Mr. Naylor said I was all right, as he had known me for many years. Certainly the L.K.W. Synd were not mentioned as the persons to look to for payment. The cheque for £5 paid to plaintiffs on account was signed by him as secretary and manager of the L.K.W. Synd at a time when he was drawing a number of cheques, and it was given to plaintiffs as Mr. Laycock did not have his cheque book on him at the time.

Mr. HORACE S. LAYCOCK, director of the Montreal London Development Agency (Ltd.) and several other companies, as well as of the L.K.W. Synd., said he obtained a lease of the Brixton Hall in February, when he gave Crosby instructions regarding the electrical fittings. The syndicate was formed on May 27, and took over the hall on July 29. He was personally responsible for payment of the work done and now claimed for. He thought the charges high, and he had been willing to come to terms, but plaintiffs refused to do so. A Mr. Kemp held one share in the syndicate, Mr. Weston two, and he held six himself; they were £1 shares.

Mr. STEVENS (for plaintiffs): Suppose the company pay this, you will pay them?

Judge PARRY: Of course he will. It is only a matter of bookkeeping. It does not matter a row of pins whether they sue you or the syndicate.

In answer to other questions, witness stated he had no legitimate business, such as a bootmaker or butcher, simply being a director in certain

companies. He was made a bankrupt in 1905, in 1911 applying for his discharge, which was suspended for a year. He had also one or two County Court judgments against him. There was an agreement between him and Mr. Kemp that he should be responsible for all accounts incurred before the syndicate was formed.

Mr. J. P. NAYLOR, electrical engineer, said it was agreed that he should superintend the installation and that plaintiffs' account should be submitted to him. He thought 20 per cent. on material and 50 per cent. on labour for a "push job" were reasonable, but the account submitted was insufficient to show what had been done.

Judge PARRY said he had heard a few unpleasant cases of that kind, but he thought this was the limit. Nobody knew what or who the L.K.W. Synd. was, but they had the material and the labour and must pay for them. He held that defendants were liable for the account, and referred to the Registrar the question of the amount, fixing 20 per cent. on material and 50 per cent. on labour as the basis for taking an account of what was due.

Tampering with Electric Wires in a Colliery.

At Mansfield Petty Sessions recently two pit lads named Williamson and Grumbley were summoned under the Coal Mines Act of 1911 for committing an act likely to endanger life, by taking the insulation of the electric light cables on the No. 12 empty deep road and connecting the cable with the signal wires.

Mr. R. H. WIGGINS (for the Bolsover Colliery Co.) said no doubt the boys did the thing for a lark, but they had been guilty of an extremely serious and dangerous offence. The connection of the signal wires with the electric light cable would produce a flash, and had there been any gas or dust about a terrible conflagration might have taken place. Electric light cables, which were insulated, were fixed to the props along the haulage road. The lads went to considerable trouble to scrape off the insulation to the extent of an inch, leaving the wire naked, and they connected with it a piece of thin wire, attached to which was a horseshoe, and let it hang down until it connected with some signal wires which ran along the side of the roadway. The idea of the lads in connecting the signal wires with the cable was to give the men who used the signals a shock. The company were especially careful with their signal wires, connecting them with a battery, the voltage of which was only sufficient to ring a bell. When the tubs were clipped on and everything was ready it was necessary for boys at the end of the rope to bring two wires together, this act ringing a bell. On Dec. 8 one of the men connected the wires to give the signal for the tubs to be hauled away and he received a nasty shock, whilst a second man received such a shock that he was struck speechless for a couple of minutes. Defendants admitted tampering with the wires, and while the colliery company did not wish to unduly press the case, they desired to emphasise the great seriousness of the offence. When naked cables carrying current at 105 volts were connected up with other wires there was bound to be a big flash. In the Government inquiry following the last colliery explosion in South Wales, it was suggested as a reason for the disaster that two signal wires, each carrying current at 25 volts, got connected, but at the Mansfield Colliery the signal wires were only carrying current at 10 volts from a battery. If the charge had been 25 volts, the Bench could imagine what would have happened had they been brought into contact with the 150 voltage of the electric cables.

After hearing the evidence the Bench fined each defendant three guineas and costs (5s. between them), or in default six weeks' imprisonment.

Devonport Tramways Arbitration.

The arbitration proceedings in connection with the purchase by Plymouth Corporation of the undertaking of the Devonport & District Tramways Co. were concluded last week.

Mr. J. W. SPARK, late borough electrical engineer to Devonport Corporation, was cross-examined by Mr. Macmillan, K.C. (for the company) as to the expected increase in the price of electric current for tramway purposes.

Mr. R. J. FITTALL, town clerk of Devonport until the amalgamation in 1914, gave evidence as to the company's history, as to the negotiations for through running, &c., and in cross-examination admitted that through-running would be unquestionably a public convenience.

Mr. J. E. WALLER, consulting engineer, said he had valued the tramways on normal pre-war prices. The proper basis was to take prices ruling at such a period anterior to the date of transfer as would enable the construction and equipment to be carried out by the time of the transfer. The price ought to be based on figures ruling some 15 months anterior to the date of transfer. He had taken the agreed figure of £12,000 as being the present value of the cars, which he estimated had an average life of 11·7 years. He estimated the gross profits from Oct. 2, 1915, to Aug. 12, 1919, at £15,514, and the net profits at £11,703. He calculated that there would be an increase of one-third in the number of passengers carried in the event of through-running being established.

In cross-examination he said that, while he had constructed tramways abroad in recent years, he had not for a good many years done any constructional work in this country. He could not get a tramway undertaking constructed "for love or money" just now. The owned lines were well maintained, but the leased ones were not. Through-running between Devonport and Plymouth was a very important matter from the point of view of public convenience. He thought 35½ per cent. increase was a very large allowance to make for through-running.

After counsel had addressed the arbitrator (Mr. R. Hall Blyth), the latter said he would take time to consider his award.

PARLIAMENTARY INTELLIGENCE.

RAILWAY CARRIAGES.

In the House of Commons last week the President of the Board of Trade (Mr. RUNCIMAN) stated, in reply to a question, that some of the principal railway companies were understood to be carrying out the recommendation that coaches should be constructed of steel as far as possible, and that any timber used should be rendered non-inflammable. On the underground electric railways, on which the rolling stock must be of a type approved by the Board of Trade, the woodwork of the cars had to be non-inflammable. The Board of Trade had no power as regarded ordinary railways to make an order declaring it obligatory that all new railway carriages shall be of non-inflammable material.

EDUCATIONAL NOTES.

Royal Technical College, Glasgow.—The annual report on the 119th session (for 1914-15) has been issued.

It is stated that every encouragement was given to enlistment and the response of students and staff cannot be too highly praised. In consequence the enrolments were much below the normal, and as the session wore on the vacant seats in the class rooms grew more noticeable and the numerical strength of the staff diminished as college work was exchanged for service in the field. In a few cases classes had to be suspended. The Roll of Honour includes eight members of the governing body and committees, 37 of the staff, 1,152 students of 1914 and 1915, and 622 students of previous sessions, a total of 1,819. Of this number 91 (including four of the staff) have been killed or have died of wounds. The total students were 3,028 (445 day and 2,583 evening students), against 5,011 (669 day and 4,342 evening students) in 1913-14; Many former members of the staff and students of the chemistry department are now engaged on munition work. There are usually 150 day students at work in the chemical laboratory, but in the last week of the session the number had dwindled to four, with two assistants.

Crystal Palace School of Practical Engineering.—Mr. P. Griffith, President of the Society of Engineers, distributed the certificates to the students at this school last week.

After the distribution, Mr. H. J. BUCKLAND, on behalf of the Crystal Palace Trustees, said the members had (both collectively and individually) worked extremely hard to obtain outside assistance in order to carry on the school. The chairman (Sir David Burnett) had written to all the principal City Companies and also to the various educational authorities, but had failed to obtain financial help. The loss for 1915 ran into four figures, and the trustees having no money to meet the deficiency, felt that their responsibility for it should end with the close of the present term. However, the Principal and his brother had decided to carry on the school, and during the next term would find more suitable and up-to-date premises.

Mr. J. W. WILSON (Principal) announced that the school's roll of honour included nearly 200 past and present students engaged in the country's service. The school had always paid its way until the war, although it had never had any private assistance, and it was not going to close. On Jan. 5 they intended to start again, and go on as before.

BUSINESS NOTICES.

Patent Development.—The proprietors of patent No. 28,617/1909, relating to "An improved process of homogeneously uniting metal bodies by heat," desire to negotiate for the sale of the patent rights or for the grant of licences. Inquiries to Messrs. D. Young & Co., patent agents, 11 & 12, Southampton-buildings, London, W.C.

Advance in Prices.—The Electric & General Works (Ltd.), 15, Victoria-street, London, S.W., notify that they have been compelled to further increase the advance on their catalogue prices for switchgear from 20 to 25 per cent. as from the 1st prox.

Alien Enemy Patents.—The British Thermit Co. (Ltd.) has applied for a licence under several patents granted to Th. Goldschmidt for a process and apparatus for jointing rails, the butt-welding of ends of rails, &c.

The Refractory Zinc Ore Treatment Co. has also applied for a licence under Patent No. 15,128 of 1911, granted to Siemens & Halske (A.G.), for manganese peroxide anodes.

Application for Restoration of Lapsed Patent.—Messrs. Heenan & Froude (Ltd.) have applied for the restoration of the patent No. 24,949/1910 for "Improvements in Dynamometers," granted to them and Mr. Fred Harrison. Objections to the Patent Office, London, W.C., by Feb. 15.

BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 6¼d. will be payable on Jan. 5 at Bankruptcy-buildings, London, W.C., to creditors of Herbt. Page (trading as Smecton & Page), electrical engineer, 63, Queen Victoria-street, London, E.C.

A first dividend (6d.) is payable at Bankruptcy-buildings, London, W.C., to creditors of Jas. Wm. and Tom W. Tattersall, electrical engineers, Kimberley-road, Willesden-lane, London, N.W.

Mr. J. W. Scarlett, 5, Cecil-square, Margate, has been appointed trustee in the bankruptcy of Geo. B. Bowell, engineer, lately trading at 4A, Zion-place, Margate.

The Cicoy Magneto Co. (Ltd.) is being wound up voluntarily, and Mr. W. G. Newman, 116, Cannon-street, London, E.C., has been appointed liquidator. A meeting of creditors will be held at 359, Goswell-road, London, E.C., to-day (Dec. 31).

The Sheffield Electrical Engineering Co. (Ltd.) is being wound up voluntarily. A meeting of creditors will be held at the offices of Messrs. Hurst & Hewitt, 8, Park-parade, Ashton-under-Lyne, on Jan. 4. Claims to the liquidator, Mr. Horace Cawood, 68, Eyre-street, Sheffield, by Jan. 15.

A meeting to receive an account of the winding up of Marsh, Son & Co. (Ltd.) will be held on Jan. 25 at the offices of Messrs. Prideaux, Frere, Brown & Co., 12, Old-square, Lincoln's Inn, London, W.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Birmingham.—The Electric Supply Committee recommend the Council to authorise a further extension of the temporary electric generating station at Nechells, at an estimated cost of £100,000.

It will be remembered that in May, 1913, the Council sanctioned the erection of a new power house at Nechells, which it was anticipated would be available for a supply of current by the winter of 1916-17. However, the demand for electrical energy increased so rapidly that 12 months ago it was found necessary to erect a temporary generating station so that the supply might be continued without intermission. The cost was estimated at £93,000; the work was approved by the Council in January last, and it was anticipated that would serve the purposes of the department until the spring of 1917, but now it has been proved that the temporary station will be wholly insufficient to meet the demands of consumers beyond the present winter. The committee feel that the increasing applications for current to meet the requirements of local industries is so urgent that it is desirable to proceed with the work forthwith.

Kilmarnock.—The Council have adopted a recommendation of the Electricity Committee to acquire a new boiler at an estimated cost of £2,560.

The Provost stated at the last meeting that there had been a great demand for electric power in the districts they had tapped. For the last month they had sold nearly half a million units for lighting and power, against 180,000 for the corresponding month last year. A great deal of the demand had come from collieries, where they had not expected such demand to arise at an early date. He believed the prices at which these contracts were being executed were such that they would show a handsome result to the Council at the end of the year. Within the last week or so they had to link up a large factory through the breakdown of their own motive power, and it was creditable to the department that they were able to do so. He had great hopes that within the next three or four weeks, when the new turbo generator was installed, the demand upon the department would be abnormally large.

Manchester.—The L.G. Board have authorised the Corporation to borrow money for the purchase of land for the proposed electricity works at Barton.

The position in regard to the threatened shortage of coal has been relieved in consequence of the pressure brought to bear by the Government and the action of the Electricity Committee in going further afield for their supplies.

Middlesbrough.—The Corporation have received sanction to a loan of £3,994 (repayable in 30 years) for mains extensions, and £1,159 (10 years) for meters and fittings, these amounts being already spent.

The L.G. Board state that no new mains should be laid, except for giving a power supply to engineering works, &c.

The Corporation will take over the electric lighting order for North Ormesby from the Cleveland & Durham Electric Power Co. as from Jan. 1. It had been agreed to pay the company £986, but since the agreement a further £101. has been spent on mains, &c.

GENERAL.

Barnsley.—The Electrical Distribution of Yorkshire (Ltd.) has agreed to the granting of a "Fringe" order to the Council for the supply of electric current to residents in Mount Vernon-road, outside the borough boundary.

Chester.—At the recent meeting of the Council it was announced that owing to the increased cost of coal and other charges it was necessary to make an advance in the charges for current, &c., and but for the efficiency of the hydro-electric works the charges would have been increased at an earlier date.

Coal Contracts.—It is reported that some coal contractors, in arranging new coal contracts with local authorities, are inserting a clause which will enable them to terminate contracts at a week's notice if they find it impossible to deliver the coal because of the enlistment of employees.

Coventry.—The Ministry of Munitions has informed the Council that it is impossible at present to declare the electricity works a "Controlled Establishment" under the Munitions of War Act (1915) as the industry was not one which was included in the definition of munitions work contained in sec. 3 of the Act.

Dover.—The Admiralty have notified the Corporation that the interest on the loan to the electric supply department of £157,000, which falls due in May next, must be increased from 4 per cent. to 5 per cent. The alteration means £1,570 more a year for interest, or a 2d. rate.

Haslingden.—The Electricity Committee have decided that future applicants for electric current can have no more than 8 ft. of cable for each service, the cost of any excess to be borne by the applicants.

Ilford.—The charge to be made by the electricity department for current supplied for traction purposes during the year ended March 31 last has been fixed at 1 d. per unit.

Maidstone.—Owing to the increased cost of coal the charges for electrical energy for lighting have been increased as follows:—

Flat rate, from 4¼d. per unit to 4½d. per unit; maximum demand, from 7¼d. and 2¼d. per unit to 7½d. and 2½d. per unit; telephone system, 8s. per 30-watt lamp per annum and 1¼d. per unit to 8s. and 1½d.; fixed charge, from 11s. per 30-watt lamp per annum to 11s. 6d. The charges for other services remain as at present.

Portadown.—The proprietor of the local electric supply works has notified that, owing to the increased cost of coal and engine oil, the price of electric current will be increased 15 per cent.

Provisional Electric Lighting Orders.—Applications for provisional electric lighting orders must be deposited with the Board of Trade on or before Dec. 21, 1915, under the provisions of the Electric Lighting Acts, 1882 to 1909, and it is now announced that there is only one application for the 1916 session—viz., by the Church Stretton Electric Supply Co. (Ltd.)—for the urban district of Church Stretton and the parishes of All Stretton and Little Stretton in Church Stretton rural district. Messrs. Oliver, Richards & Parker are agents for the order.

Rosyth.—At the last meeting of Dunfermline Council the Gas Committee submitted correspondence with the secretary of the Scottish National Housing Co. as to the proposal of the company to introduce electric light instead of gas into the houses now under erection and to be erected at Rosyth. It was resolved to ask the Convener, the Town Clerk and the gas manager to write a further letter to the company on the subject.

Testing Stations.—Many of the Borough Councils (including Bermondsey, Hammersmith, Islington and Poplar) will support Hackney Council in their proposal to ask the London County Council to suspend, during the war, the periodical inspection of pressure-testing stations, in order that the undertaking might be saved the testing fees, and the services of the officer who is engaged in collecting the records from the instruments utilised upon work of a more useful character.

Weymouth.—The Council have applied to the Board of Trade for an order to enable them to supply electrical energy to Radipole Manor, outside the borough boundary.

Woolwich.—Sanction has been received from the L.C.C. for the borrowing of £4,700 for linking the Borough Council's supply system with that of the South Metropolitan Electric Light & Power Co.

LIGHTING & POWER NOTES.

Bath.—In order to give an additional supply of power to local works a new feeder is to be laid at a cost of £1,400.

Electricity in Collieries.—Extensive developments are being made at the Linnyshaw and Bridgewater collieries, Worsley, and new electricity generating stations are being erected at Mosley Common and Ashton Field, and at the Bridgewater Collieries, Worsley, by the owner, the Earl of Ellesmere.

Electricity in Gold Mining.—At the meeting of the Champion Reef Gold Mining Co. of India recently it was stated that the new classification and tube mill plants already installed had been of substantial assistance. An electrically operated turbo-compressor had been ordered and was nearing completion. When erected and working, that would render available more air for operating rock drills and other machinery in the mines.

Wigtownshire.—At the last meeting of the Rhins District Committee of the County Council the Portpatrick Special District Subcommittee reported that as the electric lighting of the streets was discontinued on Feb. 4, 1915, by Admiralty order, they recommended that the Portpatrick Electric Supply Co. be paid £25 for the hours the light was used between Sept. 20, 1914, and Feb. 4 last. The company thought this sum quite inadequate, and it was decided by a majority to increase the payment to £35.

TRACTION NOTES.

Blackpool.—Some time ago the general manager of the tramways (Mr. C. Furness) reported that there was a loss on the contract ticket system of over £2,000 per annum, and he suggested raising the price from £3 to £4. 10s.

Owing to the strong opposition to this scheme the question was reconsidered, and on the 23rd inst. Mr. Furness suggested that contracts should be abolished altogether. This, however, was not adopted, and the Committee have decided to continue the system on the old basis.

Bristol.—The Board of Trade have made an order under the Special Acts Extension of Time Act (1915) extending the period (for one year from Oct. 31, 1915) during which the Corporation may give notice to exercise their option to purchase the tramway undertaking of the Bristol Tramways & Carriage Co.

Central London Railway.—The Board of Trade have ordered that the time limited by the Central London Railway Act, 1913, for the compulsory purchase of lands and easements be extended for one year from Aug. 15

The estimates for 1915-16 submitted to the New Zealand Parliament by the Minister of Public Works (Oct. 1) include railway construction, £700,000; additions to existing lines, £500,000; bridge construction and maintenance, £500,000; and telegraph and telephone extension, £327,000. The last figure includes automatic installation, £110,000; submarine cables, £1,000; new lines, £30,000; new exchanges and connecting new subscribers, £50,000; material, £136,000.

Edinburgh.—Notice of motion has been given by Messrs. Stevenson and Robertson to remit to the Tramway Committee to consider and report on the advisability of arranging with the lessees of the tramways to light the tramcars with electricity.

Leeds.—The Corporation tramways department has moved this week into its new headquarters at the corner of Sovereign-street, Swinegate and Lower Briggate.

The change to new and more extensive premises is due to the great development of the tramways in the last 15 years. There are over 200 cars in daily use, and about 9,000,000 car-miles are run per year. For the last 10 years or so the surplus profits have averaged over £60,000 a year, which has gone in relief of rates after paying all charges, including permanent way renewals, repair of cars, &c. The surplus profits, however, amount to less than 2 per cent. of the revenue.

L.C.C. Tramways.—Modifications have been recently made in the new all-night tramway fare scheme. Ordinary fares will be charged on cars scheduled to arrive at or leave the central London termini up to 3:30 a.m. The fares on cars starting as workmen's cars will not be affected.

Sheffield.—The holiday traffic on the municipal electric tramways was very heavy.

The receipts for Christmas Eve, Christmas Day and Monday showed an increase of £316. 16s. 3½d. compared with the corresponding days of last year. The total for the three days was £4,466. 6s. 2½d., against £4,149. 9s. 11d. On Christmas Eve over £2,050 was taken.

Women Tramcar Drivers.—At the meeting of Glasgow Corporation last week the Tramways Committee reported on the experiment made as to the suitability of women for tramcar driving.

A recommendation was made that the Corporation approve of an extended experiment which would allow of a test being made by the employment provisionally of 20 women as tramcar drivers. There are now over 1,000 women acting as conductors in Glasgow.

Woolwich.—The Borough Council has agreed that Erith Urban Council should apply to the L.G. Board for the issue of a provisional order to amend their Tramways Act of 1903, in order to enable the running of motor omnibuses.

TELEGRAPH & TELEPHONE NOTES.

Chinese Telegraphs.—It is stated that the Communications Office, Peking, has decided to start the construction of a telegraphic line between Kalgan and Taonanfu and between Mukden and Taonanfu.

The Military Government of Jehol and the Provincial Government of Fengtien have been ordered to proceed with the purchase of the necessary materials. For the other telegraphic lines to be constructed in the same region, the Communications Office will make a monthly disbursement. These include a line from Kalgan reaching Mongolia via Dolonor and one from Jehol to Taonan by passing through Chaoyang, Chihfeng, &c. The three lines will be over 1,040 miles long, requiring a capital outlay of some $1,349,500.

Radiotelegraph Notes.—The "Far Eastern Gazette" says wireless communication between San Francisco and New Zealand, via Honolulu and Tahiti, is to be established within the next five or six months.

The contracts for the erection of the 600 ft. steel towers for the United States Government wireless stations at Cavite (Philippines), Honolulu and San Francisco have been awarded to the Chicago Bridge Co.

Work on the new wireless station at Margosàtubig (Philippines) is nearly completed. Margosatubig will then be in direct communication with Samboanga, Malabang and the Manila submarine cable system.

Shanghai Telephone Service.—The "Far Eastern Review" says the Shanghai Mutual Telephone Co. now has over 5,000 telephones connected and is building an additional exchange in the residential part of the city.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says a complete unit of furnaces, boilers, and ash bins is practically ready, and substantial condensing plant, turbines, alternators and transformers are well in hand at the Victorian Railway Commissioners' Newport power house.

With regard to the agreement between Melbourne Council and the Melbourne, Brunswick and Coburg Tramway Trust for the supply by the Council of electric energy for the Trust's tramway for five years, from March 1, 1916, there is some opposition to this scheme at Brunswick, the contention being that the current should be obtained from the local supply. A conference has been arranged between representatives of Melbourne Council and of the Trust.

Brunswick Councillors have also disapproved of the action of the Trust in letting a contract for £16,000 for paving the permanent way with asphalt composition, without calling tenders. Councillor Hickford (Trust representative) replied that the Trust's engineer had staked his reputation on the success of this particular material, which other Councillors declared to have proved a failure in other parts of Melbourne. The question has been referred to a committee.

At a recent meeting of Melbourne Tramways Trust it was decided that a letter should be sent to the Premier (Sir Alex. Peacock) protesting against the appointment of a Tramways Board, and urging that the Tramways Trust should be empowered to continue the work of supervising the tramways.

North Illawarra Council has decided to invite offers from experts for a report on an electric light installation for Wollongong (N.S.W.).

An official statement recently presented to the Victorian Parliament set out the probable influence of the working of electric tramways on the railway revenue, after making allowance for the natural increase in revenue from the suburban lines. It was estimated that the Essendon Trust line caused an annual increase in railway revenue of £9,200, while the Prahran–Malvern Trust's lines caused a loss of £27,728, minus an increase through certain lines of £815, the net decrease being £26,913, or a total loss of £36,113 per annum. The estimated annual loss in connection with tramways now being built (or authorised) was as follows: Hawthorn–Burwood line, £8,800; South Melbourne line, £5,000; Northcote–Preston line, £2,190.

Thanks to the rivalry of electric lighting, which is to be adopted at Castlemaine (Victoria) at the beginning of 1916, the local gas company has announced a reduction in the price of gas from 10s. 10d. to 8s. 4d. per thousand as from Jan. 1.

The Public Works Committee of the Australian Federal Parliament

submitted a report recently upon proposals to establish further automatic telephone exchanges. Many advantages are claimed for the system compared with the manual system, such as speed of operation, secrecy of service, saving in salaries, saving in building space, greater capacity of extension, longer life and greater efficiency. Estimates submitted by the Chief Electrical Engineer and experience where the system has been installed tend to show that under the full automatic system the working cost on each line would be reduced nearly £1 a line a year. The committee recommend that the automatic system should be adopted where the establishment of a new exchange of sufficient size is in contemplation, or where existing manually-operated boards have outlived their usefulness. The innovation is proposed to be made at Sydney and at Collingwood and Malvern. It is estimated that the Sydney Exchange will cost £116,801 for the erection of an exchange with 5,000 lines. At time of transfer it is estimated the revenue will be £5,180, and with 20,000 subscribers £185,000. For Malvern, also, a new building is proposed and an automatic switchboard having a capacity of 3,600 lines, capable of extension to 7,500. The initial cost is estimated at £46,933, and the estimated revenue (with 3,600 subscribers connected) is £23,940. Collingwood station also will be a new one. It is to have a capacity of 3,400 lines and an ultimate capacity of 9,000. The estimated cost is £49,752. The revenue is estimated as £11,890 at time of transfer, and £22,610 with 3,400 subscribers connected.

"Tenders" (Melbourne and Sydney) says the suggestion of the Tasmania State Munitions Committee that £20,000 should be expended on plant has been referred to the Minister of Defence, with the request that the Commonwealth Government should establish a local factory at Hobart and Launceston. The Tasmanian Government undertakes to supply power free of charge during the war.

In connection with tenders for power plant and machine tools for the Sydney naval dockyard, the following particulars are promulgated for general information and these instructions are to take precedence over anything previously laid down, viz.: (1) *Freight* is to be regarded as being 30s. per ton on the combined weight and/or measurement (according to whichever is accepted by the shipping company), but adjustments will be made if actual freight is more or less. (2) *Delivery.*—Tenderers must definitely state whether their tenders are f.o.w., Cockatoo Island, or c.i.f. Sydney. (3) *Duty.*—All material tendered for is to be quoted duty free only, excepting in cases where machines which are already in stock (in Australia) are offered, in which case the amount of duty included in the price is to be stated. (4) *War Risk.*—The amount allowed for war risk is to be included as a special charge and to be shown separately. (5) *Payment.*—If contractors desire it, payment up to the value of 70 per cent. of the contract price will be made in London by the High Commissioner's office. Payments will be made only in Australia and London. (6) *Inspection.*—Inspection by a representative of the Commonwealth will be made at the works of the contractor either in Gt. Britain or America. (7) *American Money.*—All material must be quoted for in pounds sterling. The American dollar to be taken as 4.80 to the pound, but if actual rate is not 4.80, adjustments will be made. (8) *Machine Tools not now Required.* The following machine tools are not now required to be tendered for, viz.: Turbine boring machine, vertical and horizontal planing machines, high-speed turbine rotor lathe, shafting lathe (heavy double-ended), heavy duty lathes, vertical boring mill, horizontal planing machine, hydraulic press, hydraulic vertical plate-bending machine, pipe-screwing machine, single-head pipe-screwing machine.

An Order in Council has been issued authorising Mr. J. Bonding to supply electricity in Kingaroy (Queensland).

Messrs. McCarty, Underwood & Co. have been appointed by the shires of Flinders and Alexandria (Victoria) to prepare a report on a proposal to adopt electric lighting in Sorrento and Alexandria.

Messrs. Bridger (Ltd.), of Adelaide, have entered into an arrangement with the Municipal Council to erect electricity supply works for Mount Gambier (S. Australia).

The Attorney General of Tasmania (Mr. Ewler) has introduced a Bill to provide for the cancellation of enemy contracts. It provides for the annulment of all contracts to which an enemy subject is a party or in which he has a material interest, or which are likely to be for the benefit of enemy subjects or of enemy trade.

Referring to the Perth electric tramways, the chief commissioner of railways and tramways, in his annual report, states that some of the single tracks should be either duplicated or provided with additional loops, and that additional cross overs should be constructed.

In the Legislative Assembly at Melbourne last week Mr. Hughes, the Premier, announced that the Commonwealth was prepared to expend £500,000, if necessary, on establishing and maintaining an institution for the conduct of scientific research in its relation to industry.

The Fitzroy, Northcote and Preston Tramways Trust has been formed with Mr. Charles Ottery as chairman.

Melbourne Council recently approved the agreement to supply current to the Brunswick and Coburg Tramway Trust for five years. The charge is to be £5 per kilowatt per annum and 0.6d. per unit.

Rutherglen (Victoria) Shire Council is borrowing £350 for an electric supply undertaking at Wahgunyah.

Upper Yarra (Victoria) Shire Council has applied for an order to council to supply electricity in Warburton, Millgrove, West Warburton and Yarra Junction.

West Guildford (W. Australia) Roads Board has agreed to purchase electric power in bulk from the Perth plant of the Government.

Messrs. T. Wylde, Ball & Co., electrical engineers (Brisbane), have been invited by Townsville (Queensland) Council to report on an electric supply scheme.

Claremont (W. Australia) Council, who already own electricity works, have been approached by the Government with an offer to supply them with l.t. current in bulk at 1¼d. per unit, from the Perth power station, provided the Council give the Government the right to supply direct any power consumers in the district.

At Tumut (N.S.W.) a syndicate propose to instal a hydro-electric plant to provide power for timber cutting and other works. The State Government is to be approached respecting the water rights.

Katoomba (N.S.W.) Council has decided to discard the old steam pumping plant at the waterworks, and to obtain electric power from the Katoomba Electric Supply Co., at 1d. per unit.

The revenue of the tramway services under the control of the Prahran–Malvern (Victoria) Tramways Trust, for the quarter ended with Sept. 30, was £28,212. Passengers carried were 4,406,612, and car-miles run 531,281. Revenue averaged 12·81d. per car-mile, and operating costs, exclusive of capital charges, were 10·274d. per car-mile.

The revenue of Christchurch (N.Z.) Tramways for year to March 31 was £142,941 (15·099d. per car-mile), and working expenses were £78,072 (8·247d. per car-mile). After providing for capital charges the net profit was £10,000. Passengers carried were 16,828,269 and car-miles run 2,271,996. Total capital expenditure was £676,232. An agreement has been entered into for taking a supply of current from the Lake Coleridge hydro-electric undertaking, which is expected to reduce costs.

The annual report of the electric tramway and lighting department of Fremantle (W. Australia) for the last financial year shows income £56,326 and working expenses £39,906, leaving gross profit of £16,420. The income of the previous year was £55,386 and the gross profit £14,347. After providing for interest the net balance is £10,168, out of which there had to be provided for sinking fund (£2,850), for loan redemption account (£79), depreciation reserve (£5,241) and contribution to general revenue, Fremantle and East Fremantle Municipal Councils (£1,884). Car-miles run were 561,913 and passengers carried, 4,510,619. Average car revenue per car-mile was 13·62d. The estimate of additional capital required for the year ending Aug. 31, 1916, is: Additions to power house plant, £16,073; tramway extensions, £1,050; turnout at railway station, £215; two bogie cars, £4,000; lighting mains, transformers, &c., £1,662; total £23,000. Lighting and power consumers connected are 1,442, compared with 1,201 in 1914.

Melbourne, Brunswick and Coburg Tramways Trust has accepted a tender for the construction of permanent way. Melbourne Council will supply current at first, but the question of the Trust putting in its own power plant has been referred to a committee.

The report of the Moree (N.S.W.) Electric Lighting Co. for the year ended June 30 shows net profit from sale of electricity of £903, while £148 was derived from pumping. A dividend of 8 per cent. has been declared.

The report on the Port Melbourne electric lighting undertaking for the year ended Sept. 30 shows a profit of £557, wiping out the debit balance of £239, and leaving a credit balance over the past three years of £317, after providing for depreciation, sinking fund, interest, &c. The number of units supplied by Melbourne Council was 517,215, which cost £2,402, or 1·115d. per unit. After the transformation of the current to low tension, the Council received 404,699 units, making the actual cost 1·45d. per unit.

Canada.—The Western Canada Power Co., having failed to obtain the consent of the Treasury to sell a part of the new issue of first mortgage bonds in Great Britain, is unable to raise money to pay the half-yearly interest on the first mortgage bonds, due Jan. 1.

The committee of the holders of the three-year notes has tentatively agreed to convert the notes at par and accrued interest into 7 per cent. preference shares, provided (inter alia) that the holders of the first mortgage bonds will agree to convert the next two years' interest coupons into preference shares of the same issue. This agreement will also involve the raising of $350,000 in cash for completing the third generating unit and providing for other necessary expenditures. The capitalisation would then stand as follows: First mortgage bonds, $5,000,000; 7 per cent. preference shares (approximately), $2,850,000; ordinary shares, $5,000,000.

South Africa.—A special meeting of the Witbank Colliery (Ltd.) will be held on Jan. 28 for the purpose of considering and, if thought fit, passing a resolution authorising the extension of the objects of the company so as to enable the directors to enter into an arrangement with the Township of Witbank for the supply of electric current for light and power.

FOREIGN NOTES.

Argentina.—The Government of the Province of Buenos Ayres have decided to establish an electric power house in San Martin Park, La Plata, to supply at least a part of the public lighting of the city of La Plata (including Government Buildings) at prices lower than those now charged by the local lighting company. It is also understood to be the intention of the Government to adopt electric traction on the La Plata railway.

The "Review of the River Plate" states that the Government of the Province of Buenos Ayres have authorised the Municipal Commissioner of

Mar del Plata to enter into an arrangement with the Cia. de Electricidad de la Provincia de Buenos Ayres, for the payment of overdue accounts amounting to $91,517.24 m/n (about £8,000), and are to be paid by the Provincial Government in half-yearly instalments.

Bolivia.—The "Chamber of Commerce Journal" has received a communication (of which the following is an abstract) from a correspondent in La Paz on German trade with Bolivia :—

The present war has made its effects felt in all the markets of the world. One of the regions which has suffered most is South America, not only on account of the fact that the greater part of her exports are raw materials extracted from her privileged soil, but also for want of manufactured articles. Argentina, Brazil, Chile, Peru and Bolivia are passing through a grave crisis owing to the European War. Argentina, as a country dependent on immigration, suffers for lack of hands and credit, which were the bases of her commerce and industry. Chile, Bolivia and Peru, owing to the diminution of their exports, have suffered greatly. Happily for Bolivia, after a big drop in the price of tin, her chief export, she is now feeling the benefit of a rise in the price of this metal. Up to the present Bolivia has not suffered greatly from shortage of imported merchandise, because in former years merchants ordered articles in such abundance tha tthey could not all be sold. As a consequence of the war there is the suspension of German importations. Thirty years ago the greater part of the Bolivian trade was in the hands of France and Britain, and those countries sent good articles of all sorts. Latterly the Germans, owing to their facility for acquiring languages and their aptitude for imitating, have flooded the country with useless articles of good appearance, and they have even imitated articles made in Bolivia by the native population. It would be as well if Britain were to take advantage of the fact that (according to the writer) German commerce in the world will be ruined by the war to recover the lost ground. The study of Spanish should be encouraged, and catalogues should be in that language. Almost all the tin, rubber and copper exported from Bolivia goes to London. In 1913 the exports of Bolivia to Britain were valued at about £6,000,000, while exports to Germany were not much more than a tenth of that figure. In imports to Bolivia Germany occupied first place with £1,607,300, and Britain second with £888,100. Imports from Germany included electrical goods valued at £59,500.

China.—H.M. Commercial Attaché at Peking (Mr. W. P. Ker, C.M.G.) states that the value of net imports of foreign goods into China in 1914 was £76,022,172, compared with £86,118,303 in 1913.

The United Kingdom supplied these to the value of £14,319,172 (against £14,637,591); Hong Kong, £22,720,144 (£25,924,202); India, £5,340,244 (£7,294,133); Germany, £1,924,604 (£4,274,842); Belgium, £2,399,340 (£2,391,116); United States, £5,565,163 (£5,350,983); and Japan, £16,468,755 (£18,026,319). Exports from the United Kingdom to China are chiefly manufactured articles. The United Kingdom leads the rest of the world in the import of iron and steel bars, rods, plates, &c., and other manufactures of iron and steel, propelling machinery, machines of all kinds and motor cars, while Japan heads the list of importing countries in chemical products, glassware, lamps and lampware. Before the war Germany headed the list for electrical machinery and apparatus. Also the import of chemical products from Germany exceeded the import direct from the United Kingdom. However, the German goods, with few exceptions, do not constitute valuable items. They are for the most part goods for the success of which in the China market cheapness is more essential than quality. The most hopeful direction in which British manufacturers may look to recover a lost ascendancy over their German competitors would seem to be in the supply of electrical machinery. In regard to electrical machinery, the United Kingdom was not overtaken by Germany until 1911, and present conditions seem favourable to a recovery of the earlier British predominancy.

The bulk of the metals and metal manufactures has come in the past from the United Kingdom and Belgium, but of recent years German imports have shown progress. At Shanghai large contracts were booked on the Continent in the beginning of 1914, but shipments were curtailed on account of the war. New contracts have been mostly for American material. The progress of the import of machinery has not quite come up to the expectations entertained five or six years ago. Locomotives and tenders, electrical materials and fittings, telegraph and telephone materials, machinery and parts of machinery, railway carriages and wagons and other vehicles amounted in 1910 to £2,340,000; 1911, £1,780,000; 1912, £1,800,000; 1913, £2,200,000; and 1914, £2,430,000. The only items which show a steady increase are electrical materials, propelling machinery, textile machinery and motor cars. Electrical requirements offer the most promising field at present for British engineering enterprise. The increasing demand for lighting and power in the settlements at Shanghai is worthy of attention, while all over the country electric lighting installations are being established or enlarged. Although German imports of electrical materials have overtaken those from the United Kingdom, British manufactures are well represented in recent installations of electric light. As regards the import of machinery generally, apart from electrical materials, the lead of British goods is, so far as can be judged from the returns, well maintained. Agents should be chosen, if possible, who have practical knowledge of engineering. The agents must receive financial assistance from the manufacturers in order to meet the preliminary expenses of finding a market, and must be prepared to give extended credits to trustworthy Chinese purchasers. Quotations should be c.i.f., should clearly state time of delivery and terms of payment, and should be accompanied by plans and illustrations. Lastly, the agents should be freely supplied with attractive catalogues, samples and, if possible, working models of special machinery.

Colombia.—H.M. Minister at Bogota states that electric light fittings and shades are amongst the articles now in demand and which were formerly supplied by Germany.

Cheap hardware is being imported from the United States, and American firms are making vigorous efforts to capture trade. Terms are usually f.o.b., and mostly six months' credit.

Holland.—The following are extracts from British consular reports for 1914 :—

The establishment of telephonic communication between the Netherlands and the United Kingdom by means of a cable 105 km. in length between Westkapelle and Orfordness has been delayed by the outbreak of hostilities.

Rotterdam Municipality let on hire at the port arc lamps, 7 amperes at 1s. 4d. per hour, 5 amperes at 1s., 2½ amperes 8d., [illegible] and glow lamps ¼ ampere ⅗d.; also movable electric cranes at £1. 10s. per day or 11s. 8d. per half-day. The charge for electric cranes to lift 2,500 kilogs. or upward is $\frac{7}{10}$d. per hectowatt.

Imports into the Netherlands in 1914 included metals manufactured and brought from Great Britain 194,039 tons (against 298,120 in previous year), from Germany 1,171,322 (against 1,733,458), and from Belgium 355,669 (464,084), and metal articles, Great Britain 36,373 tons (28,061), Germany 863,132 (1,228,146), and Belgium 105,772 (144,798). Exports of metals unmanufactured and wrought included Great Britain 182,410 tons (507,892), Germany 370,457 (629,046), and Belgium 354,621 (712,080), and metal articles Great Britain 93,447 tons (156,176), Dutch East Indies 114,754 (159,056), and Germany 46,337 (70,644).

Electric lamp caps 33 million in number (against 18 million and 15 million in 1913 and 1912 respectively) are stated to have been exported to the United Kingdom.

A report from Groningen says the use of electricity for power and lighting is making great strides in the north. A large station has been built recently just outside Groningen of sufficient capacity to supply current to the whole province.

A report on The Hague and Sceveningen says German and Belgian competition in pocket electric lamps having ceased, these are being exported from the Netherlands to the United Kingdom in increasing quantities.

Honolulu (Sandwich Islands).—A consular report states that a New York firm has a contract for the supply and erection of electrically-operated coal-handling plant at Honolulu harbour. Storage capacity is to be provided for 60,000 tons of coal, and this will probably be increased ultimately to 200.000 tons

Norway.—A consular report on the trade of Norway in 1913 states that total imports were valued at Kr.590,781,100 (against Kr.560,804,100 in previous year).

Imports from Germany amounted to Kr.176,064,500 (Kr.167,955,600), and from the United Kingdom Kr.146,243,500 (Kr.147,994,500). Machinery imports from Germany were Kr.13,458,000=£745,660 (Kr.11,015,800=£611,990), and from the United Kingdom Kr.3,649,300 =£202,740 (Kr.3,307,500=£183,750). Electric wires and cables imported from Germany were 3,894 tons (2,697), glow lamps 68 tons (58), and measuring and controlling instruments, value Kr.33,700 (Kr.28,000).

Philippine Islands.—It is announced that a contract has been awarded to the Bryan London Co., of Iloilo, for the installation of a telephone system for the city of Zamboanga. The Leich Automaphone system is specified in the contract. The concrete poles will (it is stated) be also used for carrying the electric light cables in the city. Work has been started on the construction of the concrete poles which will be 30 ft. high.

Swiss Trade.—By a recent Order in Council the export of a number of articles of manufactured goods, metals and raw materials is forbidden, unless shipments are consigned to the Société de Surveillance Economique. The following is a list of the principal electrical and engineering articles, &c. :—

Accumulators (electric) and accumulator plates, acid (acetic) and acetates, hydrobromic, hydrochloric, nitric and sulphuric acids, aeroplanes and airships and engines and parts, aeroplane component parts with accessories and articles suitable for use in connection with aircraft, alcohol, alumina, anhydride salts, aluminium and antimony in all forms, ammonia, arms, asbestos; bauxite, belting, benzine, bichromate of soda, bismuth and its salts; cable (insulated), cordage, carbide of calcium, carbon sulphide, carbonate of soda, celluloid, cement, chlorates and perchlorates, tin, cobalt, magnesium, zinc, &c., chlorine (liquefied), chrome ore and metal, silver, nickel, bronze and copper ore (including pyrites), pure copper and alloys, cotton (all forms), cylinders, detonators, diamond drills for draw plates, electrical fire lighters, electric carbons, electric insulated wire and cables, electrodes, primary batteries, and component parts, emery wheels, engine packings, explosives (all kinds), ferro-chrome and ferro-nickel and all other ferro alloys, filings and scrap of old copper, tin, zinc and their alloys, glasses for optical instruments and for spectacles, graphite, grindstones and emery wheels, haematite iron, optical and observation instruments, iridium, iron ore (including pyrites) and metal, iron castings, lead, lubricants, machine tools and parts, machinery and parts thereof suitable for marine and aerial navigation, electrical machinery, dynamos and motors, machinery and parts exclusively used for the manufacture of munitions and weapons of war, magnesium, magnetos, manganese ore and metal, mercury, metallic peroxides, mica, molybdenum ore and alloys, munitions, nickel, nitrates and nitrites, oil, osmium, packings (engine and boiler), paraffin, phosporus and phos-

phate of lime, photographic plates and papers, platinum, potash and potash salts, powder, projectiles and munitions of war, rosin pitch, ruthenium, rubber, gutta-percha (all forms), vanadium, metals and filings (copper, tin, zinc and their alloys), selenium, silicon, shipbuilding materials, sodium, sulphide and hyposulphite, steel, sulphate of copper and cuprous powders, sulphates of soda, zinc, &c., sulphur dioxide (anhydride), rubber gloves, coal tar and its chemical products, telegraphs (material for), thorium, tin (in all forms), tools, chisels, picks, &c., tungsten (in all forms), vanadium ore, vaseline and mineral jellies, traction engines of all kinds, pneumatic tyres, wire (insulated), wolfram (tungsten) ore and metal (all forms), zinc, &c.

Uruguay.—It is stated that Señor Julio E. Rivero, of La Nacional Co., has secured the right to establish telephonic communication between Paysandú and Salto.

The "Teléfono Salteño" Co. (owned by Messrs. B. T. Carlevaro & Co.) have ordered the necessary materials for the construction of a branch connecting station at Chapicuy, where La Nacional Co. have an office. Communication between Paysandú Salto and Concordia is expected to be available very shortly.

Venezuela.—A consular report states that imports into Venezuela during the year ended June 30, 1914, included electrical appliances valued at £39,989.

Of this total the United States' contribution amounted to £24,161 and that of the United Kingdom and colonies to £11,928. British electrical apparatus imported showed an increase of £6,019.

Permission has been granted to Señor J. S. Afanadof to construct a telephone line (about 16½ miles in length) in the district of Ciudad Bolivar. Señor A. J. Miralles has also been authorised to construct a telephone line about 5 miles in length in the neighbourhood of Guama (State of Yaracuy).

The Venezuelan Government has granted permission to Senor Francisco Ramon Laguna to construct a telephone line, about 7½ miles in length, in the neighbourhood of Guama, State of Yaracuy.

Government permission has been granted to Senor Santiago Carcano to construct a telephone line 8½ miles in length in the San Sebastian and Ricaurte districts.

Water Power in Spain.—According to recent statistics, the use of water power in the generation of electrical energy continues to increase at a rapid rate.

The Spanish Electrical Union reports that, while only 50,000 H.P. was utilised in hydro-electric works in 1904, about 266,000 H.P. was employed in 1914. According to the Union, the River Ebro and its affluents are able to provide 1,130,000 H.P., the Duero 900,000 H.P., the Guadalquivir 750,000 H.P., the Tajo 700,000 H.P., the Guadiana 370,000 H.P. the Mino 250,000 H.P., the Jucar 190.000 H.P., and the Segura and its affluents 100,000 H.P., and the remaining rivers are estimated to be able to furnish a further quantity of 600,000 H.P.

MISCELLANEOUS NOTES.

British Industries Fair.—The Board of Trade have completed arrangements for holding a British Industries Fair at the beginning of next year on lines similar to those of the Fair organised by them at the Royal Agricultural Hall (London), in May last.

The fair, which will be opened on Monday, Feb. 21, and remain open until Friday, March 3, 1916, will be held in the buildings of the Victoria and Albert Museum, South Kensington, London, S.W. Only British manufacturers engaged in the china and earthenware, glass, fancy goods, toys and games, stationery and printing trades will be permitted to exhibit. Admission will be by invitation of the Board of Trade alone, and will be restricted to bona fide buyers for the various trades set out above.

Customs Decisions.—The following tariff classifications, which came into force on Feb. 5, have been decided upon by the Japanese Customs department :—

Electrical condensers under No. 547 (3) of tariff and water tube boiler, No. 570 (3), 25 per cent. ad val.

Garcke's Manual.—Though the publication of the 1915-16 edition (Vol. XIX.) of the "Manual of Electrical Undertakings and Directory of Officials" was made somewhat later than usual, it does not appear to have been otherwise affected by the abnormal conditions prevailing. This invaluable work of reference for the electrical industry is compiled under the direction of Mr. Emile Garcke, M.I.E.E., and the present volume contains statistical and general information (including full financial particulars, names of officials, &c.) relating to about 3,000 electrical undertakings.

Like preceding issues, the bulk of the Manual is occupied by particulars (technical, financial and personal) of all the electricity supply, electric traction, telegraph, telephone, manufacturing and miscellaneous undertakings in the United Kingdom and the colonies, by the directory of over 20,000 officials (including members of tramways and lighting committees), list of contractors, the classified Buyers' Directory, and by a mass of information on Government and statistical matters relating to the electrical industry. Notwithstanding the increased cost of production, no alteration has been made in the price of the volume, and it remains at 21s. net. The statistics, which have been carefully edited, enable the financier and investor to estimate the progressiveness or otherwise of the different sections of the industry. From the statistical "Survey of the Year" it is seen that the increase in the capital invested in electrical undertakings is only about half that of a year ago. The figures for electrical companies registered during the past year show the influence of war conditions even more strikingly, the total nominal capital of the new undertakings having increased less than £3,000,000, compared with over £11,500,000 a year ago. It is, however, reassuring to discover that the rates of return on electrical capital show an improvement in all sections save that of traction. The effects of higher tariffs, Treasury limitations as to capital, increased cost of coal, lighting restrictions and the demand for power are discussed. The electrical manufacturing figures for the past year reveal a very substantial advance in prosperity. The Manual also contains several special articles of importance in relation to the international struggle for electrical trade. Among the supplements are maps of the London and district electric supply undertakings, London electric railways, the areas of the Metropolitan Electric Supply Co., and numerous tramway and power supply systems. The large map of the United Kingdom, showing the situation of all lighting, power and traction undertakings, is again issued as a separate supplement, and it has been revised up to date. The Manual is published by the Electrical Press, 13-16, Fisher-street, Southampton-row, London, W.C.

Inquest.—On Tuesday an inquest was held at Eastbourne on E. Shadwell and Private T. Marshall, who were killed on Sunday as the result of a motor car coming into collision with a street box of the electric supply department.

Evidence was given that a motor car, with two nurses and three children, was being driven towards Pevensey Bay when it came into collision with a pillar box belonging to the municipal electricity supply department. The party in the car escaped serious injury, but one of the nurses received an electric shock.

Lieut.-Col. W. KEYWORTH gave evidence, and stated that he was driving behind the car. There were parts of switches and wires lying on the ground, and witness at first thought the car had run into a rubbish heap. The position of the wheels of the car pointed to the fact that apparently no effort had been made to turn the car from the left He had his hand on the car while he was talking to the chauffeur, but did not experience any shock. Subsequently he noticed some men stoop down to push the car. It did not move, and he suddenly heard screams. Two or three people leaped backfrom the car. One man was dragged across the road by some other people, and one man was clinging to a tree. A soldier was lying across one side of the bonnet of the car; one man in front of the car gave a movement or two, screamed and fell to the ground. He went to the electric light station with the chauffeur of the other car to ask them to switch off the current. The soldier lying across the bonnet must have been killed instantly, but the other man may have lived a few seconds. The broken switch pillar was under the front of the car when he came upon the scene.

Dr. M. V. MCKECHNIE stated that the injuries of the dead men were caused by coming into contact with the car through which a strong electric current was passing. He thought death was caused byelectric shock, and that the injuries resulted after death. The chauffeur was absolutely sober, but was suffering from severe nervous shock caused by his having had an electric shock. He told the chauffeur to stop helping the men. They wanted to pull the bodies from the car, and he told him to leave them alone, as he understood the current was still on. The bodies had, therefore, been allowed to remain on the ground until the electric current had been cut off.

The inquest was adjourned for further evidence.

New Defence of the Realm Regulations.—On Dec. 22 His Majesty in Council ordered that the Minister of Munitions may prohibit the holding of exhibitions or impose restrictions upon the holding of exhibitions of classes of goods (the products of any industrial manufacturing process or the machine tools and implements used in such process).

Reg. 7 of the Defence of the Realm Regulations applies, and one month's notice must be given of intention to hold such exhibitions.

The same Order in Council prohibits persons from entering factories, workshops or other places specified by the Admiralty, Army Council or Minister of Munitions as places which it is necessary to safeguard, except by obtaining a permit from the Admiralty, Army Council or Minister of Munitions.

Temporary Loans.—The L.G. Board have extended for one year from March 31, 1916, the time limited by the Halifax Corporation Act, 1911, for the borrowing by Halifax Corporation of money by way of temporary loan or overdraft for current expenses.

Maidstone Corporation have applied for a Provisional Order to authorise them to borrow money temporarily for the current expenses of any of their undertakings by way of loan or overdraft, and to charge any amount so borrowed upon the rates or upon any of their undertakings, and to borrow money to pay off moneys previously borrowed, &c.

Trade Unions and Strike Pay for Munition Workers.—The law officers of the Crown have given an opinion that the giving of strike pay to men in industries subject to the provisions of the Munitions of War Act is illegal, and that an action would lie at the suit of the Attorney-General against the union concerned for an injunction to restrain them from so applying any of its funds.

TENDERS INVITED.

Telephone Switchboard, Apparatus, &c.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms can be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W. *See an advertisement.*

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Coal-Handling Plant.

DARLINGTON Corporation require tenders by Jan. 12 for supply and erection of Coal Bunkers, Elevators, &c., at their electricity works. Specification from Borough Electrical Engineer.

Power House Extension.

ST. PANCRAS (London) Council require tenders by noon Jan. 10 for Steel Constructional Work of extension of power house. Drawings can be seen at 57, Pratt-street, Camden Town, N.W.

Switchboard.

MANCHESTER Corporation want tenders by 10 a.m. Jan. 5 for l.t. Switchboard for Stuart-street station. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical Supplies.

BRISTOL Guardians require tenders by noon Jan. 4 for Six Months' Supply of Electrical Fittings, Ironmongery, &c. Forms of tender, &c., from the Clerk, St. Peter's Hospital, Bristol.

ISLINGTON (London) Council require tenders by Jan. 21 for one year's supply of Transformers, Meters, Cables, Terminal, Service and Network Boxes, Lamps, Sundries, Arc Lamp Globes, Oils and Lubricants, &c. Specifications, &c., can be obtained at the Town Hall, Upper-street, N.

Electric Power Plant.

Tenders will be received at the Negociado Quinto de la Segunda Sección (Material) del Estado Mayor Central de la Armada, Ministerio de Marian, Madrid, until Jan. 26, for the Construction and Installation in the Cadiz Naval Arsenal of an Electric Power Plant. Conditions of tender may be seen at the above-mentioned Negociado. Tenders (in Spanish), on paper bearing a 1 peseta stamp, must be accompanied by specifications and plans. A provisional deposit of 20,000 pesetas (about £800) is required to qualify any tender. Local representation is necessary.

Electrical Stores, &c.

HAMPSTEAD (London) Council require tenders by 4 p.m. Jan. 6 for one or three years' supply of Electrical Engineers' Stores, Oils, Ironmongery, &c. Forms of tender from the Town Clerk, Town Hall, Haverstock Hill, N.W.

Electrically-operated Pumps.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1,301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Motor-Generator, Switchboard, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. Jan. 5 for a 15 kw. Motor-generator and Accessories, Switchboard and Connections), and by Jan. 12 for about 2,000 tons Steel Rails and 100 tons of Fish-plates Specifications, &c., from the Commissioners, Spencer-street, Melbourne.

Boiler.

The N.S.W. RAILWAYS & TRAMWAYS DEPARTMENT require tenders by noon Jan. 12 for supply, &c, of two Water-tube Boilers and Accessories at Newcastle Specifications from the Electrical Engineer, 61, Hunter-street, Sydney, N.S.W.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Electric Lighting.

SEGOVIA (Spain) Municipality require tenders by Jan. 20 for the installation and working for five years of an Electric Lighting System for the city. The contract will probably be awarded to a Spanish firm.

Electrification of Cranes.

Tenders will be received until Jan. 6 at the offices of the Junta de Obras del Puerto, Alameda de Mazarredo, 3, Bilbao, for the Electrification of Seven Movable 3-ton Steam Cranes and One Fixed 25-ton Steam Crane on the wharves at BILBAO. Local representation is necessary.

Electric Tramway.

Tenders will be opened on Jan. 28 at the Dirección General de Obras Públicas, Ministerio de Fomento, Madrid, for the Construction and Working, for 60 years, of an Electric Tramway in Madrid (Monte del Pardo district). Minimum rolling stock required, three motor coaches and three trailers. The concession is held by the Sociedad Tranvia del Este de Madrid.

TENDERS RECEIVED AND ACCEPTED.

GLASGOW.—The Tramways Committee recommend the Council to accept the tender of British Insulated & Helsby Cables for trolley wire.

ILFORD.—The tenders of W. T. Henley's Telegraph Works Co. (at £2,260. 4s. 6d.) has been accepted by the Council for the supply of 3,387 yds. of triple concentric cable, and at £59. 4s. 4d. for joint boxes. Eleven tenders were received, the lowest being accepted.

SYDNEY (N.S.W.).—The City Council have accepted the following tenders :—

H. Perks, feed-water heaters, £860 ; H. Vale & Sons, c.i. pipes and valves, £93. 5s. ; Wm. Adams & Co., turbine oil, 3s. per gallon ; Warburton, Franki (Ltd.), milking boosters, £347. 7s. 6d.

The Council have also been recommended by their Electric Lighting Committee to purchase (under existing contracts) 50 tons of pitch compound from Biturine Lavers (Ltd.), at £250 ; 100 miles 19/16 and 100 miles 19/14 bare copper cable from British Insulated & Helsby Cables. at £12,472. 18s. 7d. ; and 40,000 yds. ditto from Haes & Eggers, £5,500,

The Council have also accepted tenders of Dalgety & Co. for three Baker electric wagons fitted with Edison A10 cells, £1,180 each ; N. Guthridge for 200 kw. Bruce-Peebles motor converter, £8,737 : Babcock & Wilcox for extension of suction ash handling plant, £650 ; Standard Waygood Hercules for 58 motors, £2,996 ; and also decided to purchase, under existing contracts, from N. Guthridge three 100 k.v.a. transformers, £396 ; one 200 k.v.a. ditto, £190 ; three 200 k.v.a. ditto, £570 ; one 100 k.v.a. ditto, £132 ; 10,000-volt feeder panel, £154. 16s. ; one ditto, £150. 6s. ; two ditto, £241. 8s. ; British General Electric Co., two 415-volt transformer panels, £93. 14s. ; one 415-volt summation panel, £71. 18s. ; two ditto, £91 ; British Westinghouse Co., four 415-volt distributor panels, £212 ; one l.t. summation panel, £86 ; one 415-volt transformer panel, £65. 10s. ; one 5,000-volt ditto, £139 ; Australian General Electric Co., one 100 k.v.a. transformer, £202. 16s. ; one 100 k.v.a ditto, £238. 16s.

New Zealand Government.—The Public Service Tender Board have accepted the tender of Turnbull & Jones (lowest tender) for 120 miles of copper cable, at £3,460. (Seven tenders received, highest being £4,269.)

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL, ST. ANNE'S & LYTHAM TRAMWAYS CO. (LTD.)—At the recent meeting the directors reported an increase in receipts and that the trustees for the debenture holders had intimated their intention of distributing 4 per cent. interest on account of arrears upon the debenture stock. Traffic receipts were £34,871. 13s. 2d. and net receipts £29,158.19s., profit being £7,594. The chairman (Mr. Geo. Nicholson) described the balance-sheet as the most satisfactory since the inception of the company. The receipts showed an increase over last year of £4,300, due to the fine weather in September and October. Sixty-three of the staff had joined H.M. Forces, three had been killed in action and six wounded. In consequence they were employing 30 girl-conductors who had given every satisfaction. So far they were really paid at a wage higher than the men, for they worked shorter hours.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—After appropriating £167,888 for renewals maintenance the accounts for the year ended June 30 show a net profit of £180,661. After making certain appropriations the available sum, including £6,884 brought forward, and £60,000 transferred from reserve fund (reducing it to £483,002) is £247,546 out of which interest on debentures and debenture stock, the preference dividend and a distribution of 2½ per cent. on the preferred ordinary stock have been paid, leaving £6,666 to be carried forward. For the previous year 6 per cent. was paid on the preferred ordinary and 8 per cent. on the deferred ordinary stock, with the assistance of £10,000 from the reserve fund.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.).—At the recent meeting the chairman (Mr. G. A. Touche, M.P.) said that though the outlook at the time of the last meeting was not encouraging it was now distinctly better. Business was adjusting itself to new conditions and confidence was returning. The recent crop reports were favourable, the rains had been sufficient, and the prospects for both wheat and maize were excellent. The indications were that the present improvement would be maintained. From the beginning of April an improvement in their receipts set in, and their gross receipts for the whole year fell short of those for the previous year by less than 2 per cent. For the year to Sept. 30 the gross receipts of the combined businesses were £157,590, against £160,420 in 1914 and £154,050 in 1913. Operating expenses were £1,360 higher than last year, partly due to an increased percentage payable to the Government, and the net receipts were £83,320, against £87,510. In regard to the Light & Power Co., in spite of the adverse conditions, the net receipts were up by £1,090. The stagnant condition of business during the first half of the year bore more heavily upon the Tramway Company than upon the Light & Power Company, and the tramways were taking longer to recover. Although they had 31 miles of track open (1 mile more than last year) the car-kilometres run were very nearly the same as in 1914. The net receipts were £25,680, against £30,960, and the percentage of expenses to gross receipts was 62·8, against 58·6 per cent. The balance profit was £19,035, against £20,819. Adding £19,035 brought forward, they had £45,355. The dividend on the preference shares had been paid in February, and it was proposed to pay a further dividend for the eight months to Sept. 30, leaving £26,580 to be carried forward. The Treasury Committee had sanctioned the issue of £500,000 new promissory notes for a period of three years, and these had been placed.

ISLE OF THANET ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—At the recent meeting it was reported that the profit for the year ended Sept. 30 last was £10,950, compared with £18,003 in 1914 and £21,630 in 1913. Owing to the absence of workers and the lighting restrictions the tramway and electric supply receipts were adversely affected. The directors hope to reduce expenses during the current year, but the high price of coal, the increased cost of labour and materials militated against the attempt to reduce working expenses. Notwithstanding the adverse conditions prevailing, the profits were sufficient to pay all interest charges and to allow of £974 being carried forward. The directors did not find themselves justified in making the payment of 2½ per cent. on the preference shares foreshadowed in their last report. The prospects of the undertaking were most promising before the outbreak of the war; they had just completed large extensions of generating plant, and they were in an excellent position to meet the growing demands for electric light power and heating and also the increasing traffic on the tramways.

At the meeting, Mr. A. R. Monks, who presided, said that they had to carry on their business under very trying conditions. Although all seaside resorts had suffered, none had been more affected than the Isle of Thanet. They had spent £805 in connecting 50 new electric light consumers, and the return on that outlay was very good. Generally, the company was sounder than it had been for many years past. 63 of their men had gone to the front, and of those remaining 93 per cent. (including Mr. Ford, their manager) had been attested under the Derby scheme.

MANX ELECTRIC RAILWAY CO. (LTD.)—Sir W. H. Vaudrey, who presided at the recent meeting, moved the adoption of the report and accounts for the year ended Sept. 30 last, which stated that the gross receipts were £7,513 and the expenses £11,273. The holiday season was the poorest on record, and the summer traffic was no better than in an ordinary winter. The passengers carried were only 104,224, compared with 496,568 in the previous year, and 704,188 in 1912-13. Debenture interest for the first half of the year had been paid, but for the second half 5 per cent. second debentures had been issued in lieu of payment.

RUTHIN ELECTRIC SUPPLY CO. (LTD.)—The first annual meeting was recently held, when it was reported that, although only inaugurated nine months ago, the progress made had been remarkable, and the number of consumers connected to the mains exceeded the promoters' expectations. A number of consumers who had installed the light initially upon a prudent and conservative basis, finding the experiment satisfactory, had been gradually increasing their installation until they had electric light throughout their premises, and so great had been the demand for those extensions that it had been difficult to keep pace with it. There is also a demand for power, and several motors had been installed for a variety of purposes, such as driving mineral water machinery, propelling a fan for organ blowing, chaff cutting, driving machines in butchers' shops, and for various domestic purposes. The generating plant includes a "Fielding" suction gas engine and a dynamo capable of supplying 1,700 lamps of 25 c.p. each, and there is a battery of 127 Premier accumulators of 630 ampere-hour capacity.

NEW COMPANIES, STATUTORY RETURNS, &c.

NEW COMPANIES

ELECTRICAL MANUFACTURERS CO. OF GREAT BRITAIN (LTD.) (142,475.)—Reg. Dec. 31, capital £12,000 in £1 shares, to carry on in Russia or elsewhere the business of commission, commercial and general agents, contractors, merchants, engineers, shipowners, importers, exporters, sellers and manufacturers of and dealers in machinery, rolling-stock and hardware of all kinds, and to adopt an agreement between Bruce, Peebles & Co., Crompton & Co., the Lancashire Dynamo & Motor Co., Allen, West & Co', Brook, Hirst & Co., Eckstein, Heap & Co., Whipp & Bourne and the company. The signatories are E. H. F. Reeves and H. C. Siddeley. Private company. First directors are J. H. Bunting, E. H. F. Reeves, H. C. Siddeley, W. J. Hoggridge, J. A. Hirst, A. Eckstein and S. Whipp. The fitst directors are the respective nominees of the above-named firms, and each may retain office during the pleasure of the firm nominating him. Reg. office, 28, Victoria-street, S.W. 1

INSTITUTION OF LOCOMOTIVE ENGINEERS ("Limited" is omitted from title by licence of Board of Trade.) (142,398)—Reg. Dec. 14 as a company limited by guarantee (not formed for purpose of profit), with not more than 500 members, each liable for £1 in event of winding up, to advance the science and practice of locomotive engineering by discussion, research, experiment and other means, the diffusion of knowledge regarding locomotive engineering by means of lectures, publications, exchange of information and otherwise, and the improvement of the status of locomotive engineer, &c. The subscribers are: A. J. Hill, F. H. Trevithick, M.Inst.C.E., C. A. Suffield, W. A. Lelean, A. Woolford, W. J. Bennett and G. F. Burtt. Members are to be classified as "members," "associate members," "associates," "honorary members" and "graduates." The council is to consist of the president, six vice-presidents and not less than 12 nor more than 20 ordinary members. The first members of the council are A. J. Hill, E. L. Ahrons, A. R. Bennett, W. Beckett Burme, B. K. Field, C. N. Goodall, W. J. Bennett, A. C. C. Dumont, R. Dougal, J. F. Games, J. M. Jackson, W. A. Lelean, S. P. Smith, J. H. Stirling, C. A. Suffield, F. Turner, M. Weiss, S. H. Whitelegg and A. Woolford. Secretary: G. F. Burtt. Reg. office: 46, Malling-street, Lewes, Sussex.

TURNER & CO (CROYDON) (LTD.) (142,507.) Reg. Dec. 22, capital £2,000 in £1 shares, to take over the business carried on by F. W. Pearson as Turner & Co., and to carry on the business of constructional, mechanical, electrical, ventilating, telegraphic and general engineers, manufacturers of and dealers in vehicles, including motor-cars, boats, &c. Private company. First directors are F. W. Pearson, A. W. Welstead, A. J. Mabey and A. J. Mabey, jun. Reg. office, 16, Park-street, Croydon.

STATUTORY RETURNS.

EVERSHED & VIGNOLES (LTD.) Return to July 9 gives capital as £30,000 in £10 shares. All shares taken up. £30,000 paid. Mortgages and charges, £15,000.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—According to return to Sept. 20 capital is £40,000 in £5 shares. All shares taken up. £30,000 considered as paid. Mortgages and charges, nil.

HYDRO-ELECTRIC POWER & PUBLIC SERVICE TRUST CO. (LTD.)—In return to Dec. 31, 1914 (filed Nov. 3, 1915) capital is £500,000 in £5 shares. Seven shares taken up. Nothing called up. Mortgages and charges: Nil.

INTERNATIONAL DOWSING ELECTRIC HEATING & APPLIANCES CO. (LTD.)—Return to Dec. 31, 1914 (filed Aug. 11, 1915) gives capital as £20,000 in £1 shares. 18,107 shares taken up. Norhing called up on seven shares. £18,100 considered as paid. Mortgages and charges, nil.

LINATHODE (LTD.)—In return to Nov. 5 capital is £3,000 in £1 shares 3,000 shares taken up (of which 225 have been forfeited). £2,340 paid (including £65 paid on forfeited shares). £500 considered as paid. Mortgages and charges, £1,600.

LIVERPOOL ELECTRIC CABLE CO. (LTD.)—According to return to July 22 capital is £20,000 in £1 shares. All shares taken up, and £7,833 paid. £12,167 considered as paid. Mortgages and charges nil.

LLANGOLLEN & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—Capital in return to Sept 21 is £6,000 in 3,500 ordinary and 2,500 preference shares of £1 each. 2,114 shares taken up. £2,110. 15s. paid. Mortgages and charges, £2,800.

MALAGA ELECTRICITY CO. (LTD.)—Return to Sept. 24 gives capital as £57,000 in 10,000 ordinary shares of £5 each and 7,000 deferred shares of £1 each. All shares taken up. £50,000 paid. £7,000 considered as paid. Mortgages and charges, £34,131.

MANAOS TRAMWAYS & LIGHT CO. (LTD.)—Return to Sept. 14 gives capital as £300,000 in £1 shares. All shares taken up. £100 paid. £299,900 considered as paid. Mortgages and charges: £293,900.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—According to return to July 21 capital is £350,000 in £1 shares. 306,084 shares taken up. £201,084 paid. £105,000 considered as paid. Mortgages and charges: £121,880.

NEW ST. HELENS & DISTRICT TRAMWAYS CO. (LTD.)—Return to Nov. 12 gives capital as £150,000 in £5 shares (20,000 preference), 15,980 preference and 9,000 ordinary shares taken up. 125,410 paid (including £510 on 1,020 shares forfeited). Mortgages and charges nil.

NORTH MELBOURNE ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Capital in return to July 16 (filed Sept. 2) is £200,000 in £1 shares (100,000 preference). 67,257 preference and 100,000 ordinary shares taken up. £52,257 paid. £115,000 considered as paid. Mortgages and charges, £167,000.

NATIONAL CONDUIT & CABLE CO. (LTD.)—Capital at Oct. 14, was £1,000 in £1 shares. All shares taken up, and £7 paid. 993 considered as paid. Mortgages and charges nil.

NEWTONS LIMITED.—Return to Oct. 5 gives capital as £40,000 in £10 shares. 3,265 shares taken up and £18,650 paid. £14,000 considered as paid. Mortgages and charges, £14,000.

PACIFIC & EUROPEAN TELEGRAPH CO. (LTD.)—At Nov. 23 capital was £100,000 in £10 shares. All shares taken up. £4 per share called up. £40,000 paid. Mortgages and charges, £68,400.

MORTGAGES AND CHARGES.

ARDEE ELECTRIC CO. (LTD.)—Particulars of £2,000 debentures, created July 28, 1915, have been filed, whole amount being now issued. Property charged, company's undertaking and property, present and future. No trustees.

W. A. CREEDON & CO. (LTD.)—Debenture dated Dec. 2, 1915, to secure £200, charged on company's undertaking and property, present and future. Holder, I. Staal.

RECEIVERSHIP.

WHITSTABLE ELECTRIC CO. (LTD.)—Notice of appointment of S. G. Leech, 91, York-street, S.W., as receiver and manager on Dec. 14, 1915, under powers contained in debenture dated Aug. 13, 1914, has been filed.

CITY NOTES.

MEMORANDA (Dec. 29).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58½. Consols Pay Day, Jan. 5. **Stocks and Shares Ticket Days Jan. 12 and 26. Pay Days Jan. 13 and 27. Price of silver, 26d.**

BURMAH ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—A dividend of 5 per cent. has been declared on the 6 per cent. preference shares for the period from Feb. 1, 1906, to Nov. 30, 1906 (leaving 52 per cent. in arrear), adding £2,000 for depreciation, and carrying £842 forward.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—An interim dividend at rate of 6 per cent. per annum has been declared for the half-year ended Sept. 30.

CHILI TELEPHONE CO. (LTD.)—The directors announce an interim dividend at the rate of 6 per cent. per annum (tax free) for the past half-year, payable 16th prox.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Dec. 17:—

Collieries Electric Power Development Synd., Dimming Switch Co., Duplex Radiators, Electric Speller, Engineering Equipment, Exhibition Advertising Co., Homer Earphone Co., Horsfall Destructor Co., Hydro-Electric Lift & Crane Co., London Electric Treatment Co. (1911), Magnet Galvanising & Plating Co., Universal Patents Bureau, Vogt Engines.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The directors have declared an interim dividend of 5 per cent. (1s. per share) less tax, on account of the current year.

MEXICO ELECTRIC TRAMWAYS (LTD.—Coupon No. 35 (due 1st prox.) on the 5 per cent. first charge debentures to bearer, will be paid on and after that date at 34, Bishopsgate, London, E.C.

SIEMENS & HALSKE A.G. (BERLIN.)—It is announced that this company has paid a dividend of 12 per cent. for the year ended July 31 last, compared with 10 per cent. for the year 1913-14.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The directors have declared a 10 months' dividend at rate of 6 per cent. per annum (less tax) on the preference shares, thus paying the dividend up to Feb. 28, 1915.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—Sir Alexander F. King, K.C.B., has been appointed chairman of this company, in succession to Mr. Walter B. Kingsford, and Sir Timothy A. Coghlan, I.S.O., has been elected to fill the vacancy on the Board.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Dec. 28. The greatest care is taken in compiling the figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Dec. 28.	Rate % per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 9 4	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅛	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	83½†	4 15 10	Jan, July
5	2/3	Do. 4½% Pref.	3 5/16	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	3¾	6 0 0	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90†	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar, Sept
10	6%	Do. 6% Pref.	10½	5 18 6	Feb, Aug
St.	4½%	Do. 1st Deb.	90½	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77	5 16 11	July
5	9%	Kensington and Knightsbridge Ord.	6 5/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½†	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 3/32	7 10 11	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/32	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 5/8	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 3/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 1/32	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3⅛	6 0 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80	6 5 0	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70	5 14 3	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99¾	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93⅛	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅞	5 11 4	May, Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	5%	London Electric Ry. Ord.	1 3/16	4 0 0	Jan, July
St.	4%	Do. 4% Pref.	59½	6 14 5	Mar, Sept.
St.	4%	Do. 4% Debs.	85†	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24⅜	4 10 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	66½	6 15 10	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	108½	5 10 7	Jan, July
St	4%	Do. 4% Debs.	72†	5 11 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	73†	5 9 7	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅝	..	..
1/0	..	Do. A Ord.	¼	..	..
St.	6%	Do. 6% Inc. Debs.	104⅜	5 14 8	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name.	Price, Tues., Dec. 28.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways —*cont.*		£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	77⅜	7 14 4	Mar, Sept
..	4½%	Do. 4½% Bds.	100⅜	4 19 4	Jan, July
5	..	Yorkshire W. Riding Ord.	⅛	..	March
5	6%	Do. Pref.	4 1/16	6 19 6	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2½	5 19 6	Apl, Oct
1	6%	Do. 6% Pref.	1⅛	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1 3/16	4 7 5	Mar
100	5%	Do. Prior Lien Debs.	91	5 9 11	Jan, July
1	6%	Do. 6% Pref.	⅜	7 2 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10 7/16	7 2 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅛	5 14 3	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	1⅞	8 0 0	April
100	6%	Do. 6% Prior Lien Debs.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	10⅛	7 1 2	Jan, July
5	2/6	Do. 5% Pref.	4⅛	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3 3/32	6 9 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	5 5/16	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅞	..	Feb, Aug
St.	4%	Do. 4% Deb.	62½	6 8 6	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	3/16	7 4 6	Jan, July
St.	4%	Do. 4% Debs.	72½	5 10 4	Jan, July
..	10%	General Electric Ord.	10 5/16	9 11 1	July
10	6%	Do. 6% Pref.	9⅛	6 3 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	5%	India Rubber, G. P. &c., Ord.	9 3/16	5 9 11	Feb, Aug
10	5%	Do. Pref.	7½	6 13 4	Apl, Oct
100	4%	Do. 4% Debs.	95	4 4 3	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34⅛	7 1 0	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1 1/16	4 5 11	May, Aug
1	6d.	Do. 5% Pref.	1/16	5 6 5	May, Aug
St.	4%	Do. 1st Debs.	83⅞	4 15 4	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99⅜	4 10 3	Jun, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	101½	5 18 3	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23	6 10 5	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70	5 14 3	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	6 1/16	6 9 4	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	128½	5 8 11	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	80⅞	4 18 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 11	Feb, Aug
10	7%	Do. Ord.	12 1/16	5 11 5	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 8.	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	48⅛	6 13 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 10 4	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1/16	9 8 3	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 5	May, Nov
10	7%	Western Telegh. Co.	12⅛†	5 12 3	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99⅛	4 10 4	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	134⅞	5 18 9	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	74	6 15 2	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	5 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101	4 9 0	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Dt. St.	79⅛	5 0 8	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85	5 5 11	Jan, July
5	8%	United River Plate Ord.	6	6 13 4	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4 7/32	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10 1/16†	5 16 0	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10 1/16†	5 15 9	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	86 3/8†	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	68⅛†	5 17 3	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	8⅞	6 4 10	Jun, Dec
St.	4½%	Do. 4½% Debs	79⅛	5 18 6	Jan, July
St.	4%	Do. 4% Debs.	74	5 8 1	Jan, July
5	2/9	Do. 5½% 1st Pref.	4⅛	6 13 4	Jan, July
5	2/9	Do. 5½% 2nd Pref.	3⅛	8 0 0	Jan, July
100	2%	Brazilian Traction Ord.	5⅛	7 17 7	Fb,M,Aug,N
100	$1⅛	Do. 6% Pref.	91⅛†	6 11 6	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅛	6 14 3	May
5	2/6	Do. 5% Cum. Pref.	4⅛	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	62⅛	6 16 0	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅛	7 15 1	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	90⅛	5 10 6	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅛	6 2 4	..
100	5%	Manaos Trams 5% Debs.	6⅜	7 4 11	Jan, July
..	..	Mexico Trams Common St.	42	..	Ft,M,Aug,N,
..	5%	Do. 5% Bds.	45⅛	10 12 4	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94⅛	4 15 6	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	77⅞	6 8 7	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	95	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	1 1/16	5 19 3	..
St.	4½%	Do. 4½% Debs.	87⅛	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4⅛	5 17 8	Mar, Sept
..	7%	Canadian Gen. Elec. Common St	119⅛	5 18 2	Ja,Apl,Jly,O
St.	5%	Melbourn eElec. Supply 5% 1st Mt. Debs	93	5 7 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96⅛	5 3 8	Apl, Oct
..	..	Mexican Light & Power Ord.	29⅛	..	Ja,Apl,Jly,O
..	..	Do. Pref.	39⅛	..	May, Nov
•	5%	Do. 5% Bds.	48⅜	10 15 1	Jan, July
..	5%	Shawinigan Water & Power 5% Bds.	104⅛	4 15 5	Jan, July
..	6%	Do. Cap. Stock	140⅛	4 5 7	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	80	5 12 6	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	..	..	Jan, July
—	5½%	Do. 5½% 2nd Mort. Debs.	93⅛	5 17 4	Jan, July

* And 13½% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Dec. 28, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14½d.
Solid Drawn Copper Tubes	14½d.
Brazed Copper Tubes	14½d.
Brazed Brass Tubes	16½d.
Brass Wire	13⅝d.
Copper Wire	13½d.
Rolled Brass	13⅝d.
Brass Sheets	14⅛d.

	per ton.
Copper Sheets	£114 0 0
Spelter	£88 0 0

	per ton.
English Lead	£29 15 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£76 10 0
Brazlery Copper Scrap	£70 0 0
Clean Scrap Brass	£58 0 0
Old Lead	£24 0 0
Old Zinc	£54 0 0
Hollow Pewter	£115 0 0
Black Pewter	£75 0 0
Gun Metal	£70 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Dec. 28, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£125 0 0
Clean Mixed Brass	£58 0 0
Clean Copper	£75 0 0
Brazlery Copper	£69 0 0
Gun Metal	£70 0 0

	per ton.
Old Lead	£24 0 0
Tea Lead	£22 0 0
Old Zinc	£56 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 22	1,709	+ 158	29	52,743	+ 2,897
Anglo-Argentine	„ 23	52,156	— 609	29	2,607,179	— 133,550
Ashton-under-Lyne	„ 18	435	+ 43	38	18,160	+ 1,339
Ayr Corporation	„ 25	256	+ 36	32	12,787	+ 711
Birkenhead Corporation	„ 26	1,422	+ 167	39	53,203	+ 4,282
Birmingham Corporation. Trams	„ 18	15,600	+ 2,841	38	535,978	+ 76,504
Birmingham Corporation. Buses&c.	„ 18	750	+ 81	38	31,894	+ 18,149
Blackburn Corporation	„ 22	1,128	+ 67	39	49,568	— 216
Blackpool Corporation	„ 23	689	+ 40	39	68,094	+ 1,721
Blackpool and Fleetwood	„ 25	316	— 39	51	38,628	— 390
Bolton Corporation	..	..	..	..	..	..
Bournemouth Trams	„ 22	1,895	+ 52	38	80,801	+ 3,803
Bournemouth Buses	„ 22	10	+ 3	38	916	— 97
Bradford Corporation	..	..	..	..	..	..
Brighton Corporation	„ 26	954	+ 40	39§	43,909	+ 379
Bristol Trams Trams	„ 24	6,312	+ 1,496	51	242,472	+ 7,219
Bristol Trams Buses,&c.	„ 24	6,386	+ 1,487	51	251,322	+ 46,494
Burmah E. Trams & Ltg.	„ 25	R3,506	+ R391	..	..	..
Burnley Corporation	„ 25	1,700	+ 44	12	29,264	+ 2,182
Burton Corporation	„ 26	315	+ 7	39	11,013	+ 403
Bury Corporation	..	..	..	..	..	..
Calcutta Tramways Co.	„ 25	R67,838	+ R5,264	..	..	..
Camborne-Redruth	„ 18	140	+ 17	49	6,899	+ 92
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	„ 23	496	— 34	51	25,457	— 10
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
•Derby Corporation	„ 25	1015	+ 25	39‖	40,506	+ 1,285
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	..	..	..	..	..	..
Dublin United	„ 24	6,938	+ 563	51	311,437	+ 11,072
Dundee Corporation	„ 22	1,331	+ 86	32§	43,122	+ 2,297
East Ham Council	„ 25	1,359	— 43	38‖	50,319	+ 5,394
Exeter Corporation	„ 24	391	+ 54	38	14,646	+ 646
Glasgow Corporation	„ 25	22,290	+ 2,033	30‡	646,360	+ 46,139
Glossop Trams	„ 25	132	+ 19	52	6,522	+ 328
Gloucester Corpn.	„ 22	315	— 13	38	12,718	+ 107
Halifax Corpn. Trams	„ 21	2,010	+ 28	38	85,100	+ 907
Halifax Corpn. Buses	„ 21	41	— 2	38	1,870	— 6
Hastings Elec. Trams Co.	„ 23	849	+ 66	51	88,380	— 330
Huddersfield Corpn.	„ 18	2,437	+ 156	37	100,604	+ 14,373
Hull Corporation	„ 25	3,217	+ 122	38	118,322	— 2,303
Ilford District Council	..	..	..	..	..	..
Ilkeston Corporation	„ 22	128	+ 8	38	5,125	+ 93
Ipswich Corporation	„ 25	499	+ 68	37	21,264	+ 3,400
Isle of Thanet Co.	„ 25	253	— 49	12¶	3,159	— 968
Kilmarnock Corporation	..	..	..	..	..	..
Lanarkshire Trams Co.	„ 23	1,984	+ 258	51	100,948	— 6,067
Lancashire United	„ 22	1,546	+ 44	51	87,875	+ 5,265
Leeds Corporation	..	..	..	..	..	..
Leicester Corporation	„ 25	3,258	+ 322	52	156,661	+ 9,621
Leith Corporation	„ 25	749	+ 81	32	24,648	+ 1,577
Lincoln Corporation	„ 25	152	+ [illegible]	39	5,453	+ 615
Liverpool Corporation	„ 25	14,283	+ 1,058	51¶	684,156	+ 11,804
Llandudno&ColwynBayR.	..	..	..	..	..	..
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	„ 23	204	— 2	38	8,446	+ 254
Manchester Corporation	„ 25	17,467	+ 899	38	689,289	+ 21,732
Nelson Corporation	„ 25	188	— 4	38‖	7,107	+ 296
Newcastle-on-Tyne Corpn.	„ 25	5,920	..	39	241,754	..
Newport (Mon.) Corpn.	„ 18	818	+ 81	38	31,[illegible]	+ 610
Northampton Corporation	„ 24	794	+ 170	38¶	28,032	+ 4,918
Nottingham Corporation	„ 23	3,804	+ 122	38	142,936	+ 10,06[illegible]
Oldham Corporation	„ 26	1,978	— 268	40	90,710	+ 3,640
Portsmouth Corporation	„ 18	2,104	+ 15	38	94,953	..
Preston Corporation	„ 22	1,007	— 91	38••	37,003	+ 1,470
Reading	„ 25	1,659	— 54	39¶	65,869	+ 2,832
Rotherham Corporation	„ 22	1,216	+ 245	38	44,370	+ 5,35[illegible]
Salford Corporation	„ 27	5,193	+ 432	39‡	201,627	+ [illegible]
†Sheffield Corporation	„ 26	8,830	+ 221	38‖	354,247	+ 48,[illegible]
Southampton Corpn.	„ 22	1,841	+ 177	38	[illegible]	+ [illegible]
Southend Corporation	„ 22	623	— 72	38	31,979	— [illegible]
Southport	„ 18	728	- [illegible]	38	[illegible]	+ [illegible]
St'lyb'dge,Hyde,&c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	„ 26	1,625	+ 72	39	58,337	+ 73[illegible]
Sunderland District	„ 22	543	+ 21	8	4,[illegible]	+ [illegible]
Swindon Corporation	„ 22	166	+ 4	38	7,633	+ [illegible]
Tyneside Tram Co.	„ 18	479	— 13	24	14,421	— [illegible]
Wallasey Corporation	„ [illegible]	1,182	+ 95	38‖	49,727	+ [illegible]
Walsall Corporation	„ 25	881	+ 84	52	38,533	+ [illegible]
Wallasey Tram	„ 26	806	+ 36	39	34,915	+ [illegible]
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	..	..	..	..	..	..
West Hartlepool Corpn.	..	..	..	..	..	..
Wolverhampton Corpn.	„ 22	1,175	+ 24	12	13,122	+ 1,10[illegible]
Yorkshire W.R. Trams	„ 26	1,726	— 2	52	81,929	+ 6,6[illegible]

(a) These comparisons are with the corresponding period last year. • Partly electrical. † Includes omnibuses, &c. ‡ Minus 2 days. ‖ Minus 3 days. § Plus 3 days. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 483
Arrangements for the Week .. 486
Electric Traction on the Giovi Line. Illus.—*Concluded* .. 487
Some Difficulties in the Design of High-Speed Generators. Illustrated.—*Discussion* 488
Report on the Work of the Technology Department of the City & Guilds of London Institute 492
The Estimation of the Dispersion Coefficient of Three-Phase Induction Motors and its Application to their Design. By E. A. Biedermann, B.Sc., A.M.I.E.E. Illustrated.—*Concluded* 493
Electric Cooking at Euston Station. Illustrated 498
New Electrical Companies in 1915 499
ELECTRIC TRACTION IN 1915 .. 500
Electrical Railways. By H. M. Hobart. Illustrated. *Continued* 501
CORRESPONDENCE 505
The Swedish General Electric (Ltd.) (W. J. Turner).
Water Power in Russia. By P. Gurewitch. Illustrated 505
Public Companies Wound-up, Dissolved, &c., in 1915 508
The "Electrician" Commercial and Industrial Section .. 509–516

NOTES.

High-Speed Generators.

THE Paper on this subject, which was read by Prof. A. B FIELD before the Institution of Electrical Engineers, was well received in London and at the various local sections of the Institution, and it gave rise to informative discussion. From an account given elsewhere in this issue it will be seen that each of the speakers who took part in the discussion contributed something of value, and many interesting facts were brought to light. Several speakers stated that solid rotors could be readily obtained in this country, and gave the results of tests on specimens cut radially, tangentially and longitudinally from the forgings. This is creditable alike to the steel-maker and to the forge-master. The very heavy machining to be done on the rotors tends to release the unknown internal strains. Given a suitable material, presses sufficiently powerful and men skilled in the art of heat treatment, there can be no question as to the superiority of the solid rotor over the built-up rotor. The former shows an appreciable saving in first cost, though probably not as great as stated by one of the speakers. The three-part coil wedge described by Prof. FIELD came in for a good deal of criticism, and alternative arrangements were proposed. From the point of view of the manufacturer such wedges may be ideal, but the user also is a man of ideals, and it does not follow that the ideal of the manufacturer will coincide with that of the user. The question of ventilation received a good deal of attention, and from the discussion it is evident that many of our engineers have the matter well in hand. This is as it should be, for it is not at all unlikely that in the near future the mechanical and electrical problems connected with the design of dynamo-machines will be of secondary importance in comparison with the thermal problems. In addition to its merit as a sound piece of work the Paper has shown that matter connected with heavy engineering is welcomed. In the past far too much attention has been given to subjects of a relatively trifling nature, with the result that our competitors and rivals have done the *engineering*. We look forward to many such Papers.

Excavations in Streets.

THE recent breakdown at Finchley by which the electricity supply was completely disorganised, brings into prominence the risk which is attendant upon the opening of streets for the laying of pipes, mains or for other purposes. The procedure which is so often followed at the present day seems to be for any body, with the necessary powers, to break up the streets without consultation with those who have similar interests. The result is that an irresponsible stroke of a pick may cause a serious breakdown in the mains, as was the case at Finchley; or it may be that a water main is perforated. The latter was the case recently at Brighton where a large water main suffered in this way, and a great deal of damage was the result. In some undertakings we believe it is the practice for notice to be given of excavations, and it appears to us that this is the commonsense and businesslike method to follow. When this is done the representative of the electricity department, or it may be the water department, can be present at such excavations, and can thus save damage which might run into hundreds or thousands of pounds. Alternatively, a representative of the highways department could be present, it being assumed that the exact position of every supply main and pipe is marked on the plans stored in the archives of the department. By so doing, not only would the loss caused by material damage be minimised, but the dangers attending interruption of supply of any of the public services would also be eliminated.

City and Guilds Examinations.

FEW documents make more interesting reading than the Annual Report of the Department of Technology of the City and Guilds of London Institute. For 35 years or more this department, unhonoured and unsung, has attended to the needs of those who, in the main, have had to acquire their technical education by attending evening classes, at considerable personal inconvenience and after a long day's work in the shops or factories. From experience we know the value which the student attaches to the certificates, medals and prizes awarded annually by the City and Guilds, and we hope the day is far distant that will see the abolition or curtailment of the examinations. Rather do we hope to see the people of this country alive to the importance of technical education, and to see those in a position to give support and encouragement to the work to give generously and to give again. Relatively easy examinations in technology serve a two-fold purpose. They enable one to determine the number of students for whom it is desirable to provide higher technological education so as to equip them for positions of responsibility in the industrial world, and they act as a kind of barometer, giving as they do an approximate idea of the influence of education on indus-

trial development. For instance, from the statistical section of the report it appears that there were twice as many candidates in telephony as in the whole of the chemical and allied trades combined, and in glass making there were no candidates. To the examinations already held in electrical engineering subjects we should like to see radiotelegraphy added.

It is curious to find a higher percentage of failures in the electrical engineering examinations than in any of the others, and we venture to think that to some extent this is due to a faulty syllabus and to faults on the part of the examiners. It takes five years to teach a student the A B C of one branch of electrical engineering, and there should be an examination at the end of each year. Each of the first four of these examinations should be in two parts, one on continuous currents and the other on alternating currents, and should cover the principles of the subject. The fifth year examination (to which no candidate would be admitted till he had obtained a pass in the fourth year) should be divided into sections as at present. Taking as an example the section on machinery and apparatus, the examination should consist of three parts, namely: A general Paper (common to all sections), a Paper on design, construction, testing and performance of machinery and apparatus (alternating current *or* continuous current) with a wide range of questions, and a practical Paper on the drawing-office side of design in which the candidate would be given a month to prepare the drawings. In all years credit should be given for attendance, for home work and for note-books. We stated above that to some extent the fault was due to the examiners, and the Papers set in the final examination will serve as an illustration. In the first Paper the candidate is expected to answer five questions out of 12. Of the latter, 9½ are on alternating currents, and the question we have credited to continuous currents deals with the thermal characteristic of a magnet coil, and is, therefore, common to both. Of the questions on alternating currents no less than five deal with the induction motor. We put it to the examiners that the continuous-current motor is as important a machine as the induction motor, and that to set five questions on either one machine or the other in an examination intended to test a student's general knowledge of electrical engineering is unreasonable. Even more out of balance is the Paper on design, in which the candidate is expected to attempt four questions out of six. Five of these questions deal with alternating-current machinery, and in the Papers for an engineering degree one seldom finds questions of greater difficulty. If the purpose of an examination is to test a student's *knowledge*, surely there are better methods of doing this than the setting of questions on subjects of which he may be profoundly ignorant.

Dispersion Coefficient of Induction Motors.

In this issue Mr. E. A. Biedermann concludes his article on "The Estimation of the Dispersion Coefficient of Three-phase Induction Motors and its Application to their Design." It has been necessary to publish this important article as a serial extending over three months, and in consequence it loses much of its utility. As it is thought that many of our readers would like to have reprints, so as to get rid of the inconvenience of having to turn up references, we hope shortly to publish the article in the form of a pamphlet.

Telephones in Warfare. In a recent issue of "Western Electric News" was given a non-technical article entitled "The Telephone's Use in Modern Warfare." This article should be of interest to many outside the telephone world.

Filament Industry.—According to Mr. Maxwell Lefroy, in the "Financial Times," one ton of tungsten makes 18,000,000 filaments for lamp bulbs.

Electrical Work at Panama Canal.—The "Canal Record" gives the following outputs of the different power installations for the month of October: Gatun hydro-electric station, 3,391,130 kw.-hours; Miraflores steam station (minus), 17,130 kw.-hours; total, 3,374,000 kw.-hours. The output of the Bilboa air compressor plant was 173,676,645 cubic ft. of air compressed to 105 lbs.

Electrification and Train Delays.—The American "Railway Electrical Engineer" quotes figures from a report of the Public Service Commission for the year ended June, 1915, showing that out of 67,080 trains, 93 per cent. arrived at their destination not more than five minutes late. Of the total delays only 1½ per cent. were on account of faulty equipment. This result is said to be due to careful inspection.

Application of Arc Welding.—According to the "Steamship," there is a large saving in cost over other methods of repair on boiler jobs. Other applications are welding plates instead of riveting them, building up of stripped gears, repairs, and making of high-speed tools and filling blow holes. Recently the cruiser "Glasgow" repaired several shot holes by welding plates over them in a very short time.

Costs of Coal Delivered.—In a recent issue of "Electric Vehicles" is given the following comparison of cost of coal delivery by various means:—

One-horse wagon	7¼d. per ton
Two-ton gasoline truck	7⅛d. "
Two-ton electric truck	7d. "

The 2-ton electric truck covered more miles and delivered more coal than either a 2- or 5-ton gasoline truck.

Molybdenum in Steel.—Dr. J. O. Arnold and Dr. Read, F.I.C., in a Paper read before the Institution of Mechanical Engineers at London and Sheffield, dealt with steels containing molybdenum to the extent of 2 to 20 per cent. During the latter portion of their investigations the electrolytic method was used to isolate the carbides, and very interesting results were obtained. The authors claim to have isolated a double carbide of iron and molybdenum.

I.E.E. Examinations.—The following regulation has been approved by the Council of the Institution of Electrical Engineers:—

During the period of the war, and for such further period thereafter as in the opinion of the Council it may be advisable, any candidate for admission as Associate Member who is engaged on naval or military service, or employed (whole time) in an engineering capacity on munitions or other war work, will be exempted from complying with the examination regulations; and any such service may, at the discretion of the Council, be accepted in part fulfilment of the conditions laid down by the Institution as regards experience, provided that in other respects the candidate satisfies the requirements as regards age and training.

The Sperry Stabiliser.—In November, before the Society of Naval Architects and Marine Engineers (U.S.A.), Mr. Elmer A. Sperry read a Paper on "Recent Progress with the Active Type of Gyro-stabiliser for Ships." A description was given of a gyro-stabiliser for a 165-ton yacht. The wheel selected has a K^2W of 2,700 lb./ft.² at 2,750 revs. per min.; the roll-quenching power per increment, 5 deg.; and the weight of the gyro-rotor, shaft and armature is 2,150 lb. A full account of the Paper, together with numerous detail and arrangement drawings and test records, appeared in "Engineering" in the issue of the 31st ult.

Largest Hydro-Electric Plant in Montana.—The Montana Power Co. (U.S.A.) has recently completed its Volta plant, located about 11 miles from Great Falls. This power plant, which has a capacity of 91,600 H.P., of which 61,600 H.P. is now available, is the largest of the system of hydro-electric developments of the company. The construction of the Volta plant has taken over three years. The power-house equipment consists of four units of 15,000 H.P. each and two smaller ones of 800 H.P. each, while provision is made for an addition later of two more of the large units, which when the machinery is installed will bring the capacity of the plant above the 90,000 H.P. mark.

Origin of Measures of Length.—Col. Sir Charles M. Watson, K.C.M.G., C.B., R.E., in a recent lecture at the Royal Society of Arts, points out that our English measures are no haphazard modern invention, but have survived from prehistoric times. The English inch is equal in length to three barley corns set end to end, or the width of eight barley corns, set side by side. The inch on a carpenter's rule is still divided into eighths, and the shoemaker's tape is divided into thirds. The measures were :

3 barley corns = 1 in.	12 palms = 1 yd.
3 in. = 1 palm.	11 cubits = 1 perch.
4 palms = 1 ft.	405 ,, = 1 cables length.
6 ,, = 1 cubit.	

He points out that the division of the circle into 360 deg. has never been improved upon, and considers the English units most convenient. He also thinks the adoption of the metric system would assist foreign trade competitors.

Chains and Lifting Appliances.—Entitled "Chains and other Lifting Appliances," a Memorandum by Mr. G. S. Taylor, H.M. Inspector of Factories, has recently been issued by the Home Office. The author deals with the causes of and possible means of preventing accidents arising from the fracture or failure of chains and such metal appliances as rings, hooks, shackles, eye-bolts and swivels used for lifting purposes. The whole of the 52 pages are full of information, and a valuable feature of the work is a bibliography containing 40 references. Amongst the subjects considered may be mentioned the following : Legislation ; types of appliances ; materials ; methods of manufacture ; kinds and proportions of links, hooks, shackles, eye-bolts and swivels ; use and wear of chains, slings and other lifting appliances ; testing ; annealing ; examination ; marking ; records ; failures of chains and other lifting appliances ; accidents and dangerous occurrences. In addition there are eight plates of illustrations and five appendixes. Crane users will obtain a sound investment by purchasing the Memorandum.

Appeals for Books.—The Council of the Institution of Electrical Engineers has received appeals from the Board of Education for books and magazines for :—

(*a*) The Camps Library—*i.e.*, for camps and for soldier prisoners in Germany.

(*b*) Civilian prisoners interned at Ruhleben.

In the case of (*a*), books of the following description are welcome : Historical and scientific works, poetry, essays, works on economics, biographies, pocket dictionaries and grammars (particularly French and German), volumes of well-known series, such as the Home University Library, Pocket Shakespeares, text-books on mathematics and science.

Bulky books are unsuitable. All should, so far as possible, be of small size and weight, and each complete in one volume. All books intended for (*a*) should be handed, unwrapped and unaddressed, over the counter at any post office.

In the case of (*b*), dictionaries and grammars, and works on science and languages, history, education, law, &c., are required for use in connection with the numerous classes which have been formed at Ruhleben under the auspices of the Camp Education Department.

In this case lists only of the books offered (author and title) should be sent to Mr. A. T. Davies, Board of Education, Whitehall, S.W., from whom intimation will be received in due course as to which of the books are accepted for despatch to Germany.

Electrification of Railway Termini.—The Committee appointed for investigating the subject of electrification of railway termini in Chicago has reported that the complete electrification of the termini in that city is technically practical but financially impracticable. The report states that the scheme would equal the combined electrifications of the whole world and would involve problems never before met. It is further reported that before the steam locomotive is eliminated contamination of the air must first be reduced to a minimum from three other damaging sources—namely, high-pressure steam plant, metallurgical and other manufacturing furnaces and domestic fires. It is asserted that the steam locomotive stands only third among smoke-producing agents, using but 12 per cent. of the fuel consumed. Further, electrification would add power-house smoke in quantities sufficient to offset much of the gain through elimination of locomotive smoke, whilst the electrification would involve at least 3,476·4 miles of track and subtract only 1,291,282 tons of coal from the total of 21,208,886 tons now consumed annually in the city. The report includes a summary of the results of investigations into the value of other motive powers in comparison with electric and steam locomotives.

British Standard Specifications for Wall Plugs and Sockets and for Charging Plug and Socket.—We have received from the Engineering Standards Committee copies of Reports 73 and 74 dealing with wall plugs and sockets (5-ampere two-pin without earthing connection) and charging plug and socket for vehicles propelled by electric secondary batteries respectively.

The specification for domestic wall plugs and sockets (Report 73) relates to the 5-ampere type and for pressures not exceeding 250 volts. In view of their extended use interchangeability is of the greatest importance, and the committee have, therefore, given this aspect of the question the closest attention. In consultation with the manufacturers the dimensions necessary to obtain this interchangeability have been agreed upon, the actual design of the plug being interfered with as little as possible. It is of interest to note that the standard plug is required to have side entry for the flexible wire and a suitable hand shield.

In conjunction with the Electric Vehicle Committee of the Incorporated Municipal Electrical Association, the committee has standardised (in Report 74) the essential details necessary to secure interchangeability between any charging plug and any socket of the design selected by the Electric Vehicle Committee. The way is, therefore, left open for invention and progress should at any time another type of charging plug be introduced.

New Year's Honours.—The New Year's Honours List, which was published on Saturday last, contains the following names which are familiar to our readers :—

PRIVY COUNCILLOR : *Commander F. L. Harris, M.P.*, chairman of the Brentford Electric Supply Co., and a director of the Metropolitan Electric supply Co., is to be sworn on H.M. Privy Council.

BARONET : *Lieut.-Col. H. Webb*, M.P., mining engineer.

A. F. Yarrow, engineer and shipbuilder.

KNIGHTS : *Francis Henry Dent*, general manager of the South Eastern & Chatham Railway.

Geo. Franklin, pro-chancellor of the Sheffield University, chairman of the United River Plate Telephone and of the Telephone Development Companies, president of the Société Anonyme Ottomane des Téléphones de Constantinople, and a director of the British Thomson-Houston and Lanarkshire Tramway Companies. He was formerly president of the National Telephone Co.

Wm. Wilson Hoy, general manager of railways and harbours, Union of South Africa.

Henry James W. Fry, C.I.E., lately Director-General of Stores, India Office.

K.C.B.s : *Col. Henry Capel Lofft Holden*, C.B., M.I.E.E., F.R.S., assistant director of supplies and transport, War Office.

Noel Thos. Kershaw, C.B., assistant secretary of the Local Government Board.

K.C.M.G.s : *Hon. Thomas Mackenzie*, High Commissioner for New Zealand.

Collingwood Schreiber, C.M.G., general consulting engineer to the Government of Canada.

C.B. : *Garnham Roper*, assistant secretary, Board of Trade.

C.M.G. : *Prof. John Cadman*, D.Sc., professor of mining in the University of Birmingham.

C.I.E. : *John Norman Taylor*, officiating superintending engineer of the Irrigation Branch of the Public Works Department, Punjab.

Major Chas. H. H. Nugent, R.E., Inspector of Machinery, Military Works Services, India.

KAISAR-I-HIND GOLD MEDAL.—The Kaisar-i-Hind medal for public services in India of the 1st Class has been awarded to the following :—

Walter Samuel Sharpe, superintendent of telegraph engineering, Bombay Division, of the Indian Telegraph Department.

Henry Jas. H. Glenn, executive engineer, Province of Delhi.

Successful Tests on the St. Paul Railway.—In testing the electric locomotives designed for the 440 miles of electrified line over the Rocky Mountains, the Chicago, Milwaukee & St. Paul Railway has met with gratifying success. At the time of making tests on the regenerative braking there was no current available on the St. Paul trolley wire, but the Butte, Anaconda & Pacific furnished a goods train of about 4,020 tons with the power to haul it over 28 miles of track between Butte and Anaconda. The train actually weighed nearly 4,470 tons. A speed of up to 25 miles an hour was made with this goods train, and when the regenerative braking was applied on the near approach to some 10 deg. curves the speed was safely brought down to 16 miles per hour. With a further application the speed was reduced to 7 miles an hour, smoothly, without shocks, and without the use of the air brake. According to the "Electric Railway Journal," a number of actual speed and tonnage tests were made on the completed section of the electrified line on the 8th inst. The passenger train tests were

made by one of the new 233-ton locomotives drawing three special cars and running at various speeds up to 70 miles per hour, and the tonnage tests with the freight locomotives included pulling 2,240 tons at a uniform speed over various grades at 16 miles per hour.

OBITUARY.

H. M. O'Kelly.—The death took place at Dublin on the 17th ult. of Mr. H. M. O'Kelly, a retired superintendent of Indian Government Telegraphs.

Killed in Action.—We regret to record the death, which has occurred in France, of Lieut. W. Inchley. Lieut. Inchley was formerly lecturer on engineering at the University College, Nottingham, and on the outbreak of war he received a commission in the 2nd Battalion Duke of Wellington's Regiment, and had seen some heavy fighting.

Lieut. Clarence A. Currie, of the Royal Engineers, has died of wounds received in action. Lieut. Currie was educated at Heidelberg, King's College School and King's College, London, where he was a member of the Officers' Training Corps. He was elected an Associate Member of the Institution of Civil Engineers in November, 1914, and subsequently got a commission.

Private Jas. L. Horne, of the 1/6th Battalion Manchester Regiment, has been killed in action at the Dardanelles. Before he enlisted, Private Horne was apprenticed to the British Westinghouse Co. as an electrical engineer. He was reported "missing" some time ago, but it is now officially announced that he was killed in action on June 4.

PERSONAL.

We regret to notice that Second Lieut. Bernard John Wolfe-Barry, R.A., eldest son of Sir John W. Wolfe-Barry, has been wounded in France. The principal bones in one of his arms have been broken by a shell, but there is every hope that the arm will be saved. Mr. Wolfe-Barry, who is a member of the English Bar, volunteered for active service and got his commission in January last.

It is announced that a marriage has been arranged, and will shortly take place, between Horace Field Parshall, consulting engineer, and Miss Ellen Dunlap Payne, of Boston (Mass.), U.S.A.

Mr. A. Vines (formerly Schneider), a British born subject, and managing director of Messrs. Evershed & Vignoles (Ltd.), has by deed poll (dated Dec. 31, 1915) abandoned his former surname of Schneider and adopted and will use henceforth his mother's maiden name of Vines.

APPOINTMENTS VACANT AND FILLED.

The Borough of Swindon Education Committee invite applications for the permanent appointment of head of the engineering department of the technical institution. Commencing salary £200 per annum, rising by increments of £10 to £250. Further particulars from the Principal, to whom immediate application should be made, at the Technical Institution, Swindon. *See advertisement.*

Applications are invited for the position of shift engineer at the Chester-street generating station, Aston Manor, Birmingham. Commencing salary £130, increasing to £200 per annum. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Monday, 17th inst. *See an advertisement.*

A foreman is required for a large wiring contract. *See advertisement.*

A works electrician is wanted by the Standard Small Arms Co. Lench-street, Birmingham. *See advertisement.*

The Government of Malta require an assistant electrical engineer. Salary £130-150 per annum. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, London, S.W.

A practical electrician is required by Abertillery Urban Council. Salary £2. 10s. per week. Applications to the Clerk.

Mr. James Currie, C.M.G., has been appointed to direct the work of training munition workers. Mr. Currie was principal of Gordon College and Director of Education in the Soudan from 1900 to 1914.

Mr. J. B. Feltham, of Gloucester, has been appointed electrical engineer at Mexborough.

Manchester Corporation have sanctioned the promotion of Mr. A. E. McKenzie, chief assistant engineer, to the position of deputy chief engineer of the electric supply department at £700 per annum, increasing by annual increases of £50 to £800.

Mr. H. C. Babb, chief assistant at Hawick electricity works, has been appointed engineer and manager of Bo'ness electricity works, in succession to Mr. Rogers.

INSTITUTIONS AND SOCIETIES.

Faraday Society.—At the last meeting of this Society a general discussion was held on "The Corrosion of Ferrous and Non-Ferrous Metals," the subject being introduced by the President, Sir Robert Hadfield, F.R.S., who emphasised the importance of the loss due to corrosion. A number of Papers were contributed by Dr. C. H. Desch, Dr. J. N. Friend, Mr. L. Aitchison, Mr. S. Whyte, Mr. Arnold Philip and Mr. W. E. Gibbs. Most of the Papers dealt with the various chemical aspects, but Mr. Philip in his contribution supported the theory based on the zinc-copper couple. At the conclusion of the meeting a demonstration was given of the Cumberland electrolytic process for the prevention of corrosion.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, Jan. 11th.

Institution of Civil Engineers.

5:30 p.m. Meeting at the Institution, Great George-street, Westminster, S.W. Paper on "The Electric Locomotive," by Mr. F. W. Carter, M.A.

Manchester Section of the Institution of Electrical Engineers.

7:30 p.m. Meeting at the Engineers' Club, 17, Albert-square, Manchester. Paper on "The Pre-determination of the Performance of Dynamo Electric Machinery," by Prof. Miles Walker.

Illuminating Engineering Society.

8 p.m. Meeting at the Royal Society of Arts, St. John-street, Adelphi, W.C. Discussion opened by Mr. J. S. Dow on "Some Principles of Industrial Lighting" (with special reference to the first report of the Departmental Committee on "Lighting in Factories and Workshops").

WEDNESDAY, Jan. 12th.

Royal Society of Arts.

3 p.m. Meeting at John-street, Adelphi, W.C. Lecture by Mr. James Swinburne, F.R.S., on "The Science of Some Toys" (juvenile lecture).

Birmingham Section of the Institution of Electrical Engineers.

7 p.m. Meeting at the University. Paper by Prof. Miles Walker on "The Predetermination of the Performance of Dynamo-Electric Machinery."

Yorkshire Section of the Institution of Electrical Engineers.

7 p.m. Meeting at the Philosophical Hall, Leeds. Paper by Mr. J. R. Beard on "The Design of High-pressure Distribution Systems."

THURSDAY, Jan. 13th.

Institution of Electrical Engineers.

8 p.m. Meeting at the Institution, Victoria Embankment, W.C. Paper on "The Pre-determination of the Performance of Dynamo Electric Machinery," by Prof. Miles Walker.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

The following Orders have been issued for the week commencing Jan. 10, 1916:—

Drills: 6:25 to 7:25; 7:25 to 8:25 p.m.

Monday, Jan. 10th.—Sections 1 and 2, Technical; Sections 3 and 4, Squad, Signalling Section and Recruits.

Tuesday, Jan. 11th. School of Arms, 6 to 7 p.m.

Thursday, Jan. 13th.—Shooting for Sections 1 and 2, and Signalling Section.

Friday, Jan. 14th.—Sections 3 and 4, Technical; Sections 1 and 2, Squad, Signalling Section and Recruits.

Saturday, Jan. 15th. Uniform parade. Time and place will be posted at Headquarters later.

Appointments.—Section Commander L. A. Levy to be Musketry Sergeant.

Section Corporal J. McArthur Butler to be Section Commander of No. 2 Section.

Sections for Technical parade at Headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for shooting parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call at Samuel Brothers, Ludgate Hill, as soon as possible. Payment for Uniforms to be made to the Adjutant.

ELECTRIC TRACTION ON THE GIOVI LINE.

(*Concluded from p. 452.*)

Auxiliary Apparatus.

The two 12 kw. transformers for the auxiliary apparatus have two secondary windings, one giving three-phase current at 110 volts

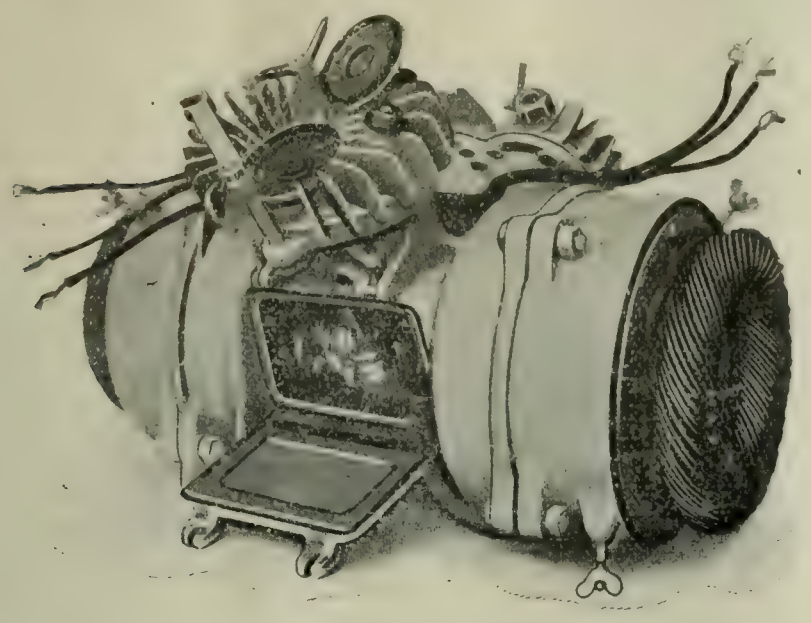


Fig. 9. Air Compressor.

between phases or 64 volts from each phase to the neutral point, and the other single-phase current at about 90 volts. From these the wires are taken to a small switchboard in the centre of the cabin for connecting any piece of apparatus to either transformer. The following are fed from these low-tension circuits :—

1. A small fan coupled directly to a 110-volt three-phase motor for cooling the main motors and the rheostat.

2. Two twin-cylinder air-compressors, each worked by two 110-volt three-phase motors directly coupled one on either side of the compressor (*see* Fig. 9). The compressed air works the brakes, the movement of the trolleys, the high-tension switchgear, the rheostat, the whistles and the sanding.

3. Another 110-volt three-phase motor driving a circulating pump for the rheostat. This is automatically set in action when using the rheostat for starting.

4. The lighting circuits.

5. The measuring instruments.

6. The electromagnets controlling the valves that admit air to the switching apparatus.

In Fig. 10 is shown the lay-out of the compressed air-piping. There are two reservoirs, one, D, for the brakes, and another, C, for the rest of the apparatus. They are connected through a non-return valve, so that the brake pressure will not be affected by a leakage in the accessory apparatus. An automatic regulator keeps the pressure at 92·5 lb. per square inch. In the rheostat there is a float that is lifted when the plates are fully submerged. This turns off the air, which then actuates the piston of a short-circuiting device.

For the electromagnets controlling the air valves of the high-tension switchgear single-phase current at 90 volts is used. The voltage can, however, be regulated down to 55 volts, so as to avoid excessive heating of the coils. Subsidiary contacts on the relays provide that the main switch cannot be closed until the speed-controller is in the correct position, and prevent the driver taking other false steps.

Special couplings on the locomotives allow any number of them to be controlled by one man in the cab of the foremost.

The controlling mechanism for starting and regulating the power taken by the motors is as simple as it is ingenious. Above the rheostat is a little horizontal balance-beam having a small angular movement, which by turning in one direction opens the valve which admits air into compartment B (Fig. 8), and in the other direction closes this and opens an escape valve. At any particular position of the driver's controller handle a certain tension is given to a spring which tends to turn the balance in the way that admits air so as to raise the liquid in the rheostat. This is opposed by a wattmeter mechanism operated by potential and current transformers in the main stator circuits, so that when the power taken rises too high the strength of the spring is overcome, the balance-lever moves over, and

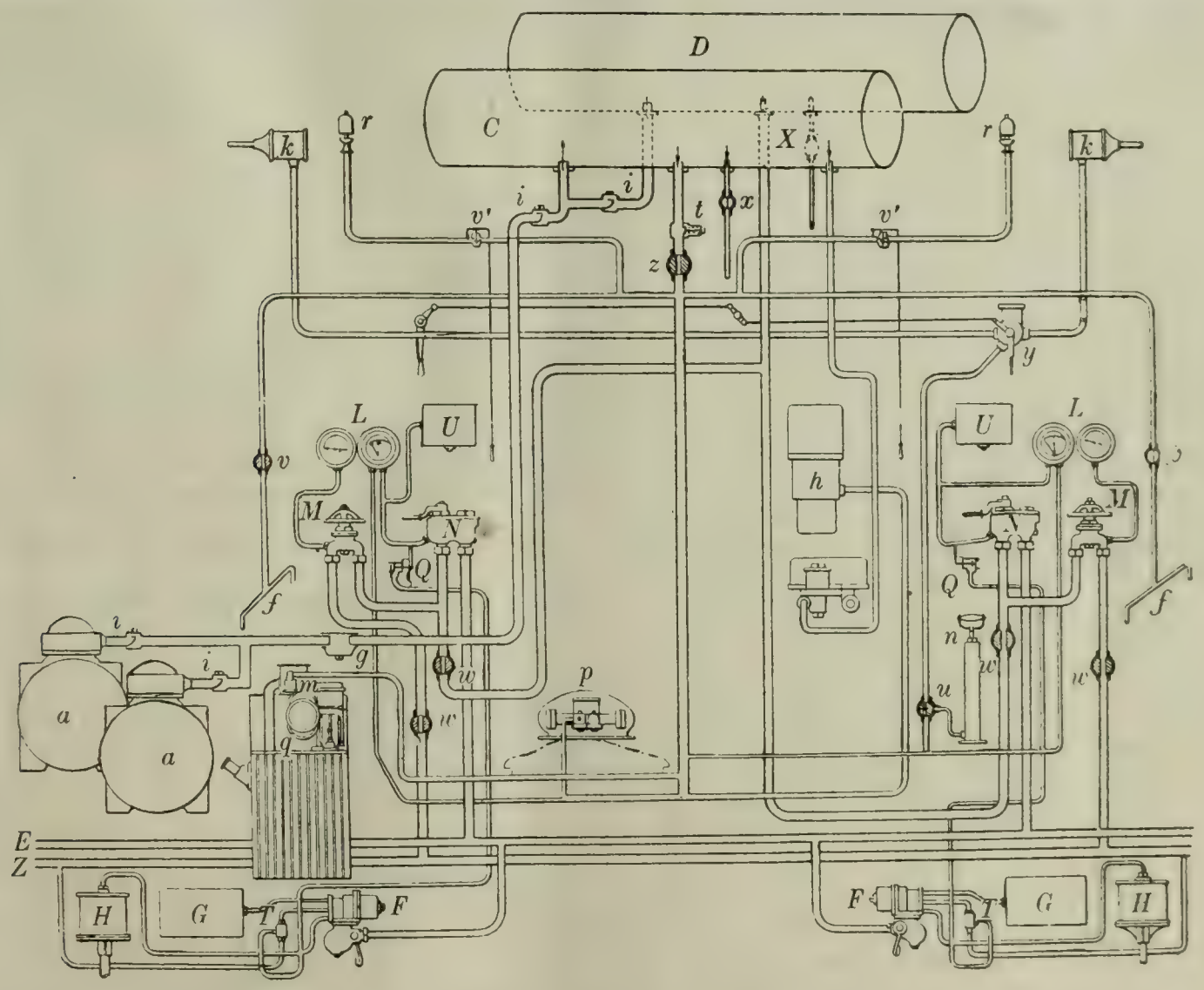


Fig. 10.—Arrangement of Air Piping.

Brake Control.—D, Main air reservoir; E, Westinghouse brake pipe; F, Triple valves; G, Auxiliary reservoirs; H, Brake cylinders; M, Control of adjustable brake; N, Contro of Westinghouse brake; Q, Escape valve; L, Pressure gauges; X, Blow-off cock; Z, Adjustable brake pipe; T, Stopping valve; U, Receiver; *w*, Isolating valves.
Electro-pneumatic Apparatus.—*a*, Compressors; *c*, Main reservoir; *f*, Sanders; *g*, Oil separator; *h*, Main switch; *i*, Non-return valves; *n*, Hand pump; *p*, Speed controller *q*, Rheostat; *r*, Whistles; *t*, Safety valve; *u*, Valve for hand pump; *v*, Valves for sanders; *v'*, Valves for whistles; *x*, Blow-off cock; *y*, Trolley control; *k*, Trolley cylinders *z*, Main valve.

air is allowed to escape, thus lowering the liquid and increasing the resistance. By this arrangement the current in the motors is never too great, whether starting, running at full speed, or climbing gradients. Thus it is possible to keep the torque at such a value that advantage is taken of all the adhesion that the circumstances permit, and to maintain it at this value during the period of starting. That the system works excellently in practice can be seen by the graph of energy absorbed when starting a 190-ton train (Fig. 11). This also shows the short time necessary to change over from cascade to parallel connections, which is done by means of the second handle of the driver's controller, operating electro-pneumatically the speed controller already referred to. It will be noticed that the total starting time is less than 200 seconds. This has also been attained with a 380-ton train requiring two engines on a gradient of 1 in 28, even in weather which was such as to make the adhesion very unfavourable.

With these locomotives on the line from Pontedecimo to Busalla, trains up to weights of 450 tons have been dealt with on the double-traction system—*i.e.*, with engines in front and rear—the coefficients of adhesion being about 0·22, on a gradient of 1 in 28. Taking this experiment as a basis, it seems fair to reckon on a normal coefficient of 0·2, and this is confirmed by daily practice, seeing that even during the winter it has never been found to be necesary to reduce the load assigned to a locomotive. Other tests related to the heating effect produced on the motors by their ordinary routine, and diagrams have been taken over a period of 20 hours on trains hauled by two locomotives. They were taken with a speed of 45 km. an hour on the pound-wound dynamo mounted on the same shaft as the alternator. There are two sets of 'bus bars, which are connected to the machines and the line by Westinghouse three-phase oil switches controlled electrically from the switchboard. From the same bars connections are taken to two 175 kw. transformers for serving the auxiliaries and to a special liquid rheostat. The latter is rendered necessary by the regenerative braking system used on the line. When a train is running downhill without the brakes and the motors are operating as generators they are turning at a speed above synchronism. If, then, there were so many descending trains that more energy was returned to the station than was being generated, the speed of the alternators would be dangerously increased if no means were adopted of absorbing the surplus. By an automatic device, however, the water resistance already mentioned is switched on to the line when these conditions arise. The rheostat makes use of the outflowing cooling water from the condensers, and the same mechanism that puts it into action also regulates the amount of water admitted according to the power to be dissipated.

The working day is limited to 18 hours, and this has had the effect of reducing the average length of time which any individual serves by 29 per cent. The limit of 18 hours has been fixed, as it was not thought advisable to run the turbo-alternators at the central station when the load was practically negligible. Other arrangements are, therefore, made for dealing with some of the last trains at night on the descending gradient. As for repairs, a careful inspection with the rectification of trifling defects takes place every 10 or 12 days, and this

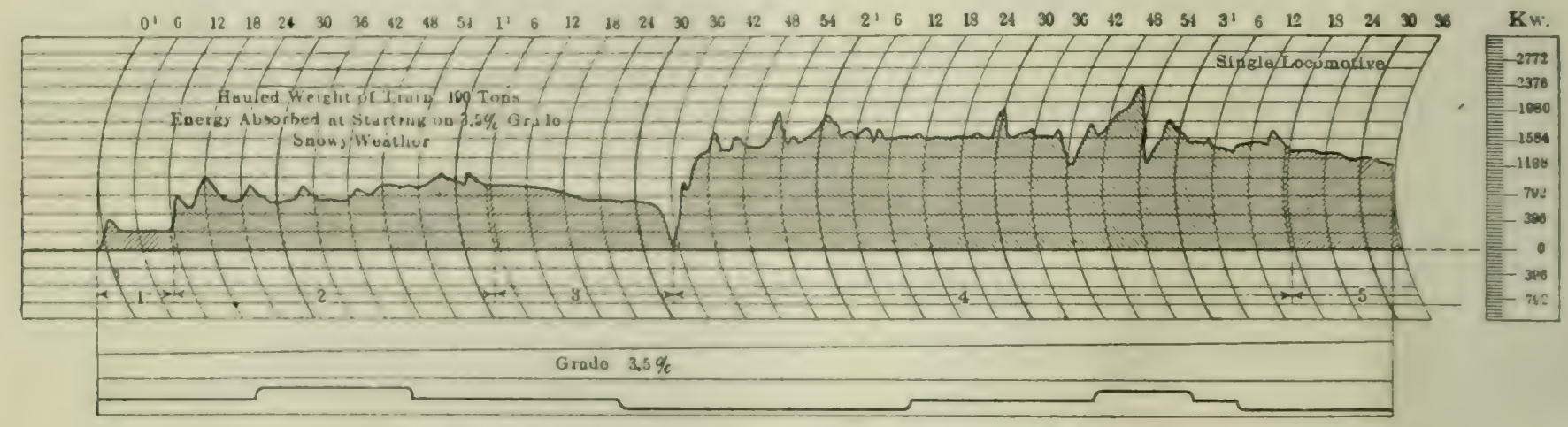


FIG. 11.—REGULATION OBTAINED WHEN RUNNING UP TO 28 M.P.H.

(1) Insertion of motors and opening of brakes; (2) Starting up with motor connected in cascade up to 14 m.p.h.; (3) Running at 14 m.p.h. (4) Changing over to parallel connection of motors and acceleration up to 28 m p.h.: (5) Running at 28 m.p.h.

up-gradient and of 22·5 km. an hour on the down-grade with the regenerative control, with an interval of 80 minutes between two successive ascents and descents. These tests showed that the rise in temperature was never more than 75° C. The locomotives are very solidly constructed, and give their output without any marked wear in the working parts. As for the apparatus for collecting the current from the overhead wire, the wear on the prismatic contact tubes was rather heavy at first, but matters have since improved; now it is possible to have a life of 3,500 km. for these tubes.

THE POWER STATION AT CHIAPPELLA.

The station has a total capacity of 10,000 kw. It is situated beside Genoa harbour, and can, therefore, take condensing water from the sea. The same transporter running from the station to the quay serves to bring in coal and takes away ashes.

There are two batteries of seven water-tube boilers each of 4,025 sq. ft. heating surface, and working at a pressure of 220 lb. per square inch. A Green's economiser is fitted to one of the batteries. Superheaters raise the steam temperature to 626° F.

There are at present two generating sets of 5,000 kw., each capable of a continuous overload of 6,250 kw., or 10,000 kw. for five minutes, but a third may be installed. Each set consists of a Parsons-Westinghouse steam turbine coupled directly to a three-phase Westinghouse alternator and an exciter. Current is generated at 13,000 volts and 16⅔ cycles, and the exciter can give a current of 1,000 amperes at 65-70 volts.

The turbines are of the mixed type (partly impulse and partly reaction) and are double-ended and symmetrical, the steam entering at the centre and leaving at each end. This eliminates all end-thrust. Water-sealed glands are used at the bearings. Speed regulation is effected by a centrifugal governor and a servo-motor. Two Westinghouse-Leblanc condensers serve each turbine.

The generators are of the rotating field type, with both stator and rotor laminated. They have two poles, so that the speed at a frequency of 16⅔ is 1,000 revs. per min. The exciter is a six-pole com-

makes it possible to continue working for a year before a general overhaul is necessary. The recuperative system has shown itself to be very suitable for lines of this description, and by it there is, as it were, a sort of link connecting ascending and descending trains, from the existence of which both of them benefit. In this respect the electric system may be fitly compared to the funicular system.

SOME DIFFICULTIES IN THE DESIGN OF HIGH-SPEED GENERATORS.

The following is a report of the discussion at the meeting of the Manchester Section of the Institution of Electrical Engineers, on Tuesday, Nov. 30th, on Prof. A. B. Field's Paper on the above subject. An abstract of the Paper appeared in our issue of Nov. 26, 1915.

Mr. A. F. McKenzie dealt with the author's remarks on the question of rotor ventilation, and asked what disadvantages obtained in cleansing the air before admission to the generator. The majority of engineers favoured this cleansing. The speaker expressed appreciation of the three-part wedge, and referred to the great difficulty—in fact, impossibility—of making a satisfactory job of a solid wedge, perhaps, of 4 ft. 7 in. long with the present high peripheral speeds giving a stress of about 2 tons per square inch at the surface of the key. There were advantages undoubtedly in having external reactances, particularly when a fault developed on the windings adjacent to the machine terminals. In such a case high internal resistance would be of little use in reducing the shock to the system, whereas external reactance would considerably reduce the current flowing to the faulty machine from the other generators. The author stated that the large machines were designed to have a short-circuit current of 11 times the normal. The speaker had recently inspected machines for 15,000 kw. machines giving the internal reactance so high that a short-circuit value of only seven times normal was obtained. The question of hollow conductors was interesting, and the speaker had seen several machines having windings of tubular or rectangular form to

enable air to pass through the conductor. The cooling would undoubtedly be more effective in these designs than in the case of cooling air coming into contact with only a small portion of the conductor periphery. The circular-type conductor was much better to insulate than the rectangular type, which tended to cause fracture of the insulating material at the corners. Mr. Seaton had referred to recent troubles in stators only, whereas he (Mr. McKenzie) had known of considerable trouble in the past with built-up rotors ; the solid rotors had, however, given no trouble whatever.

Dr. G. W. Worrall dealt with the use of fans on rotors, and advocated the use of external fans in nearly all cases. A better system of ventilation was obtained, and nothing was lost from the point of view of overall efficiency. Axial ventilation was preferable to radial ventilation, and the trend of design seemed to be in the former direction. Ventilation systems should be arranged so that all air ducts could be thoroughly cleaned. The speaker had experienced considerable trouble due to breakdown of end windings of rotors. As the author pointed out, it was almost impossible in building up machines to apply the actual pressures to windings which occurred in practice. Did the windings actually move, and if so did they take up a permanent set after the first few runs, or did they move outwards and inwards each time the machine was started and stopped ?

Mr. Juhlin congratulated the author upon the ingenious and elegant solution of a problem of extreme difficulty. As stated in the Paper, the through shaft was out of the question in a machine of the diameter and speed referred to. Even in 50-cycle machines the stress difficulties would be considerable. The author's figure of 20,000 lb. for stress inside the rotor was probably under, rather than over, the mark and in order to secure the discs it was necessary to shrink them on with stresses considerably above the running stresses. It was also required that the discs should fit the shaft when running at maximum speed, otherwise the discs would float, which was not permissible. Fortunately this country was well situated to obtain steel forgings of large and small sizes, and for that reason it was probably unnecessary to adopt a disc construction until very extreme sizes were encountered. British steel makers were prepared to supply very large rotors having excellent physical properties. The standard specification for ordering high-speed rotors was as follows :—

Ultimate tensile strength	80,000 lb. per sq. inch.
Elastic limit	45,000 lb. „ „
Elongation, in 2 in.	24 per cent.
Bending test (cold bending).....	1½ in. bent through 180 deg. without fracture.

These results were very satisfactory from every point of view, although it was unnecessary to use steel of such quality, except in very high-speed machines. In the case of ordinary small sizes where speeds were reasonably low, steel of considerably less tensile strength could be used with an ample factor of safety. The tests were not limited to the longitudinal direction, and British makers were prepared to supply forgings with the physical qualities mentioned, tests being taken in both radial and tangential directions. American steel makers had not yet been able to guarantee such radial test pieces. Recent tests on a rotor forging for a large machine running at 3,000 revs. per min. gave the following results :

	Longitudinal.	Radial.	Tangential.
Ultimate tensile strength (lb. per square inch)	90,000	83,200	88,000
Elastic limit, ditto.....	54.000	45,200	46,000
Elongation (in 2 in.)	29 p.c.	28 p.c.	28½ p.c.

All the bending tests were satisfactory at 180 deg., and radial test pieces would be taken not more than 3 in. to 4 in. from the surface. With such material there should be no difficulty in constructing large generators of 1,500 or 3,000 revs. per min. In order to make a comparison with the machines mentioned by the author, a 1,500 revs. per min. machine should be considered as the standard speed for this country. Such a machine would have a diameter of about 55 in., and its weight would probably be about 30 tons. The following details represented the procedure adopted by one of the leading British steel makers in the manufacture of large rotors. An ingot of approximately 115 tons and 94 in. in diameter would be used and 50 per cent. cut off at the top end to ensure homogeneity of material. A 12,000-ton press would forge the ingot down to the required diameter, the ends being forged down in a smaller press. The reduction in area would then be about 2½ to 1, so that the work done was quite considerable. After rough machining the rotor would be thoroughly annealed, and in this process probably more was done to the quality of the steel than was generally appreciated. Regarding the internal stresses, which were very high unless the material was treated exceedingly carefully, it was to be noted that in the finished rotor there were radial ducts dividing the rotor into sections to a considerable depth, 6 in. to 8 in. These ducts would materially tend to release the stresses in the longitudinal direction. The slots for the coils and the ventilating ducts under the slots would to a certain extent release the stresses in the longitudinal direction, so that in the finished rotor the remaining initial stresses would be fairly well released. Being assured of a supply of steel of suitable quality which would permit the construction of large machines with solid rotors, there were certain advantages which could not be neglected. In the matter of critical speed, for example, this could be calculated much more accurately in the case of the solid rotor. Another advantage of the solid rotor was that the stiffness of construction permitted a smaller diameter for a given output which would give a slightly better efficiency. It would also be possible to use self-contained blowers in many cases where, with the author's construction, the increased length would make it impossible. The outside slip-rings was a feature of considerable importance in cases where high critical speeds were required. The rings demanded a good deal of room in the construction, with the result that the critical speed had to come down or the rotor shaft had to be increased. By placing the slip-rings outside the bearings the distance between bearings was considerably reduced, and another objectionable feature, high peripheral speed, would be obviated. Greater accessibility to slip-rings was also obtained. The one objection to the solid rotor at the present time was the cost. Considering material alone, the cost would be in the ratio of 1 to 1·6 in favour of disc construction. This was counterbalanced to some extent by increased labour on the discs, but the ultimate cost of a rotor constructed of plates would probably be slightly less than the cost of the solid rotor.

Mr. G. D. Seaton said there was no less than 100,000 kw. of high-speed generating machinery out of commission in this country through defective stators.

Mr. F. A. Kuyser described a system of ventilation which eliminated some of the objectionable features of axially ventilated machines. The speaker exhibited a cross-sectional sketch of an 8,000 kw. 2,400 revs. per min. machine. Axial vent chambers were provided in the usual way by means of holes punched in the core laminations. Nine radial air ducts, each ¾ in. wide, were provided instead of one central duct. Each axial duct was, therefore, divided into 10 equal sections, the sections being connected together by means of a system of axial tubes which were welded to the ventilation spacers, the tubes serving at the same time to maintain the required distance between the punchings. At certain places the connecting tubes were left out and semi-circular distance pieces used, which allowed the air to escape from the axial ducts to the radial ducts. The air outlets were evenly distributed over the whole length of the core, an equal number of axial ducts delivering to each radial duct. In addition to the elimination of the large central discharge, another advantage could be obtained by arranging the air streams to secure a counter flow action, the air streams in adjacent ducts having opposite directions of flow. This arrangement reduced the high temperature which occurred near the air outlet of axially ventilated machines and equalised the temperature over the whole length of the core. In connection with stator coil bracing and the type of armature winding for turbo-generators, the diamond type of winding illustrated in the Paper had been extensively used in the United States. The copper coils were formed completely on metal or wood formers, insulated and baked. When complete, the coils were dropped into open armature slots and magnetic or fibre wedges inserted on the top of the coils. The bracing of the end connectors by means of radial clamps made a rigid and substantial job. Small blocks of hornbeam, or similar insulating material, were roped between the straight part of the coils which extended beyond the core and braced that portion of the winding into a solid circle. The diamond winding was usually made with the number of coils equal to the number of slots, each slot receiving two coils. Fractional pitch could be used with advantage, especially on two-pole machines, the overhang of the winding and stray field losses in the cast-iron parts of the armature being greatly reduced. Such losses were sometimes extremely high, especially if concentric type winding was employed. The winding process in the shops required comparatively little labour ; the coils were simply dropped into the open slots and wedged, the coil braces being very easily fitted. Most shop engineers preferred this type of winding to the concentric type. A disadvantage of the diamond winding was the open slots which introduced extra losses. If wide slots were used, magnetic wedges were absolutely essential. Furthermore, if a defective coil had to be replaced it involved the removal of several coils and consequent damage to insulation. Complete re-winding was, however, comparatively easy. Concentric type winding was illustrated by a sketch of a 5,500 kw. 3,000 revs. per min. machine, the winding consisting of separate bars and end connectors. When only one conductor per slot was used it was necessary to split the conductor into a number of parallel straps to avoid eddy currents. The slot conductor was machine wrapped with mica insulation and then placed axially into semi-closed slots. The ends were then bent and individual connectors electrically welded or sweated to the bars. The end connectors were braced by means of wood blocks and metal bolts, which clamped the connectors rigidly together against the end plate. Heavy metal rings connected the ends of the bolts and prevented bending. It was repeatedly observed that after a short circuit the straight coil extensions moved outward in a radial direction, and in order to prevent this movement segmental pieces of fibre were inserted in the windings between coils and also against the iron to prevent insulation cracking and causing a short to frame. Large turbos provided with this bracing had been repeatedly shorted at normal voltage and no winding damage or deformation had occurred. The concentric winding as described had the advantage that each bar could easily be replaced without disturbing the remainder, but, generally speaking, a breakdown nesessitated complete re-winding due to fire. The semi-closed slots were also an advantage appreciated by designers in avoiding magnetic wedges. The high local stray field around the end connectors resulted in heavy eddy current losses in the cast-iron parts. Referring to the subject of rotor coil bracing, the speaker gave an example of a 15,000 kw. 1,500 revs. per min. two-pole machine, having a radial forged rotor 46 in. diameter, weighing 22 tons. The torque developed on short-circuit was roughly 10 times normal, and this produced a force of 15 lb. acting on each pound of copper. The maximum deflection of the winding, which was 1¾ in. width copper, was 0·015 in. If only the flywheel effect of the turbo were taken into account the deflection was 0·008 in. These figures suggested that a substantial field strap would suffice to prevent damage

after a short circuit, and this was verified in actual tests on machines of 15,000 kw. and 30,000 kw. Bracing tended to obstruct the ventilation of the end connections, and as this temperature was often the limiting feature of design it was very important. The speaker agreed that coil-retaining rings should be secured to avoid displacement on a short circuit. Tightly shrinking on the end plates or core might be adopted in place of the key, as this could be made to ensure a solid grip at full speed and avoid the keyway which was undesirable on account of the high stresses.

Dr. CRAMP said it was difficult to judge the author's argument without more technical data than was actually quoted. The speaker had been obliged to deduce as much as possible from the suggestions given, and in this way he had calculated the field winding and other details, such as the flux per pole, which would appear to be 100-million lines. From this data it was possible to estimate the corresponding densities as well as the weight of the rotating copper, and thus to obtain an idea of the limitations imposed by the very high speed. The example selected was not one of the most difficult, since no large commutator was involved. Apart from this, however, the author had shown that the first general limitation was the frequency, and the second was the material available. Great and appropriate stress was laid upon the concurrent development of material and design, which had rendered the combination of large output with high speed possible. The speaker cordially approved the term "yield point" instead of "elastic limit" throughout the Paper, but there was no indication of what the author considered to be a safe stress with respect to a given yield point—*i.e.*, no indication was given of the factor of safety employed. It seemed desirable to point out another limit not mentioned in the Paper beyond which any increase in peripheral speed might lead to uneconomical design. This limit was introduced by a consideration of the fact that in a slotted rotor when certain limiting densities were decided upon there was a corresponding maximum slot area. Thus, if it were assumed that no flux passed straight down the slot, and that the ratio of the flux-density in the air-gap outside a given pair of slots to the flux-density at the roots of the teeth was known, then the depth of slot was given by the expression

$$R(1 - K - mK)(1 + m),$$

where R = rotor radius,
m = ratio :—width of slot/width of tooth at rotor periphery,
K = flux-density ratio just assumed.

Similarly, the width of the slot

$$= pm/(1 + m),$$

where p = slot pitch at periphery of rotor.

Thus the area A of the slot was given by

$$A = pR\left(\frac{m - mK - m^2K}{(1 - m)^2}\right),$$

whence

$$\frac{dA}{dm} = pR\left(\frac{1 - K - mK - m}{(1 + m)^3}\right).$$

Here d^2A/dm^2 was obviously negative, so that

$$1 - K - mK - m = 0$$

was the condition for (A) to be a maximum, where $m = 1 - K/1 + K$ for maximum slot area. Here p was regarded as decided by factors independent of K, which was usually the case. Under any circumstances, the depth of the slot would be such that

$$1 > K(1 + m) \qquad i.e., > 2K/(1 + K),$$

so that there was a limit to the possible value of K. In many cases the maximum possible slot area demanded a slot whose proportions were for other reasons undesirable, but the calculation at least showed in which direction maximum output lay. Now the area of the slot multiplied by the space factor, by the specific weight of copper, by the square of the velocity, and divided by gR was a measure of the centrifugal force acting upon unit length of the tooth root. Equating this to the section of the tooth root multiplied by the safe stress corresponding to the material used, would show whether the most economical design, as dictated by electromagnetic considerations, was consistent with the peripheral speed and material proposed. Taking figures which the author had not given and employing them as above, the speaker concluded that designers were approaching the limit when they would not have material which would carry the stress corresponding to the maximum copper which could be got into the slot. When this point was arrived at, either the slot dimensions could be changed (which might entail waste of material), or the material in the slots might be changed. For example, aluminium might be used, as there was no obvious reason against it. The author had pointed out the necessity of knowing, not only the physical characteristics of the material, but also its history. This was a new factor of great importance. Regarding critical speed, the speaker was quite in agreement with the author, but local designers did not take the same view. When specifying a turbo-alternator in which the critical speed was to be above the speed at which the machine ran, a well-known designer said there was no necessity for any such limit, as no one would pay for it. Presumably, this attitude would now be abolished. The author had stated that the action of the rotor was not the same as it would be if the shaft were separated from the rotor itself, and that this was mentioned as of theoretical rather than practical interest. This was not at all clear, and seemed of great practical importance. Regarding ventilation, the author stated "the system which lends itself best to the other features of the machine that we shall have to adopt is one combining an axial passage under the winding slots with a radial discharge distributed over a fairly wide central portion of the rotor." This was questioned by many designers, and it was thought that pure axial ventilation was very much better when it could be accomplished. It seemed that this statement was rather didactic, and based upon test figures which the author would perhaps publish. The disadvantage of the three-part wedge was that the edges of the teeth would be rather liable to damage when pushing the wedge into position. It also seemed difficult to get the wedges to bed properly. The speaker submitted the following as a good type of wedge :

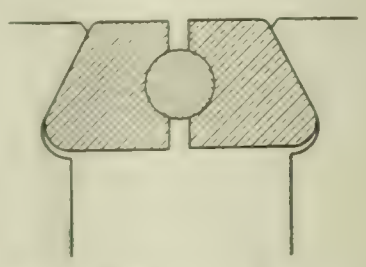


FIG. 1.—TYPE OF WEDGE.

Regarding air-gap reluctance as affected by the stator slots, Mr. Carter's Paper on "Air-gap Induction" was a fine example of what might be carried out to a very much greater extent. It was similar to the method developed by Schwarz and Christoffeln, and given in some detail in Prof. J. J. Thomson's "Recent Researches." It would be reasonable in the case of large machines to work out the special case in considerable detail, or, if such calculation was too lengthy, Prof. Hele-Shaw's method could be used, or, failing this, a fair geometrical approximation could be obtained graphically, using proportional dividers.

Prof. MILES WALKER said one of the main features of the Paper was the description of a rotor built up of thick steel plates, which, as the author pointed out, was particularly suitable for very large outputs. When dealing with very high peripheral speeds, say about 2,400 revs. per min., and large diameters it became necessary to look round for some construction other than the solid type of rotor, which was very satisfactory for fairly large sizes. The speaker assumed that the author did not advocate a departure from the solid type in cases where it was definitely proved that good results could be obtained, and where the stresses were not as high as required for the large machines run at very high speeds. Regarding rotor windings, the type shown in Fig. 3, p. 275, had been proved to be perfectly satisfactory, simple and convenient to use in ordinary shop practice; but he was convinced that for large rotors dealing with many thousands of ampere-turns per pole at high peripheral speeds a better winding could be put forward. (Prof. Walker then described a winding, details of which he had already contributed to the London discussion.) Referring to the author's design, the methods of ventilating the stator were well worked out, also the method of compressing the rotor coils while the wedge in the slots was being fitted overcame what had always been a real difficulty. The plan of getting the stator coils a long way back from the rotor was very good, and might be carried further. If the slots were made 3 in. or 4 in. deeper than at present it would be possible to get quite a wide space between stator and rotor coils. This permitted of sufficient leakage flux to cut down the stator current on short-circuit, and obviated the necessity of providing an expensive reactance coil, which caused a certain amount of loss. The extra depth of slot provided a good cooling surface which could easily be cleaned. Those acquainted with copper losses in stator conductors owing to the stray flux from the rotor would appreciate the advantage of getting the copper right away from the rotor. The general mechanical arrangement was much preferable to the type of machine where everything was bunched near the rotor with only ventilation behind. Here they had the ventilation in front on the rotor side. The speaker was convinced that this type would come forward, especially in very large machines. The author had advanced considerably towards that great desideratum after the war—the cheap supply of electrical power.

Mr. R. TOWNEND referred to his experience with the types of rotors described by Prof. Walker, which were satisfactory. He asked for information concerning the large losses which occurred due to eddy currents in different parts of the machine. If a turbo-alternator were run on short circuit and the driving power measured, this power, after deducting friction and windage losses would be considerably greater than the calculated stator C^2R loss. The difference might be 2 per cent. or more of the normal output of the machine, and if this eddy current loss could be reduced by one-half, the efficiency would be increased 1 per cent. together with a considerable reduction in heating. There appeared to be very little data available as to where this loss occurred, its magnitude in different parts of the machine, and also the extent to which it was influenced by different load conditions. The latest edition of the standardisation rules of the American Institute of Electrical Engineers advised that for the purpose of obtaining the efficiency of an alternator the whole of the measured short-circuit losses should be included, but in the speaker's opinion this value was slightly lower than the true efficiency. The subject of stray losses in turbo-alternators was deserving of thorough investigation.

The AUTHOR, in reply to Prof. Walker, said that the field winding described in the Paper was not, in his opinion, the final solution of the problem; in fact, it was doubtful if the final solution had yet shown its head. Prof. Walker's system had many advantages. A number of small slots were used, and, by excellent cooling conditions, a much shallower slot was permissible than in the system described in the Paper. On the other hand, a number of small slots was distinctly a manufacturing disadvantage when dealing with heavy pieces. The practice of putting the coil far back in order to obtain the desired reactance had been used in the United States, particularly on two-pole machines. Two slot wedges had been used, and the space between them served for ventilating purposes. The amount of space suggested by Prof. Walker might seem rather high, but that was a question of magnitude of quantities. Mr. Kapp had been responsible for a number of machines and knew some of the difficulties encountered with large central ducts. His system of

ventilation was designed to overcome these difficulties, and, if other incidental difficulties were not too great, the system had a bright prospect. It had the disadvantage of some blind-ended vents with possible manufacturing difficulties. Mr. Kuyser had also referred to short-circuit tests on two-pole 25-cycle machines, with a view to testing the stiffness of rotor coils. It was justifiable to take the risk of unbraced coils on two-pole machines, but the risk appeared too great on four-pole machines. It might be assumed that the movement of the rotor was so great a percentage of the whole inertia that a big retardation was unlikely. Cases had occurred, however, in which the shaft had been twisted, which gave some idea of the shock to the windings. Mr. Juhlin had pointed out that the 20,000 lb. stress for a hollow rotor was on the low side ; this did not include stresses due to lack of symmetry of structure or shrinkage stresses. The physical properties of large forgings obtainable in this country were very valuable, although the radial tests should certainly be taken more than 3 in. from the surface. Ductility was required, not at the thick part of the tooth, but at the root, and on account of a number of features which could not be calculated. There were manufacturing difficulties which could not be foreseen—things which were intended to fit did not ; wedges did not fit along their whole length, and certain parts of a tooth had to be stretched to throw the load upon another part, and so on. The ductility at the root of the tooth was required on account of the shape which it was usually necessary to adopt. It was more satisfactory to find steel makers in this country willing to accept orders on radial tests taken in this way. Steel makers in the States gave point-blank refusal. It was perfectly true, as mentioned by Mr. Juhlin, that discrepancy in the machining of the plates would induce weakness in the structure of the rotor, and the greatest care was necessary to obtain plates as parallel as possible. Bad joints in the rotor would show up by producing low critical speed. Outside slip-rings had many advantages, as indicated ; but the mechanical disadvantage of taking the leads through the shaft was somewhat serious, and, in the author's opinion, more than counterbalanced the advantages. Regarding the costs of machines, the author seriously questioned Mr. Juhlin's ratio of 3 to 1, and considered that there was very little to choose between the solid and built-up rotor when complete. Replying to Mr. McKenzie, the author said that he quite agreed that the advantages of air washing or filtration were enormous, and he considered that air filtration, including intake and outlet ducts, were to be prominent features in the big stations of the future. Reference had been made to recent tenders in which the maximum short-circuit was seven times normal. Did that refer to the worst possible conditions ? The 14 times referred to in the Paper represented the ratio of the maximum possible peak current to the maximum of a normal graded current. Regarding hollow conductors, there were possibilities in the case of turbo-windings, since many years ago such windings were used on large voltage transformers in the Niagara district, water circulation being used in the low-tension windings. Dr. Worrall had referred to external fans. The efficiency of these fans was very considerable, and they lent themselves well to an air system for a complete station. Regarding the possible movement of rotor windings, some movement certainly did take place, but as it was slight it was easily taken care of. The author did not consider this motion the cause of the breakdown referred to by Dr. Worrall. Mr. Townend had contributed some valuable information regarding welded joints, and he also most truly pointed out that the whole subject of short-circuit losses was greatly in need of investigation. In large machines the short-circuit losses were enormous and their distribution quite unknown. They were too big to be local, and were probably distributed throughout the machine, otherwise the consequences would be more serious. Until recently it had been the practice of the American I.E.E. to advocate that one-third of the short-circuit losses be included in the efficiency calculations, and it would appear that the latest suggestion was to include the whole of them. Probably this erred on the other side, because, with the higher magnetic densities on load, there was not the same possibility of distortion as on short-circuit, and the losses would be expected to be less. In reply to Dr. Cramp regarding the factor of safety, the author said the machines were all tested at 20 per cent. over speed, and would hold together at 50 per cent. over speed. With reference to rotor slots, size of teeth, &c., there were other matters, such as getting heat out of the copper. The tooth stresses were not a serious matter, since if they were a salient feature a better steel could be used without any great increase in cost. A 4 per cent. nickel-steel was very good, and if chrome-steel were adopted the question of tooth stresses would be negligible. The Paper did not cover commutator difficulties or similar matters, but was written expressly on the design of high-speed alternators. Regarding the dependence of critical speeds upon the deflection of the rotor, the point only became of practical importance when vibration was set up. Hitherto no vibration has occurred in these rotors. Mr. Carter's work on " Air-gap Reluctance and Main Losses " seemed to show that in general the question of air-gap reluctance could be accurately enough determined in these machines. A slight variation was of no consequence at all, and the inclusion of them could be calculated with quite sufficient accuracy by rough methods. The question of rotor-face losses, however, was obscure, and Mr. Carter's work did not cover the case. Certain conventional assumptions were made to work out the loss in terms of the permeability and specific resistance of the material. Very little was known of the permeability, and the flux was unknown. The pulsations penetrated only a short distance into the face of the rotor, and the material at the face was probably carrying a higher flux-density at low permeability. A little further along, the permeability changed, and it was this absolute uncertainty as to the way in which the permeability varied which made the Carter formula quite indefinite.

In the Discussion at Leeds, Dr. S. F. BARCLAY said :—With regard to the steel rings for retaining the rotor end windings, there is one point to which the author has not referred, and that is the opening of the rings due to the centrifugal force. For example, in the case of a typical 5,000 kw. 3,000 revs. per min. alternator when running at full speed the rotor ring increases 0·03 in. in diameter, and is, therefore, actually floating quite clear of its seatings. It is not practicable to prevent the floating by shrinking the rings on to their seatings. The floating may have several undesirable effects, but the principal one is change of balance. This undesirable feature is entirely safeguarded against by making the ring and its outer supporting flange all in one piece. This construction is adopted by Messrs. Vickers (Ltd.) as standard with all sizes of polyphase turbo-alternators. In the case of single-phase machines, a similar construction is employed, but a band of high tensile manganese-bronze is introduced between the core and the steel ring. The extra cost of the solid steel end ring compared with the built-up construction is justified by the mechanical soundness gained, and the construction also has other useful features. For example, the supporting flange can be given such stiffness that the ring does not need to be registered on the core ; an effective gap between the core and the ring may thus be provided, very considerably reducing the magnetic leakage. Moreover, the opening between the ring and the core is most effective in improving the ventilation of the rotor end windings. The short length of rotor coil between the core and the ring is given adequate support by extending the wedges beyond the core into the ring. The ring is made a sound press fit on its seating on the shaft, and is positively driven by keys of ample size. The complete ring is turned from a hollow nickel-chrome steel forging having an elastic limit of at least 40 tons to the square inch, an ultimate strength of at least 50 tons to the square inch, and a minimum elongation of 20 per cent. After being forged the rings are annealed, and after rough turning are re-annealed, oil-hardened and tempered. The treatment ensures the rings being homogeneous throughout and free from appreciable initial stress. Circumferential and longitudinal tests are taken from each ring. Under any ordinary condition of out-of-balance—such as occurs on furnace work &c.—the solid steel end rings are found to keep perfectly cool. The amount of out-of-balance for which the machines described by the author had to be designed is quite unusual, and no doubt it was desirable to introduce a little copper into the rings in the way described. The wedge described by the author is ingenious, but in my experience is unnecessary. If a good lead is given to the wedge and a metal liner is placed on the top of the coil, all the downward pressure desired can be obtained with an ordinary wedge. Moreover, the wedge described must require special tackle to apply the vertical pressure to the whole of its length, and that might be a grave disadvantage in carrying out a repair on site. As the rotor revolves, the stress in the bolts increases as they move to the bottom and decreases as they move to the top. Therefore, superimposed on the constant initial stress is an intermittent stress being applied and removed over 2½-million times a day. Since the bolts are a reamered fit in the core the diameter of the screwed portion must be less than that of the body of the bolt. Therefore, the area of the bolt in the short length between the face of the nut and where the thread ends is appreciably less than that of the rest of the bolt. As the intermittent stress comes on, the short length of reduced area stretches more in proportion than the body of the bolt, causing local weakness. Also, the driving torque, by tending to twist the rotor and increase the bolt length adds to the bolt stress, and a short-circuit must similarly add considerably to the stress. It is also to be remembered that the action of tightening the nuts must impose a considerable torsional stress on the bolts. It is, therefore, to be expected that a breakdown will occur in the course of time in consequence of a fatigue fracture at the bottom of the thread just outside the nut. It would be interesting to learn how long the machines have been running, and if there have been any failures. The construction could have been improved by using high-tensile steel bushes, a reamered fit through the core and with the bolts passing through them with an ample clearance, and turned down their whole length to a diameter slightly less than the diameter of the bottom of the thread. The statement made by the author at the discussion in London, that steel manufacturers would not accept the test in a radial direction immediately below the surface, must be contradicted. The maximum stress in the rotor occurs at the root of the tooth, and from every forging made by Messrs. Vickers (Ltd.) a radial test is made at that part, and no forging would be used unless the test showed that the properties of the steel were in every respect suitable for the duty. An example of the results obtained in the case of a rotor forging for a 5,000 kw. 2,400 revs. per min. turbo-alternator are given herewith :—

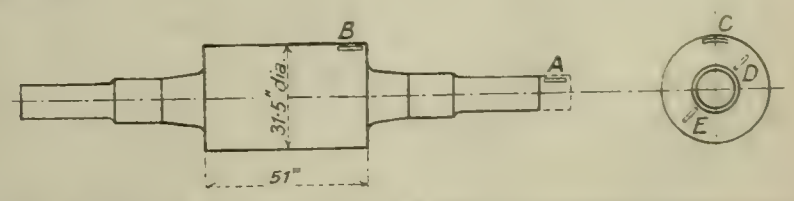


FIG. 2.—ROTOR FORGING FOR A 5,000 KW. TURBO-ALTERNATOR.

Test.	Description.	Elastic limit.	Breaking.	Elongation per cent. on 2 in.
A	Longitudinal	19·5 in.	36·0 in.	34·0 in.
B	Longitudinal	20·5 in.	36·0 in.	32·0 in.
C	Tangential	22·0 in.	37·0 in.	28·0 in.
D	Radial	20·0 in.	36·8 in.	14·5 in.
E	Radial	19·5 in.	36·4 in.	15·0 in.

It will be noticed that the tensile strength is practically uniform throughout, and the elongation—even in the case of the radial tests—has a very satisfactory value. It is always possible to work to a factor of safety of at least 6 to 1, and when it is remembered that the tooth stress is a pure tension and constant in magnitude it shows how safe is the forged rotor construction. Provided that high-class forgings can be obtained, undoubtedly the solid forging is the ideal construction for all outputs at 3,600 and 3,000 revs. per min. For large outputs at 1,500 and 1,800 revs. per min. the soundest construction is to have a hollow forged cylinder shrunk on to a through shaft. With either construction a definite guarantee can be given for the strength of the steel in the direction required. The only possible apology for the rotor built up of plates bolted together is that the construction saves money. In dealing with solid forged steel rotors there are several essential points that must be observed. (1) Large allowances must be made on the forging, so that all metal unavoidably damaged by the forging process is removed by machining; (2) by a thorough annealing after the forging has been made, and by re-annealing, oil-hardening and tempering after the forging has been rough-turned, the forging must be rendered homogeneous and freed from appreciable initial stress; (3) the rotor design must be such that at all parts the rate of change of stress is gradual and within the capacity of the steel. The average stress at any point may be quite low, but due to a too abrupt change of section the rate of change of stress may be too great, resulting in the crystals sliding over one another, and so causing a fatigue fracture to develop. Not only must the shaft between the journals and the core be carefully stepped, but also large radii must be provided at all changes of section, and, moreover, all the radii should be formed truly and be given a dead-smooth finish. An additional point in favour of the forged steel rotor that will be appreciated by the purchaser is that, in the remote contingency of there being any flaw not detected by the tests and exposed by the machining operations, it is almost certain that the overspeed test at the makers' works would show its presence, whereas with a rotor of the kind described in the Paper, any defects of design would most probably not be found out until the machine had been in service for some time. I can quite appreciate the statement made that the type of rotor described has no true critical speed, but the explanation given by the author is not clear. The area of the plates in compression is very considerable compared with the area of the bolts, and, therefore, the addition of even a few hundred pounds to the bolt stress would cause the bolts to elongate sufficiently for the plates to lose their compression and become loose. This opening and closing of the plates would effectively damp the natural transverse vibrations, and, therefore, the rotor would have no critical speed. This condition holds good if the fit of the spigots is free, but if they were made a good press fit, one inside the other, very probably there would be a definite critical speed having a value liable to change and difficult to forecast.

REPORT ON THE WORK OF THE TECHNOLOGY DEPARTMENT OF THE CITY & GUILDS OF LONDON INSTITUTE.

The Report on the work of the Department of Technology of the City and Guilds of London Institute for the session 1914-15 takes the form of a bulky volume. Unlike a good many Reports it makes interesting reading. In particular the general and statistical sections, and the examiners' reports deserve attentive study. We give below brief extracts from the Report, and we comment upon the examiners' reports on Electrical Engineering in another column.

There has never been a time at which sound technical education was so necessary for the promotion of the country's trade or promised so much for its future welfare. If the nation is to be properly equipped to take up again, with an even wider measure of success, its place in the trade of the world, it must look to those who are responsible for the technical training of the younger generation of managers, artisans and operatives.

The detailed statistics given in Tables I. to III. show clearly the main facts of the past year's work, and it will suffice to call attention to certain points of interest which deserve further explanation or comment.

Table I. —*General Results, Technology, United Kingdom.*

Year.	No. of subjects of examination.	No. of examination centres.	No. of classes.	Students in attendance.	No. of candidates' papers.	No. of passes.
1880	24	89	...	...	810	513
1885	42	167	263	6,396	3,968	2,468
1890	49	219	483	12,022	6,957	3,917
1895	58	353	739	24,920	10,293	7,824
1900	64	390	2,182	34,189	14,581	8,344
1905	69	449	2,601	41,618	19,782	11,848
1910	75	418	4,329	53,227	24,508	14,403
1914	73	407	5,949	55,996	23,119	14,576
1915	72	419	4,995	47,050	15,623	9,866

Comparing the figures of Table I. for 1914 and for 1915, it will be understood that the greater percentage reduction in the number of candidates examined as against the reduction in the number of students enrolled as in attendance at registered classes, is accounted for by the gradual withdrawal of students throughout the session, owing to enlistment and other causes due to the war. The number of candidates in the various subjects is, therefore, the better guide to the relative effect which war conditions have had upon different industries. The decrease in the number of candidates in Mechanical Engineering proper is more than one half. While the candidates in Telephony show but little falling off, the number in Telegraphy is less by 40 per cent.; there is good reason to believe that this is due to the large number of telegraph operators and linemen whose services are being utilised in the Army.

Table II.—*Results in Certain Subjects*, 1913-14, 1914-15.*

Subject.	Centres where taught.		Students in attendance.		Candidates at examinations.		Passes.
	1913–14	1914–15	1913–14	1914–15	1914	1915	1915
Telegraphy ...	34	30	1,386	793	1,015	602	415
Telephony					735	677	452
Wiremen's work.	55	57	1,349	1,097	361	253	126
Elec. engineering	124	117	5,432	4,252	1,952	1,341	626
Elec.-metallurgy.	4	4	137	78	72	37	29
Alkali m'nuf'ture	2	2	17	12	42	38	23
Soap m'nufacture	3	2	26	11	17	9	7
Coal-tar products Distillation.....	1	1	19	19	24	21	16
Color'g matters	1	1	9	8	7	13	8
Painter's oils, colours & varnishes	4	5	92	80	47	35	14
Oils and Fats....	10	8	92	74	39	33	20
Glass making	...	...	...	...	...	...	...
Leather tanning.	2	2	57	47	22	23	17
Silk dyeing.....	4	2	36	22	13	14	13
Wool dyeing.....	8	9	173	162	103	60	40
Cotton dyeing....	16	12	227	140	143	104	66
Leather dyeing...	1	1	50	11	17	18	17

The proportion of candidates who have been successful in passing their examinations stands at 63·2 per cent. of those who presented themselves, which is practically the same figure as in 1914, and no marked divergencies appear in the more important subjects, even when the reductions in numbers exceed the average. It may, therefore, be concluded that on the whole those who are still receiving technical instruction are being as well prepared as before. The decrease in the number of the older candidates entering for the Final examinations might have been expected to be higher than in the case of those entering for the lower Grades, but no such tendency is traceable; while the decrease in the candidates for the lower Grades is 35 per cent., it is only 29 per cent. for the Final examination, and in both 1914 and 1915 the number of Final candidates is between 17 and 18 per cent. of the total.

As indicated above, the variations in the percentages of failures in the different subjects considered separately (Table III.) are not more marked than may be found in other years under normal conditions. The results in Telephony show improvement; in Telegraphy they are not so good, and Electric Wiremen's Work still shows a high percentage of failures. Attention was called to the subject of Electrical Engineering in last year's Report, and it is to be regretted that the failures in Grades I. and II. are again so high in spite of the fact that the Institute makes it a general condition of entry to the examination that the candidate should have attended satisfactorily classes for both lectures and laboratory practice in this subject.

Table III. *Details of Passes and Failures in Electrical Engineering and Allied Subjects.*

Subject.	Candidates 1914	Final.			Grade (or Grades) below final.			Total.		Passes 1915
		1st.	2nd.	Fail.	1st.	2nd.	Fail.	Pass	Fail	
Telegraphy ...	602	11	23	41	181	209	146	415	187	31·1
Telephony	677	15	49	48	147	241	177	452	225	33·2
Elec. Wiremen's Work	253	10	20	11	20	76	116	126	127	50·1
Elec. Engin'r'ng Grade I.	771	...	...	...	...	...	...	364	407	52·8
Grade II.	305	...	...	...	...	...	...	173	130	42·9
Grade II. a.c.	228	...	...	...	...	...	...	78	150	65·7
Final	39	2	9	28	...	...	...	11	28	71·7
Electro-metallurgy (Grade I.)	17	...	...	...	...	...	...	13	4	23·5
Electro-metallurgy (Grade II. and final)	20	3	2	3	2	9	1	16	4	20·0

* We include in this Table the Chemical and Allied Trades, so as to give some idea of the nature of the task confronting those who are endeavouring to organise the British Chemical Industry.—[Eds. *E.*]

In India and the Colonies 634 candidates were examined, 428 passes were recorded, and three prizes were awarded. The corresponding figures for 1914 were 753 candidates, 482 passes and two prizes.

The principal items of interest from the examiners' reports on Telegraphy, Telephony, Wiremen's Work, Electrical Engineering and Electro-metallurgy are given below.

Telegraphy.—The results are still disappointing in the Final Grade. The standard reached generally is far below what it should be, seeing that the questions set are all within the syllabus and are not of a very difficult character. The more complex methods of telegraphy do not appear to receive from teachers that attention which their importance demands. The gradual and general extension of type-printing systems should be well-known to all teachers, yet most candidates imperfectly understand the most elementary principles and appear to have no proper conception of any system as a whole. The fact that few candidates attempted the question on oscillating circuits, and that most of the answers were not of a high order, indicates that the now important subject of wireless telegraphy receives scant attention from teachers and students.

Telephony.—In the Grade I. examination where explanatory or "skeleton" diagrams are asked for, candidates show reluctance to commit themselves to anything but full, or nearly full, standard diagrams of connections. Clear ideas of principles are better conveyed by simplified diagrams, and teachers would do well to encourage this class of diagram when dealing with working principles.

In the Final Grade incomplete answers and diagrams were too frequent and there was a lack of full appreciation of the more practical considerations governing the utility of various devices.

Electric Wiremen's Work.—In the written paper of Grade I. the results this year are disappointing, the answers showing that a very large percentage of the candidates either had had very little practical experience in wiring, or had not taken advantage of their opportunities. Generally the weak points appear to be a lack of knowledge of the general construction of buildings, of the newer methods of wiring, simple applications of Ohm's law, and the heating effects of the electric current. As regards the practical work this was almost as disappointing as the written work. A particularly simple test was set, and it is surprising that any candidate should have failed to do it correctly.

Generally speaking the results in the Written Paper of the Final Examination were satisfactory. Candidates generally showed an intelligent grasp of alternating-current effects, the questions being well answered, as were most of the questions in the "Electrical Calculations" section. The practical work was, generally speaking, satisfactorily done, the principal faults being a lack of neatness in trimming the ends of the flexibles and a want of foresight in arranging the fittings on the board to the best advantage. In a few cases the connections were wrong, the pilot switch being improperly connected.

Electrical Engineering.—Perhaps the most important and desirable qualities in the engineer are ingenuity and initiative. It is therefore to be regretted that many of the answers in all Grades show a great lack of these qualities in the candidates. Lack of initiative was displayed in the answers to the question in Grade II. about the method to be employed in testing a 500-volt motor on a 250-volt circuit. Only one candidate gave a satisfactory answer. Even in the Final Examination few students showed any methods of working outside the province of the ordinary text-book. In the Paper on design full particulars and dimensions of an induction motor were given, yet not a single candidate was able to tell its probable rating.

The students are not taught sufficiently well to think for themselves and to get down to what is really useful. Many marks were scored on answers requiring only a general description or a statement of materials to be employed, but the answers to questions calling for precise quantitative calculation were upon the whole disappointing unless the answer could be obtained by working out a well-known formula.

The training of an engineer ought to involve much more working out of examples in which the student is compelled to exercise his ability and ingenuity to get as useful results from the information and methods given in the books. The examination should be a test not so much of what the student knows as to what he can do. In too many cases the answers showed some ill-digested knowledge and very little ability to make use of knowledge. It would be a good plan to draw the attention of teachers most emphatically to the importance of giving the students more practice in working out calculations. Too many of them have no facility at all in the use of the slide rule or in fixing the position of the decimal point.

In Grade II., Alternating Currents, many candidates could not calculate the current in a three-phase line when given the power, the volts and the power factor. A few of the candidates in the Final Examination were quite well prepared, but for the most part the answers were of very little higher standard than those of Grade II. This points to the fact that the teaching throughout the country does not lead up to the Final standard. It is very desirable that more students should take higher classes.

Electro-Metallurgy.—The results were poor throughout, and did not reach the standard usually attained. Teachers should impress upon their pupils the great importance of the following: (1) Sketching. (2) A thorough grasp of the scientific principles underlying the practical operations of electro-metallurgy. (3) The necessity for confining the answer strictly to the question asked.

Students are not at all familiar with the chemical and physical properties of the substances they have to handle. Similarly, with apparatus, or plant, such as the dynamo or motor-generator, students give some sort of a drawing which they intend to represent a dynamo (say), but their knowledge of why the dynamo works and of the relation of its various parts, is very hazy. Such knowledge cannot be imparted through books or merely by word of mouth. It is suggested that the proper mode of doing this would be somewhat as follows: The students should be collected round a machine with sketch books in their hands. The teacher should have a black-board in front of him and should sketch each part of the machine and explain its scientific purpose. He should see that each student has made a proper sketch of each part of the machine, and made short notes against his sketches; he should further make sure that each of the students *understands* the subject.

THE ESTIMATION OF THE DISPERSION COEFFICIENT OF THREE-PHASE INDUCTION MOTORS AND ITS APPLICATION TO THEIR DESIGN.

BY E. A. BIEDERMANN, B.SC., A.M.I.E.E.

(*Concluded from page* 455.)

Summary.—Part I. of this Paper deals with a method of calculating the dispersion coefficient of a three-phase induction motor. It is divided into five sections. The first section shows how the dispersion coefficient may conveniently be separated into three components, termed the main, peripheral and flank dispersions, and how these components may be expressed in terms of the coefficients of self and mutual induction of the stator and rotor windings. Sections 2, 3 and 4 are devoted to the calculation respectively of these three components in terms of the dimensions of the machine, particular attention being given to the component termed the main dispersion. In section 5 comparisons are made of the dispersion coefficients, calculated in the manner described, with those obtained experimentally.

In Part II. the results obtained in Part I. are applied to the question of the design of a motor from the point of view of obtaining a minimum dispersion coefficient. It is shown that for this purpose a small slot pitch is as important as a small air-gap, and a method of design is outlined, beginning with the slot and resulting in fixing the diameter of the machine. It is then discussed to what extent the dispersion coefficient is likely to be increased if this diameter is departed from.

Part II.

The Application to Design.—This part of the Paper is concerned with an attempt to determine how the results deduced in the foregoing pages may be applied to the design of a motor in order to ensure its having the least possible dispersion coefficient consistent with certain other considerations.

Among the factors which influence σ are, of course, the specific loading and the flux density in the gap, both of which affect the ratio k_z, the first by increasing the length of the teeth, the second by increasing the flux density in them. The selection of these quantities, however, is settled by considerations of size, temperature rise, efficiency, &c., so that we are not here concerned with them.

Two Conditions for Small Dispersion Coefficient.—The actual size of the motor—*i.e.*, the value of d^2l_i being determined, there are two fundamental factors on which σ depends. These are: (1) The air-gap; (2) the slot-pitch.

The formula,

$$\sigma = 0{\cdot}004 + \frac{B}{S^2} + \frac{26P\delta}{S\tau_i} + \frac{k\tau}{l\tau_i}\frac{\delta}{},$$

shows at once that the smaller δ is made the smaller σ will be.

The first condition for a small dispersion coefficient is, therefore, an air-gap as small as is mechanically feasible.

Next suppose in a machine of which all the dimensions have been fixed, that the slot-pitch w (mean of stator and rotor) be reduced, all dimensions except those of the slots remaining unaltered.

Then σ_3 is unaltered. Also, if the slits in the slots are reduced proportionately, $P\left(=\frac{e}{v}+\frac{1}{3}\frac{h}{b}\right)$ will vary inversely as w, while if they remain unaltered P will increase less rapidly with diminishing w. But S also varies inversely as w. Consequently σ_2 either remains constant or else decreases as the slot-pitch is reduced. Lastly, since S varies inversely as w, σ_1 decreases with the slot-pitch.

It follows that the dispersion coefficient of any machine can always be reduced by making the slot-pitch smaller.

The second condition for minimum σ is, therefore, as small a slot-pitch as possible, taking into consideration the questions of the slot space factor and the labour costs of winding. The

relative importance of these two primary conditions—a small air-gap and a small slot-pitch—will be examined later.

The length of the air-gap may be expressed as a fraction of the diameter. This fraction will be denoted by a, so that $a=\frac{\delta}{d}$.

Method of Design.—Having settled on values for a and w, the next step is to design the slot in order to estimate the slot permeance P. There is no reason why this should not be done at this stage of the design—at least, approximately. It will be seen later that for the present purpose a comparatively rough estimation of P is sufficient. A suitable ratio having been chosen for S_2/S_1, B is obtained from Table II. The ratio τ/τ_i is also known from the slot dimensions, being equal to $\frac{w}{(w-v)}$ (mean of stator and rotor). Lastly, d^2l_i is known.

Diameter for Minimum Dispersion Coefficient.—The choice of diameter has now to be made. Given the various quantities mentioned above, the dispersion coefficient will yet vary according to the diameter chosen, and our purpose is now to show how to find that diameter which will make σ a minimum. It is possible that the diameter so found may not in all cases be suitable owing to considerations which do not enter here. Even

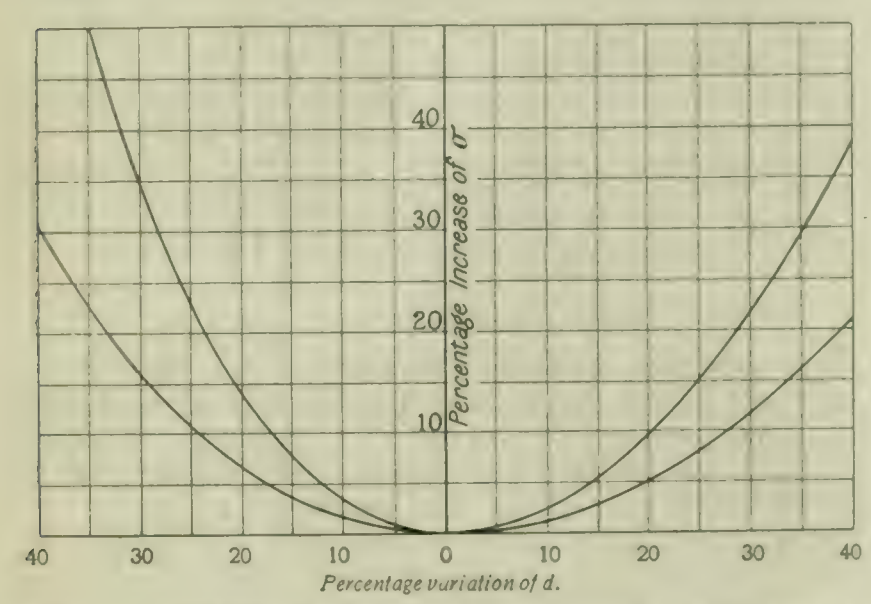


Fig. 18.—Increase of Dispersion Coefficient with Diameters Differing from the Ideal Diameter.

in such cases, however, a knowledge of the ideal diameter for minimum σ forms a guide in selecting a diameter.

If diameter $=d$, $d^2l_i=\mathrm{K}$, p = number of poles, then

$$\sigma=0{\cdot}004+\frac{\mathrm{B}}{S^2}+\frac{26\mathrm{P}\delta}{S\tau_i}+\frac{k\tau}{\tau_i}\cdot\frac{\delta}{l_i},$$

$$=0{\cdot}004+\frac{\mathrm{B}w^2}{\tau^2}+\frac{26\mathrm{P}\delta w}{\tau\tau_i}+\frac{k\tau}{\tau_i}\cdot\frac{\delta}{l_i},$$

$$=0{\cdot}004+\frac{\mathrm{B}w^2p^2}{\pi^2d^2}+\frac{26\tau\mathrm{P}wp^2a}{\pi^2\tau_i d}+\frac{k\tau a d^3}{\tau_i\mathrm{K}}.$$

For given a, w, p, B, P, k, K and τ τ_i the condition for minimum σ is obtained by differentiating the above expression with respect to d, and equating to zero, which gives

$$-\frac{2}{\pi^2}\cdot\frac{\mathrm{B}w^2p^2}{d^3}-\frac{26\tau\mathrm{P}wp^2a}{\pi^2\tau_i d^2}+\frac{3ka\tau d^2}{\mathrm{K}\tau_i}=0,$$

or

$$d^5\frac{26}{3\pi^2}\cdot\frac{\mathrm{P}wp^2\mathrm{K}d}{k}-\frac{2}{3\pi^2}\cdot\frac{\mathrm{B}w^2p^2\mathrm{K}\tau_i}{ka\tau}=0,$$

which may be written

$$d^5-0{\cdot}8775\mathrm{Q}d-0{\cdot}0676\mathrm{QR}=0,$$

where $\mathrm{Q}=\mathrm{P}wp^2\mathrm{K}k$,

and $\mathrm{R}=\frac{\mathrm{B}w\tau_i}{\mathrm{P}a\tau}$.

Solution of Equation for Diameter.—In Table VII. are given the solutions of the above equation for a range of values of Q and R large enough to include all cases. The table is applicable whatever unit of length be employed. Q and R contain only quantities which have already been selected or estimated. The value of d obtained from Table VII. then determines the proportions to be given to the motor in order that it may have the minimum dispersion coefficient possible with the given data a, w, p, B, P, k, K and τ/τ_i.

Example of Determination of Diameter.—12-pole motor, $d^2l_i=\mathrm{K}=10^5$ cm.^{3}. Assume $w=2$ cm., $b=1{\cdot}2$ cm., $h=3{\cdot}6$ cm., $r=0{\cdot}2$ cm., $e=0{\cdot}1$ cm., $a=\frac{\delta}{d}=\frac{1}{1{,}000}$, $k=4$, and $\frac{S_2}{S_1}=\frac{5}{4}$. Then, B$=1{\cdot}95$ (from Table II.), and P$=1{\cdot}5$.

$$\therefore\ \mathrm{Q}=\frac{\mathrm{P}wp^2\mathrm{K}}{k}=\frac{1{\cdot}5\times2\times12^2\times10^5}{4}=1{\cdot}08\times10^7,$$

and

$$\mathrm{R}=\frac{\mathrm{B}w\tau_i}{\mathrm{P}a\tau}=\frac{1{\cdot}95\times2\times9\times1{,}000}{1{\cdot}5\times1{\cdot}0}=2{,}340.$$

Table VII. then gives about 75 cm. for the diameter.
$\therefore\ l_i=18$ cm., $d\ l_i=4$ approximately.

Variation of σ with the Diameter.—The question immediately arises as to how much σ will be increased if we use a diameter differing from that obtained in the manner described above, *assuming that the values of* B, P, k *used were correct.* The answer to this is given in Fig. 18, which shows two curves, one giving the maximum and the other the minimum possible percentage increase in σ above its theoretical minimum as the

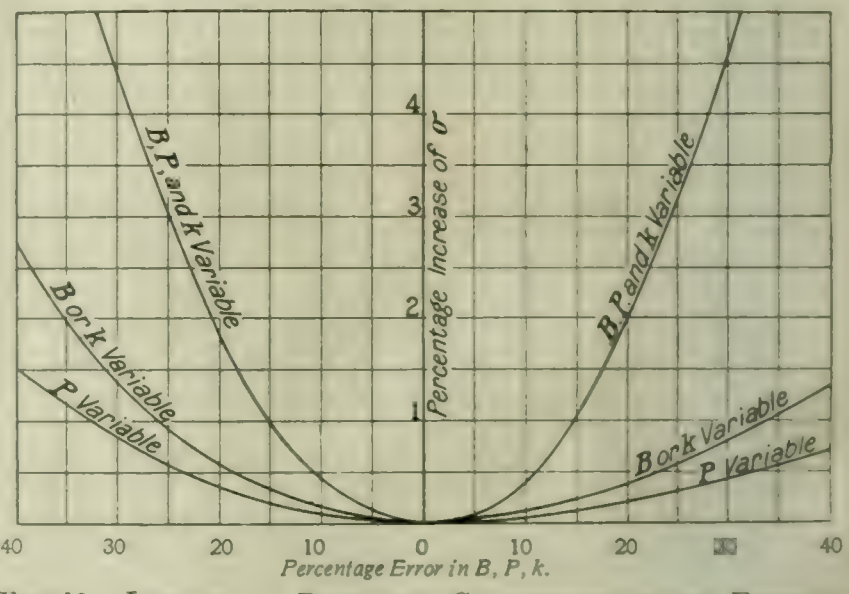


Fig. 19.—Increase of Dispersion Coefficient due to Errors in in Assumed Values of B, P, k.

diameter used is varied from that corresponding to $\sigma_{min.}$ The maximum curve is obtained with very small motors with comparatively large values of R, while the minimum curve applies to very large motors with relatively small values of R. It appears, therefore, that in any case d may differ some 10 to 15 or even 20 per cent. from the theoretically correct value, without causing more than a very small increase of the dispersion coefficient. Owing to this fact the same stampings can be used, without much detriment, for machines of the same size but with different numbers of poles. The diameter of the stamping used should then be equal to the correct diameter to give $\sigma_{min.}$ for that number of poles which is the mean of the different numbers of poles for which the stamping is to be used.

Reliability of Method of Determining Diameter.—We have now to inquire as to the reliability of the above method for determining the correct value to be given to the diameter to obtain the best result. It, of course, depends entirely on the correctness of the values of B, P and k used; but an error in any of these quantities does not involve a corresponding increase in the ratio $\sigma/\sigma_{min.}$, where $\sigma_{min.}$ denotes the value of σ which would have been obtained with the true ideal diameter, and σ is the value obtained using the incorrect value of the ideal diameter.

In Fig. 19 are shown curves giving the maximum percentage increase in σ above the minimum value, due to a given percentage error (1) in B only or in k only, (2) in P only, (3) in B, P *and* k. The error in the last case is supposed to be of opposite sign in k to what it is in B and P, as this gives the greatest resultant error in d, and therefore the greatest increase in σ.

It will perhaps be as well to explain at somewhat greater length the meaning of the curves of Fig. 19.

Suppose B, P, k denote the correct values of the quantities which these letters represent, and that the values actually used in the determination of d are B′, P′, k', which differ by, say, 20 per cent. from B, P, k respectively, k being too small and B, P too large. The value of d obtained might be as much as 9 per cent. greater than it should really be for the motor to have the least dispersion coefficient possible with the *actual value* B. P, k. The result of using a value of d which is 9 per cent. too large, is that the motor so designed will have a dispersion coefficient 2 per cent. greater at the most than it would have had, had the correct value of d been used. This is the percentage increase of σ which is shown in Fig. 19. Thus, the curve shows that an error of 20 per cent. in B, P and k causes an increase of at the most but 2 per cent. in σ, and an error of 30 per cent., an increase of less than 5 per cent. If only *one* of the quantities B, P, k is incorrect the resulting increase of σ is far less, as is shown by the other curves in Fig. 19.

While a given error in B or k has approximately the same effect on σ an equal error in P has not much more than half that effect. Thus, even a 40 per cent. error in P only causes 1½ per

Table VII.—*For Determining Diameter of Rotor.*

$\frac{Q}{Pwp^2K/k}$	$R = Bw\tau_i/Pa\tau$																		
	250	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	6,000	8,000	10,000	12,000	15,000	17,500	20,000	22,500	25,000
$0{\cdot}5\times10^3$	6·4	7·2	8·2	8·9	9·4	9·8	10·1	10·5	10·7	11·0	11·3	11·6	12·4	12·8	13·2	14·0	14·4	14·7	15·0	15·5
$1{\cdot}0\times10^3$	7·3	8·3	9·5	10·1	10·7	11·2	11·5	12·0	12·4	12·6	12·9	13·4	14·0	14·6	15·2	16·0	16·4	17·0	17·3	17·5
$2{\cdot}0\times10^3$	8·5	9·7	11·0	11·7	12·3	12·9	13·4	13·7	14·0	14·4	14·6	15·0	16·0	17·0	17·5	18·5	19·0	19·5	20·0	20·5
$4{\cdot}0\times10^3$	9·8	11·2	12·6	13·5	14·3	14·9	15·4	15·8	16·3	16·6	17·0	17·5	18·5	19·5	20·0	21·0	21·5	22·5	23·0	23·5
$7{\cdot}0\times10^3$	11·3	12·7	14·2	15·2	16·0	16·7	17·4	17·8	18·2	18·6	19·0	19·5	20·5	21·5	22·5	23·5	24·5	25·0	25·5	26·0
$1{\cdot}0\times10^4$	12·2	13·5	15·2	16·0	17·0	18·0	18·5	19·0	19·5	20·0	20·5	21·0	22·0	23·0	24·0	25·0	26·0	27·0	27·5	28·0
$1{\cdot}5\times10^4$	13·2	14·5	16·5	17·5	18·5	19·5	20·0	20·5	21·0	21·5	22·0	23·0	24·0	25·0	26·0	27·5	28·5	29·0	30·0	30·5
$2{\cdot}0\times10^4$	14·2	15·7	17·5	19·0	20·0	20·5	21·5	22·0	22·5	23·0	23·5	24·0	25·5	27·0	28·0	29·0	30·0	31·0	31·5	32·0
$3{\cdot}0\times10^4$	15·5	17·0	19·0	20·5	21·5	22·5	23·0	24·0	24·5	25·0	25·5	26·0	28·0	29·0	30·0	31·5	32·5	33·0	34·0	35·0
$4{\cdot}0\times10^4$	16·5	18·0	20·5	21·5	22·5	23·5	24·5	25·0	26·0	26·5	27·0	28·0	29·5	30·5	32·0	33·5	34·5	35·5	36·0	37·0
$7{\cdot}0\times10^4$	18·5	20·5	22·5	24·5	25·5	26·5	27·5	28·0	29·0	29·5	30·5	31·5	33·0	34·5	36·0	37·5	38·5	39·5	40·5	41·5
$1{\cdot}0\times10^5$	20·0	22·0	24·5	26·5	27·5	28·5	29·5	30·5	31·0	32·0	32·5	33·5	35·5	37·0	38·5	40·0	41·5	42·5	43·5	44·5
$1{\cdot}5\times10^5$	22·0	24·0	27·0	28·5	30·0	31·0	32·0	33·0	34·0	34·5	35·5	36·5	38·5	40·5	42·0	44·0	45·0	46·0	47·0	48·0
$2{\cdot}0\times10^5$	23·5	25·5	28·5	30·5	32·0	33·0	34·0	35·0	36·0	37·0	37·5	38·5	41·0	42·5	44·0	46·0	48·0	49·0	50·0	51·0
$3{\cdot}0\times10^5$	26·0	28·0	31·0	33·0	34·5	36·0	37·0	38·0	39·0	40·0	41·0	42·0	44·0	46·5	48·0	50·0	51·0	53·0	54·0	55·0
$4{\cdot}0\times10^5$	28·0	30·0	33·0	35·0	36·5	38·0	39·5	40·5	41·5	42·5	43·5	44·5	47·0	49·0	51·0	53·0	55·0	56·0	57·0	59·0
$6{\cdot}0\times10^5$	30·5	32·5	35·5	38·0	40·0	41·5	43·0	44·0	45·0	46·0	47·0	48·5	51·0	53·0	55·0	57·0	59·0	61·0	63·0	65·0
$8{\cdot}0\times10^5$	33·0	34·5	38·0	40·5	42·5	44·0	45·5	46·5	48·0	49·0	50·0	51·0	54·0	56·0	59·0	61·0	63·0	64·0	66·0	68·0
$1{\cdot}0\times10^6$	34·5	37·0	40·0	42·5	44·5	46·0	47·5	49·0	50·0	51·0	52·0	54·0	57·0	59·0	61·0	64·0	66·0	68·0	69·0	71·0
$1{\cdot}5\times10^6$	37·5	40·0	43·5	46·5	48·5	50·0	52·0	53·0	55·0	56·0	57·0	58·0	62·0	64·0	66·0	69·0	72·0	74·0	75·0	77·0
$2{\cdot}0\times10^6$	40·0	42·5	46·5	49·5	51·0	53·0	55·0	57·0	58·0	59·0	60·0	62·0	65·0	68·0	70·0	74·0	76·0	78·0	79·0	81·0
$3{\cdot}0\times10^6$	44·0	46·5	51·0	54·0	56·0	58·0	60·0	62·0	63·0	64·0	65·0	67·0	71·0	74·0	77·0	80·0	82·0	84·0	87·0	89·0
$4{\cdot}0\times10^6$	47·0	50·0	54·0	57·0	60·0	62·0	64·0	65·0	67·0	68·0	69·0	71·0	75·0	78·0	81·0	85·0	87·0	89·0	92·0	94·0
$5{\cdot}0\times10^6$	50·0	53·0	57·0	60·0	63·0	65·0	67·0	68·0	70·0	71·0	73·0	75·0	79·0	82·0	85·0	89·0	91·0	93·0	96·0	98·0
$6{\cdot}0\times10^6$	52·0	55·0	59·0	62·0	65·0	67·0	69·0	71·0	72·0	74·0	75·0	78·0	82·0	85·0	88·0	92·0	95·0	97·0	99·0	101·0
$8{\cdot}0\times10^6$	56·0	59·0	63·0	66·0	69·0	71·0	73·0	75·0	77·0	78·0	80·0	82·0	87·0	90·0	93·0	97·0	100·0	103·0	105·0	108·0
$1{\cdot}0\times10^7$	59·0	62·0	66·0	70·0	72·0	75·0	77·0	79·0	81·0	82·0	84·0	86·0	91·0	95·0	98·0	102·0	105·0	107·0	110·0	113·0
$1{\cdot}5\times10^7$	65·0	68·0	72·0	76·0	79·0	82·0	84·0	86·0	88·0	90·0	91·0	94·0	99·0	103·0	106·0	111·0	114·0	117·0	120·0	122·0
$2{\cdot}0\times10^7$	69·0	72·0	77·0	81·0	84·0	87·0	89·0	91·0	93·0	95·0	97·0	100·0	105·0	109·0	113·0	117·0	121·0	124·0	127·0	129·0
$3{\cdot}0\times10^7$	76·0	79·0	84·0	88·0	92·0	95·0	97·0	99·0	101·0	103·0	105·0	108·0	114·0	119·0	123·0	128·0	131·0	135·0	138·0	140·0
$4{\cdot}0\times10^7$	82·0	85·0	90·0	94·0	97·0	100·0	103·0	105·0	108·0	110·0	112·0	115·0	121·0	126·0	130·0	135·0	139·0	143·0	146·0	149·0
$5{\cdot}0\times10^7$	86·0	89·0	94·0	99·0	102·0	106·0	108·0	111·0	113·0	115·0	117·0	120·0	127·0	132·0	136·0	142·0	146·0	149·0	153·0	156·0
$6{\cdot}0\times10^7$	90·0	93·0	98·0	103·0	106·0	110·0	113·0	115·0	117·0	120·0	122·0	126·0	132·0	137·0	142·0	147·0	151·0	155·0	158·0	162·0
$8{\cdot}0\times10^7$	96·0	100·0	105·0	110·0	113·0	117·0	120·0	122·0	125·0	127·0	129·0	133·0	140·0	145·0	150·0	156·0	160·0	164·0	168·0	171·0
$1{\cdot}0\times10^8$	101·0	105·0	110·0	115·0	119·0	122·0	126·0	128·0	131·0	133·0	135·0	139·0	146·0	152·0	157·0	163·0	168·0	172·0	176·0	179·0
$1{\cdot}5\times10^8$	112·0	115·0	121·0	126·0	130·0	134·0	137·0	140·0	143·0	145·0	148·0	152·0	159·0	165·0	170·0	177·0	182·0	187·0	191·0	195·0
$2{\cdot}0\times10^8$	120·0	123·0	129·0	134·0	138·0	142·0	146·0	149·0	151·0	154·0	157·0	162·0	169·0	175·0	181·0	188·0	193·0	198·0	203·0	207·0
$3{\cdot}0\times10^8$	132·0	136·0	141·0	147·0	151·0	156·0	159·0	161·0	165·0	168·0	171·0	176·0	184·0	191·0	197·0	205·0	210·0	216·0	220·0	225·0
$4{\cdot}0\times10^8$	142·0	145·0	152·0	157·0	162·0	166·0	170·0	173·0	176·0	180·0	183·0	187·0	196·0	203·0	209·0	217·0	223·0	228·0	234·0	238·0
$5{\cdot}0\times10^8$	150·0	153·0	160·0	165·0	170·0	174·0	178·0	182·0	185·0	188·0	191·0	196·0	205·0	213·0	219·0	227·0	234·0	239·0	244·0	249·0
$6{\cdot}0\times10^8$	156·0	160·0	167·0	172·0	177·0	181·0	185·0	189·0	192·0	196·0	199·0	204·0	213·0	220·0	227·0	235·0	242·0	248·0	254·0	259·0
$8{\cdot}0\times10^8$	168·0	171·0	178·0	184·0	189·0	193·0	198·0	202·0	205·0	208·0	212·0	217·0	226·0	234·0	241·0	250·0	257·0	263·0	269·0	274·0
$1{\cdot}0\times10^9$	177·0	180·0	187·0	194·0	199·0	204·0	208·0	211·0	215·0	218·0	222·0	227·0	236·0	245·0	253·0	262·0	269·0	275·0	282·0	288·0
$1{\cdot}5\times10^9$	196·0	200·0	206·0	212·0	218·0	223·0	227·0	231·0	235·0	238·0	242·0	248·0	258·0	267·0	275·0	285·0	292·0	300·0	306·0	312·0
$2{\cdot}0\times10^9$	209·0	213·0	220·0	227·0	232·0	237·0	242·0	246·0	250·0	254·0	257·0	264·0	275·0	284·0	292·0	302·0	310·0	318·0	325·0	332·0
$3{\cdot}0\times10^9$	231·0	235·0	243·0	249·0	255·0	260·0	265·0	269·0	273·0	277·0	281·0	288·0	300·0	310·0	318·0	330·0	338·0	345·0	353·0	360·0
$4{\cdot}0\times10^9$	248·0	252·0	260·0	266·0	272·0	277·0	282·0	287·0	291·0	295·0	299·0	307·0	318·0	330·0	338·0	350·0	359·0	367·0	374·0	382·0
$5{\cdot}0\times10^9$	262·0	266·0	274·0	280·0	286·0	292·0	297·0	302·0	306·0	310·0	314·0	322·0	335·0	345·0	355·0	366·0	375·0	385·0	393·0	400·0
$6{\cdot}0\times10^9$	274·0	278·0	286·0	293·0	298·0	304·0	310·0	314·0	319·0	323·0	328·0	335·0	348·0	360·0	370·0	382·0	391·0	400·0	408·0	416·0
$8{\cdot}0\times10^9$	294·0	298·0	306·0	313·0	319·0	325·0	330·0	335·0	340·0	345·0	349·0	357·0	370·0	382·0	392·0	405·0	415·0	424·0	432·0	440·0
$1{\cdot}0\times10^{10}$	307·0	315·0	322·0	330·0	336·0	342·0	347·0	352·0	357·0	362·0	365·0	373·0	388·0	400·0	412·0	425·0	435·0	444·0	453·0	461·0
$1{\cdot}5\times10^{10}$	340·0	347·0	355·0	363·0	369·0	375·0	382·0	387·0	392·0	396·0	401·0	410·0	425·0	439·0	450·0	463·0	474·0	484·0	493·0	503·0
$2{\cdot}0\times10^{10}$	364·0	372·0	381·0	388·0	395·0	402·0	407·0	412·0	417·0	423·0	428·0	437·0	450·0	465·0	477·0	492·0	505·0	516·0	527·0	537·0
$3{\cdot}0\times10^{10}$	402·0	412·0	420·0	427·0	434·0	440·0	447·0	452·0	457·0	462·0	467·0	477·0	493·0	508·0	520·0	536·0	548·0	559·0	570·0	580·0
$4{\cdot}0\times10^{10}$	433·0	442·0	449·0	457·0	463·0	470·0	477·0	483·0	488·0	494·0	499·0	510·0	528·0	544·0	557·0	572·0	584·0	595·0	607·0	616·0
$5{\cdot}0\times10^{10}$	457·0	466·0	474·0	483·0	490·0	496·0	503·0	509·0	515·0	520·0	526·0	535·0	552·0	567·0	579·0	597·0	612·0	623·0	635·0	645·0
$6{\cdot}0\times10^{10}$	480·0	488·0	496·0	505·0	512·0	518·0	525·0	531·0	537·0	542·0	547·0	558·0	575·0	590·0	604·0	622·0	637·0	650·0	662·0	675·0
$8{\cdot}0\times10^{10}$	515·0	523·0	532·0	540·0	548·0	555·0	562·0	567·0	573·0	578·0	584·0	594·0	612·0	628·0	642·0	662·0	677·0	690·0	703·0	715·0
$10{\cdot}0\times10^{10}$	545·0	553·0	562·0	570·0	577·0	584·0	590·0	597·0	603·0	609·0	615·0	625·0	643·0	660·0	675·0	695·0	710·0	724·0	737·0	750·0

cent. increase of σ. It was for this reason that it was said that a comparatively rough estimation of P was sufficient for determining d.

The fact that comparatively large errors in B, P and k cause such little increase of σ above the minimum possible with their true values, makes this method of determining d reliable to a far greater degree than is the estimation of the actual value of σ. We have seen that errors as large as 20 per cent. may occur in this latter estimation, though it is probable that such a large discrepancy is partly due to error in the observed values of σ. At any rate, errors of 10 per cent. are to be expected, whereas the curves of Fig. 19 show that it is very unlikely that

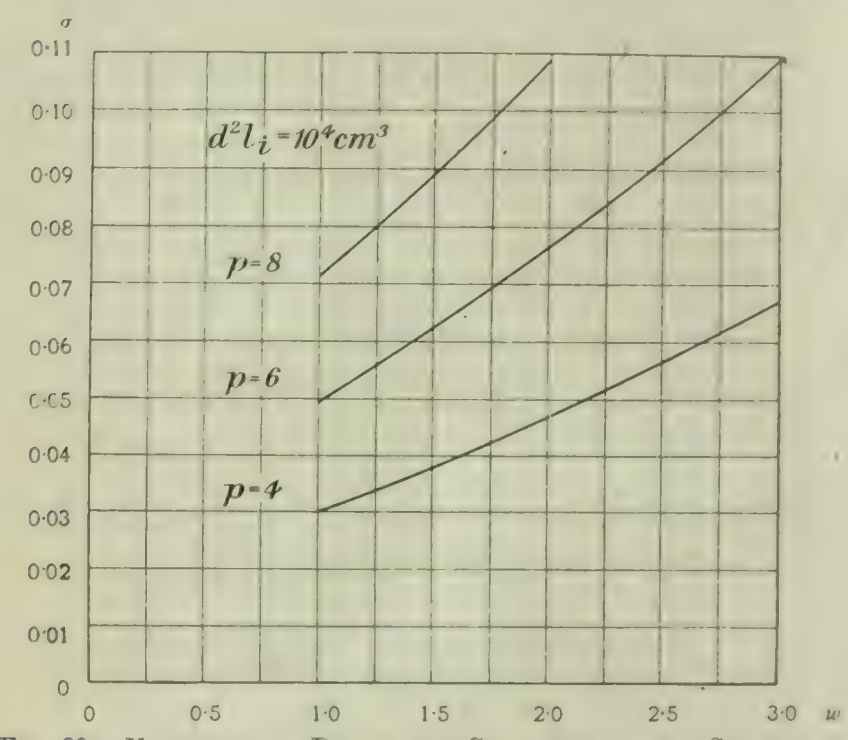


Fig. 20.—Variation of Dispersion Coefficient with Slot-pitch.

σ will be as much as even 5 per cent. greater than the minimum possible for the given quantities B, P, k provided the diameter be determined in the manner described above.

Desirability of Adopting Approximately the Diameter Found for $\sigma_{min.}$—The curves of Fig. 18 show that the value of d selected may differ by some 12 to 20 per cent. from the correct value of d to give σ_{min} without making σ more than 5 per cent. greater than its possible minimum value. This, however, *is only true if the value of* B, P, k *used in determining* d *were correct.* Supposing these values were incorrect to the extent of some 20 per cent., then, as already stated, the value of d obtained might be about 9 per cent. too high. If, now, a diameter be

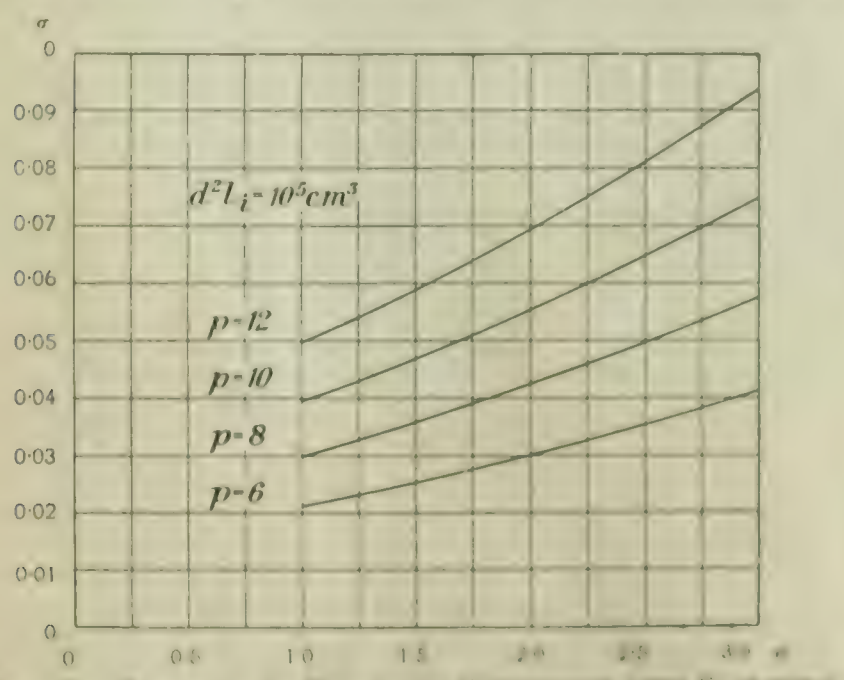


Fig. 21.—Variation of Dispersion Coefficient with Slot-pitch.

selected, say, 15 per cent. greater than this it will really be, not 15 per cent., but 25 per cent. greater, and this, as Fig. 18 shows, may cause an increase in σ of anything from 8 to 15 per cent. Had there been no error in B, P or k, the resulting increase of σ would have been only some 3 to 6 per cent.

Again, supposing the diameter selected be 25 per cent. greater than the value determined for d, it would be 36 per cent. greater than the *correct* value of d, which would make σ anything from 17 to 30 per cent. greater than $\sigma_{min.}$, whereas, had there been no error in B, P, k the selection of a diameter 25 per cent. too great would have caused an increase in σ of only some

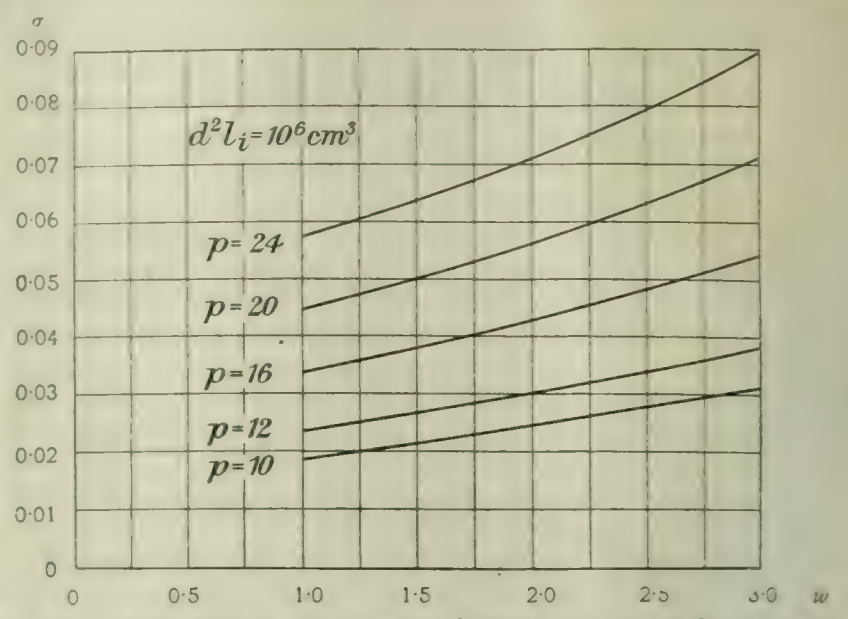


Fig. 22.—Variation of Dispersion Coefficient with Slot-pitch.

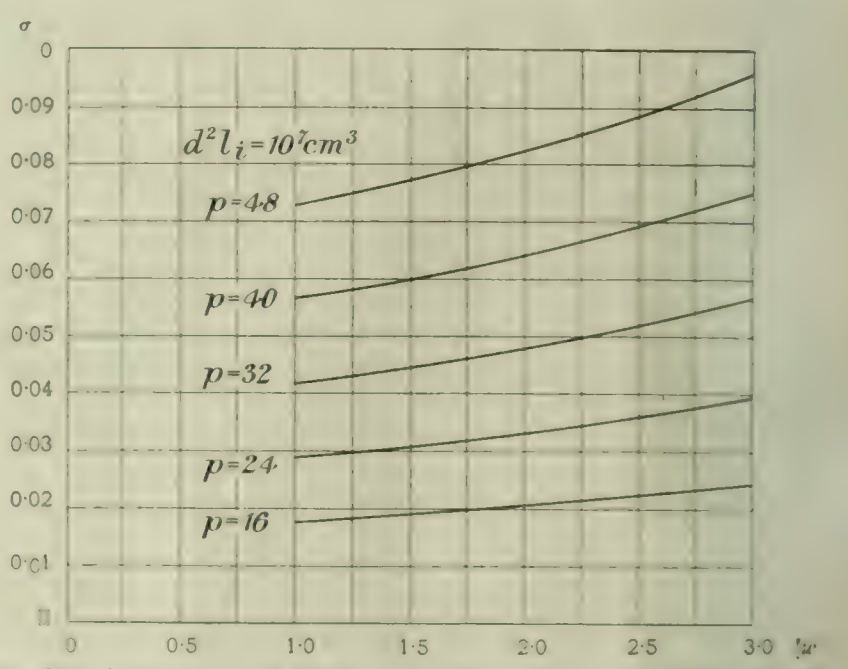


Fig. 23.—Variation of Dispersion Coefficient with Slot-pitch.

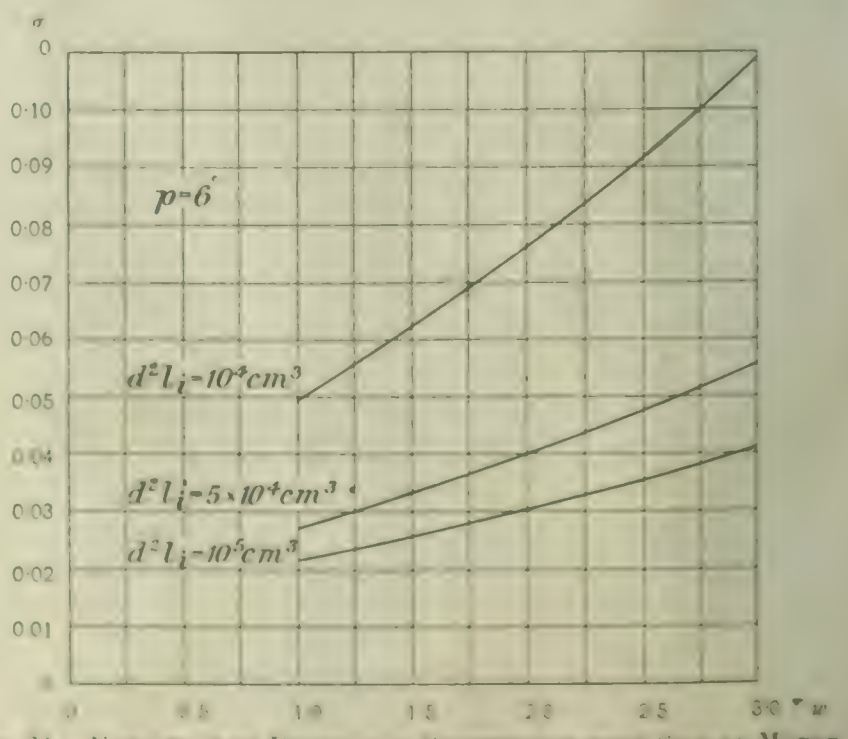


Fig. 24.—Variation of Dispersion Coefficient with Size of Motor.

8 to 15 per cent. There is thus an advantage in selecting for d a value close to that determined for σ_{min} because, by so doing, we ensure that σ will be only very slightly greater than $\sigma_{min.}$, *even if there were considerable errors in the values of* B, P, k *used in the determination of the diameter.*

Importance of Small Slot-pitch.—The importance of using a small slot-pitch is emphasised by the series of curves shown in Figs. 20 to 23. In these the values of σ are plotted against those of the slot-pitch. The various dimensions (in centimetres) which have been used in making the calculations for these curves are given in Table VIII., and the diameters have

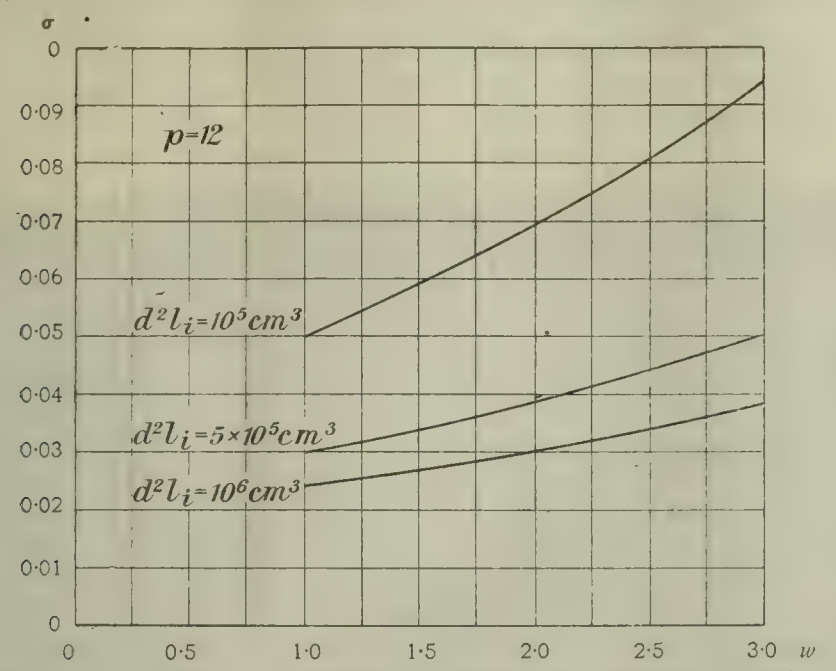


FIG. 25.—VARIATION OF DISPERSION COEFFICIENT WITH SIZE OF MOTOR.

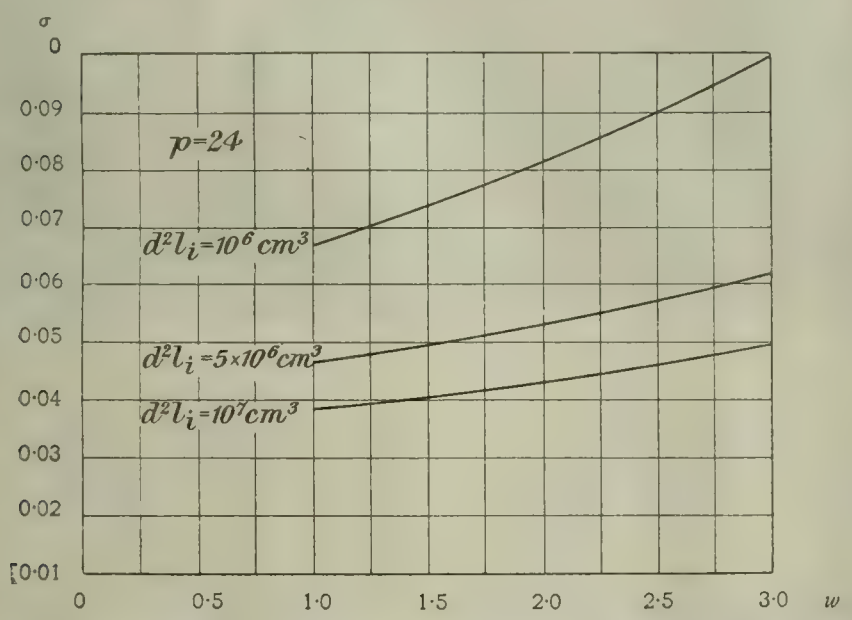


FIG. 26.—VARIATION OF DISPERSION COEFFICIENT WITH SIZE OF MOTOR.

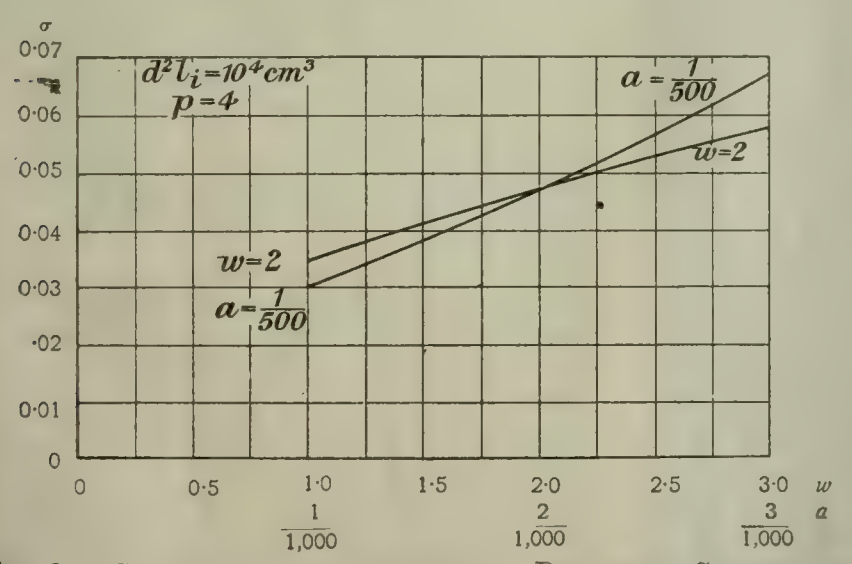


FIG. 27.—COMPARISON OF VARIATIONS OF DISPERSION COEFFICIENT SLOT-PITCH AND GAP-RATIO.

been determined by the method described above. In each figure are shown a number of curves corresponding to different numbers of poles.

Table VIII.—*Data for Figs.* 20 *to* 23.

—	$K=d^2l_i$.	$a=\delta_1 d$.	b.	h.	v.	e.
Fig. 20 ...	10^3	1/500	$0{\cdot}6w$	2·5	$0{\cdot}1w$	0·1
Fig. 21 ...	10^4	1/750	$0{\cdot}6w$	3·0	$0{\cdot}1w$	0·1
Fig. 22 ...	10^5	1/1,000	$0{\cdot}6w$	3·5	$0{\cdot}1w$	0·1
Fig. 23 ...	10^6	1/1,250	$0{\cdot}6w$	4·0	$0{\cdot}1w$	0·1

Though the curves are primarily intended to show the importance of a small slot-pitch, they also bring out clearly the advantages of low supply frequency and high speed, as both these conditions mean a smaller number of poles. Using the same data the curves of Figs. 24 to 26 have been drawn to show how σ decreases as the size of machine increases.

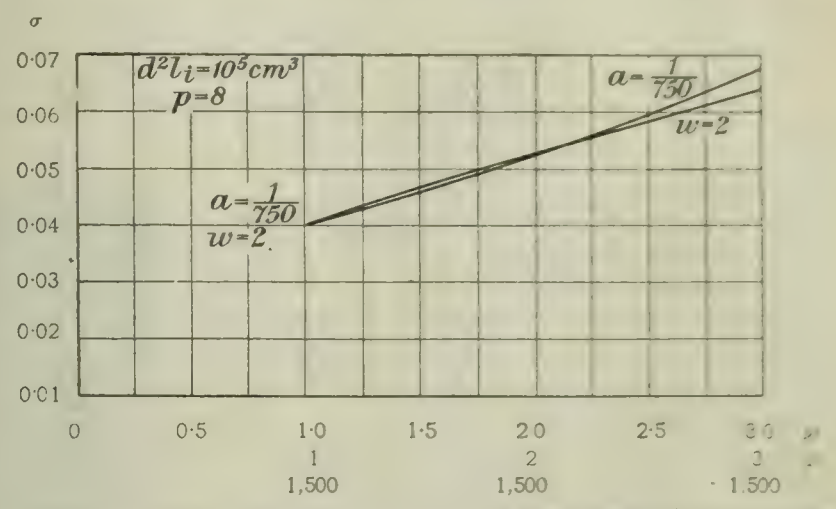


FIG. 28.—COMPARISON OF VARIATIONS OF DISPERSION COEFFICIENTS WITH SLOT-PITCH AND GAP-RATIO.

Relative Importance of Small Slot-pitch and Small Air-gap.—The relative importance of a small air-gap and a small slot-pitch is indicated by the curves of Figs. 27 to 30. In these figures some of the curves of Figs. 20 to 23 are compared with another set of curves calculated for a constant slot-pitch of 2 cm., but for a varying value of the ratio of gap-length to

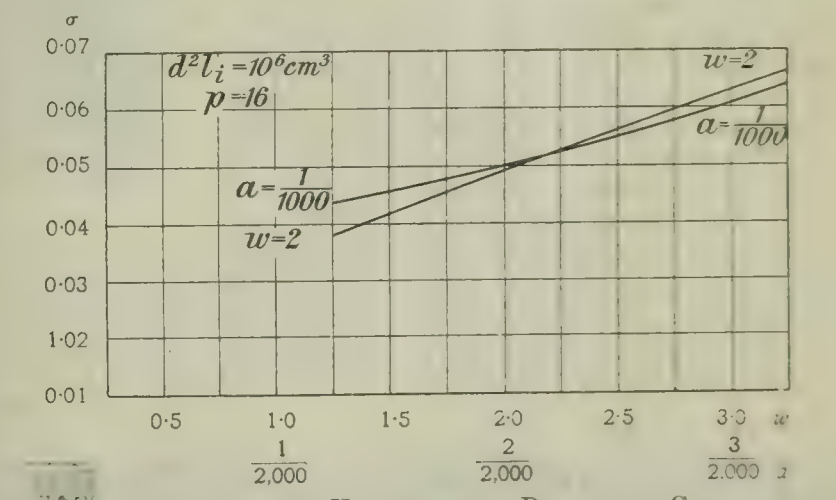


FIG. 29.—COMPARISON OF VARIATIONS OF DISPERSION COEFFICIENTS WITH SLOT-PITCH AND GAP-RATIO.

diameter. The other data used in these latter curves are as shown in Table VIII. (slot-pitch=2 cm.). The scales for slot-pitch and gap ratio have been made proportional, so that the curves show the relative effects produced by varying the slot-pitch or gap ratio by the same percentage.

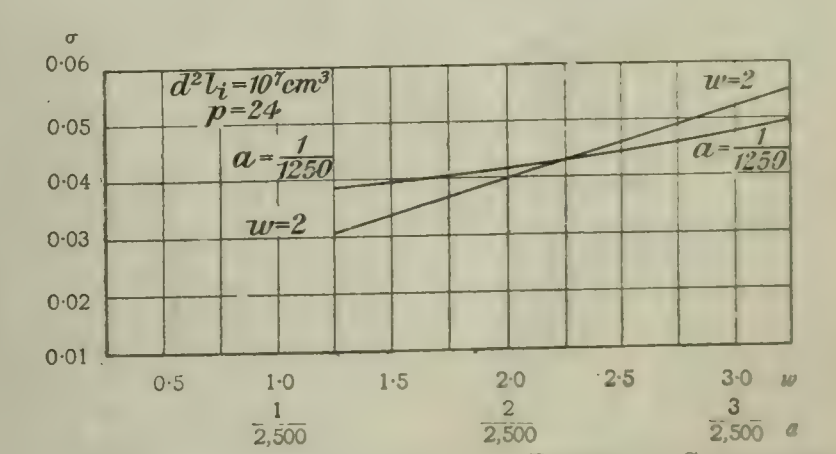


FIG. 30.—COMPARISON OF VARIATIONS OF DISPERSION COEFFICIENT WITH SLOT-PITCH AND GAP-RATIO.

Of course, this comparison depends to a certain extent on the particular slot dimensions and values of the ratio a which are assumed, but the curves serve to show that in general the two factors slot-pitch and gap-ratio have about equal importance. In small machines the slot-pitch tends to have the greater

influence, while in large machines the gap ratio becomes rather the more important, but the difference is in any case slight.

Conclusions.

The conclusions arrived at in this part of the Paper may be summed up as follows :—

I. *A small slot-pitch is of equal importance to a small air-gap.*

II. *Given the slot-pitch and certain other quantities, fixed by various considerations, there is a definite diameter for the stator of the motor which will ensure its having the least possible dispersion coefficient.*

III. *This diameter may be departed from considerably without causing much increase in the dispersion coefficient, though it is better if possible, for certain reasons which have been explained, to select a value for the diameter not differing much from the one obtained for the ideal diameter.*

ELECTRIC COOKING AT EUSTON STATION.

At the present time many of our railway companies are particularly well placed to take up the advantages of electric cooking. At their largest stations they are responsible for hotels and large refreshment rooms, and frequently have their own electric generating stations.

We are glad to find that the London & North Western Railway is moving in this direction. Last week we had an opportunity of inspecting the plant for electric cooking which has been put down by the company at Euston Station, and which is used for supplying the needs of the new dining room at that station. The plant has been supplied by the Brompton & Kensington Accessories Co., and is of considerable extent, as will be seen by the following brief description.

The kitchen is situated in the basement and comprises a large boiling table, which is equipped with 23 boiling plates. Of these seven are 12 in. loaded to 2,000 watts, eight are 10 in. loaded to 1,500 watts, and the remainder are 8 in. loaded to 1,200 watts. Each plate is controlled by a rotary switch giving full, medium and low heats, the ratios being 1 : ½ : ¼, and each is provided with a fuse and pilot lamp. The switches, fuses and lamps are fitted below the edge of the table and are enclosed to prevent damage. The pilot lamps are across the full pressure of 230 volts and are protected by means of metal caps, leaving a comparatively small protected aperture through which the light can be seen. The top of the boiling table is a $\frac{5}{16}$ in. steel plate ground bright, having overall dimensions of 11 ft. by 4 ft. The wiring is carried in watertight cast-iron channels, and is arranged to be readily accessible. Near the boiling table is a Bain Marie, in two sections, each having a maximum loading of 1,500 watts.



Fig. 2.—Electric Ovens at Euston.



Fig. 1. Electric Boiling Table at Euston

There is a small double grill in the kitchen, with hot closets over each grill, and a collector for the fat below. This grill takes 7·0 kw. The grilling elements consist of grooved fireclay bars, spirals of nichrome wire being laid in the grooves. The hot closet is heated merely from the grill. A simple raising and lowering device is provided, and control is effected by means of four organ stop switches.

An unusual feature consists of two large boilers. Each of these takes 7·5 kw, and is provided with three heating elements, each separately controlled, thus giving three heats. The capacity of each boiler is 30 gallons. In both cases the pan is made of cast iron, with strainer and draw-off cork. The boiler is heavily lagged and cased outside with planished steel. The covers are balanced, and the top rim of the pan is provided with a water lute to prevent escape of steam. The present requirements necessitate the boiling of about 12 hams per day, and apart from this work the boilers are found to be very useful for a variety of work. Hot water for general purposes, which is obtained from a coal heated boiler, is laid on to these ham boilers, and also on to a potato steamer. The input to the latter is 4·5 kw. by means of three heating elements. Control is by three single-pole switches, fuses and pilot lamp mounted on a steel switch base on the wall. There are six steaming compartments, each 19 in. diameter and 6 in. deep.

There is a range of four ovens with hot closet on top, the overall dimensions being 9 ft. 8 in. by 4 ft. 6 in. and 2 ft. 4 in. deep. The internal dimensions of each oven are 30 in. by 24 in. and 24 in. deep, and the hot closet is 9 ft. 5 in. by 1 ft. 3 in. and 2 ft. deep. The frame is constructed of cast-iron. The ovens are well lagged, and the fittings are of robust construction, easily removable. The heating elements are arranged at the sides of the oven to give an even distribution of heat, and are well protected. A cast-iron box is pro-

vided to receive the supply cables which are carried in screwed barrel, thus providing a permanent earth connection. The loading of each oven is 5 kw., controlled by means of two three-heat switches, giving 7 degrees of heat. The hot closet has a maximum loading of 3 kw., controlled by two single-pole switches.

On the opposite side of the kitchen is a hot closet having dimensions 6 ft. 3 in. by 2 ft. 6 in. and 2 ft. 9 in. in height, fitted with sliding doors and bright top plate and having a capacity for 1,000 plates. The frame is constructed of cast-rion and the sides and doors are double-cased to prevent loss of heat. The loading is 4 kw., and control is effected by means of two single pole switches, which, together with the fuses and pilot lamps are mounted below the edge of the top. In the vegetable room there is a similar but smaller hot closet loaded to 2·5 kw. Our illustrations show the boiling table and ovens.

Each piece of apparatus is on a separate fuse and on a separate meter, so that very useful information will be obtained by the railway Company as to the cost of working each class of apparatus. As regards ventilation, there are a number of air inlets about 18 in. above floor level, and the air is extracted by means of ducts along the ceiling. The ventilation is controlled by means of two fans for the basement, and there are also three fans for the dining room, all the controllers of the fans being grouped together in the basement.

The serving room is on the floor above, and is equipped with a carving table for five joints. The top of this table is of rolled steel plate, the dimensions being 11 ft. 8 in. by 3 ft. 1 in. The cutting dishes are of "Silverling," the usual balanced covers being provided. Below the top of this table is a large hot cupboard, and by this means the top is maintained at a suitable temperature. There is also a shelf on which the plates are placed, and as this is electrically heated, the meat after being cut does not become cold during the interval between carving and serving. Control is by means of six single-pole switches, fuses and pilot lamps mounted below the edge of the top. The maximum loading of the cupboard is 8·0 kw. and of the shelf is 2·0 kw. The service between the basement and the serving room is maintained by two push-button automatic electric lifts, installed by Messrs. Waygood, and a good deal of thought has been expended in making the service satisfactory in transporting the eatables between the two departments. For example, a tray from the potato steamer can be taken straight from the steamer and put into the lift, and then placed on a hot vegetable server near the lift in the serving room. Soup is dealt with in a similar fashion. The loading of the vegetable server is 4·2 kw. Finally, there is a double silver grill for the dining room, the grill being provided with hot closets both at the top and bottom. The input to each grill is 5 kw., and to the bottom cupboard 2·5 kw. The total power used by the installation is about 130 kw. The total number of meals at present provided per day is about 400.

The whole of the plant was supplied by the Brompton & Kensington Co., under the supervision of Lieut.-Col. F. A. Cortez-Leigh, T.D.R.E., the chief electrical engineer of the Railway Company, to the requirements of the Hotel Department.

NEW ELECTRICAL COMPANIES IN 1915.

We give below a list of the more important electrical engineering companies registered during the past year, with their capital :—

A. Robinson & Co.	£15,000
Andover & District Electricity Co.	10,000
Anglo-American Metals Synd.	3,000
Anglo-Chinese Engineers' Association	53,750
Anglo-Russian Engineering Co.	5,000
Ardee Electrical Co.	5,000
Arthur Lyon & Wrench	12,000
Bachelet French Synd.	50,000
Barraclough Bros.	3,000
Beacon Carbons	5,000
Biddles Rly. Patents Synd.	7,000
Birmingham Power Transmissions	7,000
Buffalo Forge Co.	6,000
C. E. Co. (Ltd.)	5,000
Caerphilly Electric Supply Co.	6,000
Cahirciveen Electric Light & Power Co.	£1,800
Cark & District Electric Supply Co.	2,000
Comparri Wireless Control Synd.	5,000
D. & M. Synd. (Hollister's Patents)	2,500
Donkin & Co.	66,000
Duroglass	50,000
E. H. Wheeler & Co. (Manchester)	5,000
E. S. Co.	2,000
East Lancashire Electrical Co. (Accrington)	1,000
East London Electric Co.	1,000
Ecco Battery Co.	12,000
Electric Lamp Factors	6,000
Electric Lamp Repairs Co.	5,000
Electrical Manufacturers Co. of Gt. Britain	12,000
Electrical Wholesalers' Federation, limited by guarantee	
Electro Alloys	£10,000
Electro-Galvanisers	20,000
Electrode Co. of Sheffield	40,000
Electrodes	10,000
Elieson Electric Traction Co.	1,000
Engine Patents	3,150
Ferguson, Pailin & Co.	10,000
Francis Polden & Co.	5,000
Free Wire Light Co.	1,000
Fuller's Wire & Cable	25,000
General Cable Mfg. Co.	6,000
Highfield Synd.	5,000
Hobson Mfg. Co.	20,005
Industrial Invention	3,000
Institute of Industry (of Gt. Britain & Ireland), limited by guarantee	
Institute of Locomotive Engineers, limited by guarantee	
Irish Hydro-Electric Synd.	10,500
Invicta Glass & Nautical Instrument Co.	10,000
J. Truman & Co.	7,000
Killorglin Electric Light & Power Co.	1,650
London & Burmese Wolfram Co.	40,000
London Glass Works	30,000
London Telephone (New System) Co.	7,000
M. Howlett & Co.	20,000
M. L. Magneto Synd.	15,000
Marsh Bros. (Electricians)	4,000
Mica Lubricant Co.	5,000
Mid-Somerset Eectric Supply Co.	7,000
Midhurst & District Electric Supply Co.	47,500
Milton Accumulators	1,000
New Era Signs	5,000
New Quebec Graphite Co.	7,000
Newcastle West & Dist. Electric Light & Power Co.	£3,000
Newton Bros. (Derby)	31,000
Nordisk Electrical Power Co.	10,000
North British Electrical Co.	3,000
Pearson's Electric Miners' Lamp Co.	5,250
Poulsen Wireless Telegraph Co.	450,000
Public Works & Railways Construction Co.	10,000
Pullan Engineering Co.	3,000
Quasi Arc Co. (France)	5,000
Runbaken Magneto Co.	3,000
Scear, Scott & Co.	3,000
Sheffield Alloys	30,000
Sidney Minns & Co.	8,000
Simplex Sleeper Synd.	3,450
Snyder Electric Furnace Co.	1,000
Sperry Gyroscope Co.	2,000
Strand Electric Supply	6,000
Surrey Electrical Co.	2,000
T. W. Glaze & Co.	6,000
Telephone Mfg. Co.	25,000
Tormo Mfg. Co.	20,000
Tredelect Engineering Co.	3,000
Tungsten	30,000
United Tube Corpn.	150,000
W. A. & R. J. Jacobs	3,000
W. Goodyear & Sons	100,000
Wadebridge & District Electric Supply Co.	3,450
Watson & Sons (Electro-Medical)	25,000
Wave Transmission (British Empire) Synd.	1,000
Wells Compound Co.	2,000
Westwood Electrical Co.	4,000
Whipp & Bourne	35,000
Wholesale Electrical Co.	2,000
Wilsons & Berry	15,000

1,200 versus 600 volt Trolley Systems.—The "Street Railway Journal" refers to a Paper presented at a recent meeting of the Public Utilities Association of West Virginia by Mr. S. B. Fortenbaugh, who outlined the advantages of the 1,200-volt system for inter-urban railways. To illustrate his statements he gave the results of calculations for a 25-mile line with 5 miles additional in terminal cities, using 30-ton cars and making 20 miles per hour schedule speed with one stop per mile between cities. Hourly service for 18 hours per day was assumed. With 1,200 volts, one sub-station of 600 kw. capacity would be required in place of three of 300 kw. capacity each at 600 volts. The load factor would be 20·8 per cent. and 13·8 per cent. in the two cases respectively, and the efficiency 77 per cent. and 70 per cent. The daily energy saving due to the use of the higher voltage was 350 kw.-hour, or 10·4 per cent. of the total. With direct generation of direct-current power at 1,200 volts, as compared with alternate-current transmission the saving in power is about 33·5 per cent , made up as follows : Step-up transformer loss, 3 per cent. ; transmission line loss, 2 per cent. of remainder ; "all-day" sub-station losses, 30 per cent. of remainder. On the basis of 2,700 kw.-hour per day delivered to the trolley wire, and 1 per cent. per kilowatt-hour energy cost the money value of the saving is £2. 14s. per day, or £986 per year. With alternate-current generation and distribution the saving in cost of power is due to improved load factor. On the same basis this saving amounts to 14s. per day, or £256 per year. At £20 per month per sub-station for labour, maintenance and miscellaneous expense the 1,200-volt system saves £480 per year in sub-station expense. The total saving is, therefore, £986 per year for direct-current generation and £736 for alternate-current generation. Capitalised at 5 per cent. these savings are equivalent to additional investments of £14,720 and £19,720 respectively. Mr. Fortenbaugh claimed that the net saving in the initial cost of "electrification material" will vary between 10 per cent. and 20 per cent. in favour of 1,200 volts.

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ELECTRIC TRACTION IN 1915.

Although consideration of new schemes of electric traction in this country has not been possible during the past year, progress has nevertheless been evident in the completion of at least one scheme and in substantial progress in another. We refer particularly to the London & South Western and to the London & North Western Railways. In the case of the London & South Western, part of the electrification is an accomplished fact, though the full benefit of the change will not be experienced until after the war, when the abnormal conditions of travelling come to an end. The present electrification embraces 150 miles of single track—namely, the circular route via Wimbledon, Kingston, Twickenham, Richmond and Brentford, including the branch to Shepperton, although it is intended to carry it eventually to Guildford, the total length then being equivalent to about 300 miles of single track. The system adopted in this case is third-rail with a pressure of 600 volts. As we recently described this work in THE ELECTRICIAN, we need say no more about it on the present occasion.

With regard to the London & North Western Railway considerable progress has been made, and it is probable that the electrified part of this line will be in operation before so very long. This remark also applies to the Manchester and Bury line of the Lancashire & Yorkshire Railway, which differs from the two preceding examples in that the pressure will be 1,200 volts.

In America progress has been made chiefly with continuous current, the tendency being to favour high pressures ; thus the Butte, Anaconda & Pacific Railway has been equipped for continuous current with a pressure of 2,400 volts. Double collectors are used, and it appears that no difficulty is experienced even at speeds of 60 miles per hour. In this case the electrical energy is obtained at the very

favourable price of 0·265d. per kilowatt-hour. On the Chicago, Milwaukee & St. Paul Railway a pressure of 3,000 volts continuous current has been employed, and if the experiment is successful the length of the electrified line will be extended to a total of 850 miles. The construction was not carried out in either case during the past year, but these lines have now come into greater prominence owing to the publication of results of working. Further interesting details were given recently by Mr. H. M. HOBART in the James Forrest Lecture, and figures were at the same time published showing the rapid advance of high-pressure continuous-current traction during the last few years. Thus, the number of miles of single track operating (or under construction) with single-phase was 1,040 in 1911, and has only increased to 1,490 miles in 1915, whereas the mileage for high-pressure continuous current at 1,200 volts and over was 1,100 in 1911, and has increased to 3,720 in 1915. These figures refer only to the U.S.A. It is also interesting to note that although the electrically-equipped single-track mileage of steam railways in the United States and Canada is 3,460 miles, which seems a considerable amount, this constitutes less than 1 per cent. of the total single-track mileage of the steam railways in those countries.

As to what the higher permissible limit of pressure in continuous-current traction may be, time alone will show. Mr. N. W. STORER has described interesting experiments at a pressure of 5,000 volts, and this was even raised to 7,000 volts, on the lines of the Michigan United Traction Co. What is particularly interesting about this work is that it was carried out on an inter-urban car of 40 tons, so that the space available for the motors was comparatively small. The difficulty was solved by having two armatures for bi-polar motors in one casing, which practically means two motors in one casing, at 2,500 volts, there being two such sets in series on the 5,000 volts. The two armatures of each set are permanently in series. By the adoption of bi-polar motors the electrical stress over a given pitch of the commutator is halved, as compared with a four-pole motor, and, on account of the re-arrangement of material, the total weight does not seem to have been materially increased. In this particular case mercury rectifiers are used, but although these devices have been employed experimentally in several cases very little seems to have been published as to the actual results obtained.

There is a noticeable tendency for American railways to purchase their electrical energy, but, unfortunately, the same cannot be said for this country.

Electric traction on the London Underground Railways remains much where it was, though it may be recorded that the City & South London Railway, the oldest of its kind, is now coupled up with the remainder of the system by taking its power from the Lot's-road generating station.

In automobilism steady progress has been made by the electric vehicle. Useful work has again been carried out by the Electric Vehicle Committee of the Incorporated Municipal Electrical Association, and an interesting Paper was read by Mr. FRANK AYTON on the "Use of Electric Vehicles in Municipal Service." In this Paper very suitable forms of service for such vehicles were emphasised, and there is no doubt that there are many municipal duties for which the electric vehicle is particularly well adapted. We refer more especially to the collection of refuse, to street watering, to fire brigade work and to services in connection with electricity works. According to a Paper by Mr. R. J. MITCHELL, the handling of refuse electrically costs about 1s. 8d. per ton, as against 2s. 9d. by petrol motors and 3s. 5d. for horse-drawn vehicles. It may be said generally that the electric vehicle shows to great advantage in any service involving frequent stops. It is, therefore, applicable to a great deal of work which is carried out by commercial vehicles. As an example of this we may mention that Messrs. Liberty have found the cost per mile for electricity in such vehicles to be 0·4d., as against 1½d. for petrol. Apart from such vehicles, the electric omnibus is making its way to an encouraging extent. It only remains for the station engineer to do what he can to favour the movement. There are many who are doing all that is possible in this direction, but, on the other hand, there are some who are inclined to keep back the advance by exacting such absurd and harmful rates as 5s. per charge. Much can also be done by the adoption of standard apparatus, and we are glad to note that the Engineering Standards Committee has now issued a specification of a standard charging plug in combination with the Electric Vehicle Committee of the Incorporated Municipal Electrical Association.

On canals some progress has been made in electric haulage, the most notable example being the Panama Canal, where large electric tractors are being used. As a much more modest example we may mention the Trent and Mersey Canal, the equipment of which was described in these columns during the past year.

In connection with electric traction systems there is still a difficulty in some countries, more particularly in the United States, on account of the electrolysis of underground pipes. This is due to the lack of regulations such as we have in this country, and which have produced the very happy elimination of any such trouble. It is difficult to understand why similar action has not been taken in the United States and elsewhere.

The year's record of railway working, speaking generally, without reference to electric traction, has been marred by two terrible accidents—namely, those at Gretna and at Jarrow. In both cases trains were fitted with gas lighting, and a deplorable loss of life occurred through fire. Although the Board of Trade has recommended that gas lighting should be abandoned, no active steps seem to have been taken to substitute electric lighting for gas. Many trains are electrically illuminated, but there are many that are not. It is certainly time that public opinion forced some action to be taken, and that legislation should be introduced to prevent the use of train illuminants of a character which can only increase the danger very materially in case of accident.

ELECTRICAL RAILWAYS.*

BY H. M. HOBART.

(*Continued from p.* 458.)

Summary.—After referring to the growth of electric traction on railways, and to the cheapening of electric energy in recent years, the author discusses in detail the results obtained on the Butte, Anaconda & Pacific, the Chicago, Milwaukee & St. Paul, and the Norfolk & Western Railways. It is shown that the electric locomotive compares very favourably with the steam locomotive for freight service. Attention is drawn to the importance of regenerative control, and the author concludes by showing that the high-pressure continuous-current system is the most suitable for general use.

Influence of Greater Speed and Heavier Trains on Outlay for Engine Crews and Train Crews.—The greater weight of the trains under electric operation has permitted of decreasing the number of trains per day by 25 per cent. Furthermore, the running time on the various sections has been greatly decreased, and delays have been largely eliminated as compared with the conditions formerly obtain-

* Abstract of the James Forrest Lecture, 1915, delivered before the Institution of Civil Engineers on Dec. 14.

ing with steam locomotives. The consequences of the improvements in these respects are very marked as regards decreased outlay for wages of engine men and train crews. As regards the engine crews, the improvement is strikingly shown in Table IV.

Table IV.

	No. of hours engine crews were employed in various services.		
	Regular hours.	Overtime hours.	Total hours.
Month of June, 1913, when operation was with 27 steam locomotives	4,280	1,010	5,290
Month of June, 1914, when operation was with four steam locomotives and 17 electric locomotives	3,300	440	3,740
Decrease in June, 1914, as compared with June, 1913	980	570	1,550
Do. in per cent.	23%	56%	29%
Inferred percentage decrease with "all-electric" service	25%	65%	33%

Only a single engine crew is employed even when a train is headed by two 72-ton electric locomotives, since the control is effected entirely in the leading locomotive. Although the scale of wages paid by the Butte, Anaconda & Pacific Railway is the same as formerly with "all-steam-locomotive" operation, the total expenditure for wages of engine men has decreased from £21,000 per annum with "all-steam-locomotive" operation (or £780 per locomotive) to £14,000 per annum at present with four steam and 17 electric locomotives. Of this latter figure of £14,000 per annum, £5,000 per annum is due to the four steam locomotives (or £1,250 per locomotive), and £9,000 to the 17 electric locomotives (or £530 per locomotive), although the average mileage per electric locomotive is 41,000 miles per annum, against an average of only 32,500 miles per annum for each of the four steam locomotives. The outlay for engine crews per locomotive-mile is shown in Table V.

Table V.

	Expenditure for wages of engine crews per locomotive-mile.
Prior to the summer of 1913, when employing 27 steam locomotives	6·6d.
At present, with four steam locomotives and 17 electric locomotives—	
Per steam locomotive-mile	7·2d.
Per electric locomotive-mile	3·2d.

A related saving which should be credited to electric operation is that of £6,200 per annum in trainmen's wages, a decrease of 21 per cent. This decrease is mainly accomplished by the greater speed, less delays and consequent great reduction in overtime. Although this decrease in outlay for trainmen's wages is not a component of locomotive expenditures, it has been effected through improvement in locomotive performance, and from this viewpoint it is interesting to note that it works out at a saving of 1·7d. per locomotive-mile.

Locomotive Expenditure per Locomotive Mile.—It will be seen that for so miscellaneous a traffic as that on the Butte, Anaconda & Pacific Railway analyses of the component sorts of traffic are practically out of the question. The locomotive expenditures per locomotive-mile during the last six months of "all-steam-locomotive" operation are compared with those during the corresponding six months of the following year, when four steam locomotives and 17 electric locomotives were used, in Table VI

This results in an annual saving (taking 800,000 locomotive-miles) under the heading of "Locomotive Expenditure" of £74,000. There is involved a further annual saving of some £6,000 in outlays for wages of train crews, and a debit of, say, £6,000 for repairs and maintenance of sub-stations and distribution system, and the associated wages and supervision items.

The original costs of the electrification of the Butte, Anaconda & Pacific Railway, set forth as required of the railway company by the Interstate Commerce Commission, are as follows:—

Engineering and superintendence (including general preliminary report)	£2,190
Roadway tools (used for construction 19 and 22)	770
Crossings, fences, guards and signs	50
Interlocking and signal apparatus. (The introduction of electric operation required the installation of a new system)	4,450
Poles and fixtures (approximately 91 miles of track)	27,100
Distribution (approximately 91 miles of track were wired	71,500
Sub-station building (existing buildings were used)	40
Electrical equipment (five 1,000 kw. motor-generator sets and 17 72-ton locomotives)	134,200
Interest	2,000
Total	£242,300

The completion of the electrification of the entire 114 miles of single track and the outlay for the four additional locomotives may be roughly taken as increasing this capital expenditure to £300,000. The credit of £74,000 per year, at which we arrived above, is 24·7 per cent. of this total capital expenditure. Furthermore, the additional equipment is being provided to enable the railway to transport 20 per cent. more ore to the Washoe smelter. Consequently, the traffic will henceforth amount to nearly 1,000,000 locomotive-miles per annum, and the revenue will be proportionately greater. It is thus undoubtedly conservative to state that the savings, as compared with steam-locomotive operation, will within seven years of the inauguration of electric operation—*i.e.*, by the year 1920—have liquidated the capital expenditure of £300,000 incurred in the years 1913, 1914 and 1915.

Table VI.

	Locomotive expenditure per locomotive-mile.		
	"All-steam-locomotives" operation.	Operation with four steam locomotives and 17 electric locomotives.	
	Pence per steam locomotive-mile.	Pence per steam locomotive-mile.	Pence per electric locomotive-mile.
I. Maintenance of equipment expenses—			
Repairs	6·5	8·6	2·2
Depreciation*	1·0	2·1	1·2
Supervision	0·4	0·8	0·2
Total	7·9	11·5	3·6
II. Transportation expenses—			
Wages of engine men	6·6	7·2	3·2
Engine-house expenses	1·9	1·8	0·9
Fuel and power	19·9	18·1	7·0
Water	0·3	0·3	
Lubrication	0·6	0·7	0·2
Other supplies	0·3	0·6	0·2
Total	29·6	28·7	11·5
Total (I.) plus total (II.)	37·5	40·2	15·1

* The amount to be set against depreciation is more or less arbitrarily fixed by the Interstate Commerce Commission, and does not necessarily reflect the physical condition of the locomotive.

Relative Investment Costs of Electric and Steam Locomotives.—The largest item in the capital expenditure for electrifying a railway of this character is that for electric locomotives. In considering the relative status of steam and electric locomotives, sight must not be lost of the circumstance that for every electric locomotive in existence the number of steam locomotives runs into the hundreds. In the manufacture of steam locomotives the experience of many years is available. Standardised parts are employed throughout. The market price of steam locomotives is of the order of only £30 per ton, as against £80 or £90 for electric locomotives. This would give a price of, say, £6,000 for each Butte locomotive, or, say, £134,000 for the locomotives and tractors. These 21 electric locomotives will handle a 20 per cent. greater traffic than the displaced 27 steam locomotives. We may conservatively consider the 21 electric locomotives as equivalent (with respect to their capacity to handle the traffic) to 32 steam locomotives with an average weight, including tender, of 140 tons, and an average cost of (30 × 140 =) £4,200 apiece. Thus the outlay for these 32 steam locomotives would be (32 × 4,200 =) £134,000. With the particular price basis selected, this gives us the same total outlay for locomotives, whether steam or electric, and it may in general be said that the greater weight usually required per locomotive and the greater number of locomotives necessary to handle a given amount of traffic will necessitate as great a total outlay for steam locomotives as for electric.

The item of "repairs"* of steam locomotives is inherently much greater per mile than that for electric locomotives of approved types. The author refers to the experience obtained on the New York Central and other railways in support of this view.

* "Repairs" should not be confused with maintenance, of which it is only one component, the other components consisting of "depreciation" and "supervision."

Sub-station Machinery.—In the case of the Butte, Anaconda & Pacific Railway it sufficed to locate the sub-station machinery at two points about 26 miles apart. This relatively great distance apart is rendered practicable by the use of the 2,400-volt system for supplying the locomotives. Had it been necessary to keep the pressure down to 600 volts, at least half a dozen sub-stations would have been necessary, and then not only would their aggregate initial cost have been at least twice as great as for the two 2,400-volt installations, but they would have had a much lower load-factor and a lower "energy" efficiency. Furthermore, a greater outlay would have been required for the wages of sub-station attendants. The sub-station machinery comprises five 720 revs. per min. motor-generator sets, each having a continuous rating of 1,000 kw. The design comprises a synchronous motor direct connected to two four-pole commutating generators, each giving a pressure of 1,200 volts at its commutator, connected in series. The entire outlay for sub-station machinery has been only a matter of some £30,000. An examination of the load curves for 10 days in December, 1913, showed an average load-factor of 34 per cent.

The motors of the motor-generator sets are proportioned to absorb 1,450 kv.-amperes when the sets are delivering 1,000 kw. This is in order that they may be worked with such over-excitation of the motor fields as to have a leading power-factor. This leading power-factor offsets the lagging power-factor of other customers of the Great Falls Power Co., which supplies the electricity to the railway company.

The distribution from the sub-stations has involved the installation of about 250 British tons of copper for feeders. The feeder cables are carried on the trolley-line poles. In addition to the positive feeder system, which accounts for about 200 tons of copper, the track return circuits are reinforced with about 50 tons of negative feeders, also carried on the trolley-line poles.

The various items in the cost of the distribution system are approximately as follows :—

Feeder copper	£200	per mile.
Trolley wire	130	,,
Line material	65	,,
Poles	60	,,
Steel strand	60	,,
Bonds	45	,,
Cost of erection	550	,,
Total cost	£1,110	,,

The maintenance of the entire distribution system, including track bonding, is running at about £22 per mile of single track.

Roller Pantograph Collectors.—Each of the 72-ton freight locomotives is fitted with a roller pantograph trolley. The additional four freight locomotives are each fitted with two pantographs, but only one is in use at a time. All the heavier freight trains are headed by two 72-ton locomotives, and consequently the current for the heavier freight trains is collected at two contact points. The general practice during starting and accelerating is to keep the current at not more than 500 amperes per 72-ton locomotive. Currents as great as about 800 amperes will be collected from the 4/0 trolley wire, and on the reasonable assumption that the current will not divide equally between the two pantographs, it is incumbent upon each pantograph to be capable of dealing with current up to 500 amperes in the service on the Butte, Anaconda & Pacific Railway. The 4/0 trolley wire will have a rise of about 180°C. when carrying 1,000 amperes continuously in the open air. For this temperature rise it can carry a considerably greater current for a few minutes. It is to be noted that the current will flow to the points above the locomotives from both directions from the nearest feeding points behind and ahead of the locomotives. Taking these data into consideration, it will be seen that the system could deal with four 72-ton locomotives simultaneously located between two adjacent feeding points and requiring an aggregate of some 2,000 amperes.

The Chicago, Milwaukee and St. Paul 3,000-volt Electrification.

This electrification is over a section of 440 miles, and comprises (including yards and sidings) 650 miles of single track. In the event of satisfactory experience with electric operation of the 440 miles, the railway contemplates continuing the electrification to Seattle, on the coast, which will make a total distance of 850 miles. The railway commenced in the latter part of 1914 to put its electrification plans into effect, and 42 electric locomotives, each weighing 250 tons, together with machinery for 14 sub-stations and material for the transmission and distribution of the electricity, are now being supplied. In the spring and summer of 1915 the 113 miles between Three Forks and Deer Lodge were equipped for electrical operation, and it is intended that by the beginning of 1916 all trains passing over this division shall be propelled exclusively by electric locomotives. The electricity will be supplied under a contract with the Montana Power Company, which has 10 hydro-electric plants in this region.

The price of the 100,000-volt 60-cycle three-phase electricity delivered to the railway company at the feeding-in points is 0·26d. per kilowatt-hour. The sub-stations step down the pressure from 100,000 volts to 2,300 volts, and by motor-generator sets convert the 2,300-volt three-phase electricity into 3,000-volt direct current. Each motor-generator set comprises a 60-cycle synchronous motor, direct connected to two 1,500-volt direct-current generators connected in series.

There are 14 sub-stations having a total capacity of 74,600 kv.-amperes of transformers to supply the synchronous motors, as

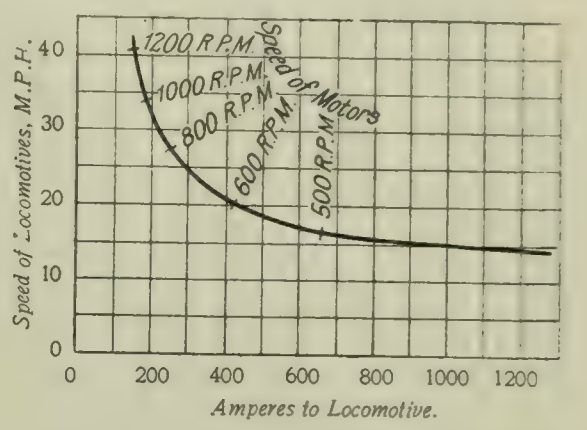


Fig. 1.—Speed-current Curve of Chicago, Milwaukee & St. Paul 3,000-volt Goods Locomotive.
Diameter of driving wheels, 52 in. ; gear ratio, 4·56.

against 59,500 kw. in direct-current generators. Taking the overall efficiency of the sets as 91 per cent., the input to the synchronous motors for a rated output of 59,500 kw. from the generators is 65,500 kw., and since the corresponding input is 74,600 kv.-amperes, the machines may be operated with a power factor of 0·88 ; that is to say, if the fields of the synchronous motors are sufficiently over-excited, the transformers will provide an incoming current which will lead with a power factor of 0·88.

The 42 locomotives each have a continuous rating of 3,020 h.p., and weigh 250 tons. A 250-ton St. Paul locomotive is thus 40 per cent. more powerful than two 72-ton Butte locomotives operated as a single machine. In addition to this, the St. Paul locomotives are

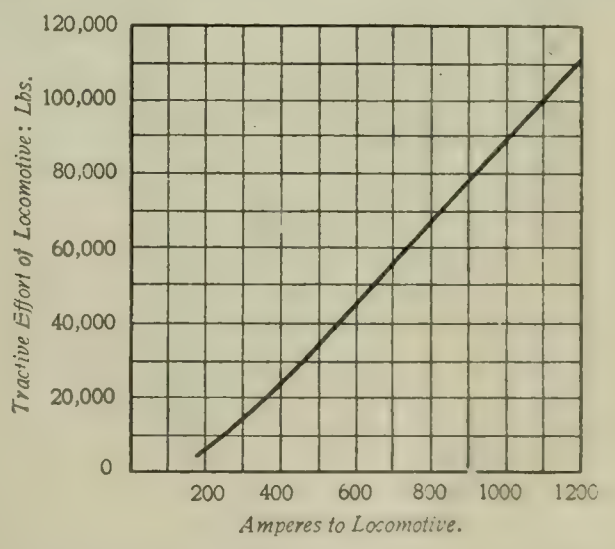


Fig. 2.—Tractive Effort-Current Curve of Chicago, Milwaukee & St. Paul 3,000-volt Goods Locomotive.

equipped for regenerative braking for long periods on down grades. The electrical equipment is consequently very liberally designed, and weighs 73 lb. per horse-power of continuous rating.

Of the 42 locomotives, 30 are for freight service. The remaining 12 locomotives are for passenger service. Except for difference in gear ratio and an additional weight of 18 tons for steam-heating equipment, the passenger locomotives are identical with the freight locomotives. Six of the 30 freight locomotives also have the steam-heating equipment, and are thus available for hauling passenger trains.

The trolley is of the "double-wire catenary" construction, and

consists of two 4/0 wires suspended from the same catenary, but by independent hangers. This interesting and very effective construction is difficult to illustrate. Above tangent track, the two wires lie close together, and are not readily distinguished from one another. But on curves there is a little distance between the two wires at the points of suspension. The points of suspension of the one wire, by means of its hangers, are midway between the points of suspension of the other wire. This alternation continues right along the structure.

The locomotive's pantographs each carry a double-pan collector. By means of such a double-pan collector making sliding contact with two 4/0 trolley wires supported as above described, 2,000 amperes can be satisfactorily collected at any speed up to 60 miles per hour. There will be no occasion to collect so great a current as 2,000 amperes in the contemplated service. Each locomotive is fitted

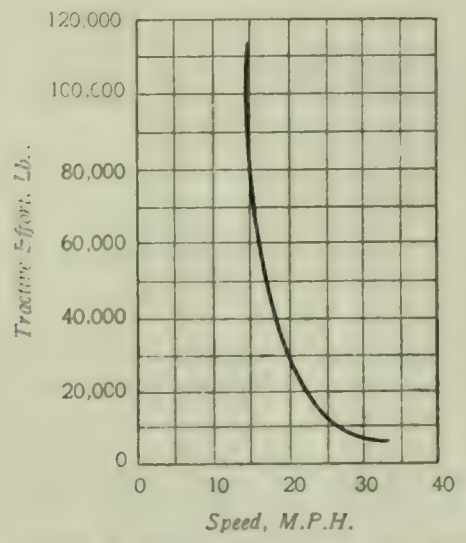


Fig. 3.—Tractive Effort-Speed Curve of Chicago, Milwaukee & St. Paul 3,000-volt Goods Locomotive

with two pantographs. The method of alternate suspension of the two trolley wires has been found to provide an exceedingly smooth operation with complete elimination of any tendency to flash at the points of suspension at any speed. These locomotives give a traction effort (continuous rating) of 71,000 lb.

The locomotive characteristic curves at 3,000 volts are given in Figs. 1, 2, 3 and 4. The eight motors are geared to the locomotive's driving wheels, and each has a continuous rating of 378 h.p. at 1,500 volts. They are permanently connected in series pairs, each pair using a pressure of 3,000 volts for the parallel running position. Each motor is cooled by the forced circulation of air through it from an external blower outfit.

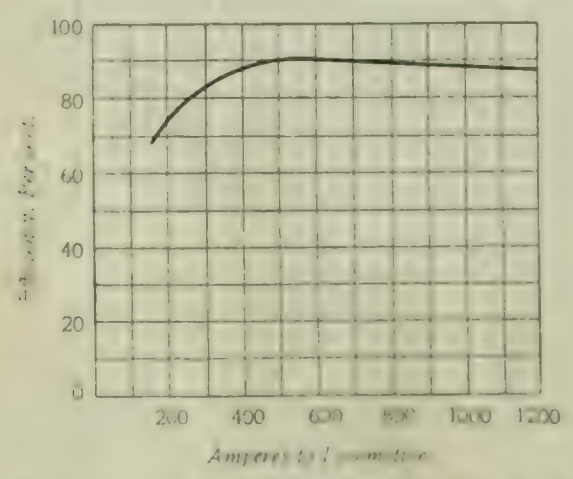


Fig. 4. Efficiency-Current Curve of Chicago, Milwaukee & St. Paul 3,000 volt Goods Locomotive.

The passenger locomotive weighs 268 tons, and will haul a 700 ton trailing passenger train at a speed of 60 miles per hour on level track, and it will carry this train up all gradients of not over 1·5 per cent. For 2 per cent. grades the assistance of a pusher will be required. A 550-ton train can be hauled up a 2 per cent. grade by one of these 268-ton passenger locomotives without assistance.

The heaviest duty of the freight locomotives consists in drawing a trailing load of 2,230 British tons from Lombard to Summit over the Belt Mountains. The distance is 49 miles, the ruling grade is 1 per cent., and the average grade for the 49 miles is 0·7 per cent. The tractive effort for the average grade is 54,000 lb. From the characteristic curve in Fig. 3 we find the corresponding speed to be 16·5 miles per hour. The average output from the motors is 2,380 h.p. and the average current is 670 amperes. When this run is made without stops it will take three hours to cover the 49 miles between Lombard and Summit. On the ruling grade of 1 per cent., the tractive effort required is 71,000 lb., and the corresponding speed and the output are 15·9 miles per hour and 3,020 h.p. The average consumption for this 49-mile run is 49·5 watt-hours per ton-mile. Assuming 75 per cent. efficiency from the points where the electricity is delivered to the railway, the amount of electricity purchased is 66 watt-hours per ton-mile, and, since the price is 0·26d. per kilowatt-hour, the outlay for power is 43d. per train-mile.

The best steam locomotive alternative consists in hauling such a train by a locomotive with 200 tons on drivers. Such a locomotive with loaded tender would weigh 330 tons. When hauling a 2,230-ton trailing load on the average grade of 0·7 per cent. the speed will not exceed 8·3 miles per hour, or about half the speed of the electric locomotive. Exclusive of stops, the time required for the 49 miles would be 6·0 hours. By calculation the author arrives at a fuel cost of 58d. per train-mile, taking coal at 12s. per ton. The 49-mile run forming the subject of this estimate represents the heaviest duty, and it will, for the purposes of a rough survey, be assumed that the average consumption of electricity and coal per locomotive-mile will, taken over the year, be only one-third of the amounts estimated for the 49-mile run.

While large Mallets can be bought for a matter of £24 per British ton, electric locomotives of the type under discussion cost fully three times as much, say at least £80 per ton. On the other hand, the repairs of a 330-ton Mallet amount to a matter of at least 12d. per mile, as against not over 5·5d. per mile for the 250-ton electric locomotive. If we credit both locomotives with a 15-year life, crediting the electric locomotive with 35,000 miles per annum, and the steam locomotive with 25,000 miles per annum, and debiting both locomotives with 7d. per mile for wages of crew, the account stands :—

	Annual outlay in pounds sterling.	
	Per 250-ton electric locomotive.	Per 330-ton Mallet loco.
Fuel and power	£2,080	£2,020
Wages of locomotive crews	1,020	730
Repairs of locomotive	810	1,250
Interest (5 per cent.), taxes and insurance (3 per cent.) and amortisation (4·6 per cent.)	2,400	950
Total	£6,310	£4,950
Total per locomotive-mile	43·3d.	47·5d.

For the above study, which is based on equal weights of train hauled, the saving in favour of the electric locomotive is of inconsiderable amount. In practice, however, advantage is taken of the inherent ability of hauling heavier trains with electric locomotives and at higher speeds. In both of these respects electric operation increases the capacity of a railroad and incidentally decreases the outlay for wages of engine-crews and train-crews. This has already been brought out in the analyses of the results actually obtained on the Butte, Anaconda and Pacific Railway. Indeed, the Mallets actually employed on the Chicago, Milwaukee and St. Paul Railway are much smaller than that on which the above illustration is based, and cannot, even at their lower speed, handle the service for which the electric locomotives are adequate. The weight of the electric locomotive is practically equal to the combined weight of steam locomotive and tender, it has a 38 per cent. greater weight on drivers, and consequently can, for a given limiting coefficient of adhesion, develop a 38 per cent. greater tractive effort. This gives for a 1 per cent. gradient a result in favour of the electric locomotive to the extent of 44 per cent. for the assumed conditions. Even in these estimates the Mallet has not been debited with any greater friction than the electric locomotive, although some investigators have arrived at values of the order of over 30 lb. per ton for the resistance of Mallet locomotives. On those sections of the line where the grade is much in excess of 1 per cent. for any considerable distance, a second 250 ton electric locomotive will be employed as a pusher. On the 440 miles between Harlowton and Avery there are only two points where, with electric operation, a pusher locomotive will be required, whereas with steam locomotive operation many such points were required. At the ends of the pusher divisions sidings are provided permitting the pusher locomotive to be transferred to the head of the train where it supplements the other locomotive in providing regenerative braking on the down grade.

(To be concluded.)

CORRESPONDENCE.

THE SWEDISH GENERAL ELECTRIC (LTD.)

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Questions raised in anonymous letters which have lately appeared in the electrical press seem to indicate a desire on the part of some writers to ascertain the position of firms having connections with manufacturing companies in neutral countries.

We should, therefore, be glad if you would make it known in your columns by publishing this letter, that we shall be very pleased to give full particulars of our company and of our parent concern, Allmanna Svenska Elektriska Aktiebolaget, Vesteras, Sweden, on application at our offices, Canada House, Kingsway, W.C., where the documentary evidence we have already had the pleasure of putting before you, and which has also been submitted to the authorities, will be available for inspection.

This evidence we have no doubt will be accepted as satisfactory proof that Allmanna Svenska Elektriska Aktiebolaget is a purely Swedish concern, not under the influence of any banks, firms or persons in countries now at war with Great Britain, and that this company's business has been conducted in a manner in no way detrimental to the interests of the Allies. None of the shareholders and none of the directors of the Swedish company are of enemy nationality. The Swedish company has issued in all 150,000 shares, held by 1,530 shareholders. The largest number of shares held in one hand is 2 per cent. of the total. The Swedish company has no working arrangements or understandings of any kind with enemy firms for the protection or control of each other's interests. The Swedish General Electric (Ltd.) has issued in all 5,000 shares, of which 4,996 are held by Allmanna Svenska Elektriska Aktiebolaget.

The Swedish General Electric (Ltd.) has secured the services of various persons resident in England previously in the employ of companies controlled by German capital, but they have done so, following the example of prominent British firms, solely in their own interests and without any arrangement whatever with the companies by whom such persons were formerly employed, or with the foreign firm controlling same There is no agreement or understanding whatever with, or regarding, any such employés by which any such employés shall at any future time enter into their former employment, or in the employ of any other British or foreign firm.

The Swedish General Electric (Ltd.) has not since the outbreak of war bought or sold any goods manufactured in countries now at war with Great Britain, or taken over or assisted in the disposal of stock owned at the outbreak of war by companies controlled by enemy capital.—We are, &c.,

London, Jan. 3. SWEDISH GENERAL ELECTRIC (LTD.)
By order of the board,
W. J. TURNER, Secretary.

[We have received no anonymous letters on this subject, but we have pleasure in publishing the above letter.—EDS. *E.*]

WATER POWER IN RUSSIA.

BY P. GUREWITCH.

In European Russia alone (including Finland, Ural and Caucasia) the available water-power is roughly 10,000,000 kw. (equal to 13,400,000 H.P.*), yet Russia's water-power is least developed of any. While in the U.S.A. in 1912 2,471,000 H.P., in Japan 450,000 H.P., in Switzerland 300,000 H.P., and in Italy (in the Piedemont province alone) over 400,000 H.P. were produced through the exploitation of water-power, according to the inquiries of the Imperial Russian Technical Society the total capacity of the water-power plants in Russia amounted in 1910 to hardly 250 000 H.P. About 80 per cent. of these plants had only a capacity of some 10 H.P. to supply flour mills, saw mills, small factories, farm equipments, &c., the generating machinery being mostly of a primitive character.

Lately, however, a tendency to change from the primitive water wheels to the more-perfect turbines is noticeable. During 1890-1900 the Russian machine factories produced annually water turbines with a total capacity of only a few hundred horse-power, but in the following decade a total capacity of 2,000 H.P. were on an average constructed per annum. In the last few years the annual Russian water turbine production rose to 7,000 H.P. per year. Therefore, during the last 25 years water turbines of a total capacity of about 50,000 H.P. to 60,000 H.P. have been produced in that country. Yet one of the oldest of the Swiss factories in this branch has produced during its existence about 4,800 turbines of a total capacity of 2,660,000 H.P., ranging from 11,500 H.P. to 14,500 H.P.

Further, the Russian factories (chiefly small workshops) produce only quite simple water turbines of small efficiency, the better qualities of turbines being imported. Russia's chief supplier in this, as in all other machines, is Germany, which provided in 1909 water-power machinery to the value of 301,000 marks, in 1910 455,000; 1911, 248,000; 1912, 218,000; 1913, 254,000 marks. The number of such machines imported in 1913 from Germany was 77, in addition to a small number from other countries, chiefly U.S.A., Sweden and Switzerland. From these figures it is obvious that the Russian import of water-power machinery was unimportant, the explanation being, as mentioned above, that most Russian plants are of small capacity. As a means of generating electrical energy, water-power at present plays an unimportant roll in Russia, large hydro-electric stations and long transmission lines being completely unknown.

According to the recently published statistics of Russian electric stations for 1913, in which particulars of about 80 of the 225 electric stations are given, 47 stations possess steam plant of a total capacity of 221,000 kw., 16 oil or gas engines of a total capacity of 9,572 kw., and 16 stations (with a capacity of 9,692 kw.) have, besides steam engines, internal combustion engines. Only one station (in Suchum Kale, Caucasia, a town with 30,000 inhabitants) uses water-power and possesses horizontal Francis turbines with a capacity of 435 kw.

It would not be right to conclude from this that Russia, with its preponderance of flat land, has no water-power available. Not only in the frontier districts of Finland, Caucasia and Ural, but in Russia itself, especially in the north-western and south-western provinces, very considerable water-power awaits the exploiter. It is in these thickly-populated provinces that Russian industry is chiefly developed, so that the necessity for cheaper energy is very urgent The opening up of the latent water-power of the north-western provinces is of great importance, chiefly in consequence of their immense distance from the southern Russian mining centres, which make them solely dependent on imported coal.

The rapids of the Western Dvina alone have a capacity of about 120,000 H.P., whereby the Baltic provinces (and the most important Riga district), as well as the province on the Dvina, could be supplied with cheap electrical energy from this source. The water-power of the river Niemen could also easily be exploited, while in a more northern direction the rapids of the Wolchow, flowing from the Ilmen lake to the Ladoga lake, could, according to approximative estimates, at Novgorod produce 30,000 H.P. to 50,000 H.P., and the rapids of the Msta river, flowing to the Ilmen lake, about 30,000 H.P. The Narwa waterfall, with a fall of 8 m. to 10 m., is formed at the town of Narwa by the river Narwa, flowing from the Peipus lake to the Finnish Gulf, is the only water-power used to supply power to many factories. If this fall were completely exploited, 40,000 H.P. to 70,000 H.P. would be readily available. In Olonetz province considerable energy could be generated by exploiting the water-power of the Suna (10,000 H.P. to 20,000 H.P.), and those of the Wyg, Suchona and Wytegra rivers.

In East Russia the exploitation of the water-power of the Belaja and the Tchusowaja, as well as of the numerous lakes formed by dams, would put new life into the metal industry of the Ural provinces, with their wealth of magnetic and manganese iron ores, which formerly provided the whole of Russia with iron. In consequence of mineral coal scarcity and the iron having to be charcoal smelted, the Ural iron industry was crowded out by the newer south Russian iron industry, with vast coal mines at hand. Electro-metallurgical industry in the Ural would develop at a rapid rate on being supplied with cheap electrical energy, as there are, besides iron, large deposits of copper, platinum and other metals.

Finally, in south-western Russia, by the exploitation of the rapids of the river Dnieper, 120,000 H.P. to 200,000 H.P. could be obtained. These rapids, nine in number, named "Porogi," are spread over a distance of 37 km. below Ekäterinoslav, and form a great hindrance

* For comparative purposes the following figures may be of interest: The potential water-power in Germany (chiefly in Bavaria) is about 1,500,000 H.P., in Switzerland 2,532,000 H.P., and in Sweden over 6,000,000 H.P. Of Sweden's available water-power about 3,500,000 is not yet utilised. In Japan, according to the Japanese statistics of the Ministry of Traffic, there are 383 hydro-electric stations, with a total estimated capacity of 2,172,000 H.P. Particulars of the water-powers of the U.S.A. were given in THE ELECTRICIAN for October 8, 1915.

to navigation on the southern part of this river, which has a width of from 300 m. to 360 m. Three of the most dangerous rapids, with falls of 2·7 m. to 3·6 m., present magnificent views similar to those of the Rhine at Shaffhausen. When one considers that the Dnieper rapids are situated in the centre of the south Russian iron districts, it is easy to realise how important a hydro-electric station with a capacity of over 100,000 H.P. would become for supplying the south Russian mining district with cheap electric energy.

Important rapids are also formed by the southern Bug river, as well as at Iampol by the river Dniester, which possesses the fastest current of all Russian rivers, so that large powers could be procured from this source. The districts are shown in the accompanying map.

One must take into consideration that, in exploiting Russian water-power, powerful rapids situated in densely populated districts are under review, and those engaged in farming operations over large tracts of land will become potential consumers of electrical energy.



Map showing the Water Power Resources of Russia

The work of making the rivers navigable for shipping would go hand in hand with the exploitation of the water powers, and in this way the absence of railways and well-kept roads over enormous distances would be overcome.

In Caucasia, and especially in Turkestan (Russian Central Asiatic possessions), the irrigation of the provinces, which suffer from great dryness, would come to be taken in hand at the same time as the exploitation of water power, and the already vast importance of Turkestan, which must greatly increase after the war, would be favourably affected by the enterprise. More than half the cotton used in manufacturing operations in Russia is provided by Turkestan.

From the foregoing it is clear that far reaching problems are presented to hydraulic engineers and capitalists by the exploitation of Russia's water-power. As the two great objects can be pursued at the same time, the outlook for prospective profits are most favourable. On the other hand, large capital is necessary for the successful execution of these projects. This capital could be raised in Russia after the war only with great difficulty, but for the medium-sized and smaller projects, requiring less capital, it could undoubtedly be raised in the near future. A commencement was made in 1912 by the so-called "Stuart concession," granted to English capitalists by the Russian Government for the purpose of exploiting the river Terek and Lake Goktcha (1,913 ft. above sea level), and the erection of a hydro-electric station with a capacity of 40,000 kw. to provide North and Trans-Caucasia with cheaper electric energy. Recently another project has been worked out in Caucasia for exploiting the Kuban and Small Laba rivers. The construction costs of this project are calculated at about 15,000,000 roubles, the hydro-electric station having a capacity of 45,000 H.P. According to Russian newspapers, the conditions of the contract concerning the cession of the land necessary for the scheme has been ratified by the Viceroy in Caucasia. Very soon the water-power in Finland will probably be exploited. Two companies have been striving for a long time to obtain concessions for erecting hydro-electric stations here. One of these (the "Company for Transmission of Waterfall Power"), with a capital of 6,000,000 roubles, owns some important Finnish falls on the river Wuoxen (Wyborg province); the second is the "Company for Long-distance Stations." Both companies centre in Petrograd. The share capital of the last-named company (4,000,000 roubles) is in the control of the "Imatra" Soc. Anon. pour la production et la distribution de l'énergie electrique, Brussels, and the "Bank for Electrical Enterprises," Zurich (share capital 75,000,000fr.), working mostly with German capital, is largely interested. The main purpose of the "Imatra" Company is the exploitation of the waters of the small Imatra fall in Finland, which belongs to the company's offshoot, the "Company Force," of Helsingfors. The bed of the river Wuoxen (or Voksa) becomes narrow in the region of the Imatra falls from 177 m. to 46 m., and the river falls more than 20 m. within a distance of 325 m., so that extraordinary power is at the disposal of the owners.

According to the Russian "Commercial and Industrial Gazette," a commission was appointed by the Imperial Finnish Senate in January, 1913, for the purpose of discussing the question of exploiting the energy from the falls and rapids of the river Wuoxen for generating energy for electrifying the Finnish State railways, and a project for the erection of electric stations at the Imatra Falls, with a capacity of 85,000 H.P. and costing 22,000,000 Finnish marks, was laid before this Commission. The above-mentioned "Company for Transmission of Waterfall Power," of Petrograd, received permission in the summer of 1913 to submit a further project of an ambitious character, and surveys have shown that a scheme of considerable magnitude is possible. A canal is to be made 18 km. in length, through which a volume of 500 cm. per second of water will flow. Construction cost of the canal, with dams and locks, and including the electric plants, has been estimated at 100,000,000 Finnish marks. On the basis of this project, the company presented an application to the Finnish Senate in 1913, asking for concessions to carry out the work. As the largest waterfall of the Wuoxen, the Imatra Fall, belongs to the Crown, and its volume of water on the realisation of this enterprise would be considerably lessened, the company proposed to the Finnish Crown, as indemnification, to supply the Finnish State railways on the line from Wyborg to Petrograd with energy gratis and to pay 500,000 Finnish marks annually for the first three years, 1,000,000 yearly for the next three years, and afterwards 1,500,000 marks per annum; after 90 years the entire enterprise to be handed over to the Finnish Government without payment. Besides this, 50,000 kw. of electrical power is, under the proposal,

to be delivered to Finnish consumers at a low rate. The total capacity of this plant is calculated at 1,600,000,000 kw.-hours yearly, sufficient to supply all future requirements for electric lighting, tramways, electrification of the railways of the Wyborg and Petrograd provinces, and the demands for motive power of all the factories in the Petrograd district.

The Finnish Government referred the project to the Stockholm Bureau for Water-power Plants to examine and approve. In May, 1914, the Government Commission placed its reports before the Finnish Senate and advised certain alterations. To ensure perfect safety, a tunnel instead of a canal was suggested. The experts calculated the cost of the project at 157,000,000 Finnish marks. The Senate postponed a final decision till the autumn, and ordered that further surveys be made. An alternative project was suggested for a number of hydro-electric stations along the Wuoxen, having the same character as a system adopted at Lagan, in Sweden, by which a capacity of 100,000 H.P. to 600,000 H.P. was gradually developed. At the same time, inquiries were to be made at the Russian Ministry for the Interior, War Office and Admiralty as to the expected future requirements of Petrograd for electrical energy for the next 20 years. The furtherance of these projected enterprises has been postponed through the outbreak of the war. It is considered certain, however, that the very important question of providing the Petrograd district with cheap electrical energy must be solved in the near future.

According to the Russian "Commercial and Industrial Gazette;" also, the Company for Transmission of Waterfall Power has recently sought from the Governor of Viborg concessions to erect a hydro-electric station at the Rouchiali Fall, which is owned by the company. The total capacity of this proposed station is 80,000 H.P. Nine turbo-generators, each of 10,000 H.P. capacity, are to be provided.

It is still difficult to say in what manner the important problem of the exploitation of Finland's water-power for supplying the district of Petrograd with electrical energy will be finally solved, but the war has brought home to everyone that the more intensive exploitation of Russia's water-power is an absolute necessity, not only from the economical standpoint, but also for the safety of the State. The greatest calamity to Russia during the war, as is well known, has been lack of fuel, as, in spite of the extensive coal mines in South Russia, she is still dependent on imported coal. Although from 1900 to 1910 Russia's coal output has increased 90 per cent., while England's in the same time has increased only 20 per cent., Germany 50 per cent., and U.S.A. 65 per cent., Russia's demand for coal, in consequence of the rapid development of Russian industry, could not be covered by interior production. Russia's coal production has risen from 25,000,000 tons in 1909 to 34,000,000 tons in 1913. But when one considers that England produced in the last-named year 287,000,000 tons, Germany 192,000,000, France 41,000,000 tons of coal, it is clear that, on the whole, Russia's coal output is very small. Consequently, according to Russian statistics, Russia had to import in 1913 about 7,700,000 tons of coal (including 4,000,000 tons from England and 3,130,000 tons from Germany).* In order to understand the cause of the disorganisation in supplying Russia with coal during the war, one must take into consideration that about 70 per cent. of the total Russian coal output is mined in the Donetz basin (South Russia), 21 per cent. in the Dombrowa basin (Russian Poland), and only about 9 per cent. in other Russian provinces. The worst off in regard to coal supplies also in normal times were the Baltic provinces and the Petrograd district, railway rates for coal transport from the far-distant Donetz coal district being so high that the factories and electric stations used chiefly imported coal. For instance, the electric stations of Petrograd, Libau, &c., used Cardiff coal, and the works in Pernau, Riga, &c., the coal of the Yorkshire Association. In consequence of cheap shipping freights, imported English coal was always cheaper than inland Donetz coal, in spite of the high import tariff.

Russia's coal import fell extraordinarily on account of the war, and consequently the Donetz coal mines were obliged to supply also the north-western and the south-western Russian provinces, the latter having formerly imported considerable quantities of coal from Germany (chiefly from Silesia). The coal consignments to other provinces had, therefore, to be curtailed, and a coal famine has been the result. Further, a considerable number of extra goods trucks had to be apportioned for the longer coal transport from the Donetz basin, throwing more work that in ordinary times on the already overburdened Russian railways, which were already hardly able to cope with the increased demands made by the military transport department. As very often a scarcity of wagons prevailed, there has been in Petrograd and in other provinces a severe coal famine, bringing the electrical stations, tramways and water works, which require enormous quantities of coal, to a very serious situation.

* According to English statistics England exported to Russia in 1913 6,000,000 tons of coal (or 7·8 per cent. of England's total coal exports of 77,000,000 tons).

All these difficulties would be easily got over were the whole Petrograd district supplied with electrical energy from a distant water-power station in Finland. As soon as cheaper electrical energy is available, the whole of the factories will supplant steam power by electrical energy, and the demand for foreign coal would lessen considerably, and the unfavourable Russian balance with foreign countries would greatly be improved by the decrease in payments for imported coal, amounting to £6,000,000 sterling.

The cheapening of electrical energy in the Petrograd district would also give an enormous impetus to the whole industry, and make it possible to electrify the railway systems of Petrograd. The general tariff for 1 kw.-hour in Petrograd is enormously high, being 30 kopeks (=7½d.) for private lighting (in Berlin 45 pfg.=5½d.). The average price received by all electric stations in Petrograd in 1913 was 19·13 kopeks (=5d.) for private lighting, and 5·42 kopeks (=1½d.) for technical purposes per kilowatt-hour. In spite of this high tariff the four stations in Petrograd delivered in 1913 125,000,000 kw.-hours. In regard to the number of consumers, Petrograd, with 38 consumers of electrical energy to 1,000 inhabitants, was even more favourable than in other capitals of Europe. In comparing the amount of electrical energy produced, it will be seen that Berlin consumed per inhabitant in 1911-12 170 kw.-hours, London in 1910-11 110 kw.-hours, Vienna 72, and Petrograd 64 kw.-hours only. From the above figures it is clear that the use of electricity has room for much growth in Petrograd, all the more so as the amount of gas burned in Petrograd is, as already indicated in a previous number of this journal,* very nominal.

Till now the supply in Petrograd of electrical energy has been very disadvantageous to the users, as, besides the municipal electrical station for the electric tramway, having a capacity of about 10,000 kw., there are three private electrical stations, causing administration and other costs to be very high. The oldest company, the Company for Electric Lighting of 1886, as to whose liquidation much has been written, has a station with a maximum capacity of 25,000 kw., the Belgian Company, a capacity of 18,460 kw., and the Company for Electric Plants, a capacity of 12,320 kw. The maximum capacity of all electric stations in Petrograd was in 1913 about 65,000 kw.

Recently the Petrograd municipal authorities decided to purchase the three private electric stations in Petrograd. These three works, being built in different districts of the city and working for the most part with out-of-date machinery, can hardly be expected to be able to cope with the growing demands for energy without thorough and costly reconstruction. Also the systems are very different, which militates against unity in working in the future. The Company for Electric Lighting of 1886 produces three-phase current at 3×2,000 volts and 50 periods (supply pressure 120 volts), the Belgian Company single-phase current at 2,000 volts and 42·5 periods (supply pressure 110 volts), the Company for Electric Plants single-phase current at 3,000 volts and 50 periods and the Municipal Tramway station three-phase current at 6,600 volts and 25 periods. With regard to the motive power, there were in these four works in 1913 19 modern steam turbines, 18 vertical steam engines of old type and seven Sulzer tandem engines, with a total capacity of about 63,000 kw.

The question of the practical supply of the Petrograd district with cheap electrical energy in the future can be solved solely by erecting long-distance hydro-electric stations. As is well known, fuel is the chief factor controlling the price of electric energy, and accounts for 70 per cent. of the cost of production. It is, therefore, clear that cheap current cannot be supplied to Petrograd unless water power is used, owing to the prohibitive price of coal, which has to be imported abroad or from the Donetz basin. In the latter case, on account of the high railway rates, the coal is almost as expensive as the imported coal.

In conclusion, let me give a short summary of the present conditions of the electrochemical industry in Russia, which is closely connected with the problem of Russia's water-power exploitation. As is well known, the chief conditions required by a prosperous and progressive electrochemical industry is the possibility of having an enormous quantity of electrical energy at the cheapest possible tariff. Cheap electrical energy apart from brown coal and peat can be procured by means of water-power only. As already stated above, the exploitation of Russia's water-power being still in its infancy, electrochemical industry could not till now exist there, and the total capacity of all Russian electrochemical factories hardly exceeds 7,000 kw.

Aluminium, one of the most valuable metals for industry, is not produced at all in Russia.† For the production of calcium carbide there are in Russia only two furnaces, in West Europe about 70. Switzerland alone exported in 1913 calcium carbide to the value of Fr.7,008,000, Russia's consumption of this product in 1912 amounting to only 1,450 tons (value £42,100).

The production of electro-steel, which is carried on in nearly all

* *See* THE ELECTRICIAN of April 30, 1915.

† *See* THE ELECTRICIAN of October 8, 1915, p. 29.

important steel works of Europe and America, has till now been of absolutely no importance in Russia. For the production of ferro-alloys, which are used in producing the better qualities of steel, there is in Russia (in Ural) only one unimportant factory, although Russia's needs in electro-steel as well as in ferro-alloys are very large. For instance, in 1913, ferro-aluminium, ferro-silicium, ferro-mangan, &c., to a value of 2,159,000 marks were exported from Germany alone to Russia.

The conditions for the erection of works to produce ferro-alloys are especially favourable in Caucasia. The Caucasian manganese mines (in the Kutais province) supplied nearly the whole world with manganese. According to German statistics 447,000 tons of maganese ores, value 17,431,000 marks, were imported by Germany from Russia. For the erection of works to produce electrolytic copper Caucasia would be also very suitable, as notwithstanding the present backward conditions, 10,000 tons of copper were mined in Caucasia in 1913, Russia's total copper output being 34,300 tons.

The production of potassium chlorate by electrochemical means, which is of great importance for the manufacture of explosives and for the match industry, is only slightly developed in Russia. Before the war only one factory for this product was in existence—namely, in Russian Poland (Petrikau province). A second factory, at the Imatra Fall, was closed down for a long time, but during the war it has been again opened.

For the production of nitrates from the air, carborundum, &c., there is not a single works in Russia, although Russia has imported these products in large quantities. Only its requirements in caustic soda and chloride salts can be covered in Russia by the inland factories. It is certain that with a progressive exploitation of Russia's water-power, which can only be developed by the help of foreign capital, the electrochemical industry in Russia will make extensive and rapid strides, as, besides the important inland market, the necessary raw materials are ready to hand. The enormous demands made by the war for electrochemical products have shown the whole Russian nation quite clearly the absolute necessity of Russia having its own electrochemical industry.

With further reference to the question of investment, so far as Russia is concerned, English capital has been chiefly put into Russian gold mining and naptha enterprises. Both are of a speculative character, and it is doubtful if they are of great value to the English investor. German banking institutions have, on the other hand, grasped the industrial problem, and utilised it to their best advantage. German capital has troubled itself but little in connection with speculative enterprise, but has utilised its energies in financing great industrial projects in countries where capital has been required, such as Russia and South America, and the German banks have received not only the interest on their capital, but also very large contracts for the German factories, with which German financial projects are so closely allied. Leading Swiss and Italian manufacturers have, to a less or greater extent, adopted similar tactics, and by founding a South American bank to finance South American commerce and industry, and a Russian bank to finance Russian commerce and industry, have directed capital into these avenues of investment, ensuring, as I have said, a good rate of interest on their investments and a continuous shoal of orders for machines, material and accessories which have served to keep their factories going all the time. Lately America has adopted the same wise course, and instead of frittering her investments in enterprises of an undoubted high speculative character, has secured a large share of the world's orders for the necessary equipment of large industrial undertakings. In the exploitation of water-power projects very large sums of money have thus been invested, and have become, speaking generally, most reliable and continuous dividend earners. The exploitation of Russian water-powers offers, I believe, a similarly free and profitable field of work.

PUBLIC COMPANIES WOUND-UP, DISSOLVED, &c., IN 1915.

The following are the principal electrical and engineering limited liability companies which have been wound up (either voluntarily or compulsorily) during the past year. A dagger (†) denotes that the company has been struck off the register of joint stock companies, and a star (*) indicates that the company was wound up by an order of the Court.

*Adnl Electric Co.
†Alkaline Accumulators, Paul Gouin.
Ailen & Grosse.
†Anglo Brazilian Power & Shipping Corpn.
†Anti-Friction (Foreign & Colonial) Atlas Electrical Co. (Patents) Co.
†Auxiliary Power Co.
Baldur Engineering & Supply Co.
†Beam Co. (British Elec. & Mechanical Co.)
†Bishop's Stortford & Stansted Electric Lighting Co.
†Blast Furnace Power Synd.
†British Automat. Telephone Synd.
British Drawn Wire Lamp Co.
British Electric Automatic Machines.
†British Electric Light Wiring Co.
†British Ever-Ready Electrical Co. (old company).
†British Magneto Co.
†British Medical Electric Appliances Co.
British Prometheus Co.
†British Tungsten Metals Synd.
†British Wireless Telegraph Synd.
Cicoy Magneto Co.
†Circuitous Power Co. [Synd.
†Collieries Elec. Power Development
†Consolidated Electric Works & Appliances.
†Conveyors.
†County Electric Traction Co.
Dacolight Engineering Co.
†Dimming Switches.
†Duplex Motor Engine Co.
†Duplex Radiators.
†Electric Batteries & Carbons.
†Electric Fire Prevention Appliances & General Mfg. Co.
Electric Rly. Signalling Synd.
†Electric Speller.
Electric Stores.
Electric Utility Co.
†Electrical Fittings Co. (1911).
Electrical Power Storage Co. (on amalgamation with Pritchetts & Gold, Ltd.)
†Electrical Power Users' Assocn.
†Electrical Regulators & Economisers.
*Electro Steel Foundries.
†Electrocoustics.
†Engineering Equipment.
†Frank Suter & Co.
Gamble's Patent Telephone Recorder Co. (Continental).
†Garnier Enamelled Letter and Advertising Sign Co.
General Electrolytic Parent Co.
G. Straus & Co.
†Hayward's Heath Elec. Supply Co.
Helsby Wireless Telegraph Co.
Holborn Electric Fires.
†Homer Earphone Co.
†Horsfall Destructor Co.
†Humpage, Jacques & Pedersen.
†Hydro-Electric Lift & Crane Co.
†Illuminated Advertising Screens
†Illuminated Signs. [Co.
†Indestructible Accumulators.
†Institution of Signal Engineers (Inc.)
†Insulators.
†International Elec. Transport & Enterprise Co., of Alsace-Lorraine.
†International Synd. for Elec. Water Power & Pub. Wks. Concessions.
John Bellamy.
†Leeds & Bradford District Electric Co. Rlys.
†Leeds Electric Co.
Leitner Electrical Co.
†Liquid Air Power & Automobile Co., of Gt. Britain.
†London Elec. Treatment Co. (1911).
†Magnet Galvanising & Plating Co.
†Magnetic Separator.
†National Automatic Fire Alarm Co.
†National Electric & Motor Corpn.
National Engineering Co.
†New Imperial Electric Lamp Co.
†North Lancashire Tramways.
Otis Elevator Co. (for reorganisation).
†Pacific Radiotelegraph Co.
Parana Power Synd.
†Penmachno, Corwen & Bettws-y-Coed Light Rly. Co.
Phœnix Electric Heating Co. (1914).
†Pictorial Telegraph Synd.
Pintsch's Electric Mfg. Co.
†Power & Construction Synd.
†Power Engineers.
†Premier Electric Control.
†Radio & Electric Power Co.
Read Holliday & Sons.
Sheffield Electrical Engineering Co.
South American Cable Co.
†Southwold Electricity Works.
Spagnoletti (For reconstruction).
Spanish National Submarine Telegraph Co.
Spiral Regulating Dynamo Co.
†Spiral Turbine Synd.
†Star Electric Light Co.
†Sunturbo Engineering Co.
Teleradio Co.
†Telephone Disinfecting Co.
†Traction & Power Agency.
†Tramways Construction Synd.
†Tungsten Metal Co.
†Turbiro Synd.
†United Electrical Construction Co.
†Universal Patents Bureau.
Universal Radio Syndicate.
Venner's Electrical Cooking & Heating Appliances.
†Vogt Engines.
†Witney Electric Supply Co.
†Wolfram (Tungsten) Synd.

NEW BOOKS AND NEW EDITIONS.

[Copies of the new books mentioned below can be obtained *post free* from THE ELECTRICIAN Offices on payment of the prices indicated in parentheses. It is only necessary to specify the number when sending remittance.]

632. "Relativity and the Electron Theory." By E. Cunningham. 4s. net (4s. 4d.).

633. "Marine and Stationary Diesel Engines." By A. H. Goldingham. 12s. 6d. net (12s. 10d.)

634. "Wireless Telegraphy and Telephony." By W. H. Eccles. 12s. 6d. net (12s. 10d.)

635. "Questions and Numerical Exercises in Physics and Chemistry." By D. Baird. 1s. net (1s. 3d.)

636. "Elasticity and Resistance of the Materials of Engineering." By W. H. Burr. 7th edition. 23s. net.

637. "Introducton to the Physics and Chemistry of Colloids." By E. Hatschek. 2nd edition. 3s. net (3s. 4d.)

638. "Elements of Heat-Power Engineering." By Hirshfeld and Barnard. 2nd edition. 21s. net.

639. Intermediate Applied Mathematics Papers. (University of London, 1905-15, with answers.) 2s. 6d. (2s. 10d.)

640. Matriculation Mathematics Papers. (University of London, June, 1905-15, with solutions.) 1s. 6d. (1s. 10d.)

641. "Gases of the Atmosphere: History of their Discovery." By Sir W. Ramsay. 4th edition. 6s. net (6s. 4d.)

642. "Analytical Chemistry." Vol. II., Quantitative Analysis. By F. W. Treadwell. 4th edition. 15s. net.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	509	Electrical Fittings and Glassware. Illustrated	96
Imports and Exports of Electrical Manufactures	510	Calendars, Diaries, Novelties, &c.	97
LEGAL INTELLIGENCE	510	Lundberg's New List, No. 1	98
Bankruptcies, Liquidations, &c.	510		
Electricity Supply	511		
Traction Notes	511	Miscellaneous Notes	513
Empire Notes	511	Tenders Invited	513
Foreign Notes	512	Tenders Received & Accepted	514
		Companies' Meetings and Reports	515
The Round Table	93	New Companies, &c.	515
Electro-Harmonic Society	93	City Notes	515
"Witton" Motor Starters and Controllers. Illustrated	94	Electrical Companies' Share List	515

COMMERCIAL TOPICS.

Gas Lighting of Trains. According to recently published figures, the electrically lighted vehicles of British railways are still in a deplorable minority. The strong recommendations of the Board of Trade on this subject after each succeeding railway accident in which fires attributable to gas have broken out, appear to have had very little effect on certain of the railways. It appears that the South Eastern Railway and the Great Northern Railway of Ireland are the only two companies upon which the number of electrically lighted carriages is in excess of those in which gas is employed as an illuminant. In the case of the Midland and the North Eastern Railway Companies the figures show an almost alarming disparity on the side of gas. The Midland Railway Co. has 4,560 carriages in which gas is used and only 760 in which electricity is the illuminant; the North Eastern Railway Co. can only boast of 580 carriages lighted by electricity against 3,670 in which gas is retained. In no instance are the electrically lighted carriages in a preponderance. The London & North Western Railway Co. is the only undertaking which can show anything approaching a balance as between the two systems. The figures specify 3,000 electrically lighted carriages and 4,430 gas lighted. This is a condition of things which, even having regard to the embargo which the war has placed upon the introduction of public improvements, should not in the national interest be allowed to continue. One of our lay contemporaries, the "Daily News," in commenting upon these figures, speaks quite plainly upon the risk which the travelling public must still incur in gas lighted trains. It says: "It is merely the cost which has led to the disregard of the continual recommendations of the Board of Trade on the subject. The other cost—the cost in life—of the refusal has been grimly enough established. It is the travelling public's own fault if it does not now insist that it shall no longer be disregarded." This is a view which must meet with general endorsement. It is a matter for extreme regret that the railway companies have so persistently failed to recognise their obligations to their patrons in this matter.

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Electrical Progress in South Africa. The municipal electrical engineers in the South African Colony have now banded themselves together into an association, and it will be noticed from a report in another column that they have recently held their first annual congress. The first president is Prof. J. H. Dobson, who is general manager of the gas, electricity supply and tramways department of the Johannesburg municipality. We have not yet received full particulars of the Papers presented at the congress, but the titles of several of these indicate that subjects of a live character are being discussed. Many municipal electrical engineers in the Union are men of the younger school of electrical thought, and we gather that they have a keen appreciation of the commercial side of a municipal electricity undertaking. It is to be expected that in the preliminary stages of the movement engineering difficulties, both at the power station and on the distribution system, will present themselves and form fruitful subjects for general discussion, but the fact that Mr. John Roberts, the enterprising Borough Electrical Engineer of Durban, read a Paper on the subject of tariffs, and that this provoked considerable discussion, indicates that the need for bringing in the consumer is being kept well in view. We wish the new association every success, and have no doubt that its membership roll will be considerably increased during the coming year.

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Electricity Supply in New Zealand. In a recent issue we gave some particulars of the progress of electricity supply in Victoria, and we also gave a résumé of the statutory enactments of the State relating to electrical concessions. In the present issue we set out a list of the 38 Orders in Council which were granted during the year ended March 31, 1915, for the supply of electrical energy, or for constructing electric tramways, &c., in the Dominion of New Zealand. It will be noticed that many of the Orders are for powers to authorise the erection of overhead transmission lines, and the utilisation of water power in generating electrical energy. Home manufacturers and exporters of electrical plant and supplies should keep in touch with these and existing concessionnaires of electric supply and tramway undertakings, for there is sure to be an increasing demand from the Dominion. As a matter of fact, it is already reported that the electrical trade in Wellington (N.Z.) is greatly affected by the war, as it is not so easy now for an electrical firm to secure delivery of goods as it was six months ago. There is a steady depletion of stocks of brass holders and plugs, hitherto supplied by Germany to a large extent, and if a source of supply of these and other small electrical goods is not soon found, some embarrassment will be experienced very shortly. In addition to an intense anti-German feeling in New Zealand, there is a general desire to obtain goods from the Mother Country, and failing necessary supplies from home local dealers will be compelled to look to America for them.

* * * *

The Wall Plug Problem. The commercial development of electricity supply, particularly for domestic purposes, is naturally bound up with the design of such an important accessory as the wall plugs and sockets for use in connection with fires, cooking apparatus, and portable appliances generally. Attempts to standardise the centres of plug pins and certain necessary features in the design of the plugs and sockets, have so far ended in comparative failure. With the extension of the use of fires and cookers the need for standardisation, at any rate of the plug centres, will become more pronounced. By comparison with the many other electricity consuming devices at present in use, electric cooking and heating is in a considerable minority. It may, therefore, be said that the problem of interchangeability has not yet become very pronounced. The issue by the Engineering Standards Committee of a specification for wall plugs and sockets possesses a certain interest at the moment, though it cannot be said that the recommendations put forward in any way advance the prospect of the making of standard plugs and sockets on a general scale. It is true the specification deals only with the 5a-mpere size of plug, a pattern which hardly comes within the category of cooking and heating installations. At the same time, the manner in which the Committee has dealt with this pattern does not encourage the hope that their recommendations will be very helpful in respect of the larger sizes. The question of gripping the cable in the plug is not dealt with at all in the specification referred to. This omission is to be regretted, because troubles with flexible cords on portable apparatus usually arise at the point of entry into the plug. Then again, the present method of securing the cover of the socket in position is hardly a satisfactory one. It leaves a loophole for the careless workman to run threads in on the cross and put the sockets out of alignment and also run the risk of breaking the cover itself. Unless a separate switch is used with the wall plug, there is always the risk of shock if the plug is handled carelessly and if the fingers are brought into contact with the pins at the moment they touch the live socket. We think that as several manufacturers have succeeded in developing a satisfactory switch plug in which the circuit can only be made at the plug with the switch in the off position and the act of pushing home the plug closes the circuit, this design has everything to recom-

mend it for general acceptance. We have in mind a particular pattern of plug in which there is a third prong which is longer than the two live pins and which is utilised to operate the switch mechanism. This third prong can be made to act as an earthing terminal. Looking at the entire problem of plugs and sockets, the present state of affairs is far from being satisfactory and we think they are likely to continue so until representatives of accessory manufacturing elements are placed on the Engineering Standards Committee and are given an opportunity to give their views practical effect.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Dec. 23, 1915, *to* Jan. 1, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]. *France:* Unenumerated, 52 pkgs.

Hull.—*U.S.A.:* Electrodes, 60 pkgs.

Liverpool.—*U.S.A.:* Elec. copper, 20 ; [illegible] : unenumerated, 243 pkgs. *Spain:* Elec. carbons, 276 pkgs.

London.—*U.S.A.:* Elec. machinery, £1,482; carbon candles, £801; elec. lamps, £983; telephone material, £184; lamp parts, £185; wire and cable, £17; unenumerated, £4,922. *Holland:* Elec. lamps, £7,430—66 pkgs.; unenumerated, £85. *France:* Unenumerated, £898—28 pkgs. *Denmark:* Unenumerated, £10. *Japan:* Elec. lamps, £52; unenumerated, £90. *Sweden:* Elec. lamps, £476. *Canada:* Wire and cable, £520. [illegible]: Elec. lamps, £133; [illegible] £140. [illegible] £31 *Italy:* Elec. [illegible], 51 pkgs.; [illegible] £1,720.

EXPORTS.

To Australia.—*Adelaide:* Wire and cable, £1,367. [illegible] £113. *Melbourne:* Telephone materials, £49; wire and cable, £1,930; elec. machinery, £1,019; unenumerated, £251. *Sydney:* Wire and cable, £3,003; telegraph material, £30; elec. machinery, £710; unenumerated, £714. *Wellington:* Wire and cable, £202; elec. glow lamps, £748; elec. machinery, £815; unenumerated, £307. *Adelaide:* Unenumerated, £37. *Fremantle:* Wire and cable, £486; unenumerated, £169. *Perth:* Unenumerated, £701. *Christchurch:* Unenumerated, £72. *Napier:* Wire and cable, £76. *Dunedin:* Wire and cable, £1,200; unenumerated, £418. *Hobart:* Unenumerated, £39. *Invercargill:* Unenumerated, £25.

Africa.—*Durban:* Unenumerated, £1,008. *Cape Town:* Submarine telegraph cable, £600; unenumerated, £113. *Beira:* Unenumerated, £60. *Port Elizabeth:* Elec. machinery, £70; wire and cable, £119; unenumerated, £645.

South and Central America.—*Buenos Ayres:* Wire and cable, £553; telegraph material, £19; unenumerated, £536. *Puerto Colombia:* Unenumerated, £46. *Guayaquil:* Unenumerated, £146. *Antigua:* Unenumerated, £52. *Lourenco Marques:* Wire and cable, £67.

Holland.—*Amsterdam:* Wire and cable, £1,219. *Rotterdam:* Unenumerated, £399.

U.S.A.—*New York:* Wire and cable, £530; unenumerated, £239.

West Indies.—*Jamaica:* Unenumerated, £22.

Egypt.—*Alexandria:* Wire and cable, £101. *Port Said:* Wire and cable, £186; unenumerated, £7. *Port Sudan:* Wire and cable, £73; unenumerated, £137. *Suez:* Telegraph material, £8.

Japan.—*Dalny:* Unenumerated, £55. *Kobe:* Unenumerated, £186. *Yokohama:* Unenumerated, £191.

Malta.—Unenumerated, £196.

Russia.—*Vladivostock:* Elec. machinery, £69; unenumerated, £62. *Archangel:* Unenumerated, £15.

[illegible]. *Bombay:* Unenumerated, £1,122. *Calcutta:* Unenumerated, £1,705. *Madras:* Unenumerated, £580. *Singapore:* Unenumerated, £95. *Ceylon:* Telegraph material, £56; unenumerated, £356. *Kilindini:* Unenumerated, £59. *Karachi:* Unenumerated, £45. *Bangkok:* Unenumerated, £214. *Penang:* Unenumerated, £44.

China.—*Shanghai:* Elec. machinery, £145; unenumerated, £437. *Hongkong* Unenumerated, £491.

Canada.—*Toronto:* Unenumerated, £35. *Montreal:* Unenumerated, £274. *Halifax.* Elec. machinery, £1,020; wire and cable, £9,500; unenumerated, £78.

Italy.—*Genoa:* Elec. machinery, £338; unenumerated, £5,602.

France.—*Dieppe:* Elec. machinery, £138. *Paris:* Unenumerated, £476. *Havre.* Wire and cable, £40; elec. machinery, £277; unenumerated, £23. *Calais:* Unenumerated, £24.

FOREIGN GOODS (duty paid and free).

Rotterdam: Unenumerated, £325. *Egypt:* Unenumerated, £17. *Japan:* Unenumerated, £3. *Genoa:* Unenumerated, £95. *Brazil:* Unenumerated, £43. *New York:* Unenumerated, £2,159. *Sydney:* Unenumerated, £13. *Wellington:* Unenumerated, £91.

IN TRANSIT.

Bombay: Elec. [illegible] 165. *Hong Kong:* Elec. lamps, 184. *Singapore:* Elec. [illegible], £3,500.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Second Patent for Getting Zinc Electrolytically.

An application for licence to manufacture an anode giving increased electrical conductivity was made last week in the Patents Court.

A fortnight ago the Refractory Zinc Ore Treatment Co. applied for licence to use the German-owned patent 605 of 1909 for an anode of massing manganese peroxide. The electrical conductivity of the massive manganese peroxide was comparatively small, and the Refractory Zinc Company asked for licence to use patent 15,128 of 1911, of Messrs. Siemens & Halske (Berlin), for an anode in which pieces or rods of lead peroxide were embedded in pure manganese nitrate or in a mixture of crystalline peroxide and manganese nitrate. By this means is obtained an intimate union of the lead peroxide conductor with the manganese peroxide, so that the conductivity of the anode is increased.

Mr. C. B. Burdon, for Messrs. Siemens & Halske (who opposed), said he wished to correct statements made at the last hearing to the effect that the main work in applying that electrolytic process to the production of pure zinc had been done by applicants, and that some of Messrs. Siemens & Halske's patents were based on their investigations. He had lately received a belated letter which indicated that the foreign patentees took out patents in 1913 independent of the experiments of the Refractory Zinc Ore Company. When he protested against the low royalty suggested he was told that the work out of which the patent grew was really done by applicants. The royalty offered was a microscopic one. It worked out at half a farthing in the pound. It was 1s. per ton on the pure zinc produced and spot zinc for delivery at the moment was selling at between £80 and £100 a ton, instead of £22 as before the war.

The deputy Controller (Sir Cornelius Dalton) observed that the present price was an artificial price, but the royalty did appear small.

For the applicants, Mr. Edward Evans said the difficulty was that they did not yet know what was the commercial life of an anode.

Sir Cornelius Dalton said that it was impossible to go into the subject-matter of the letter Mr. Burdon had received because there was no means of verifying it, but the question of royalty in those electrolytic processes was of importance in more ways than one.

Mr. Evans said applicants were entirely deprived of the patentees' assistance in proving that process experimentally and applying it economically to zinc. An elaborate and expensive plant would be required to produce the zinc apart from that required to produce the anodes, and they would have to look to British manufacturers to help them. They had found how important those things were for zinc production.

Sir Cornelius Dalton: If you pay a small royalty it is all in favour of somebody else coming along and asking to have a licence against you. What you ask for is that practically you should have a licence for nothing.

Mr. Evans suggested that a price on the basis of the zinc produced was an unfair way of reckoning it. He would put it on the weight of the anode When applicants had the assistance of Messrs. Siemens & Halske they were only required to pay 4 marks per ton. But they had developed that thing on its commercial side entirely without the help of the patentees. It was only because Siemens & Halske were purveyors of electrolytic plant that the Refractory Zinc Ore Treatment Co. had recourse to them, and the Berlin firm supplied applicants before the war with a certain amount of electrical apparatus.

On behalf of the opponents a double royalty was suggested on the basis of the electrode and also on the zinc produced. Dr. Isherwood at the last hearing (Mr. Burdon added) spoke of making 20,000 anodes. That was a large number, and he might find, in certain circumstances, that he had manufactured them out of proportion to the amount of zinc to be obtained. As to the royalty of 4 marks a ton, it should be borne in mind that the smallness of the royalty was due to the fact that the patentees were told that prices were then so cut in the zinc trade in this country by foreign competition that it would not be possible to pay more. Messrs. Siemens & Halske sent over one of their experts to help.

Mr. Evans then suggested 5 per cent. on the manufactured anodes.

Sir C. Dalton objected that the Public Trustee would have a difficulty if the royalty was not on the selling price, as in all other cases. Any other mode of computation would involve him in elaborate and tiresome investigation. The output was all they could look to.

Mr. Evans said that he took it that if they got a licence they could transfer it.

Sir C. Dalton replied that that could be done by arrangement with the Board of Trade. Applicants would pay a royalty of 5 per cent.—he gathered that was the offer—on the anodes they made for sale to a zinc-getting company, or 1s. per ton on any zinc they chose to manufacture.

Mr. Evans desired to have it provided that where they paid royalty on any anodes there was to be no further royalty in respect of zinc.

Mr. Burdon urged that that was the wrong way to reckon it. It was very awkward because the value of the anodes was in their use during working, their durability and so on. The working process should pay. These applications were all round about the production of zinc, and he asked that the licence should specify that the power to use the anodes was not given for any other electrolytic purpose, and that all parties should pay a royalty to be estimated upon the basis of the zinc produced.

Sir Cornelius Dalton said the Board of Trade would communicate with applicants as to their licences when they had looked into the matter.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of Salisbury Lamps (Ltd.) will be held at 15, Eastcheap, London, E.C., on Feb. 7.

Wm. Carey Wild, electrical engineer, 57, Rhodes-street, Halifax, has been adjudicated bankrupt. First meeting of creditors will take place on Jan. 12 at the County Court House, Prescott st., Halifax, and public examination at same place on Jan. 14.

Augustine Garbutt, electrical engineer, formerly trading at 2, Kirkstall-road, and 67A, North Hall-street, Halifax, has been adjudicated bankrupt.

Winding-up Petition.—A petition for winding up Cedes Electric Traction (Ltd.) will be heard in the High Court on Jan. 18.

ELECTRICITY SUPPLY.

EXTENSIONS.

Birmingham.—On Wednesday the Corporation adopted the recommendation of the Electric Supply Committee to extend the plant and equipment of the temporary supply station at Nechells, at an estimated cost of £148,660.

Bradford.—Various extensions of the electric supply mains are being carried out by the Electricity Committee

Finchley.—The Council have applied to the L.G. Board for sanction to borrow £10,000 for electric supply extensions.

Greenock.—It has been decided to apply for sanction to a loan of £40,000 for extensions of the electric supply undertaking.

Leicester.—It was reported to the Council on Tuesday that it would be necessary to expend £14,000 upon extensions of the electric supply works in order to give the increased power supply demanded by engineers and manufacturers. It was stated that the Tramways Committee had been advised that the Government would be prepared to sanction the expenditure, and the report was, therefore, approved.

Salford.—Application is to be made to the L.G. Board for sanction to borrow £1,600 to cover the cost of the supply and erection of a 500 kw. rotary converter set, together with switchgear and l.t. cable.

Several agreements are to be entered into for the supply of electrical energy for power.

West Bromwich.—The Electricity Committee has received sanction to borrow £8,850 for the extension of generating plant, &c.

A sum of £1,759 is for economiser, steel chimney, motor for stoker and water softener; £4,517 for boiler, &c.; and £2,574 for engine-house extension and of foundations for boilers, chimneys, &c.

The Committee recommends the entering into of an agreement with the Oriental Tube Co. for the supply of current of a minimum quantity of 80,000 units per annum.

GENERAL.

Aberdeen.—The Electricity Committee have made arrangements for the renewal of the contracts for the supply of electrical energy to the Harbour Commissioners, and to the Great North of Scotland Railway Co.

During November 1,301,800 units of energy were generated, compared with 1,138,140 units in 1914, an increase of 163,660 units.

Bethnal Green (London).—From time to time during the past 12 years Shoreditch Council have laid mains and services in Bethnal Green, some of the works having been undertaken on the understanding that Bethnal Green Council would, when in a position to supply current, purchase the mains, whilst other works have been carried out by the Shoreditch authority in the absence of objection on the part of Bethnal Green.

The Shoreditch mains and apparatus are of little use in connection with the a.c. supply system adopted for Bethnal Green. In view of the fact that the contractors are proceeding with the laying of new cables in the areas in which the Shoreditch mains are situated, the Electricity Committee recommends the Council to authorise them to negotiate further with Shoreditch Council for the purchase of the mains in order that the matter can be settled promptly.

Castlewellan (Co. Down).—The formal inauguration of the public electric lighting took place on the 27th ult., when Lady Clare Annesley switched on the electric current.

The generating station was equipped and the distributing network erected by the Irish Towns Electric Light & Power Co., of Belfast. There are 40 street lamps which are lighted from sunset till 10:30 p.m. from Sept. to March, and the cost is £1 per light per annum. The charge for electrical energy for private lighting is 6d. per unit, and for power and heating purposes 3d. per unit.

Chelmsford.—The Council will apply to the L.G. Board for an order under the Special Acts (Extension of Time) Act, 1915, extending for one year the time within which the Corporation may exercise its option to purchase the local undertaking of the Electric Supply Corpn.

The order was granted in 1894 to Messrs. Crompton & Co., and was subsequently transferred to the Electric Supply Corpn. Sec. 58 of the order empowers the local authority within six months after the expiration of 21 years from the commencement of the order to notify the undertakers of its intention to purchase the undertaking. Such notice would have to be served between July 20, 1915, and Jan. 20, 1916, and, having regard to existing conditions, the Town Clerk has advised that an extension of time should be sought.

Finchley.—The electrical engineer (Mr. E. Calvert) reported at last week's Council meeting upon the recent breakdown of the supply.

Mr. Calvert said that that was the first occasion on which the supply of current had been completely disorganised since 1903. Each of the three main areas of supply were affected, and there were numerous minor faults on consumers' premises. The breakdown had partially damaged the large generating set. The major fault was due to a pick hole in one of the distributing mains, and he was of opinion that all street openings should be under supervision, as similar damage had been done on several occasions.

The suggestion with regard to the supervision of future excavations was adopted by the Council.

Sunderland.—The Sunderland Shipbuilding Co. has been permitted to lay an electric cable from their power station at the South Dock across the East Quay of the dock extension, Hudson Dock North, through the River Wear Commissioners' lands to the edge of the quay.

Worcester.—Mr. W. J. Hill has been appointed chairman of the Electricity Committee.

The Committee is considering a letter from the Worcester Electric Traction Co., claiming a revision of the prices at which the Council supplied them with electrical energy under the agreement of May 11, 1900.

In order to improve the flow of water from the River Teme to Powick electricity works, it has been decided to spend £700 on certain works, including a fish screen.

TRACTION NOTES.

Belfast.—The manager of the Corporation tramways department is satisfied with the results attending the employment of boys as conductors.

The local branch of the National Amalgamated Union of Labour recently passed a resolution protesting against the employment of women as conductors, but the chairman of the Tramways (Ald. Tyrrell) stated that if the necessity arose, the Corporation would employ women, and it would then be a case of "God help the man or the body of men who interfered with them."

Glasgow.—A tramcar accident on Sunday last resulted in over 50 passengers being injured.

A tramcar, which was proceeding down Bilsland-drive, jumped the rails at a curve, a few yards from the Forth and Clyde Canal Bridge, and dashed into the canal wall. The car was wrecked, the upper deck being torn almost completely from the lower portion.

Hull.—At the last meeting of the Tramways Committee the chairman (the Mayor, Ald. Hargreaves) referred to the increasing trouble experienced in the tramway service owing to delays at the level crossings on every route in the city.

He said the position during the last few weeks had become almost intolerable; night after night, between 5 and 6:30, he had seen crowds of people waiting for cars, and within three or four minutes no fewer than 14 cars had come up one closely behind another. The existing Board of Trade Regulations (made eight or 10 years ago) were out of date, and were not applicable to the new railway methods of having trains made up of 70 or 80 trucks passing along so slowly that the street traffic at the level crossings was held up for several minutes.

The manager (Mr. McCombe) also reported that there was shunting at the crossings, which was absolutely illegal.

The committee instructed the Lord Mayor, with the deputy-chairman (Mr. Wheatley), the manager and the town clerk (Mr. H. A. Learoyd), to take any steps thought necessary to obtain an improvement.

Walsall.—The Tramways Committee has been authorised to purchase a British made motor van for parcel traffic work at an estimated cost of £140.

EMPIRE NOTES.

Australasia.—According to the local press, the electrical trade in Wellington (N.Z.) is being greatly affected by the war. It is not so easy now for an electrical firm to secure delivery of goods as it was six months ago. There is a steady depletion of stocks of brass holders and plugs, hitherto supplied by Germany to a large extent, and if a source of supply of these and other small electrical goods is not soon found, some embarrassment will be experienced by the trade during the next 12 months.

The annual report of the Victorian Secretary for Mines for 1914 states that the State coal mine at Wonthaggi has had a prosperous year and is now the largest producing mine in Australia. At the mine over 1,000 men are employed. Electric coal-cutters are used extensively, electricity being also utilised for lighting, &c.

The Swedish Consul-General at Auckland (Mr. A. A. Winslow) states in a note in the "Journal" of the Swedish Chamber of Commerce in London that new regulations relating to the leasing of Government land for the manufacture of wood pulp in New Zealand have been issued. He adds that there seems to be a fair outlook for the production of wood pulp and the manufacture of paper in New Zealand if sufficient capital can be interested to instal a plant. The timber is said to be of a high grade. A syndicate has a concession covering 30,000 acres of wood-pulp timber

lands, with more available, and it has also a water-power site capable of generating about 4,000 H.P. of electrical energy to operate the plant. The New Zealand Government is interested in the development of this industry, and has offered to remit all rents and royalties on the first 500 tons of pulp.

The proposal to further connect the northern and southern suburbs of Melbourne by a tramway to the heart of the city, terminating close to the point where the South Melbourne and Port Melbourne lines leave it has been advanced by the completion of Mr. V. J. Crowley's report on behalf of the Melbourne, Brunswick and Coburg Tramways conference. The proposed route is set out in the report, and the total length will be about 8¼ miles, of which about 5 miles will be double track. It is proposed to use the overhead trolley system, and the lines will be to the standard gauge rails. Power will be taken from the trust's sub-station. The capital cost is estimated at £123,900, including permanent way £87,260, overhead work with feeders £19,190, and cars £10,000. Annual expenses are estimated at £13,125 for working expenses (350,000 car-miles at 9d.), interest at 5 per cent. £3,097, sinking fund at 1½ per cent. £1,858, total £24,275. Mr. Crowley anticipates a loss of £838 per annum at first.

"Tenders" says the moving spirit in the proposed hydro-electric scheme at Tumut (N.S.W.) is Mr. F. Kinred, of Tumut.

Mr. Lascelles Parrington, the Australian representative of the Electric Construction Co., has removed to Collins House, 360, Collins-street, Melbourne. Mr. Parrington also represents the Bastian Meter Co. and the Electric Power Storage Co.

Canada.—Thirty Municipalities have endorsed the proposal to construct an electric railway from Toronto to London at an estimated cost of £2,800,000.

Electricity Supply in New Zealand.—During the year ended March 31, 1915, 38 Orders in Council were issued authorising the supply of electrical energy, or the execution of electric traction schemes. The following is a list of the licensees, with brief particulars of the locality and purpose for which the licence was granted :—

Mataura Borough Council (Borough of Mataura), extending electric lines; Christchurch Tramway Board (Summer Estuary), erecting electric lines; Ditto (Fendalton), erecting electric lines; Ditto (Upper Riccarton), erecting electric lines; Ditto (Opawa), erecting electric lines; Ditto (Fendalton-road), erecting electric lines; Wanganui Borough Council (Wanganui), erecting electric lines; Havelock North Town Board (Havelock North Town District), erecting electric lines; Ohakune Borough Council (Borough of Ohakune), using water for generating electricity and erecting electric lines; Winton Borough Council (Borough of Winton), erecting electric lines; Eltham Co-operative Dairy Co. (Borough of Eltham), using water from Waingongoro River for generating electricity; Feilding Borough Council (Feilding and Counties of Oroua, Manawatu and Kairanga), erecting electric lines; Wanganui Borough Council (Wanganui), erecting electric lines; Dunedin City Council (Otago P.D.), erecting electric lines; Gisborne Borough Council (Borough of Gisborne and Pt. Cook County), erecting electric lines; Ohakune Borough Council (Borough of Ohakune), using water from Mangawhero river for generating electricity and erecting electric lines; Heathcote County Council (Cashmere and St. Martin's Rdgs.), erecting electric lines; Wellington Corporation (Wellington), erecting electric lines; New Plymouth Borough Council (Borough of New Plymouth and Taranaki City), using water from Waiwakaiho river for generating electricity and erecting electric lines; Christchurch Tramway Board (Sydenham), erecting electric lines; Tauranga Borough Council (Borough of Tauranga and Tauranga County), using water from Omanawa river for generating electricity and erecting electric lines; Christchurch Tramway Board (Papanui), erecting electric lines; Wanganui Borough Council (Wanganui), erecting electric lines; Waverley Town Board (Waverley District), using water from Mangatangi stream for generating electricity and erecting electric lines; Whangarei Borough Council (Whangarei Borough), erecting electric lines; Tokomaru Farmers Co-operative Co. (Pt. Waiapu County), erecting electric lines; Tamaki West Road Board (Tamaki West Road District), erecting electric lines; Mr. John Frank Pettie (Waipiro Bay), erecting electric lines; Stevenson & Cook Engineering Co. (Borough of Port Chalmers), erecting electric lines; Mr. Frederick James Mansell (Town District of Bulls), erecting electric lines; Invercargill Borough Council (Southland County), extension of electric lines; Napier Borough Council (Beyond Borough of Napier), extension of electric lines; Kaponga Town Board (Kaponga Town District), using water from Kaupokonui stream for generating electricity and erecting electric lines; Miramar Borough Council (Borough of Miramar), erecting electric lines; Mr. Charles Frank Murray (Wheatsheaf), using water from Woodside Creek for generating electricity; Mr. James O'Dowd (Township of Tapanui), erecting electric lines; Auckland City Council (City of Auckland), erecting electric lines; and Mr. James Robertson (Borough of Marton), erecting electric lines.

India.—The following notes are extracted from the Review of the Trade of India for the year ended March 31, 1915, by the Director of Statistics to the Indian Government :—

Electrical machinery for use in connection with water power plant has great capabilities of expansion. The number of electrical installations in India is large and increasing. All the larger towns and chief ports have electricity supply and electric tramway undertakings, or are about to use power for these purposes. In recent years the collieries have largely adopted electrical equipment, and here German goods have found an opening.

The Calcutta market has in late years been flooded with cheap German materials for electric wiring and fittings, cables, switches, ceiling roses and cutouts, and the United Kingdom should secure the trade, provided the requirements of the market are carefully studied.

The market for machinery for mills and factories is promising. It is necessary, however, for agents and commercial travellers to encourage the use of their machinery by actual demonstration to mill owners and others interested in Indian industries.

Earthenware and porcelain hitherto came chiefly from the United Kingdom, although an appreciable quantity was imported from Germany and Austria-Hungary. German goods included china clay insulators.

Metal lamps have been largely imported from Germany and Austria-Hungary. The United States has made enormous strides in capturing this trade. The combined value of the imports of these goods from Germany and Austria-Hungary in 1913-14 was £100,600, and in the four months April to July, 1914, £33,300.

Municipal Electrical Engineering in South Africa.—The first Annual Congress of the Association of Municipal Electrical Engineers of the Union of South Africa was held in Johannesburg in November. The Congress commenced on Nov. 15 and terminated on Nov. 20.

There were present the undermentioned municipal electrical engineers : Messrs. M. McDonough (Bethlehem), W. F. Long and G. H. Swingler (Capetown), J. Roberts and E. Poole (Durban), W. H. Blatchford (Greytown), J. R. English (Heilbron), T. Millar (Harrismith), J. H. Dobson, F. T. Stokes and E. T. Price (Johannesburg), T. Jagger (Ladysmith), T. C. Wolley-Dod (Pretoria), B. Sankey (Port Elizabeth), A. S. Munro (Pietermaritzburg), F. Castle (Oudtshoorn), N. D. Ross (Potchefstroom), W. Bellad-Ellis (Queenstown), R. Mortimer (Roodepoort), W. Leonard (Standerton), — Ward (Newcastle), L. L. Horroll (Pretoria), L. B. Proctor and W. S. Guildford (Boksburg).

The delegates were welcomed by the Mayor (Mr. Norman Anstey) and the Chairman of the Tramway & Lighting Committee (Mr. T. F. Allen).

Prof. J. H. Dobson, general manager of the gas, electric supply and tramways department of Johannesburg Municipality, was unanimously elected president for the year. In the afternoon the members visited the Rosherville Station of the Victoria Falls & Transvaal Power Co.

On the 16th the delegates visited the Crown Mines. The party went down the mine, visited the large underground electric pumping plant and afterwards inspected the surface plant. In the afternoon the president (Prof. J. H. Dobson) delivered his inaugural address, and was accorded a hearty vote of thanks on the motion of Mr. T. C. Wolley-Dod, seconded by Mr. Sankey. Mr. W. F. Long, city electrical engineer of Capetown, read a short Paper entitled "Some Notes on the Prevention of Corrosion in Condenser Tubes," and a lengthy discussion followed.

On the 17th the Congress met at the Town Hall, and after informal business, Mr. John Roberts, borough electrical engineer, Durban, read a Paper on "Tariffs of Prices for Electricity." This Paper was also much discussed. In the afternoon the delegates visited the power station of the Randfontein Estates & Gold Mining Co., being welcomed on the mine by Mr. T. P. E. Butt, chief electrical engineer to the company.

On morning of the 18th November a Paper on "Diesel Engines" was read by Mr. W. Bellad-Ellis, borough electrical engineer, Queenstown, and after discussion the members visited the various places of interest in the town. In the evening the members were the guests of the S. A. Institute of Electrical Engineers at the Transvaal School of Mines & Technology, when Prof. J. H. Dobson read a Paper entitled "The Distribution Plant of the Johannesburg Municipal Electric Supply System," and received a hearty vote of thanks for this valuable Paper.

On the 19th further discussions on the Papers took place, an din the afternoon Johannesburg municipal power station and distribution system were visited, also the large municipal abattoirs. The Congress was brought to a conclusion on Saturday the 20th, when informal business was transacted, and the following additional officers and Council were elected for the ensuing year, as follows: President, J. H. Dobson; Vice-Presidents, W. F. Long, B. Sankey, John Roberts and W. Bellad-Ellis; Hon. Secretary, F. T. Stokes; Hon. Treasurer, E. T. Price.

FOREIGN NOTES.

China.—H.M. Commercial Attaché at Peking (Mr. W. P. Ker, C.M.G.) reports that the Chinese Ministry of Agriculture and Commerce have recently established a Commercial and Industrial Commission to collect statistics and develop trade in China, and that it desires to receive catalogues from British manufacturers.

These should be addressed to the Commercial and Industrial Commission, Ministry of Agriculture and Commerce, Peking.

Mr. Ker also recommends publishers of periodical trade publications to send specimen copies of their publications, stating amount of annual subscription to the Commission with a view to the publications being considered for addition to the library which the Commission is establishing.

Paraguay.—H.M. Chargé d'Affaires at Asuncion (Mr. F. A. Oliver) reports that he has recently drawn the attention of the Paraguayan Minister for Foreign Affairs to the fact that the Inland Revenue Department has been claiming a fee of $20 gold (£4) for the registration of a British trade mark, instead of $50 currency (5s.).

The $20 fee is that prescribed for a trade mark of foreign origin, whereas in accordance with Article 5 of the Anglo-Paraguayan Commercial

Treaty of 1884, the fee for a British trade mark is that prescribed for a trade mark of native origin—*i.e.*, $50. His Excellency agreed that the larger tax on marks of foreign origin could not justly be imposed in the case of British marks, and has given directions to that effect.

MISCELLANEOUS NOTES.

Controlled Munition Works.—It is announced that the Minister of Munitions has made an order under sec. 4 of the Munitions of War Act, 1915, declaring 396 additional establishments as controlled establishments as from Jan. 1, making a total of 2,422 controlled establishments.

Defence of the Realm.—On Dec. 31 the Minister of Munitions ordered that the war material to which Reg. 30A of the Defence of the Realm Regulations, 1914, applies shall include platinum metal ore, residues and bars containing same. Applications for permits under the order must be made to the Ministry of Munitions, Armament-buildings, Whitehall-place, London, S.W.

Foreign Trade.—The Foreign Trade Department of the Foreign Office has been established as a new department in order to carry out the policy embodied in the Trading with the Enemy (Extension of Powers) Act, 1915, which authorises the prohibition of trade by any person, firm or company in the United Kingdom with any enemy persons or association established in neutral countries.

As the new department will be concerned with preventing trade by British firms and companies with the enemy in neutral countries, it has been decided to merge with it the Trading with the Enemy Department of the Home Office, which has had the duty of enforcing the measures already taken to prevent trading with the enemy.

Questions of contraband or the hindrance of oversea trade between neutrals and the enemy and the licensing of exports from this country, and all questions of trading with the enemy other than those mentioned above, will continue to be dealt with by the Government Departments which have hitherto been charged with these questions.

In order to secure the full benefit for British interests of the policy of the department, the advice and asistance of business men will be invited through the Chambers of Commerce and other trade organisations. Mr. L. Worthington Evans, M.P., has undertaken the direction of the new department with the title of Controller of the Foreign Trade Department of the Foreign Office. Communications (including those relating to matters previously dealt with by the Trading with the Enemy Department of the Home Office) should be addressed to the Controller of the Foreign Trade Department, Lancaster House, The Mall, S.W.

Inquest.—An inquest was held on the 29th ult. on James Pardoe, a driver in the A.S.C., who was killed at Blackheath on the 27th ult.

It appeared that some overhead electric light wires had been blown down by the gale, and Pardoe, not seeing them, fell over them and was unable to extricate himself.

A verdict of accidental death was returned.

Patent Specifications.—The "Illustrated Official Journal (Patents)" for Jan. 12 states :—

In order to give the public the advantage of having abridgments of specifications up to date while retaining their numerical sequence, applications for patents made subsequent to 1915 will be given new numbers when their complete specifications are accepted or become open to public inspection before acceptance. The new numbers will start with No. 100,001 (without any indication of date), and will supersede the original application numbers in all proceedings after acceptance of the complete specifications. It is intended in future to issue abridgments of specifications in the "Journal" a few weeks later than that in which their acceptance or publication is advertised, so that they will be available for search purposes soon after the printed copies of the specifications are on sale ; but, until the system is fully in force, they will only be issued when there are sufficient to make up a full sheet of 16 pages. The present series of abridgments will run concurrently with the new series in the "Journal" until April, 1917, when it will be entirely superseded.

Sale of Signalling Apparatus.—A circular has been issued by the War Office in regard to the sale of signalling apparatus.

It is stated that it has come to the knowledge of the Army Council that various firms of instrument makers are stocking signalling apparatus, mainly, it is believed, for sale to officers for instructional purposes. It is not desired to restrict the sale of signalling apparatus for this purpose to authorised persons, but as the possession of such apparatus without "lawful authority" is a contravention of the Defence of the Realm regulations, it is necessary to regularise the stocking of apparatus of this nature by approved firms by the issue of a permit under conditions which will ensure that the apparatus will only be sold to authorised persons. Chief Constables have been notified that after due warning being given the possession of signalling apparatus without a permit from the Competent Military Authority by any firm will be treated as a contravention of the Defence of the Realm regulations, and that any firm requiring a permit should apply to that authority. A permit to possess signalling apparatus should only be granted in cases where the Competent Military Authority is satisfied (*a*) that the applicant normally deals in scientific apparatus and goods of this description, and (*b*) that the bona fides are above suspicion. Applications for permits have to be referred to the Chief Officer of Police for the district where the applicant carries on business for information on both these points. Strict conditions are laid down in regard to the sale or transfer of signalling apparatus, and it is pointed out that the permit does not include permission to possess apparatus for the sending or receiving messages by wireless telegraphy. Electric torches or hand lamps are not included in the term "signalling apparatus," unless they are provided with a special key, shutter, or other fitting designed for the purpose of signalling.

Telegraph Service with Russia.—It is announced that an urgent telegraph service with Russia was introduced on the 1st inst.

The charge will be 1s. 1½d. a word (triple ordinary rate) and the word "Urgent" must be inserted before the address and be paid for as an extra word. Urgent telegrams receive priority of treatment over other private telegrams on the Great Northern Telegraph Co.'s lines and on the Russian landlines, but in view of the pressure now prevailing it must be understood that a rapid service cannot be guaranteed. Telegrams should be handed in at the company's office, 15A, St. Helen's-place, or at a Post Office.

Will.—The late Dr. F. S. Pearson, president of the Brazilian Traction, Light & Power Co., the Barcelona Traction, Light & Power Co., the Mexico Tramways Co., the Rio de Janeiro Tramway, Light & Power Co., the Mexican Light & Power Co., and other companies, who went down in the "Lusitania" on May 7 last, left estate in the United Kingdom of the value of £328,960.

TENDERS INVITED.

Telegraph and Telephone Supplies.

Tenders are invited by the Postmaster-General's Department of the COMMONWEALTH OF AUSTRALIA for the supply of Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks, &c. Tenders to the Official Secretary, Commonwealth of Australia, 72, Victoria-street, S.W., by noon Jan. 19. *Further particulars (as to quantities required, &c.), are given in an advertisement.*

Converters, Boosters, &c.

MANCHESTER Electricity Committee require tenders by 10 a.m. Dec. 18 for Sub-station Converters, Traction Boosters and Steam and Water Piping. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Coal-Handling Plant.

DARLINGTON Corporation require tenders by Jan. 12 for supply and erection of Coal Bunkers, Elevators, &c., at their electricity works. Specification from Borough Electrical Engineer.

Hydro-Electric Generator.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Electrical and Tramway Stores.

ISLINGTON (London) Council require tenders by Jan. 21 for one year's supply of Transformers, Meters, Cables, Terminal, Service and Network Boxes, Lamps, Sundries, Arc Lamp Globes, Oils and Lubricants, &c. Specifications, &c., can be obtained at the Town Hall, Upper-street, N.

DUBLIN Port and Docks Board require tenders by Jan. 12 for 12 months' Electrical Supplies, Oils, &c. Forms of tender from the Secretary, Westmoreland-street, Dublin.

CROYDON Corporation want tenders by 10 a.m. Jan. 24 for one year's supply of General Stores for their Tramways Department. Schedules (A to M) from the Tramways Manager.

Electrically-operated Pumps.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1,301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Telegraph and Telephone Material, &c.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tender forms can be obtained at the Commonwealth Offices, 72, Victoria-street, London, S.W.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23. Tender forms, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories (schedule No. 344) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tender forms, &c., in above cases from High Commissioner for the Commonwealth of Australia, 72, Victoria-street, London, S.W.

Tramway Material.

JOHANNESBURG (Transvaal) Council require tenders by noon Jan. 25 for supply of (1) 800 pairs of Fishplates for girder Tram Rails (Contract 66); and 100, or alternatively 200 Rolled Steel Tramcar Tyres (Contract 69). Specifications, forms of tender, &c., from the Municipal Offices, Johannesburg.

Boiler Tubes.

JOHANNESBURG Council also want tenders (by noon Feb. 15) for supply of 250 18 ft. by 4 in. Tubes for Water-tube Boilers. (Contract 70). Specification, forms of tender, &c., from the Municipal Offices, Johannesburg.

Electric Power and Lighting Plant.

Tenders will be received at the Negociado Quinto de la Segunda Sección (Material) del Estado Mayor Central de la Armada, Ministerio de Marian, Madrid, until Jan. 26, for the Construction and Installation in the Cadiz Naval Arsenal of an Electric Power Plant. Conditions of tender may be seen at the above-mentioned Negociado. Tenders (in Spanish), on paper bearing a 1 peseta stamp, must be accompanied by specifications and plans. A provisional deposit of 20,000 pesetas (about £800) is required to qualify any tender. Local representation is necessary.

SEGOVIA (Spain) Municipality require tenders by Jan. 20 for the installation and working for five years of an Electric Lighting System for the city. The contract will probably be awarded to a Spanish firm.

Tenders will be received until Jan. 14 by the Municipal Authorities at S. PEDRO DO SUL (Portugal) for a concession for the Electric Lighting of the town. The contract will probably be awarded to a Portuguese firm, but material may be purchased abroad.

TENDERS RECEIVED AND ACCEPTED.

KEIGHLEY.—The Tramways Committee recommend the Council to accept the offer of Clough, Smith & Co. to construct the overhead equipment for trolley vehicles from the present terminus at Hebden-road, Haworth, to Lower Town, Oxenhope, the capital payment to be suspended until after the end of the war.

SALFORD.—The following tenders have been accepted by the Council:

Brown Bayley's Steel Works, 300 steel tramcar tyres, £1,361 [illegible]; Hadfield's (Ltd.), 14 manganese steel crossings, £292 10[illegible]; British Westinghouse Co., 500 kw. rotary converter set, £1,4[illegible]9; and Albion Motor Car Co., 4-ton motor petrol wagon, £775.

WEST BROMWICH.—The following tenders for the supply of plant are recommended for acceptance by the Electricity Committee:—

Gwynnes Limited, motor-driven centrifugal pump; Kennett Water Softener Co., water softener; Cochrane & Co., c.i. pipes; Babcock & Wilcox, high pressure steam pipes.

BRISBANE (QUEENSLAND).—The tender of the Brisbane Electric Co. (at £3,852) has been accepted by Brisbane Hospital Committee for an electric light and power installation.

"Indian Engineering" states that Sir William Maxwell, Director-General of Indian Posts and Telegraphs, will return from leave about the third week of February.

ELECTRIC LAMPS.—The following tenders have been accepted by the L.C.C. for the supply of electric lamps:—

Edison & Swan United Electric Light Co., items 1–7 (carbon filament lamps); Cryselco (Ltd.), items 8–27 (metallic filament lamps, with filaments not of drawn wire); Corona Lamp Works, items 8–13, 18–21 and 26 (metallic filament lamps, with filaments of drawn wire).

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

23,563 CLEURET & BONNEUIL. Electric ringing-apparatus, or other mechanism having [illegible]. (17/12/13.)

[illegible] Electrically-operated tabulating [illegible].

24,013 [illegible] Automatic electricity meters. (17/12/13.)

24,543 BLATHY. Brake magnets for electric meters. (23/12/13).

A [illegible] the adjustment of the brake magnets of electric meters, consisting in the provision in or in close proximity to the shanks of the magnet of a set screw or a wedge by the displacement of which the pole faces of the magnet may be pressed apart, or drawn towards each other.

1915 SPECIFICATIONS.

1,483 HIKELEY. Integrating electric wattmeters.

A graphic recording watt-hour meter of the cyclometer type, having a single electro magnet by the action of which the record strip is forced against the cyclometer wheels, which wheels are locked during the printing operation, and the strip is wound [illegible].

3,860 HISLOP. Electric fire alarm contact makers.

4,585 BOWDEN & THOMPSON. Protection of electric cables.

8,895 BEATTIE. Arrangements for protecting telephone, telegraph, and the like instruments against lightning or excessive electric potentials.

11,555 VREELAND. Production of undamped or sustained electrical oscillations.

An electrical oscillator, employing an oscillating circuit or circuits, in which sustained or undamped oscillations are generated by means of a mercury vapour arc, concentrated in a restricted stream of high energy-transforming capacity.

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 6, 1915.

17,116 HEIBERG. Electrical table lamp. (9/1/15, Norway.)*
17,128 B.T.-H. Co. (G.E. Co., U.S.) Electrically-driven vehicles.
17,134 CARTER & RENOLD. Coil clutches.*
17,143 CRADDOCK. System of railway control. (5/12/14, New Zealand.)*
17,155 SCHROEDER. Electrical rotary converters.

December 7, 1915.

17,160 STATTER & ST. JOHN. Accessories for use with telephones.
17,166 CAMPBELL. Power systems.
17,168 CANTON. Incandeseent electric lamps.
17,169 CANTON. Illuminating elements for electric lamps.
17,172 BELL. Magneto driving and adjusting mechanism.*
17,174 BOWER. Frictional ignition lighting devices.
17,176 SPENCER. Aerial searchlight.
17,185 FOSTER. Thermo-electric couple.
17,186 BUTTERFIELD & ASHWORTH. Extraction of tungsten from the ore.
17,191 HEINS. Magneto-electric ignition machine for internal-combustion engines. (22/1/15, U.S.)*
17,195 B.T.-H.Co. (Electric Controller & Mfg. Co., U.S.) Electro-magnetic switches. (Addition to 20,534 /11.)
17,216 AMMONS. Automatic fire alarm systems. (8/12/14, U.S.)*
17,217 AMMONS. Fire alarms. (21/1/15, U.S.)*

December 8, 1915.

17,228 KAWANAMI. Electric bomb-dropping air ships.
17,229 HEURTLEY. Telegraphy.
17,247 B.T.-H. Co. (G.E. Co., U.S.) Talking machines and driving mechanism therefor.
17,[illegible] [illegible] & [illegible]'s TELEGRAPH INSTRUMENTS SYND. Apparatus for reversing [illegible].
17,[illegible] [illegible] & [illegible] ELECTRIC Co. Means for effecting remote control of electrical apparatus.
17,268 MELLERSH-JACKSON. (E. T. Young, U.S.) Method of generating and controlling [illegible].*
17,275 [illegible] Portable electric lighting lamps and operating keys for the same [illegible].

December 9, 1915.

17,[illegible] [illegible] Electric [illegible].
17,313 [illegible] [illegible].
17,319 BELLING. Electric [illegible].*
17,321 [illegible] Switches [illegible].

December 10, 1915.

17,325 [illegible] Electric [illegible].
17,326 [illegible] Alternating [illegible].
17,333 [illegible] & [illegible] [illegible].
17,335 [illegible] Electric [illegible].
[illegible] & Electric Motors [illegible]. (17/12/15, Sweden.)*
17,[illegible] [illegible] & [illegible]'s Cable & [illegible] Co. Electrical signalling devices.

December 11, 1915.

17,[illegible] [illegible] Electric [illegible].
17,369 [illegible] [illegible].
17,374 [illegible] & [illegible] Trolley [illegible] for electric tramways.
17,[illegible] [illegible] & Holmes Telephone [illegible] systems.*
17,[illegible] [illegible] & Holmes [illegible].*
17,400 [illegible] & [illegible] [illegible].

December 13, 1915.

17,413 [illegible] [illegible].*
17,419 [illegible] Brushes for electric motors. (11/12/14, [illegible].)*
17,[illegible] [illegible] [illegible].
17,[illegible] [illegible] [illegible].

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

BRITISH COLUMBIA ELECTRIC RAILWAY CO.—At the meeting last week a statement by the chairman (Mr. R. M. Horne) Payne was read. It stated that British Columbia had suffered from the effects of the war very much more acutely than any other part of Canada. There had resulted a commercial paralysis which had produced so great a falling off in their receipts that it would probable it would not earn in the current year more than sufficient to pay its debenture interest. By cutting down capital expenditure to the utmost possible extent and enforcing the most rigid economy the company was now in a position to withstand even the present acutely bad times, although they would continue for several years. Unfortunately, as events had turned out, they had extended their tramway system and increased their equipment and power plants largely beyond the requirements of the business at present available, and had, therefore, for the time being, large amounts of capital unremuneratively employed. The ordinary effects of the commercial depression had been greatly accentuated by the advent of an extraordinary form of competition in the jitney 'bus. Since the commencement of the winter rains there had been a considerable and continuous reduction in the number of jitneys operating, particularly in Vancouver. It was expected that that reduction would at least continue during the remaining winter months. Their general manager was of opinon that they should not be troubled next summer with the jitney 'bus to the same extent as during the past summer. They had hitherto struggled to maintain a thoroughly efficient service throughout all the districts, but should the jitney competition continue on an extensive scale the company must cease to operate some of the outlying lines. At present the jitneys took the cream of the paying traffic in the more thickly populated centres, leaving the company to provide for the whole of the unremunerative business. The company's position was extremely disappointing, but it would right itself with the return of normal conditions.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LTD.)—The report for the past year states that it was impossible to maintain the service during the summer, but a large proportion of the season's expenses had been incurred when the steamer service to the island was reduced to one per day, and although economies were effected, the year's deficit was £1,188, against a profit of £565 in 1913-14 and £2,435 in 1912-13. The directors do not see any prospect of the next season being a profitable one, and they have reduced the expenses to the absolute minimum. They have made arrangements for financing the company, and they expect that it will pass safely through the crisis.

NEW COMPANIES AND RECEIVERSHIP.

NEW COMPANIES.

HAMPTON'S HEATING CO. (LTD.) (142,422)—Reg. Dec. 16, capital £3,000 in £1 shares, to carry on the business of heating, ventilating, mechanical, consulting, hydraulic and electrical engineers and contractors, electricians, tool makers, &c. Private company. First directors are E. Hampton (chairman) and R. M. Hampton (managing director). Secretary: H. E. Cox. Reg. office: 18, City-road, Cardiff.

A. & B. HANSON (LTD.) (142,512)—Reg. Dec. 23, capital £5,000 in £1 shares, to carry on the business of contractors, builders' merchants, electrical and gas engineers, &c. Private company. First directors are A. H. Boot (managing director) and R. M. Rowse (both permanent).

SWINDON ENGINEERING WORKS (LTD.) (142,443).—Reg Dec 17, capital £10,000 in £1 shares, to carry on the business of engineers, tool makers, metal workers, motor manufacturers, electricians, &c., and to adopt an agreement with G. A. Smith. Private company. First directors are G A. Smith and W. Denham.

TEMPLE BROS. (LTD.) (142,541).—Reg. Dec. 24, capital £1,000 in £1 shares, to carry on the business of electricians, electrical, mechanical, ventilating and general engineers, makers and repairers of and dealers in electrical and other fittings, telephones, indicators, fire alarms, lightning conductors, automatic time recorders, time switches, electrical, scientific and mathematical instruments, &c. Private company. First directors are: W. J. Stewart (Chairman) and J. Hamilton.

RECEIVERSHIP.

NAYLORGRAPH (LTD.)—Notice of appointment of G. H. Warmington, 33, St. Swithin's-lane, E.C., as receiver and manager on Dec. 21, 1915, under powers contained in debentures dated from Aug. 14, 1912, to Nov. 18, 1914, has been filed.

CITY NOTES.

MEMORANDA (Jan. 5).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 59. Consols Pay Day, Feb. 2. Stocks and Shares Ticket Days Jan. 12 and 26. Pay Days Jan. 13 and 27. Price of silver, 26⅝d.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) The interest on the 4 per cent. mortgage debenture stock for the half-year ending Jan. 31, due on the 1st prox., will be paid by warrant on Feb. 1 next. The 4 per cent. mortgage debenture stock register will be closed from the 27th to the 31st inst., inclusive.

UNDERGROUND RAILWAYS POOLING SCHEME.—An agreement for pooling and dividing surplus revenue has been entered into between the City & South London, the Central London, the London Electric and Metropolitan District Railway Companies and the London General Omnibus Co. The agreement provides that the surplus earnings of each of the contracting Companies, after payment of standing charges and due provision for depreciation and reserve, shall be paid into a common fund which shall be distributed in certain proportions.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Jan. 4. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues, Jan. 4.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 10 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅞	6 0 9	Feb. Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	82½	4 16 8	Jan, July
5	2/3	Do. 4½% Pref.	3 15/32	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	3⅞†	6 0 0	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	11⅜	7 11 7	Feb, Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St.	5%	Do. 5% Deb. St.	99½†	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98†	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	9⅝	6 0 9	Feb, Aug
St.	4½%	Do. 1st Deb.	90½†	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77	5 16 11	July
5	9%	Kensington and Knightsbridge Ord.	6 3/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	86	4 13 0	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75¼	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2¼	7 15 7	Mar, Aug.
St.	4½%	Do. 1st Mort. Deb.	80†	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99†	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/32	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 5/16	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 3/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80†	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 3/32	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	5	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3¾†	6 0 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80½	6 4 3	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70	5 14 3	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99¼	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	71⅞	5 11 4	May. Nov
St.	5%	Do. Pref. 18.6	80	6 5 0	Feb, Aug
10	⅝%	London Electric Ry. Ord.	1 3/16	4 0 0	Jan, July
St.	4%	Do. 4% Pref.	59½	6 14 5	Mar. Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24⅞	4 8 7	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82¼	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83¼	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16¼	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	85½	6 11 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	108½	5 10 7	Jan, July
St	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	73	5 9 7	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 1/16	..	..
1/0	..	Do. A Ord.	1/16	..	..
St.	6%	Do. 6% Inc. Debs.	104½	5 14 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price, Tues., Jan. 4.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	78⅜	7 12 1	Mar, Sept
..	4½%	Do. 4½% Bds.	100¼†	4 19 4	Jan, July
5	..	Yorkshire W. Riding Ord.	⅜	..	March
5	6%	Do. Pref.	4⅛	6 19 6	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅞	5 14 10	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	4 7 11	Mar
100	5%	Do. Prior Lien Debs.	90¼†	5 10 2	Jan, July
1	6%	Do. 6% Pref.	⅜	7 2 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 2 5	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5	6 0 0	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2	7 10 0	April
100	6%	Do. 6% Prior Lien Debs.	101	5 18 10	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅜	6 12 7	Jan, July
5	2/6	Do. 5% Pref.	4⅜†	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98†	4 11 10	Jun, Dec
1	20%	Castner Kellner	3⅛	6 9 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	3⅛	9 2 10	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅞	..	Feb, Aug
St.	4%	Do. 4% Deb.	62½	6 8 6	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	⅜	7 4 6	Jan, July
St.	4%	Do. 4% Debs	72½	5 10 4	Jan, July
..	10%	General Electric Ord.	10⅛	9 11 1	July
10	6%	Do. 6% Pref.	9⅛	6 3 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅜†	10 17 8	Feb, Aug
10	5%	Do. Pref.	7½†	6 13 4	Apl, Oct
100	4%	Do. 4% Debs.	99⅛	4 0 8	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34½	6 18 2	Mar, July
100	4%	Do. 4½% Debs.	93†	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	83	4 16 5	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99½	4 10 3	Jun, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100⅜	5 19 1	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23⅛	6 9 9	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69½†	5 15 0	Ja.Ap,Jly,O
10	5%	Cuba Submarine Ord.	⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	6⅛	6 9 4	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	128½	5 8 11	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	co	5 7 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81½	4 18 2	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	79½	5 0 11	Feb, Aug
10	7%	Do. Ord.	12⅜	5 12 7	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. ex Coup. 8	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	48⅜	6 13 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜†	5 10 4	April
1	7%	Do. 7% Pref.	1⅜†	4 7 10	July
10	1%	West India & Panama Ord.	1⅛	9 2 10	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 5	May, Nov
10	7%	Western Telegh. Co.	12½	5 12 0	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79†	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99⅛	4 10 8	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	134½†	5 18 9	Ja,Ap, Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	7½†	6 14 3	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	100⅜	4 9 8	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79†	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	85†	5 5 11	Jan, July
5	8%	United River Plate Ord.	5⅛	6 16 2	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜†	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90†	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10⅛	5 15 8	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10⅛	5 19 3	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80⅝	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	67⅛	5 14 5	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	8⅜	6 4 1	Jun, Dec
St.	4½%	Do. 4½% Debs	77½†	5 15 6	Jan, July
St.	4%	Do. 4% Debs.	72⅛†	5 10 4	Jan, July
5	5½%	Do. 5½% 1st Pref.	3⅝†	6 19 8	Jan, July
5	5½%	Do. 5½% 2nd Pref.	3⅜†	8 0 0	Jan, July
100	2%	Brazilian Traction Ord.	5⅛	7 14 5	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	91⅛	6 11 9	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 14 3	May
5	2/6	Do. 5% Cum. Pref.	4⅛	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64	6 12 1	..
5	9½%	Calcutta Elec. Trams. Ord.	9⅛	8 1 8	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	91	5 9 11	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅜	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69	7 4 11	Jan, July
..	..	Mexico Trams Common St.	4⅜	..	Fb,M,Aug,N.
..	5%	Do. 5% Bds	44½	10 11 3	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94½	4 15 6	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 5) yr. Bds	78	6 5 4	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅜	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	95	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10⅜	5 19 3	..
St.	4½%	Do. 4½% Debs	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6	7 10 0	May, Nov
5	5%	Do. 5% Pref	4⅛	5 17 8	May, Nov
..	7%	Canadian Gen. Elec. Common St	117½†	5 18 11	Ja,Apl,Jly,O
St.	5%	Melbourn eElec. Supply 5% 1st Mt. Debs	94†	5 1 10	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	90⅛	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29⅛	..	Ja,Apl,Jly,O
..	..	Do. Pref.	39⅛	..	May, Nov
..	5%	Do. 5% Bds.	47⅛	10 11 5	Jan, July
81½	5%	Shawinigan Water & Power 5% Bds.	103½†	4 16 3	Jan, July
..	6%	Do. Cap. Stock	140†	4 5 9	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96⅝	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	80½	5 12 0	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	1⅛	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	91½†	5 19 11	Jan, July

* And 13½% Bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Jan. 4, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	14½d.
Solid Drawn Copper Tubes	14½d.
Brazed Copper Tubes	14½d.
Brazed Brass Tubes	16½d.
Brass Wire	14½d.
Copper Wire	13½d.
Rolled Brass	14½d.
Brass Sheets	14⅝d.

	per ton.
Copper Sheets	£119 0 0
Spelter	£83 0 0
English Lead	£31 0 0
Antimony	Nominal.

Old Metals:	per ton.
Clean Scrap Copper	£79 0 0
Brazlery Copper Scrap	£72 0 0
Clean Scrap Brass	£50 0 0
Old Lead	£24 10 0
Old Zinc	£55 10 0
Hollow Pewter	£115 0 0
Black Pewter	£75 0 0
Gun Metal	£68 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Jan. 4, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£125 0 0
Clean Mixed Brass	£61 0 0
Clean Copper	£77 0 0
Brazlery Copper	£71 0 0
Gun Metal	£70 0 0
Old Lead	£25 0 0
Tea Lead	£23 0 0
Old Zinc	£60 0 0
Hollow Pewter	£115 0 0
Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Dec. 29	1.902	+ 314	30	34.645	+ 3,211
Anglo-Argentine	,, 31	60,549	+ 2,451	52	2,667,728	— 131,099
Ashton-under-Lyne	,, 25	448	+ 4	39	18,607	+ 1,343
Ayr Corporation	Jan. 1	269	+ 21	33	13.057	+ 732
Birkenhead Corporation	,, 2	1.432	+ 169	40	54.636	+ 4,452
Birmingham Corporation. Trams	Dec. 24	14,525	+ 1,945	39	550,504	+ 78.449
Birmingham Corporation. Buses&c.	,, 24	755	+ 124	39	32,649	+ 18,274
Blackburn Corporation	,, 29	1,232	— 49	40	50.800	— 289
Blackpool Corporation	,, 30	891	+ 60	40	68,986	+ 1,874
Blackpool and Fleetwood	Jan. 1	414	— 17	52	38,964	— 320
Bolton Corporation	.. 2	3.040	— 130	40§	107.049	— 1,673
Bournemouth Trams	Dec. 29	2,029	+ 166	39	82,829	— 3,969
Bournemouth Buses	,, 29	9	— 3	39	925	— 94
Bradford Corporation	,, 25	6,045	— 213	38	251,258	+ 10,165
Brighton Corporation	Jan. 2	990	+ 109	40§	41.899	+ 488
Bristol Trams Trams	Dec. 31	5,883	+ 964	52	7,251	+ 2,045
Bristol Trams Buses,&c.	..	..	..	..	..	..
Burmah E. Trams & Ltg.	Jan. 1	R3.222	+ R171	..	..	..
Burnley Corporation	,, 1	1,779	+ 296	13	31,043	+ 2,478
Burton Corporation	,, 1	365	+ 54	40	11,378	— 349
Bury Corporation	.. 2	1.368	+ 93	40§	53.893	— 297
Calcutta Tramways Co.	,, 1	R66.731	+ R5,983	..	..	..
Camborne-Redruth	Dec. 25	147	— 8	50	7,046	+ 84
Cardiff Corporation	.. 25	2.768	+ 92	38	104.120	— 2.478
Cork Electric Trams Co.	,, 30	558	+ 152	52	26,025	+ 143
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	Jan. 4	1,244	+ 184	39§	41,750	+ 1,470
Dover Corporation	Dec. 25	256	+ 18	38	12,115	+ 2,142
Dublin & Lucan Railway	,, 31	276	— 7	26	3,868	+ 59
Dublin United	..	..	..	..	..	..
Dundee Corporation	,, 29	1,399	+ 134	33§	44,522	+ 2.431
East Ham Council	Jan. 1	1,309	+ 133	39	51,629	+ 5,527
Exeter Corporation	Dec. 31	323	— 54	39	14,970	+ 791
Glasgow Corporation	Jan. 1	2,784	+ 927	31‡	669,114	+ 42,712
Glossop Trams	,, 1	144	+ 32	1	144	+ 32
Gloucester Corpn.	Dec. 29	344	+ 25	39	13,062	+ 132
Halifax Corpn. Trams	,, 28	2,181	— 202	39	87.281	+ 705
Halifax Corpn. Buses	,, 28	50	— 6	39	1,920	— 13
Hastings Elec. Trams Co.	,, 31	1.064	+ 108	52	89.729	— 212
Huddersfield Corpn.	Jan. 1	2.642	+ 168	39	14,509	+ 14.509
Hull Corporation	,, 1	3.421	+ 154	39	121.743	— 2.148
Ilford District Council	,, 1	685	+ 9	39	25.690	+ 2.939
Ilkeston Corporation	..	..	..	..	..	..
Ipswich Corporation	.. 1	548	+ 114	38	21.812	+ 3.520
Isle of Thanet Co.	,, 1	292	— 3	13*	3.451	— 965
Kilmarnock Corporation	,, 1	197	— 7	33	5.587	— 164
Lanarkshire Trams Co.	Dec. 31	2.973	— 647	52	103.421	— 6 714
Lancashire United	,, 29	1.805	+ 144	52	89,680	+ 5.3[illegible]
Leeds Corporation	Jan. 1	9.515	+ 1.024	40	355.476	+ 27 14[illegible]
Leicester Corporation	.. 1	3.651	+ 505	1	3.651	+ 505
Leith Corporation	,, 1	82[illegible]	+ 98	33	25.468	+ 1,675
Lincoln Corporation	,, 1	171	+ 29	40	5.624	+ 644
Liverpool Corporation	,, 1	13.836	+ 960	..	..	..
Llandudno&ColwynBayR.	Dec. 31	189	— 10	4	817	— 30
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	.. [illegible]
Maidstone Corporation	..	..	..	..	..	..
Manchester Corporation	Jan. 1	17,417	+ 285	39	706.736	+ 22.518
Nelson Corporation	,, 1	223	+ 71	39[illegible]	7.750	+ 3[illegible]
Newcastle-on-Tyne Corpn.	,, 1	5 424	..	40	247.178	..
Newport (Mon.) Corpn.	,, 1	[illegible]	+ 164	40	33.403	+ [illegible]
Northampton Corporation	Dec. 31	[illegible]	+ [illegible]	39[illegible]	25.717	+ 4.94[illegible]
Nottingham Corporation	.. 30	3.745	+ 783	39	140.[illegible]	+ 10.[illegible]
Oldham Corporation	Jan. 2	2.282	+ 214	41	[illegible]	+ 3,854
Portsmouth Corporation	Dec. 25	1.[illegible]	+ 89	39	[illegible]	..
Preston Corporation	,, 29	1.023	+ 1[illegible]	39**	38.[illegible]	+ 1 [illegible]
Rochdale	Jan. 1	1.747	+ 2[illegible]	40¶	[illegible]	+ 3.040
Rotherham Corporation	Dec. 29	1.306	+ 87	39	45.876	+ 5.445
Salford Corporation	Jan. 3	5.287	+ 245	40‡	207.074	+ 8.182
Sheffield Corporation	,, 2	9.445	+ 1.048	39	3[illegible]	+ 4[illegible]
Southampton Corpn.	Dec. 29	1,483	+ 303	39	59.133	+ 6.582
Southend Corporation	,, 29	651	+ [illegible]	39	32.629	— 7.958
South Shields	,, 25	[illegible]	+ 33	39	30.792	+ 1.230
St'lyb'dge,Hyde,&c., Jt. B.	..	..	..	..	..	..
Sunderland Corporation	Jan. 2	1,697	+ 158	40	60.035	+ 897
Sunderland District	Dec. 29	683	+ 50	9	4.987	+ 321
Swindon Corporation	..	..	..	..	..	..
Tyneside Tram Co.	.. 29	505	— [illegible]	25	14.925	— [illegible]
Walsall Corporation	Jan. 1	1.[illegible]	+ 1[illegible]	39§	[illegible]	+ [illegible]
Wandsworth Corporation	..	..	..	..	..	..
Wanstead	.. 1	[illegible]	+ 87	40	35.769	+ 3.485
Warrington Corporation	Dec. 30	[illegible]	+ 1[illegible]	39	18.097	+ [illegible]
West Ham Corporation	,, 30	3.070	+ 4[illegible]	39	121.905	+ 10.522
Wigan Corporation	..	..	..	..	..	..
Wolverhampton Corpn.	.. 29	1.373	+ 21[illegible]	13	14.[illegible]	+ 1.323
Yorkshire W.R. Trams	Jan. 2	1.[illegible]	+ [illegible]	1	1.[illegible]	+ [illegible]

(a) T[illegible] * Partly electrical. [illegible] & ‡ Many 3 days. § Many 3 days. ¶ Plus 3 days. [illegible] ** [illegible]

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CONTENTS OF THE CURRENT NUMBER.

NOTES	517	Notes on the Ignition of Explosive Gas Mixtures by Electric Sparks. By J. D. Morgan. Illustrated	536
Arrangements for the Week	520	The Design of High-Pressure Distributing Systems	538
Electrical Railways. By H. M. Hobart. Illus.—*Concluded*	521	CORRESPONDENCE	540
The Double Dynamometer Wattmeter. By C. V. Drysdale, D.Sc. Illustrated	523	The Wiring of Artisans' Dwellings (James Cleary).	
Electrification of the Manchester to Bury Section of the Lancashire & Yorkshire Railway. Illustrated	526	The Electric Locomotive. By Frederick William Carter, M.A., Assoc.M.Inst.C.E.	540
The Predetermination of the Performance of Dynamo-Electric Machinery. By Prof. Miles Walker. Illus.	531	LEGAL INTELLIGENCE	541
ELECTRIC LIGHTING, TELEGRAPHY AND OTHER APPLICATIONS OF ELECTRICITY IN 1915	534	PARLIAMENTARY INTELLIGENCE	542
		Educational Notes	542
		The "Electrician" Commercial and Industrial Section	543–550

NOTES.

Street Switch Boxes.

THE inquest has now been held on the two victims of a fatal accident which occurred recently at Eastbourne. As far as we are aware this accident is unique. For some reason or other the motor car swerved and dashed into a cast-iron switch box, such as is commonly used on electricity supply systems. The box was demolished and the metal work of the car appears to have come against the high-tension switchgear or cables. The unfortunate victims attempted to move the car back and were promptly killed, and several other men were burnt through attempting to pull the car back by means of a steel rope. Something has been made of the "mysterious" character of the accident by writers in the daily press. There was, however, nothing mysterious about it. A motor car on a dry road is well insulated from earth by means of the rubber tyres, and, consequently, any persons trying to move the car when standing on the street surface must inevitably receive shocks if the metal work of the car is in contact with the high-tension switchgear. If only an ordinary rope, instead of a steel rope, had been used, some of the casualties would have been prevented. The moral of the accident seems to be that switch boxes should be placed farther back from the edge of the street, preferably on the far side of the footway. There are well-known reasons against using underground boxes, and it is practically impossible to provide against accidents from a motor car not kept under control.

Committees and Higher Technical Education.

LAST week the Derby Education Committee succeeded in making itself ridiculous by deciding in the interests of economy to dispense with the services of an able lecturer in receipt of the beggarly wage of £3 a week, or £165 a year to be precise. The man referred to, apparently with some success, had engaged in outside work, and at the meeting of the Town Council it was stated that this had come as a surprise to the Education Committee. Broadly interpreted, the conditions of employment at Derby are that the men employed by the Committee should devote the whole of their time to college work. At the Council meeting wisdom prevailed over folly by the narrow margin of one vote Were such conditions peculiar to Derby the matter would not call for any comment, but, to our discredit, with relatively few exceptions such conditions prevail in the technical colleges and schools throughout the country. At Derby the question arose as to how far the researches to which exception was taken had been made in the technical college. We can well understand that such questions will arise as long as Education Committees are composed largely of men ignorant of the meaning and purpose of higher technical education. Even in London the restrictions imposed by the London County Council are such that many good men find it impossible to accept service under the Council. Most of the colleges affirm that research by the staffs of the colleges is encouraged so long as the interests of the students do not suffer. As an indication of the encouragement given we need only mention that senior members of the staff are expected to teach from 25 to 30 hours per week. To this must be added the time required for preparation, for the marking of students' homework, and for the general work of the department. The attitude of many members of Education Committees towards lecturers and teachers who serve under them is tyrannical, and it is not a matter for surprise that when live men accept appointments, they quickly rebel against conditions not only highly detrimental to their interests, but to higher education generally. We hope that the example of the Derby Town Council will be emulated in all towns where Education Committees endeavour to exercise an authority which they either do not or should not possess.

Measurement of Power.

IT is doubtful whether any electric measuring instrument has been subjected to more hostile criticism in the past than the wattmeter, and few instruments are of greater practical importance. Of the several types of indicating wattmeter available, the dynamometer type stands alone as a convenient precision instrument of robust construction, equally suitable for laboratory and test-room purposes. The sources of error of the dynamometer wattmeter are now fairly well known, and, in the majority of cases, it has been a relatively easy matter for instrument makers to render these errors negligibly small. In the official report of the Frankfort Exhibition (1891), Prof. H. F. WEBER showed that with non-sinusoidal terminal pressures the instrument reading had to be multiplied by two correcting factors in order to obtain the true watts. The first of these, namely $(1+\tan^2\varphi')\div(1+\tan\varphi\tan\varphi')$ is the one in general use, and the second is always greater than unity, but even for very distorted wave shapes is only about 1·0001, and can therefore be always put equal to 1. The principles under-

lying the construction of a satisfactory dynamometer wattmeter were laid down by Dr. C. V. DRYSDALE in these columns 15 years ago, and an instrument constructed according to these principles was described. The theory of the instrument was given in an original communication to the "Journal" of the Institution of Electrical Engineers in 1910, and it was shown that a wattmeter which is free from eddy currents, and in which the resistance exceeds 1,000 Ω per millihenry of equivalent shunt inductance, will never have an error of more than 0·001 in the power factor under practical conditions, except when testing condensers with very irregular wave-forms.

ELSEWHERE in this issue is to be found the first part of a well-illustrated article in which Dr. DRYSDALE deals with the construction and application of the double-wattmeter bearing his name. The tests described serve to give an idea of the utility of the instrument, and the results are highly creditable both to Dr. DRYSDALE and to Mr. H. TINSLEY, the maker of the instrument. All users of the dynamometer-type wattmeter must, at one time or another, have been exasperated by the narrowness of the range of a given instrument. As a rule, pivot instruments have one range, or at the most two current ranges, and we should like to see the number of ranges increased as in the "Drysdale" wattmeter, so as to cover, at reasonable cost, all the currents likely to be encountered in the test room. The double-wattmeter is to commercial testing what the alternating-current potentiometer is to scientific testing, namely, a laboratory equipment in itself. Such instruments along with others which have been, and which are being, developed by our manufacturers, will go a long way towards making us independent of foreign firms for the supply of reliable instruments of precision. The example set by Dr. DRYSDALE in "giving away" so much information is one which, we venture to suggest, should be generally followed in the description of instruments, machinery and apparatus.

Preventing Freezing.—In a recent issue of the "Motor" there is an illustration of a "freeze up" preventing device. A 4 c.p. carbon filament lamp is inserted in the radiator tank and supplied from the car-lighting circuit. It produces just enough heat to keep the cooling water in circulation.

High Load Factor.—In the contract between the New Haven Railroad and the New York Edison Co. and the United Electric Light & Power Co., the "Electric Railway Journal" of New York mentions that the West Farm Sub-station draws a minimum load factor of 70 per cent. In return the railway gets its power at a low rate.

Norwegian Water Power.—According to the "Electric Railway Journal" of New York, the Royal Commission of Norway has prepared a remarkably complete report on the whole question of Norway's supply of energy. The Commission recommends that the large waterfalls which the State owns in Northern Norway may be early dealt with.

Technical Education The War and After.—At the recent meeting of the Association of Teachers in Technical Institutions Prof. Barker North read a Paper on the above subject. He drew attention to the enormous strides made by Germany during the last 33 years in the pig-iron, cloth and dyeing industry. Several speakers in the discussion favoured compulsory technical training for workpeople.

A Growing Tyneside Industry. The Shipbuilding and Engineering Supplement of the "Liverpool Journal of Commerce" recently referred to the growing lamp-bulb industry at Leamington on Tyne. At present the average weekly output is 300,000 bulbs of various sizes and patterns. The firm has over 300 bulbs on its list. They also manufacture about 2 tons weekly of glass tubes for tungsten filament lamps.

Centenary of the Safety Lamp.—Miners in the North have been celebrating on January 10th the centenary of the Davy lamp. Sir Humphry Davy devoted his attention to this matter after an explosion in May, 1812, which killed some 92 miners. The original lamp is in the Geological Museum, Jermyn-street, S.W.

Mitigating Electrolysis.—In a Paper issued by the American Bureau of Standards methods of dealing with electrolysis of pipes and railway return systems are dealt with. The conclusion is drawn that return feeders should be insulated, and the chief reliance should be placed on reducing the potential drops as low as possible.

Midget Electric Drilling Machine.—The "American Machinist" refers to small electric drills made by the Standard Electric Tool Co., Cincinnati, Ohio. They are made in three sizes, viz., $\frac{3}{16}$ in., $\frac{1}{4}$ in. and $\frac{5}{16}$ in. The first two sizes are fitted with three-jaw geared chucks, and the last one with a two-jaw screw chuck. They weigh 6 lb., 7 lb. and 8 lb. respectively.

British Telegraphy.—The length of telegraph line worked by the Post Office in 1913-14 was 81,000 miles, the total being made up as follows: Overhead lines, 68,452 miles; underground lines, 9,072 miles; submarine lines, 3,476 miles. The length of wire comprised in the lines thus worked was 2,886,025 miles—viz., overhead wire, 947,392 miles; underground wire, 1,926,743 miles; and submarine wire, 11,890 miles.

Sound Carrying.—The Sheffield "Daily Telegraph" mentions in a recent article that the Commercial Wireless & Development Co., San Francisco, own patents of the "Magnavox" instrument. This instrument weighs about 15 lb., and is worked electrically. Four miles is the distance to which it has carried the human voice so far. It is the invention of Mr. P. A. Jensen, of Copenhagen, and Mr. E. S. Pridham.

Pumping Work at Panama.—The "Canal Record" states that the pumping equipment for the new dry dock at Balboa will consist of four 54 in. main centrifugal pumps, a 3 in. bilge pump and two high-pressure pumps. The latter furnish water at 300 lb. per square inch for operating the main and drainage pump valves. The pumps are all motor-driven, and the motor-switching arrangements and wiring are to be erected in a building over the pump well.

The "Simpson Light."—Writing in the "Lancet" Drs. Harmer and Cumberbatch, of St. Bartholomew's Hospital, refer to the rays produced, and the therapeutic effects they have obtained from the "Simpson" lamp. This lamp uses as electrodes a mixture of the ores of tungstate of iron and wolfram and produces rays having a more intense ultra violet than the Finsen arc. They think it may be useful in cases of disease of the throat and nose.

Electric Vehicles.—Mr. F. Ayton, M.I.E.E., writing in the "Standard" recently, points out that electric vehicles for use in town delivery work are at least 25 per cent. cheaper to run than petrol vehicles, besides being simpler and more reliable. He states that as a result of the Electric Vehicle Committee's efforts a uniform tariff of 1d. per unit is now charged by the majority of electrical undertakings for charging the storage batteries of the vehicles.

Mobile Searchlight.—"Motor Traction" in a recent issue, refers to an interesting searchlight outfit. The generating plant is carried on a 2-ton motor lorry, and is separately driven by a two-cylinder engine of 4·75 in. bore by 4·5 in. stroke. This is coupled direct to a Westinghouse dynamo which develops 56 amperes, 125 volts at 1,200 revs. per min., and has a centrifugal governor for close regulation. There are two searchlights 14 in. in diameter and 5,000 c.p. and cables enable them to be operated $\frac{1}{4}$ mile from the generator.

Education after the War.—According to "The Times," Sir O. Lodge, at the annual conference of Educational Associations referred to certain perils which during a long era of peace had been overlooked. Germany had set up a soulless *ad hoc* preparation for business, concentration on a material ideal, and elevated this into the region of worship and sentiment.

In our country the neglect of intellectual things, the widespread ignorance of natural facts, even amongst our leaders, and concentration of a passive kind of material prosperity, was another danger.

Johannesburg Electric Supply System.—An interesting Paper was read by Prof. J. H. Dobson, M.Sc., recently before the South African Institution of Electrical Engineers, in which he dealt with the early history and expansion of this system. From 1904 till the end of 1914 the population of Johannesburg has increased from 160,331 to 253,274, and the units consumed in 1909 were 11,316,874, compared with 24,943,859 in 1914. During the same period the maximum load has increased from 5,400 kw. to 10,900 kw.

Saving of Fuel.—Dr. Dugald Clerk in a recent Paper entitled "The World's Supplies of Fuel and Motive," read at the Society of Arts, gave some interesting figures. Factories consume 45 million tons of coal per annum, domestic purposes 36 million, blast furnaces 18 million, railways 14 million and steamships 8 million. While a saving of about 66 per cent. can be effected in factories by using gas generators and engines, only about 22 per cent. can be saved in the domestic consumption by using gas for cooking and heating and briquettes and coke.

Report-Writing for Engineering Students.—It is well known that students and young engineers are often lamentably weak in the writing of concise reports. We are therefore glad to see that the Massachusetts Institute of Technology is dealing with this question in its curriculum. The course includes practical investigations of subjects of engineering interest, such as the practicability of establishing a dye manufacturing plant, the feasibility of starting an auto-truck sight-seeing enterprise, and the wisdom of equipping the new buildings of the Institute at Cambridge with an electrically-operated blue printing outfit. Presumably the reports are made as the result of individual investigations.

Professional Organisation.—A course of 10 lectures under above heading will be given at the London School of Economics and Political Science, Clare Market, Kingsway, W.C., by Mrs. Sidney Webb, D.Litt., and Mr. F. H. Hayward, D.Litt, M.A., B.Sc. The lectures will be at 6 p.m. and the fee for the course is 12s. 6d.

Six lectures will be given by Mrs. Webb on "The Sphere of Vocational Organisation in the Control and Direction of Industries and Services," beginning January 17th. Dr. Hayward will give four lectures on "The Principles and Practice of Professional Organisations, with Special Application to the Present Position and Prospects of the Teaching Profession in England and Wales," beginning February 28th.

Two Flywheel Breakdowns.—Under this heading there is an article in "Vulcan" dealing with a breakdown to a spur-wheel and a flywheel. In the former the wheel had a diameter of 17 ft. with teeth 4 in. pitch by $13\frac{3}{4}$ in. broad. It had 10 spigoted arms cottered into a solid boss, and the speed of the teeth was 34·25 ft. per second. The wheel was built in 1866, and had run ever since. The second was a flywheel on an horizontal tandem steam engine of 385 I.H.P. The flywheel was 20 ft. in diameter, built up by a disc boss, eight arms and eight weight segments. Its rim speed was 43·3 ft. per second. In December, 1911, two arms gave way, and finally in October, 1915, it collapsed. The illustrations are interesting.

Government Production of Nitrates in U.S.A.—The establishment of a Government plant to make nitric acid out of the air for use in manufacturing smokeless powder, in case the supply of nitrates, which now comes entirely from Chile, should be cut off by war, has been recommended to the U.S.A. Government in a report by the Naval Consulting Board. Dr. L. H. Baekeland, chairman of the Committee on Ordnance and Explosives, said that unless this country had such a plant all of the preparedness in the way of big guns could be speedily rendered useless by an enemy able to seize the Chilean ports or to interfere with ocean traffic between this counrty and Chile. The plan is that the Government shall take possession of water-power somewhere in the interior, inaccessible to an invading enemy, and there erect a plant to make nitric acid from the air and experiment in order to obtain the best and cheapest methods. Since nitrate cannot be taken from the air at an expense small enough to make it a profitable enterprise, it is absolutely necessary, according to Dr. Baekeland, that the United States Government should undertake to develop it. The United States is almost entirely self-dependent as far as munitions are concerned, with the exception of nitrates.

Comparative Installation Costs.—The following is taken from a Paper entitled "Modernisation of Power Plant in Factories," read by Mr. W. A. Tookey before the Junior Institution of Engineers recently: As regards the relative first costs, it is difficult to do more than to approximately indicate these, as so much depends upon local circumstances appertaining to the site and the amount of piping, cabling, &c., that may be required. As a very rough guide, the accompanying chart has been prepared, and from this it will be seen that, for true comparisons, the interest upon the additional capital involved

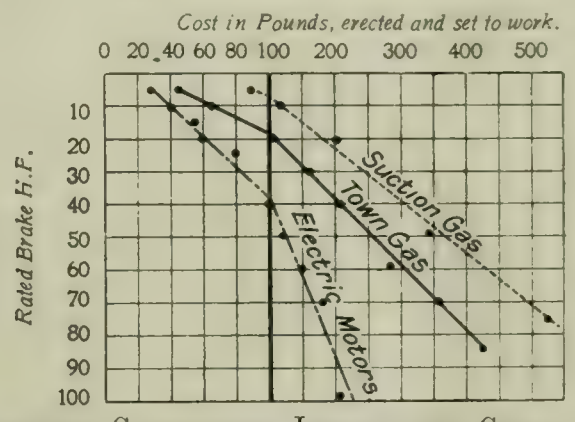


CHART SHOWING COMPARATIVE INSTALLATION COSTS OF TOWN GAS, SUCTION GAS AND ELECTRICITY POWER PLANTS.

in the case of gas engines should be set off in favour of the electric motor. Take a 20 H.P. machine, for example. The chart shows that while a motor fixed would cost about £60, a gas engine of equal output would cost nearly double, and a suction-gas engine and producer about $3\frac{1}{2}$ times as much. The town gas engine should, therefore, be debited with £6 per annum as additional standing charges to cover higher depreciation and interest, while the suction-gas plant should be debited with an additional £15 for the same reason.

Institute of Industry.—The luncheon given by this Institution on the 12th inst. was followed by a discussion on the new national business policy inaugurated by the Institute. The discussion was opened by Mr. J. Taylor Peddie, who was introduced by the chairman (Mr. F. J. Nettleford). Mr. Peddie read a Paper on the "National Economics of Political Economy," and dealt at some length with the objects of the Institute of Industry, which was (he said), in reality, a British economic league, the purpose of which was to do for the industry of this country what the "Hansa Bund" had done for German industrial activity. The next speaker was Sir Edward Carson, who, though disclaiming an intimate knowledge of business, delivered a rousing address, which was evidently much appreciated by the many leading business men present at the luncheon.

Sir EDWARD CARSON advised them to watch carefully for symptoms of peace, and above all to guard against a premature peace. He advocated the abolition of party cries and a rational recasting of our sources of revenue to meet the greatly increased debt. In his opinion they should at once get rid of the distinction between classes and masses, and just as the nation had fought battles, so should they fight industry. He further urged the giving to all of a maximum, not a minimum. In conclusion he uttered a word of caution concerning State interference or control, and suggested the State's support instead.

Lord BALFOUR OF BURLEIGH strongly opposed abstract principles and advocated the enlistment of the services of leaders of organised labour.

Lord CHARLES BERESFORD supported the idea of the formation of a Ministry of Industry, and recommended them to foster individual industry and enterprise.

In moving the following resolution, Sir CLIFFORD CORY emphasised the importance of research and of technical education on the development of industry. The motion, which was carried unanimously, was as follows:

"That this meeting of manufacturers and other representative men

closely connected with all phases of industrial activity in the British Empire fully endorses and approves of the objects and policy of the Institute of Industry (of Great Britain and Ireland), Ltd., and recommends all persons or companies interested in the industrial life of the British Empire to support the Institute by becoming members."

OBITUARY.

W. R. Cassels.—We learn from the "Review of the River Plate" that Mr. W. R. Cassels, the founder of the firm of W. R. Cassels & Co., electrical engineers, of Buenos Ayres, died at Buenos Ayres on Dec. 10. Mr. Cassels first went to South America in 1870 and established a successful business at Rio de Janeiro which is still flourishing in the hands of his successors. Ten years later he went to Buenos Ayres and founded the firm now known as Cassels & Co. He was also one of the founders of the River Plate Electricity Co. and the Rosario Electric Light Co. Recently his youngest son was killed in action in France, and his son-in-law, Mr. H. L. Harris, has also died of wounds.

Killed in Action.—The death is announced of Sec.-Lieutenant Wilfred C. Hunter, R.G.A., who was recently killed in France. The deceased officer was the third son of Ald. T. Hunter, Rugby, and was one of five brothers, four of whom joined the Army when war broke out and obtained commissions. He was 25 years of age, was educated at Rugby School, and afterwards became secretary to the Rugby Lamp Co. (Ltd.).

Capt. A. C. Whitaker was killed in France on Dec. 31. He studied mechanical engineering in Owens College, Manchester, and afterwards entered the service of Messrs. Crossley Bros. He went to South America where he was in charge of the erection of that firm's power stations. Returning to this country in 1914 he enlisted and was afterwards given a commission.

Corporal Duncan J. Cameron, Royal Engineers, who was serving with the Mediterranean Expeditionary Force, has been killed. He was educated at Heriot-Watt College, Edinburgh, and had served his apprenticeship as mechanical and electrical engineer.

PERSONAL.

Mr. C. W. Shepherd, who has been manager of the Edinburgh & District Tramway Co. for the past 13 years, has resigned, but he will continue in the service of the company as secretary. Mr. J. R. R. Cox succeeds Mr. Shepherd as general manager and engineer.

Royal Engineers (T.F.).—The following changes have been made:
London Electrical Engineers.—Capt. C. H. R. Thorn is restored to the establishment.
Wessex Divisional Engineers.—Lance-Corporal B. S. Orme (from Electric Lights Company, Cornwall Fortress Engineers) to be Second Lieutenant.

APPOINTMENTS VACANT AND FILLED.

The Council of the Indian Institute of Science invite applications for the post of assistant professor of electrical technology. Salary, 625 rupees per mensem, with a house. Further information from Messrs. Jeremiah Lyon & Co., 4, Lombard court, London, E.C., and applications must be sent to the Director of the Indian Institute of Science, Bangalore, India, by Feb. 15. *See also an advertisement.*

The Council of the Metropolitan borough of Southwark invite applications for the position of charge engineer at their electric supply station (salary £3 per week); also a junior engineer (salary £2 per week). Applications to the town clerk (Mr. P. H. Gray), Walworth-road, S.E., by Jan. 24. *See an advertisement.*

Messrs J. G. White & Co. (Operating Department), 9, Cloak lane, London, E.C., advertise for a resident engineer for combined tramway, light and power property in the tropics.

A manager of a London electric supply company is advertised for in another column.

A firm of switchgear manufacturers advertise for a foreman.

Shift engineers, station fitters and wiremen are required at camps near Salisbury. Applications to Chief Engineer, Southern Command, Radnor House, Salisbury.

A shift engineer is required at Walsall Corporation's electricity works. Applications to the Engineer and Manager by Jan. 27.

The Borough of Swindon Education Committee invite applications for the permanent appointment of head of the engineering department of the technical institution. Commencing salary £200 per annum, rising by increments of £10 to £250. Further particulars from the Principal, to whom immediate application should be made, at the Technical Institution, Swindon.

Applications are invited for the position of shift engineer at the Chester-street generating station, Aston Manor, Birmingham. Commencing salary £130, increasing to £200 per annum. Applications to the city electrical engineer, Mr. R. A. Chattock, 14, Dale End, Birmingham, by Monday, 17th inst.

Prof. W. H. Perkin has been appointed head of the research department and chairman of the Advisory Council of British Dyes (Ltd.) in place of the late Prof. R. Meldola.

Mr. R. M. Bailey, resident engineer of Summer-lane station, Birmingham, has been transferred to the Nechells station, and Mr. R. P. Boulton has been promoted to the position of resident engineer at Summer-lane.

Mr. G. W. J. Praat, traffic superintendent, Bournemouth telephone district, has been appointed superintendent of telegraph and telephone traffic in Ceylon.

Mr. W. Towers, of Stirling, has been appointed superintendent of the Admiralty power station at Rosyth.

Mr. A. M. Duckham, of the Munitions Inventions Department of the Ministry of Munitions has been appointed Deputy Director-General of Munitions Supply.

Mr. H. C. Babb, chief assistant engineer at Hawick, has been appointed engineer and manager of the Bo'ness electricity works.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, Jan. 15th.

Birmingham and District Electric Club.

7 p.m. Meeting at Swan Hotel, New-street, Birmingham. Paper by M. A. Johnson on "The Manufacture and Performance of Electric Incandescent Lamps."

WEDNESDAY, Jan. 19th.

Nottingham Society of Engineers.

7:30 p.m. Meeting at the Welbeck Hotel, Milton-street. Paper on "The Use of Electricity in the Conveyance of Coal from the Working Face to the Pithead," by Mr. R. A. Sheldon.

THURSDAY, Jan. 20th

Institution of Electrical Engineers.

8 p.m. Meeting at Victoria Embankment, W.C. Paper by Mr. H. H. Harrison on "The Principles of Modern Printing Telegraphy."

FRIDAY, Jan. 21st.

Royal Institution.

5:30 p.m. At Albemarle-street, Piccadilly, W., lecture on "Problems in Capillarity," by Prof. Sir James Dewar, M.A., LL.D., D.Sc., F.R.S.

Institution of Mechanical Engineers.

6 p.m. Meeting at the Institution, Great George-street, S.W. Paper on "The Flow of Air through Nozzles," by Capt. Thomas B. Morley, B.Sc.

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Colonel C. B. Clay, V.D.

The following Orders have been issued for the week commencing January 17, 1916:—

Drills: 6.25 to 7.25; 7:25 to 8:25 p.m.

Saturday, Jan. 15th.—Uniform Parade, 2.45 p.m., Chester House.

Monday, Jan. 17th.—Sections 1 and 2, Technical; Sections 3 and 4, Squad Signalling Sections and Recruits.

Tuesday, Jan. 18th.—School of Arms, 6 to 7 p.m.

Thursday, Jan. 20th.—Shooting for Sections 3 and 4.

Friday, Jan. 21st.—Sections 3 and 4, Technical. Sections 1 and 2, Squad Signalling Section and Recruits.

Sections for Technical parade at Headquarters, London Electrical Engineers, 46, Regency street, S.W.

Sections for shooting parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call at Samuel Bros., Ludgate hill, as soon as possible.

Payment for uniforms to be made to the Adjutant.

ELECTRICAL RAILWAYS.*

BY H. M. HOBART.

(*Concluded from p.* 504.)

Summary.—After referring to the growth of electric traction on railways, and to the cheapening of electric energy in recent years, the author discusses in detail the results obtained on the Butte, Anaconda & Pacific, the Chicago, Milwaukee & St. Paul, and the Norfolk & Western Railways. It is shown that the electric locomotive compares very favourably with the steam locomotive for freight service. Attention is drawn to the importance of regenerative control, and the author concludes by showing that the high-pressure continuous-current system is the most suitable for general use.

Regenerative Braking.

The electric service on the Chicago, Milwaukee & St. Paul Railway will include the feature of regenerative braking. The author considers the case of a 96-mile line rising to 3,800 ft. at the mid point, and shows that with electricity at 0·336d. per kilowatt-hour, the outlay on electricity per locomotive-mile is 36·8d. without regenerative control, and 27·4d. with regenerative control. A main consideration, however, in adopting regenerative control relates to the lesser wear of the wheels, the brake-shoes and the brake rigging. With mechanical braking, the speed at which a heavy freight train may be taken down mountain grades is often limited by the permissible heating of the brake shoes. With regenerative braking, the limit is raised to that imposed by other factors such as the safe speed imposed by curves or by the construction of the rolling stock or permanent way.

With a dense traffic the employment of regenerative braking introduces savings of another character as the result of the interchange of current between neighbouring trains. Ascending or accelerating trains draw a part of their power directly from neighbouring descending or stopping trains. It is analogous to the installation of many additional sub-stations distributed along the route. With electricity thus interchanged between neighbouring ascending and descending trains, there is associated a lower loss in the distributing system than is the case when the electricity is sent over a considerable distance from the sub-stations to the train. Furthermore, the sub-stations are relieved of a part of the burden, and the load-factor of the remaining part is increased. Thus the sub-stations are shielded from the peaks of load and need not be equipped with motor-generators of so great a short-time rating. Indeed, their continuous rating may also be less, since the average output is decreased when supplying trains with regenerative equipment, except in so far as such equipment will be heavier and will increase the total weight moved. The energy efficiency of these motor-generators will be higher with the more uniform load. These conclusions only hold good for a dense traffic. The maximum of advantage from the employment of regeneration so far as regards decreased outlay for power will be obtained with a dense, well-distributed traffic and with the use of so high a working pressure as to permit of locating the sub-stations long distances from one another.

The modern motor for locomotive equipments is provided with forced ventilation and is much lighter for a given continuous output than were the earlier self-cooled motors. An important feature affecting its appropriateness for regenerative braking is that its continuous output is well up towards the output of which it is capable for one or two hours for a given temperature rise. Consequently it is not necessary to greatly increase its weight in order that it shall be able to perform as a generator on down grades and when decelerating the train. This was not the case with the railway motor of a dozen years ago. If the subject had been thoroughly analysed in those days it would have been found that in most cases the increased weight of the electric equipment would have occasioned a 10 per cent. or, in some cases, even a 15 per cent. increase in the total weight of the car or train. Consequently, a 20 per cent. decrease in the energy consumption expressed in watt-hours per ton-mile obtained in virtue of regeneration would have left an insignificant margin for net decrease in energy consumption per car-mile or per train-mile. There is also a saving in the capital invested in generating station, transmission line and sub-stations. For instance, if there were required for the operation of an electric railway with a dense traffic, an output from the generating station of, say, 100,000,000 kw.-hours per annum then, while for an ordinary system without regenerative control, it would be necessary to instal fully 25,000 kw. rated capacity of generating sets; this aggregate capacity would, with regenerative control, be materially reduced, say, to 22,500 kw. rated capacity. It will be recognised from a consideration of the various factors entering into the problem that it requires very careful estimating to arrive in any particular case at a fair quantitative comparison of two systems, the one with and the other without the regenerative feature.

* Abstract of the James Forrest Lecture, 1915, delivered before the Institution of Civil Engineers on Dec. 14.

The Norfolk and Western 11,000-volt Railway.

The Bluefield division of the Norfolk & Western Railway comprises the 29 miles of main line from Vivian to Bluefield in the State of West Virginia. Sidings, branches into the coal workings and yard trackage bring the aggregate electrified length of single track up to 97 miles. The line has long grades, sometimes amounting to over 2 per cent. Electric operation of the Bluefield division of the Norfolk & Western Railway was inaugurated in May of this year (1915), with 12, 240-ton locomotives of the split-phase type. This type of locomotive operates from a single-phase overhead conductor. In the case of the Norfolk & Western system, a pressure of 11,000 volts and a periodicity of 25 cycles per second are supplied from the overhead conductor.

Each 240-ton locomotive is made up of two 120-ton halves, and each half may be operated as an independent locomotive. The trains are, however, very heavy, and for grades of 1·5 per cent. or more, two 240-ton locomotives are necessary, the one at the head of the train and the other pushing at the rear. Trains of this composition and comprising 45 cars loaded with coal, weigh 2,900 tons, or, including the two 240-ton locomotives, 3,380 tons. They are known as "tonnage" trains. Such a train is made up at or near the west end of the division. The up-grade trip from Vivian to Ruth at the eastern end of the Elk Horn Tunnel is made at a speed of 14 miles per hour. Formerly it required three 240-ton Mallet engines, two at the head and one at the rear end of the train, to make the same trip at about 7 miles per hour, exclusive of stoppages for coal and water. Such a steam-locomotive train weighed complete 3,620 tons, or 7 per cent. more than the electric train. The total elevation from Vivian to Ruth is about 900 ft. The distance is 15 miles, the average grade thus being about 1·13 per cent.

The Norfolk & Western electrification provides the following important features:—

1. Decreased outlay for wages of locomotive crews and train crews, due to the greater speed and longer trains.
2. Decreased outlay for maintenance of electric locomotives as compared with that of Mallets.
3. Greater annual train (and ton) mileage per locomotive.
4. Greatly increased capacity of the division.
5. Superiority of electric traction for lines with frequent and long tunnels.
6. Decreased outlay for track maintenance with electric locomotives, as compared with Mallets.
7. Savings in brake-shoe renewals, and freedom from speed restrictions on down grades due to the heating of brake shoes in virtue of employment of regenerative control.
8. Elimination of congestion at tunnels, especially at the single-track Elk Horn Tunnel.

It is desired to dwell for a moment on this last feature. The 3,000 ft. single-tracked Elk Horn Tunnel is the bottle-neck of the system. Even the inherently slow Mallets were driven through the tunnel at reduced speed to reduce the quantity of smoke and gases. It was necessary to delay sending in a train until sufficient time had elapsed to partly free the tunnel from the smoke and gases emitted by the preceding train. Now, however, electric trains maintaining a speed of 14 miles per hour can be despatched through the Elk Horn Tunnel at the rate of a train every three minutes, as against 6 miles per hour steam trains, of less useful weight, every seven minutes. Taking into account the greater useful tonnage per train which can be carried electrically through the tunnel, and the greater speed, it may be fairly stated that any bunching up of tonnage on the division can be relieved by electric operation in about one-third the time which would be required with steam locomotives.

The 12, 240-ton electric locomotives operating on the Norfolk & Western Railway are equipped with the split-phase system*; 25-cycle 11,000-volt single-phase electricity is collected from the overhead conductor by a pantograph trolley with a sliding collector. The rotors of the polyphase motors are provided with definite windings and slip-rings, so that water-rheostats may be inserted in the rotor circuits during the starting and also for the purposes of speed control. The motors can be operated with either eight or four poles. With the former connection the speed is 14 miles per hour, and the continuous rating is 2,600 h.p., corresponding to a tractive effort of 68,600 lb. With the four-pole connection the speed is 28 miles per hour, and the continuous rating is 3,000 h.p., corresponding to a tractive effort of 40,000 lb. For these two connections the weight of the electrical equipment per horse-power of continuous rating works out respectively at 86·0 lb. and 75 lb.

The author then shows by diagrams the great increase in the ratio

* See The Electrician, Vol. LXXV., p. 469.

of ton-mileage to train-mileage of freight traffic in recent years on American railways, and points out that the rapid introduction of the electric locomotive is inevitable as a means of further increasing this ratio.

A brief account is then given of the "1913" passenger locomotives of the New York Central Railway. There are 16 now in service. This type weighs 115 tons and is designed for high-speed passenger service. Its continuous rating is 2,000 H.P., and corresponds to a tractive effort of 13,840 lb. at 54·5 miles per hour. Its one-hour rating is 2,600 H.P., and corresponds to a tractive effort of 20,400 lb. at 48 miles per hour. The locomotive operates from a 600-volt conductor rail. The two-axle guiding trucks at each end are each fitted with two motors. These, with the four motors carried by the articulated middle truck, make a total of eight motors for the locomotive. The entire weight is on drivers, the weight per axle being 14·4 tons. Each motor has a continuous rating of 250 H.P. For this rating a volume of 3,000 cubic ft. of air per minute is blown through it. The motors are bipolar, and their armatures are mounted directly on the axles, gearing losses thus being eliminated. The locomotive is suitable for all speeds up to 75 miles per hour.

The characteristic curves for the motor employed are given in Fig. 5, and the efficiency of the motors, for a speed of 48 miles per

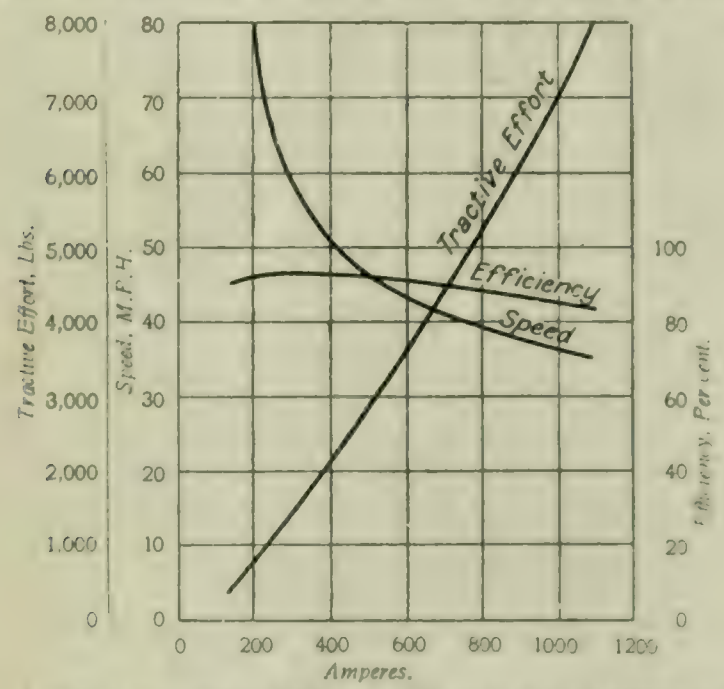


Fig. 5.—Characteristic Curves of Motor for "1913" Type of New York Central Passenger Locomotive.

hour, is seen to be 91 per cent. Allowing an additional 2·5 per cent. to cover the energy consumed by the blower and other auxiliaries, we have—

	Per cent.
Efficiency of electrical equipment	88·5
"Drivers-to-drawbar" efficiency	89·5
Efficiency from collecting shoe to drawbar	79·2

Relative Extent, in 1915, of Single-Phase and High-Pressure Direct-Current Electrification.

In the following Table are given data of the growth, in the United States, of single-phase and high-pressure direct-current electric railways during the last nine years

It should not be concluded from the data in the Table below that there is no longer any activity in America in applying the single-

Total Mileage of Single-track Operating and Under Construction.

Year.	Single-phase.	High-pressure direct current.		
		1,200 and 1,500 volts.	2,400 and 3,000 volts.	Total for high pressure direct current.
	Miles.	Miles.	Miles	Miles
1906	650	...	—	
1907	1,040	..	—	
1908	1,130	...	—	
1909	960*	...	—	
1910	980*	600	—	600
1911	1,040*	1,100	—	1,100
1912	1,040*	1,600	100	1,700
1913	940*	2,200	200	2,400
1914	1,340	2,750	450	3,200
1915	1,490	2,810	910	3,720

* The falling off in increase in single phase mileage during 1909 to 1913 was partly due to changing over eight roads (aggregating over 300 miles of single track) from single phase to direct current

phase system to railways. For tramways and light railways single-phase apparatus is generally admitted to be inferior, and no new undertakings have adopted the single-phase system for several years. But extensive single-phase applications have been made in the electrification of sections of main-line railways. Notable amongst these are the Norfolk & Western Railway, the New York, New Haven & Hartford Railway and the Pennsylvania Railway.

The author is satisfied that the high-pressure direct-current system is so distinctly superior in essential respects as ultimately to ensure its general use on main-line railways, in preference to the single-phase system or any of its modifications. The author quotes opposite opinions by Mr. B. G. Lamme and Mr. W. S. Murray.

It is not proposed in this Paper to deal quantitatively with the relative merits of single-phase and direct-current locomotives further than to state the author's conclusion that, owing to the lower "drivers-to-drawbar" efficiency and the lower efficiency of the electrical equipment of single-phase locomotives, a given output from the drawbar will (taking into consideration all the varieties of traffic on the railway) require so much greater consumption of electricity by the locomotives as to fully offset any economies in sub-stations and distribution system. This conclusion concerning the relative consumption of the two types simply refers to one of the items entering into a comprehensive comparison. Amongst other matters requiring consideration are the relative initial costs of locomotives of equal capabilities of the two types, the relative outlays for repairs, and the relative reliability.

In view of the increasingly frequent allusions in the technical press to the use of rectifiers on "single-phase" locomotives, it should be pointed out that a rectifier supplied with single-phase current differs from a polyphase rectifier in that it does not inherently supply the practically non-pulsating current required for obtaining the best operating results from direct-current motors.

When consideration is given to the characteristics of single-phase and direct-current locomotives we find ourselves faced with the purchase at the point of delivery to the sub-stations, either of a given quantity of single-phase lagging-power-factor electricity or an appreciably less quantity of three-phase unity power-factor or even leading-power-factor electricity. It will rarely be practicable to supply the former kind of electricity to the sub-stations at a price per kilowatt-hour less than 30 per cent. in excess of that at which the latter kind of electricity can be profitably supplied to the substations.

In America by far the most usual periodicity is 60 cycles per second. Most of the great transmission systems employ 60 cycles. If the single-phase system were to be employed by a railway purchasing 60-cycle electricity it would be necessary to equip the sub-stations with motor-generator sets. Such motor-generator sets would consume 60-cycle three-phase electricity and deliver single-phase 25-cycle electricity. On this plan the sub-stations with the single-phase system would be on the same basis, as regards the greater first cost and the lower efficiency of rotating machinery, as the direct-current system, leaving the single-phase system at a disadvantage as regards both total first cost and annual overall efficiency from generating station to drawbar of locomotive. The same considerations apply in Great Britain and other countries in which by far the most usual periodicity is now 50 cycles per second. It would either be necessary to employ separate generating stations to provide the 25-cycle single-phase electricity and forego the advantages of high load-factor and diversity-factor, or else interpose motor-generator sub-stations of the same order of cost and efficiency as the motor-generator sub-stations required for the high-pressure direct-currnet system.

Cost of Electricity at the Locomotive.

At this point it is of interest to investigate the cost of electricity as delivered at the locomotive with direct-current and single-phase systems. Let us compare the three following systems :—

(*a*) Polyphase, 60-cycle generation and high-pressure transmission to sub-stations where the pressure is stepped down, the electricity then being delivered into polyphase synchronous motors operated at unity power-factor, and afterwards being delivered from direct-connected, high-pressure direct-current generators, and thence distributed to high-pressure direct-current locomotives.

(*b*) Polyphase, 60-cycle generation and high-pressure transmission to sub-stations where the pressure is stepped down, the electricity then being delivered into polyphase synchronous motors operated at unity power-factor, and afterwards being delivered from direct-connected, 25-cycle, single-phase generators, and thence distributed at an average lagging power factor of 0·75 to single-phase locomotives.

(*c*) Single-phase, 25-cycle generation (in large stations for supplying many locomotives), and high pressure transmission to sub-stations where the pressure is stepped down, and the electricity distributed direct from the step-down transformers, and at an average lagging power factor of 0·75, to single phase locomotives.

We may assume that the electrification in question requires at the locomotives some 70 million to 90 million kilowatt-hours per annum, or a matter of about 100 million kilowatt-hours from the generating station. The comparisons are so arranged that the results are independent of the precise annual consumption; it is only desired to indicate that the amount of electricity required is of the order of 100 million kilowatt-hours per annum.

The results of the author's calculations are given in Table VII. Regeneration is not taken into consideration, but it should be pointed out that, while considerable gains are available with regeneration in system *a*, the split-phase type of single-phase equipment is the only one permitting of the commercial utilisation of regeneration, and that even then the range of speeds permitting of its use is relatively limited. From the nature of the method of comparison the efficiencies of the different systems do not constitute criteria of their relative economy, since costs are assessed to each loss when it first comes up for consideration. Under the most favourable conditions single-phase locomotives are not likely to consume less than 15 per cent. more electricity than direct-current locomotives for the same output at the drawbar averaged over the entire traffic of a railway. Taking this percentage, relative figures for the outlay for electricity are derived in Table VII.

Table VII.

—	System *a*.	System *b*.	System *c*.
Assumed cost of electricity as delivered from generating station, per kilowatt-hour	0·290d.	0·290d.	0·360d.
Annual overall efficiency from generating station to pantograph	71·8%	75·0%	80·9%
1. Cost of electricity as delivered at the locomotives, per kilowatt-hour	0·738d.	0·678d.	0·625d.
2. Relative consumption of electricity at locomotive pantographs	1·00	1·15	1·15
Product of 1 and 2	0·738	0·780	0·719
Ditto in terms of total cost of electricity for System (*a*) taken as 100	100	106	97·5

The 6 per cent. and 2·5 per cent. differences are too small to be considered in this rough comparative study. Consequently, we may, on the basis of our assumptions, which have certainly not favoured the direct-current system, take the outlay for electricity as about the same for the three systems, leaving the single-phase systems handicapped by the greater inherent cost of single-phase locomotives.

If, up to the locomotive, any material savings could have been demonstrated for the single-phase system, then the correct choice would be influenced by the density of traffic; the greater outlay per single-phase locomotive with a sparse traffic being more than offset by the savings up to the locomotive, while with a dense traffic the greater outlay per single-phase locomotive would more than offset any savings up to the locomotive. Since, however, up to the locomotive, the costs are a stand-off, it would appear that even with a sparse traffic the direct-current system is the most economical, and that the percentage by which it is more economical increases with the percentage which the locomotive investment bears to the total investment.

The conclusions of this Paper are to the effect that: First, we are on the eve of the extensive employment of electric locomotives on railroads at present operated with steam locomotives; second, that the direct-current system is the most appropriate; and, third, that direct-current locomotives for use from high-pressure contact conductors are now a thoroughly demonstrated success.

THE DOUBLE DYNAMOMETER WATTMETER.

BY C. V. DRYSDALE, D.SC.

Summary.—The author refers to wattmeter corrections and to the double wattmeter. He next deals with these instruments for measuring three-phase power, and discusses the errors involved including that of interference between coils. Some examples of their use in testing are then given and a new form of instrument is described.

Among electrical testing operations, power measurements are of prime importance. As polyphase supply is now so common, an instrument which will indicate the power on such circuits directly and accurately is of considerable value; and although four types of instruments may be employed, the writer has always preferred the dynamometer form as being the only one which combines high accuracy with robust construction and moderate portability.

Ever since the inception of the dynamometer wattmeter by Profs. Ayrton and Perry in 1881, there has been a tendency to look askance at it as an accurate instrument. This is probably because its inventors themselves showed insufficient confidence in it. They developed a theory of its inductive error in such a form as to make that error appear large and indeterminate at low power factors; and they carried their distrust of the dynamometer wattmeter so far as not only to propose the electrostatic form in its place, but to devise tests like the three ammeter or three voltmeter methods which, at their best, were probably inferior in accuracy to the worst wattmeter ever constructed. In consequence there is no instrument in the whole list of electrical testing devices which has come in for such an amount of distrust and suspicion in the past as the dynamometer wattmeter, and even today there is a tendency to advocate electrostatic devices in its stead for standardising work, in spite of their much greater delicacy of construction, large power consumption with heavy currents, and comparatively sluggish action.

In THE ELECTRICIAN for March 15, 1901, the writer put forward a simple theory of the dynamometer wattmeter, showing that the whole of the supposed ambiguity of the inductance correction vanished if it were applied as a term to be added instead of as a multiplying factor, and that this not only enabled the correction to be easily applied whenever necessary, but showed that it was rarely of serious importance, and that it was quite easy to design a wattmeter so that the inductance error was never sufficiently large to be detected. As this is of fundamental importance it may be permissible to give the following graphical illustration.

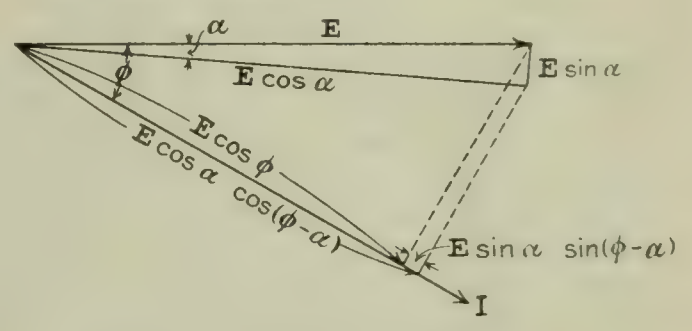


FIG. 1.—EFFECT OF SHUNT INDUCTANCE.

In Fig. 1 the P.D., E, and current, I, are shown as vectors, the current lagging by the angle φ. Then, with sinusoidal supply, the true power w=EI cos φ, or is obtained by multiplying the current I by the projection of E upon it =E cos φ.

Now if inductance is introduced into the wattmeter shunt, the effect is to divide the voltage E into two perpendicular components: one, E cos α, employed in overcoming the resistance of the shunt, the other, E sin α, required for overcoming its inductance, α being the angle of lag in the shunt. It is evident, therefore, that the wattmeter reads as if the voltage had been altered to E cos α, and the angle of lag of the main current to $\varphi-\alpha$, so that the projection of the effective voltage on the current vector on the current is E cos α cos $(\varphi-\alpha)$, instead of E cos φ. We therefore have

$$\text{True power } w=\text{EI cos } \varphi.$$
$$\text{Wattmeter reading } w'=\text{EI cos } \alpha \text{ cos } (\varphi-\alpha).$$

In the classic form of the correction, a factor f is introduced which when multiplied by the wattmeter reading w' gives the true power w, and this becomes infinite at zero power factor. But if we simply take a term e such that $w=w'-e$, we have $e=w'-w=$EI $\{\cos \alpha \cos (\varphi-\alpha)-\cos \varphi\}$, which easily works out to EI sin α sin $(\varphi-\alpha)$. This is immediately seen from the diagram, as the difference between the two projections is evidently the projection of E sin α upon I, or E sin α sin $(\varphi-\alpha)$. In practice the angle of lag in the shunt is only a small fraction of a degree, so that sin φ may be written for sin $(\varphi-\alpha)$, and sin α=tan α=Lω/R or Tω, where L is the inductance of the shunt, R its resistance, $\omega=2\pi\times$frequency, and T is the time constant L/R. Consequently the formula reduces to the simple and entirely unambiguous form

$$w=w'-\frac{L\omega}{R}\text{EI sin } \varphi=w'-T\omega W \text{ sin } \varphi$$

where W=EI, the "apparent watts." We may also write W sin φ with sufficient accuracy as $\omega\sqrt{(W^2-w'^2)}$, and we have $w=w'\mp T\omega\sqrt{(W^2-w'^2)}$, which enables the correction to be instantly made if the time constant of the wattmeter shunt is known. The negative sign is for lagging and the positive for leading currents.

It will be seen that when the power factor is small w'^2 becomes very small, and $w=w'\mp T\omega W$, so that the correction is actually most simple in the case where the old correction factor becomes indeterminate or infinite. A wattmeter correction should in fact be regarded as a zero displacement rather than as a change of constant; and it is as absurd to say that a wattmeter gives ambiguous results on low power factors, because the correction factor becomes infinite, as it would be to claim that a galvanometer having a zero reading of −2 divisions cannot give a definite result when deflected to zero, because the reading would have to be multiplied by infinity to get the true deflection, instead of simply adding the zero displacement.

The above investigation applies to sinusoidal wave forms only, but the writer has shown* that in all but a few special cases, such as the testing of condensers on very irregular wave forms, the error does not differ greatly from that given.

The chief use of the above correction, however, is that it enables us to design a wattmeter so as to keep the inductive error within any assigned limits. The expression $T\omega W$ is the maximum error in the wattmeter reading, and if the instrument is arranged as is usually the case, so that with the full P.D. and current at unity power factor a complete scale deflection is obtained, the expression $T\omega$ represents the maximum deflection due to inductive error, as a fraction of the scale length. In an ordinary indicating instrument having 100 scale divisions we cannot read closer than 1/10th division or to 0·001 of the scale length. If we take the maximum working frequency at 100 ~ per second from which ω=628, we then have T=L/R=0·001/628 from which R=628,000L. So long as the resistance in the shunt circuit is more than 628 ohms per millihenry of inductance the inductive error will produce no readable effect. If, on the other hand, we have a precision torsion head carrying 500 divisions which we can estimate to 1/10th division, or to 1 in 5,000, the resistance R must be 5 × 628 = 3,140 ohms per millihenry in order that the inductive error may be unreadable. By reducing the control sufficiently this result can be easily obtained.

The electrical conditions which the writer therefore laid down in 1901 for an accurate dynamometer wattmeter, were as follows:—

(*a*) Shunt resistance to be at least 3,000 ohms per millihenry of inductance.

(*b*) Added resistance to have negligible capacity.

(*c*) Eddy currents to be avoided by keeping all metal out of the field.

(*d*) Current coils to be subdivided to avoid eddies, thus permitting them to be grouped in series or parallel for alteration of current range.

A single-phase wattmeter constructed on these principles was described in THE ELECTRICIAN article of 1901, and immediately afterwards the author designed a double form of the instrument for use on polyphase circuits. Four of these double wattmeters were constructed for the laboratories of the Northampton Institute in 1902, and used for single, two and three-phase motor, generator, and transformer tests. Probably these were the first double dynamometer wattmeters for polyphase work, but it appears that Dr. A. E. Kennelly had used a double instrument for the differential determination of transformer losses as early as 1893.†

As the theory of the double wattmeter on three-phase circuits is not always clearly understood by practical engineers, it may be well to point out that it may be easily established without any mathematical demonstration whatever.

In Fig. 2 we have the usual connections for three-phase measurement by two wattmeters. The mains are represented by 1, 2 and 3, and one wattmeter is connected with its main coil carrying the current I_1 and its pressure circuit between 1 and 3. The other wattmeter carries the current I_2, and its pressure circuit is connected between 2 and 3. In the double wattmeter the two systems have the same constant, and the moving coils are connected mechanically, so that the reading is the sum of the power indicated by the two systems.

If lead 2 is broken, it is clear that the wattmeter indicates the power supplied by mains 1 and 2, while if lead 1 is broken,

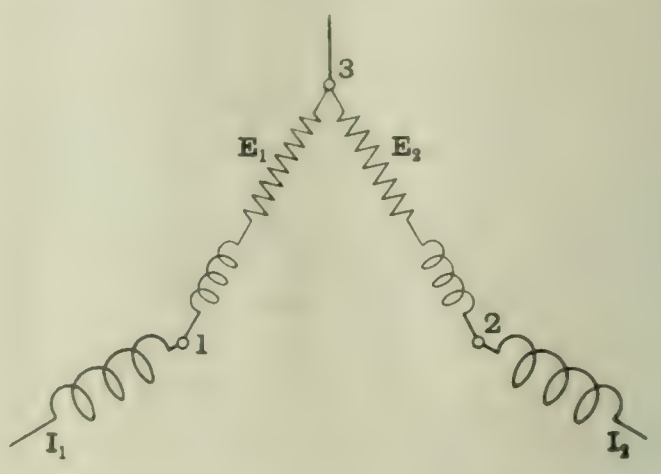


FIG. 2.—TWO-WATTMETER METHOD FOR THREE-PHASE POWER.

it indicates the power supplied by 2 and 3. If, on the other hand, lead 3 is broken, the two systems of the wattmeter are in series across leads 1 and 2, and it will be readily seen that the indication of the double instrument is the power supplied by these leads, as although there are two wattmeters each taking the same main current, the shunt current is reduced to half the normal for the same voltage. A little consideration will show that the indication of the wattmeter will remain the same whatever the potential of the point 3 may be. For example, if in this case we take the extreme step of connecting

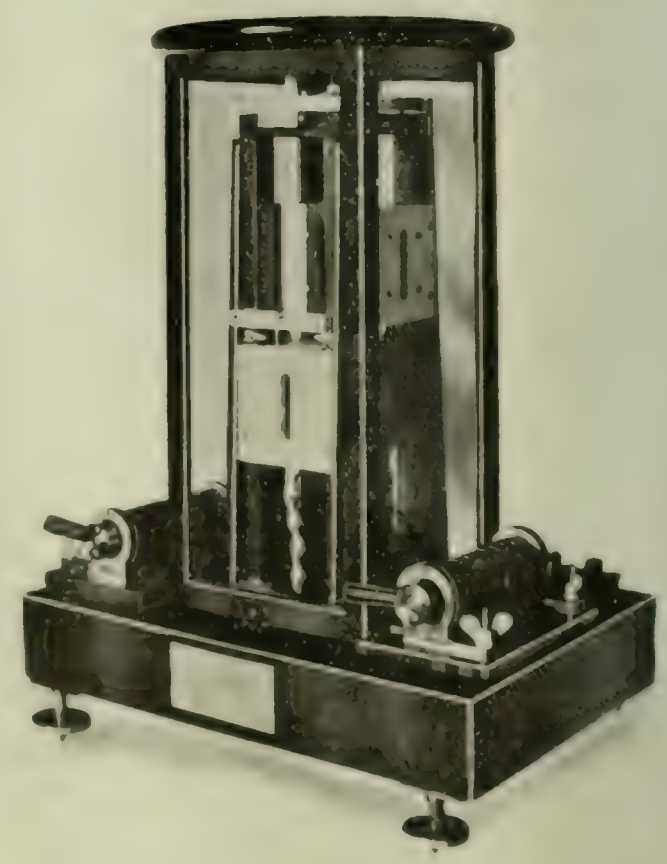


FIG. 3.—50 AMPERE DOUBLE ASTATIC WATTMETER.

3 to 1 or to 2, the reading is absolutely unaffected, since it only cuts out one wattmeter, but raises the current in the shunt of the other to its normal value. When all three mains are supplying current therefore, the double wattmeter indicates the sum of the power transmitted by each pair of leads.

The first of these double wattmeters were non-astatic, with straight wire suspensions, and with a mercury commutator for effecting the changes of grouping of the main coils. In 1907 their construction was undertaken by Mr. H. Tinsley, of S.

* "Journal" I.E.E., 1910, Part 199, Vol. XLIV., p. 255, *et seq.*

† "E.T.Z.," No. 12, 1893, p. 164.

Norwood, and since then they have been made astatic, and with cylindrical spring control, while a cylindrical commutator has been devised for effecting the various series-parallel combinations.

Fig. 3 is a photograph of the double wattmeter in its present form, and Fig. 4 a diagram of its coils. The base and framework of the instrument are of mahogany, the dimensions of the base being 17 in. by 12 in., and the total height from the bench to top of torsion head 24 in. in the standard type, up to 250 amperes per phase. Ivoroid coil boxes contain the main coils which are of 10 separately insulated strands, and are arranged astatically in pairs, the axes of the two systems being at right angles. The separate strands are brought out to the brushes of the series-parallel commutator.

The moving system, seen in Fig. 4, consists of a crossed mica vane, upon which the astatic fine wire coils are wound. The ends of the coils are connected by four very fine phosphor-bronze strips to springs fixed to the uprights, and from thence to the terminals on the base. A small amount of added resistance is put in series with each moving coil to bring it up

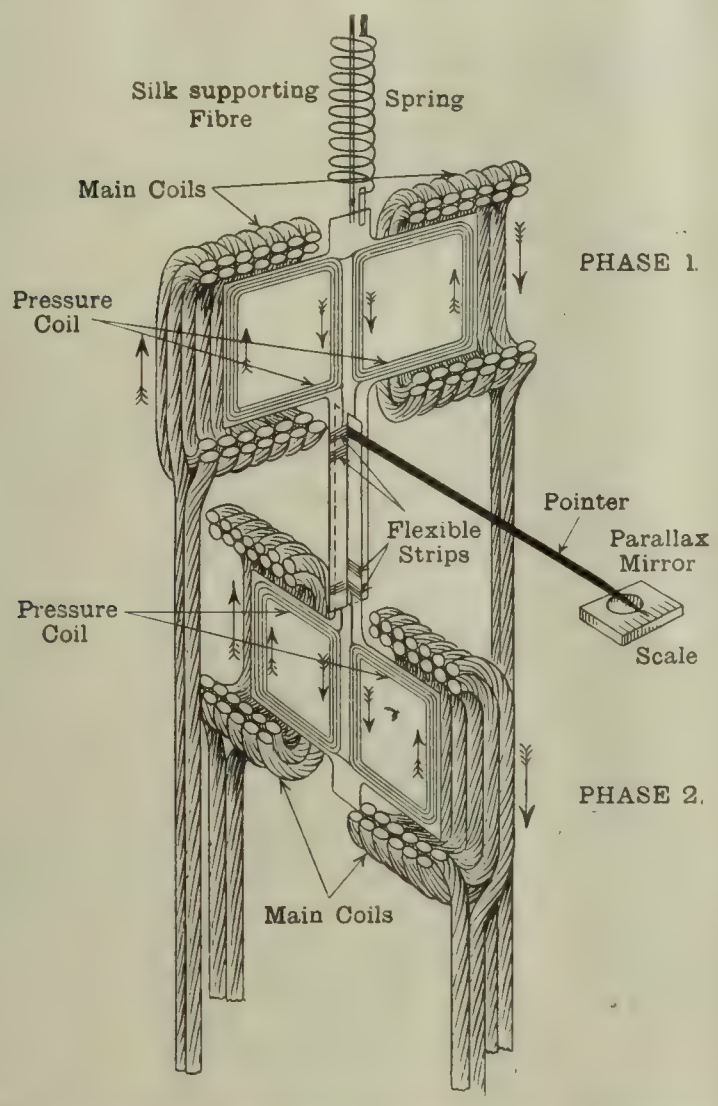


Fig. 4.—Systems of Double Dynamometer Wattmeter, showing Astatic Coils.

to 100 ohms. A light German-silver cylindrical spring is attached to the top of the moving coil system, and to the divided head which is over 6 in. diameter, bearing 500 mm. divisions on it. The weight of the moving system is taken up by a silk suspension attached to a support fixed to the coil boxes, and projecting up inside the cylindrical spring, so that it is axial but unaffected by the turning of the latter. The two sets of moving coils and their connections are separated by more than an inch, so that the instrument may be used with 2,000-3,000 volts P.D. between the systems. Special care is taken with the mounting of the cylindrical spring and torsion head to secure the closest possible proportionality of the readings. Two ivoroid pins project upwards from the divided head through the top of the case, and a large wooden disc rests on them, and is employed as a torsion head. Balance is secured with the aid of a light aluminium pointer attached to the mica vane, and travelling over a zero index and parallax mirror attached to the frame.

The series-parallel commutator is an extension of the original commutator used in the early Ayrton and Perry ammeters, and is arranged to give the four possible complete combinations of the main coils—1/10, 2/5, 5/2, 10/1, the numerator representing the number of coils in series, and the denominator the number in parallel. Fig. 5 shows a general view of this commutator, and Fig. 6 a development of its surface, indicating its combinations. The figures 1 to 10 represent the points of contact of the brushes, and the letters a to j the connections between diametrically opposite contacts. The whole instrument is so connected to its terminals that if adjacent main and shunt terminals are connected right round the base in simple series, the deflection will be positive, and the two systems will

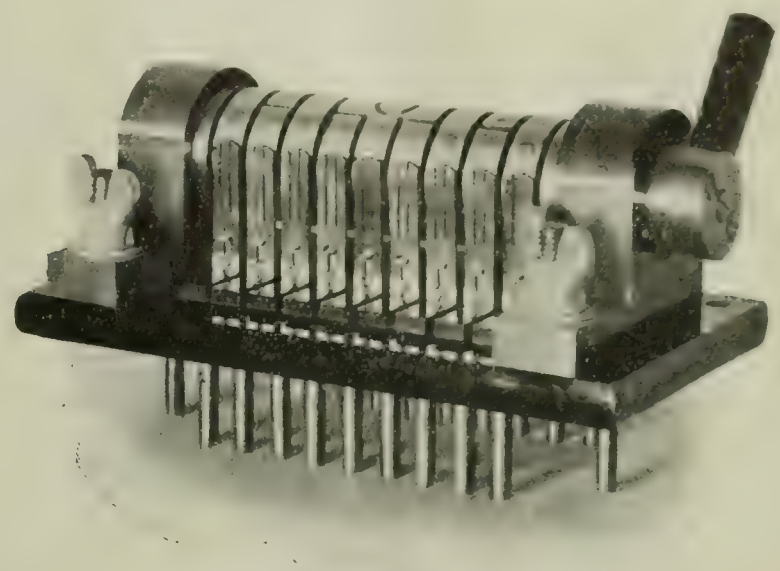


Fig. 5.—Series-parallel Commutator for 250 Amperes.

assist one another. This gives the most simple and natural arrangement of the connections when the instrument is used on three-phase circuits.

Resistance Boxes.—The resistance boxes for use in series with the moving coils ordinarily have a total resistance of 100,000 ohms, and are suitable for pressures up to 2,000 or 3,000 volts per phase. The wattmeter moving coils are made up to 100 ohms, and the resistance box enables this to be increased to 200, 500, 1,000, 5,000, 10,000, 20,000, 50,000 or 100,000 ohms. Each section of the high resistance winding is about 1,400 ohms, and is of manganin wire wound over a mica strip 5 in. long by 2 in. broad, and nearly 1 mm. thick. In order to avoid capacity errors which are usually the more serious in high resistance work, the winding is inductively

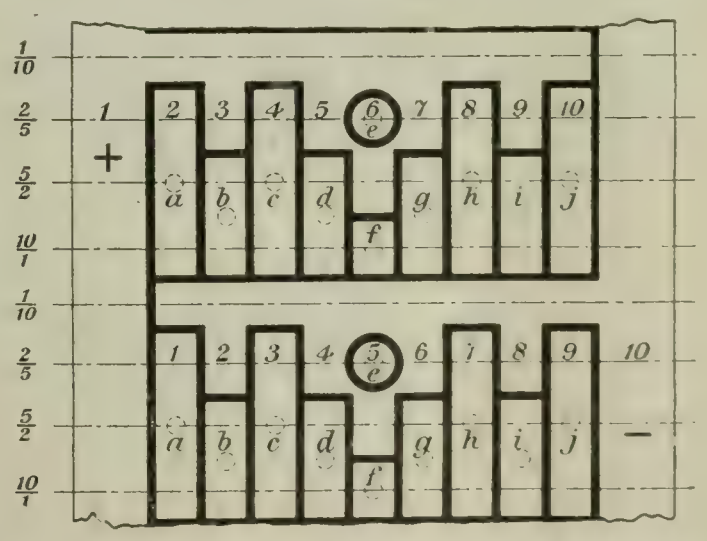


Fig. 6.—Development of Series-parallel Commutator.

wound, but calculations show that the time constant of the coils is less than 5×10^{-9} seconds, and that the error in the phase angle even at 1,000 ~ per second is less than 3×10^{-6} radian or 0·0002 degree, so that it is entirely negligible under all practical conditions. A rough calculation of the capacity gives it at less than 5×10^{-13} farads per section, so that the time constant CR is less than 7×10^{-10} seconds, or considerably less than the inductive time constant. The resistance boxes may therefore be taken as having no inductive or capacity errors under all practical conditions.

(To be continued.)

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE & YORKSHIRE RAILWAY.

Introduction.

The improvements made from time to time by the Lancashire & Yorkshire Railway in the work of conveying passengers quickly and comfortably have been most marked, and about 18 months ago the directors of this railway, acting on the advice of Mr. J. A. F. Aspinall, the general manager, determined upon the electrification of that important section of the company's lines extending from Manchester to Bury, and passing through the favourite residential suburbs of Heaton Park and Prestwich. A map of this district is shown in Fig. 1.

The Lancashire & Yorkshire Railway Co. first adopted electrical working on the section between Liverpool and Southport in 1904, and the highly satisfactory results obtained have induced the company to apply electric traction with complete confidence on what is familiarly known as the Prestwich branch. Experience has proved that electrification of suburban railways encourages the growth of traffic, and has the additional advantages of increasing the capacity of the line and of terminal stations.

This is the first railway in the Manchester district to be converted to electric traction, and the inauguration of such a service marks an improved stage in the economic development of the city, and the evolution of rapid transit between the city and its suburbs.

This district, being the second portion of the company's system to be electrified, derives the benefit of 11 years' experience gained on the Liverpool and Southport line.

The live-rail direct-current system, as used on the Liverpool and Southport line, is still adhered to, but the voltage has been raised from 600 to 1,200. The railway company have been led to adopt this higher voltage due to the satisfactory results gained on their electrified line between Bury and Holcombe Brook, where direct-current is used at 3,500 volts, but with overhead construction.

The growing importance of North Manchester as a healthy residential district, and the ever-increasing number of people who are making their homes there, induces the belief that the new undertaking will be as conspicuously successful as its forerunner, which now affords means of rapid transit for thousands of people between their homes on the Southport line and the City of Liverpool, where they have the fastest suburban service in the world.

Great as have been the improvements in recent years for reaching the inner suburbs of Manchester, the need for improved travelling facilities to the outer suburbs had not been fully met. The time occupied in travelling is often the measure of the distance at which the city worker can live away from his place of business, and this with the usual methods of transit means that he must live within a radius of 3 miles. When the full service of electric trains is established on the North Manchester suburban line the residential area will be increased, because the augmented and accelerated service will bring the outlying districts virtually nearer than they are to-day. Prestwich, for example, is five minutes nearer to Manchester Town Hall than it has been hitherto. The district served by the new electrification scheme, standing as it does at an average height of 300 ft. above the sea level, is becoming increasingly popular for residential purposes. The purchase of Heaton Park by the City Corporation, and the town planning schemes which are in hand, have greatly encouraged building operations in that district.

The electrification was commenced before the outbreak of war, and as the necessity was felt for a rapid and efficient train service, and considering that at that time appreciable progress had been made and all tenders placed, it was decided that the work should be completed at the earliest possible moment.

The scheme has been carried out under the general direction of Mr. J. A. F. Aspinall, the general manager of the railway company, by his chief mechanical engineer, Mr. George Hughes, and his chief civil engineer, Mr. D. C. Rattray. All plans and specifications were prepared and contracts for all plant placed by the C.M.E. staff at Horwich, in addition to which a preponderance of the detail work, both in connection with the drawings and manufacture of material, have been carried out at the company's locomotive works at Horwich. The civil engineering portion was dealt with by the C.E. department at Hunt's Bank, Manchester.

Although the progress has been considerably delayed due to the present crisis, it is anticipated that the line will be opened for passenger traffic early in the year.

The length of the line which is now being converted represents 22 miles of single track; but as this is only the first stage of an important electrification scheme for the Manchester area it was decided to provide a new power station of sufficient capacity, in the first instance, to serve the needs of present requirements and provide for considerable future extensions.

In consequence of the war, the full service of electric trains will not be put into force immediately, but 27 per cent. of the existing steam trains will be replaced by electric trains, and further electric trains will be added which will augment the present service by 25 per cent. When the full electric service is established there will be 90 trains in each direction per day. The trains will run every 20 minutes between 5:30 a.m. and 7:30 a.m. and 7:10 p.m. to 11:30 p.m.,

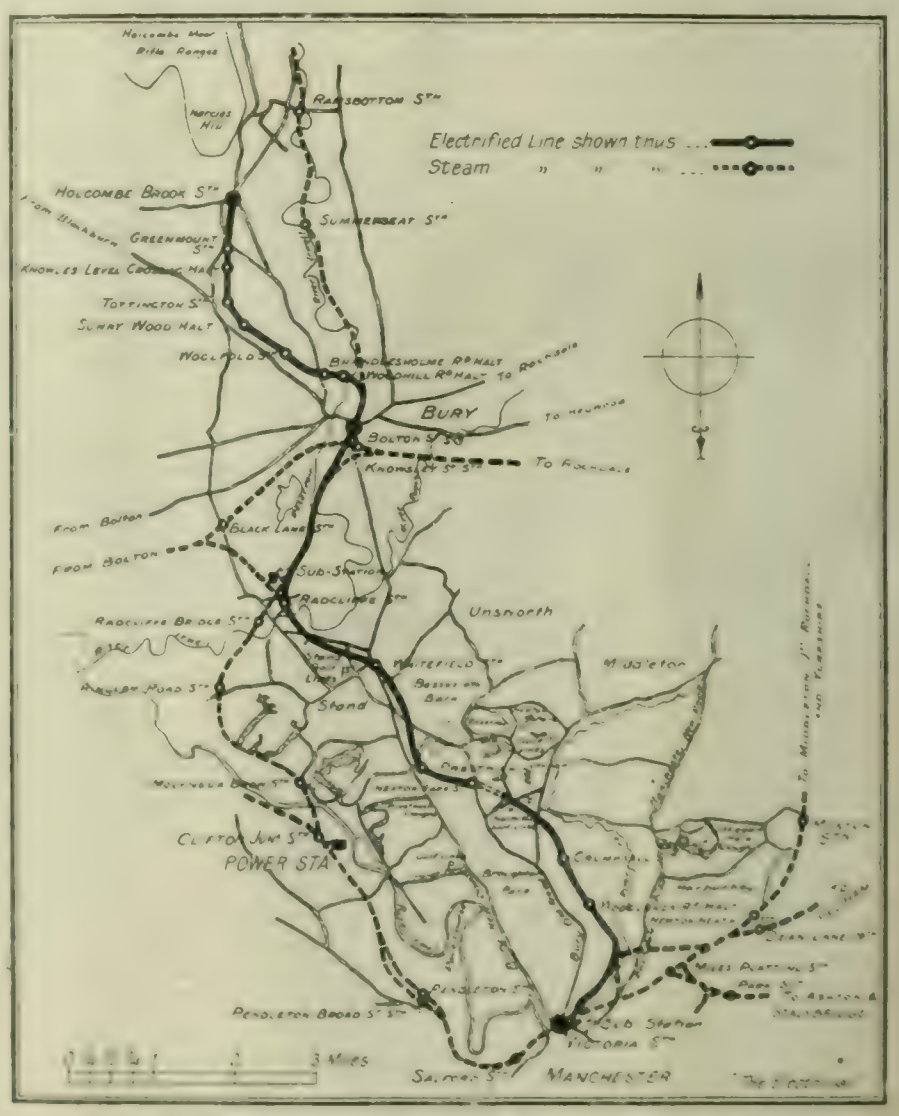


Fig. 1.—Map of Manchester and Holcombe Brook Section.

and from 7:30 a.m. to 7:10 p.m. there will be a 10 minutes' service to Radcliffe, with every other train running through to Bury, making a 20 minutes' service to the latter town.

Power Station.

In considering the question of the design and situation of the power station at Clifton, due regard has been paid to the four controlling factors in power-station location—namely:—

1. It should be as near as possible to the electrical centre of gravity of the anticipated load.
2. It should have suitable subsoil for foundations.
3. There should be a good and ample supply of water, and
4. Easy facilities for the supply of coal and removal of ashes.

The power station under consideration has been built near Clifton Junction Station, a point 4¾ miles from Manchester, on the main line between Manchester and Bolton, a situation which fulfils all the above-mentioned conditions. It occupies a central position to the Lancashire section of the Lancashire & Yorkshire Railway, and is adjacent to extensive coalfields. The foundations are everything that could

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE AND YORKSHIRE RAILWAY.

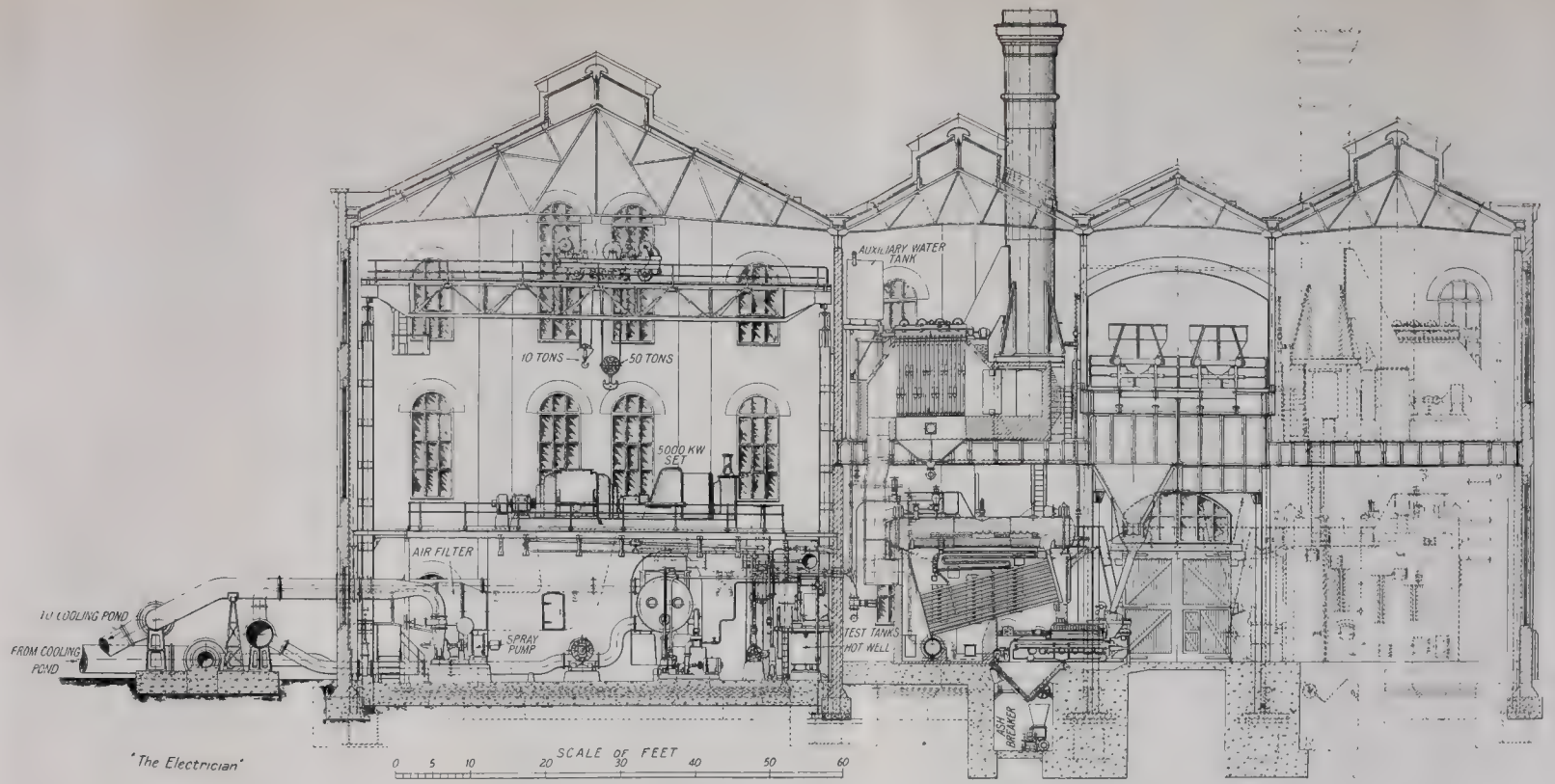


Fig. 3. Cross Section through Power House.

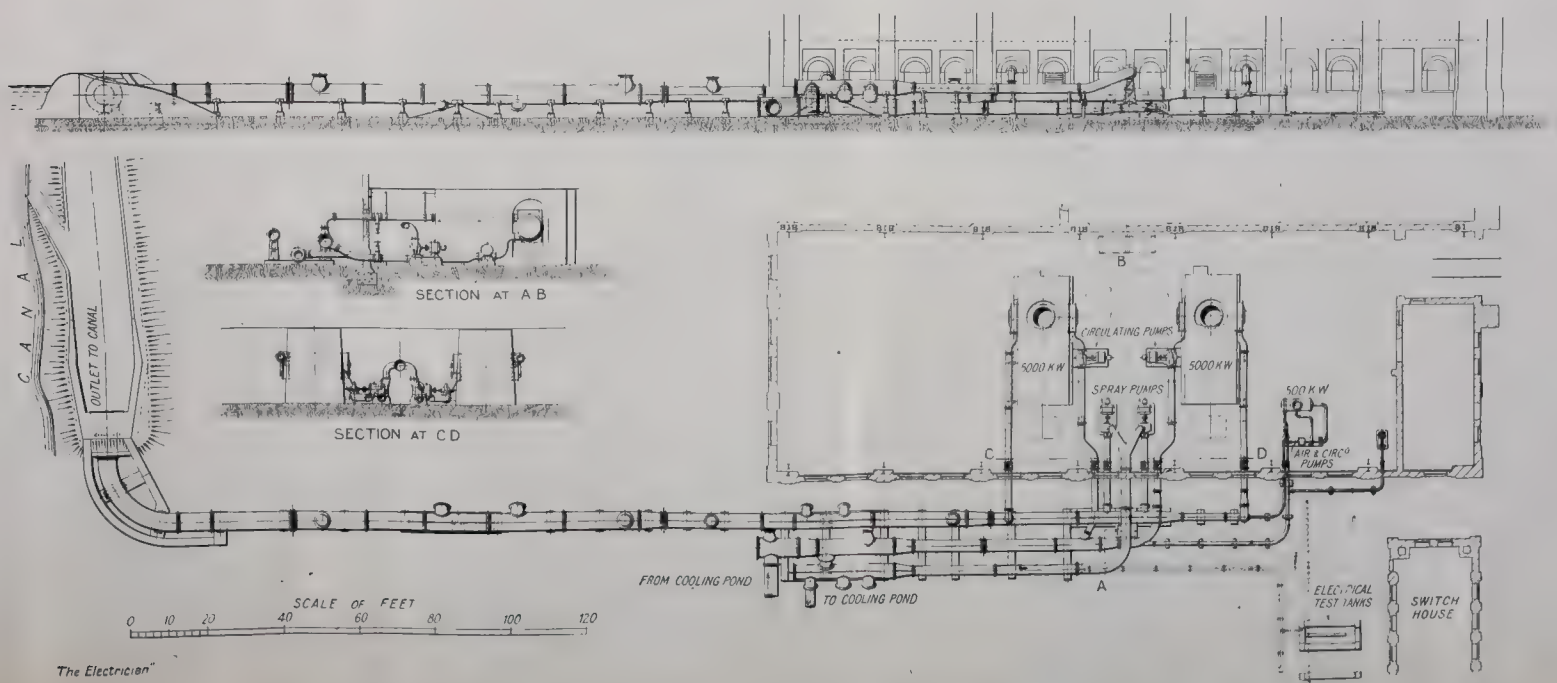


Fig. 14.—Arrangement of Circulating Water Pipes.

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE AND YORKSHIRE RAILWAY.

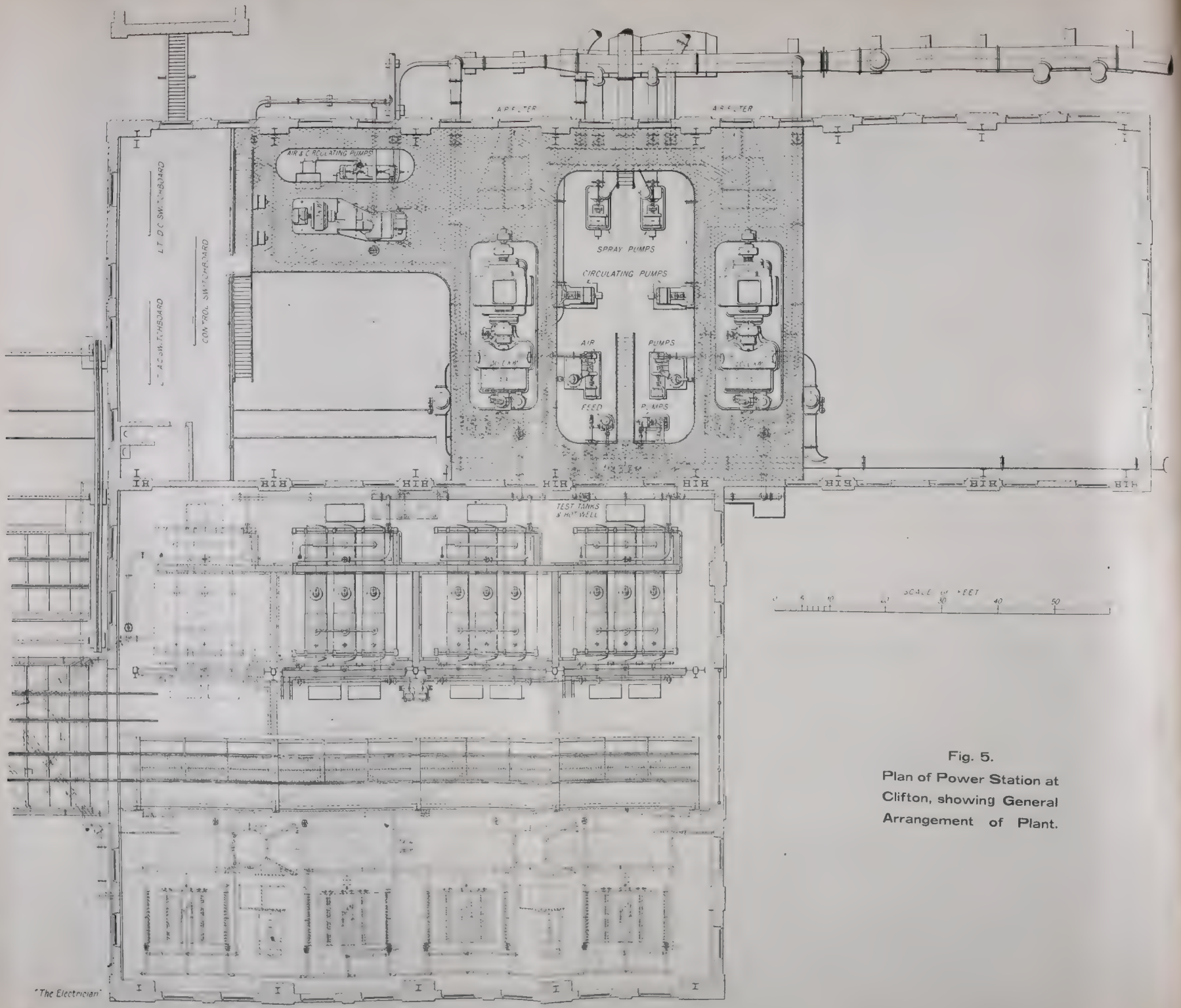


Fig. 5.
Plan of Power Station at Clifton, showing General Arrangement of Plant.

be desired, and there is a good supply of water from the Manchester, Bury and Bolton Canal, which is owned by the railway company.

The ground level at the power station is 37 ft. below the main line, which at this point is carried on an embankment, thus enabling coal wagons to be run directly over the tops of the coal bunkers. This arrangement makes use of what is obviously the best coal conveyor—namely, the coal train running between the colliery and the power station—thus obviating the necessity of installing coal-conveying appliances.

For the purpose of handling material between the two levels during the constructional period, and for subsequent use, a 50-ton electric overhead travelling crane, manufactured by T. Broadbent & Sons (Ltd.), of Huddersfield, has been provided.

An inspection of the block plan of the power station and its surroundings (Fig. 2) shows the general lay-out of the station with regard to the railway and the canal, together with the inlet and outlet connections of the canal for the supply of cooling water. A spray cooling pond is also provided to supplement the natural cooling, which takes place from the canal itself. The slight natural flow of water along the canal is in the direction of Manchester, and the cooling water scheme makes use of this feature, the artificial cooling being brought into play when necessary.

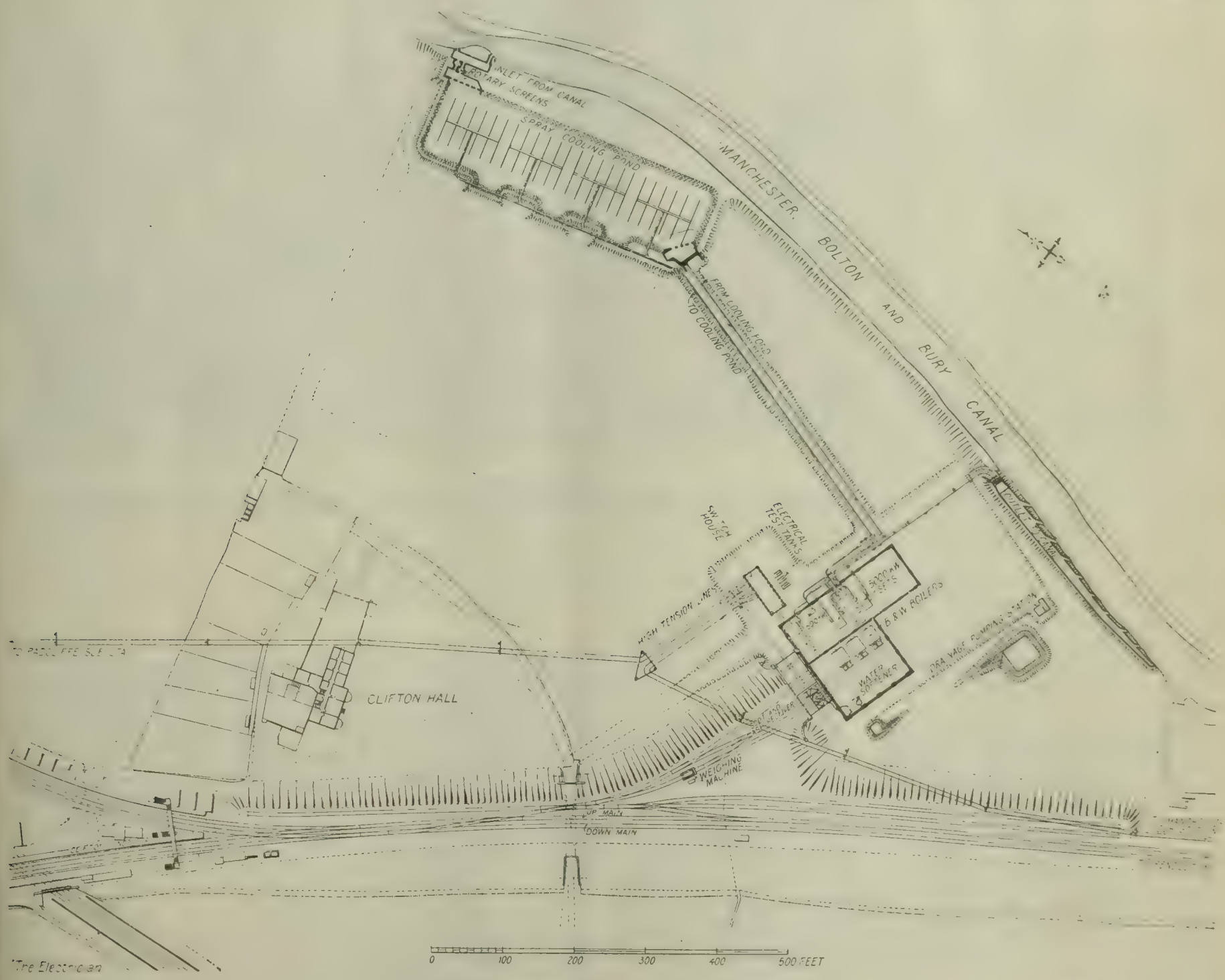


FIG. 2.—BLOCK PLAN OF POWER STATION.

It will be noticed from Figs. 3, 4, 5 and 6 that the power station structure consists of a steel skeleton filled in with brickwork. The steel work carries the crane runways, roof, economiser floor with economisers, fans and chimneys.

The building is of a substantial design, in which the following objects have been kept in view :—

(*a*) Ample room around the various machinery.
(*b*) Accessibility for repairs and ease of inspection.
(*c*) Abundance of light to all parts, and
(*d*) The lay-out of the auxiliary machinery specially has been such as to keep everything in full view of the operating staff.

A general view of the turbine room is shown in Fig. 7 and of the boiler room in Fig. 8. The experience gained with other electrification schemes has shown that power stations generally have not been designed with a sufficient provision for growth, which in the majority of cases has proceeded at a very rapid rate. At Clifton this contingency has been carefully provided for.

Boiler Room.—The boiler room is 110 ft. long and 90 ft. wide, and is parallel with the turbine room. The boiler room at present contains three Babcock & Wilcox water-tube boilers, each having a normal evaporation of 32,000 lb. of water per hour from and at 212°F., the steam pressure being 200 lb. per square inch gauge, superheated to 700°F. at the outlet. A glance at Fig. 5 will show that the boilers are arranged in pairs alongside each other ; each pair makes up a steam unit, and is provided with its own induced-draught plant and chimney.

The boilers are fitted with chain-grate mechanical stokers of Babcock & Wilcox's latest type. They are driven by three-phase 440-volt motors, and fitted with a variable-speed gear-box, allowing a speed variation to the grate of from $6\frac{1}{4}$ ft. to 25 ft. per hour. The grate area of each boiler is 144 sq. ft., the heating surface 7,135 sq. ft., and the superheating surface is 2,635 sq. ft. "Green's" economisers are used, and have been placed above the boilers. This position was found to be the most advantageous, as it reduces the width of the boiler room and the length of the chimney stack, thereby causing a smaller resistance to the products of combustion. Each boiler has its own economiser, which is fitted with 256 tubes, $4\frac{3}{16}$ in. diameter by 9 ft. long. The tubes are provided with electrically-driven scrapers. The induced fans are capable of dealing with the products of combustion from two boilers when working together. The fans were manufactured by Messrs. Musgrave & Co., of Belfast ; they are provided with ring-lubricated water-cooled bearings, and are driven by a 40 H.P. 440-volt three-phase motor, having a speed of 360 revs. per

min. The motor is of the totally-enclosed squirrel-cage type (*see* Fig. 9).

The chimneys, manufactured by Clayton, Son & Co., of Leeds, are made up of mild steel plates varying from $\frac{5}{16}$ in. to $\frac{1}{2}$ in. in thickness. They are 6 ft. internal diameter, brick lined, the tops being 87 ft. 6 in. above the firing-floor level. The ash from the boilers, after passing over the back end of the grate, drops into ash hoppers, and from that point is taken periodically, by means of Messrs. Babcock & Wilcox's suction ash arrangement, to a large receiver placed at the entrance to the coal bunker roads (*see* Fig. 10).

From this receiver, the ash, after having been cooled by a spray of water injected into the receiver itself, is loaded periodically into wagons at the main line level. Provision is made so that soot from the economisers can be dealt with in the same way as the ash. Electrically-driven ash breakers are provided between the ash hopper and the suction ash pipe. The ash pipe is made of cast iron, and is 8 in. diameter by $1\frac{1}{4}$ in. thick. It runs along the ash tunnel the full length of the boiler room. In this pipe two inlet boxes are arranged underneath each boiler, so that the ash may drop straight into the ash hopper, through the breaker, direct into these inlet boxes. At the end of the main ash pipe there is a bell-mouth opening for admitting air. The soot from the economisers is taken by a separate cast-iron pipe running underneath the economiser floor.

The ash receiver has a capacity of 30 tons, and is provided at the bottom with a two-way shoot, so that the contents may be discharged into wagons on either of the roads which run over the coal bunkers. The air exhauster is motor driven (*see* Fig. 11), and is of the "Roots" blower type, having a capacity of 3,250 cubic ft. of air per minute, at a pressure of about $2\frac{1}{2}$ lb. per square inch. It was manufactured by the Sturtevant Engineering Co., U.S.A.

The coal bunkers are situated in the centre of the boiler room (*see* Figs. 8 and 10), and are filled by means of bottom-hopper wagons, the rail level being 37 ft. above the boiler room firing-floor level, and 7 ft. above the economiser floor level. The hoppers are constructed of mild steel plating, and are of ample capacity, holding 50 tons of coal without trimming. Corrugated sheet-steel partitions separate the coal bunkers from the economisers.

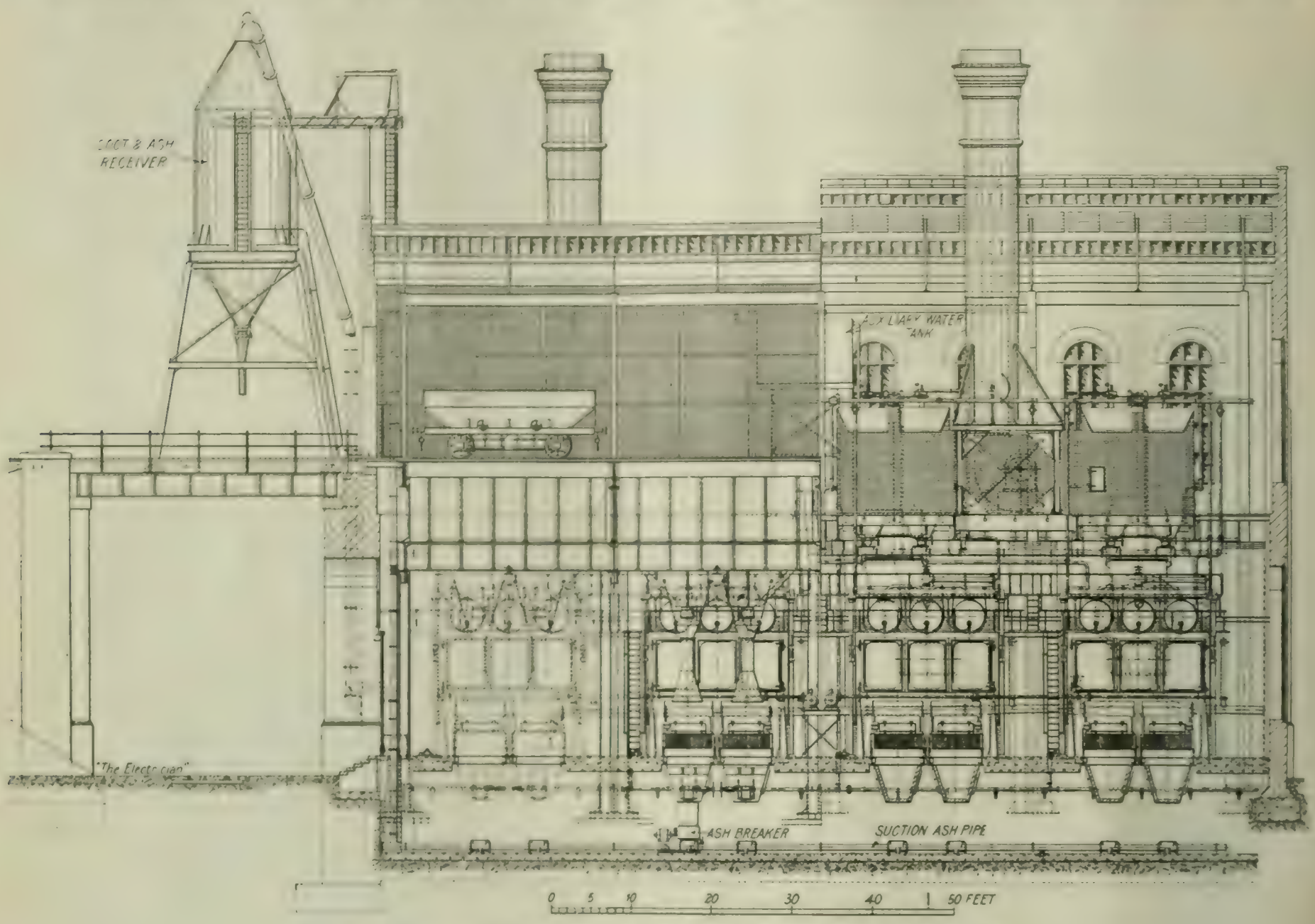


Fig. 4. Longitudinal Section through Boiler and Economiser Rooms.



Fig. 6.—General View of Power Station, showing Outgoing Transmission Line (North View).

Each boiler is fed by a separate hopper having two shoots directing the coal into the receivers for the chain-grate stokers, suitable baffles controlling the supply. A 30-ton weighing machine is provided on the approach road, for checking the coal supply. No weighing apparatus has been installed on the bunkers themselves.

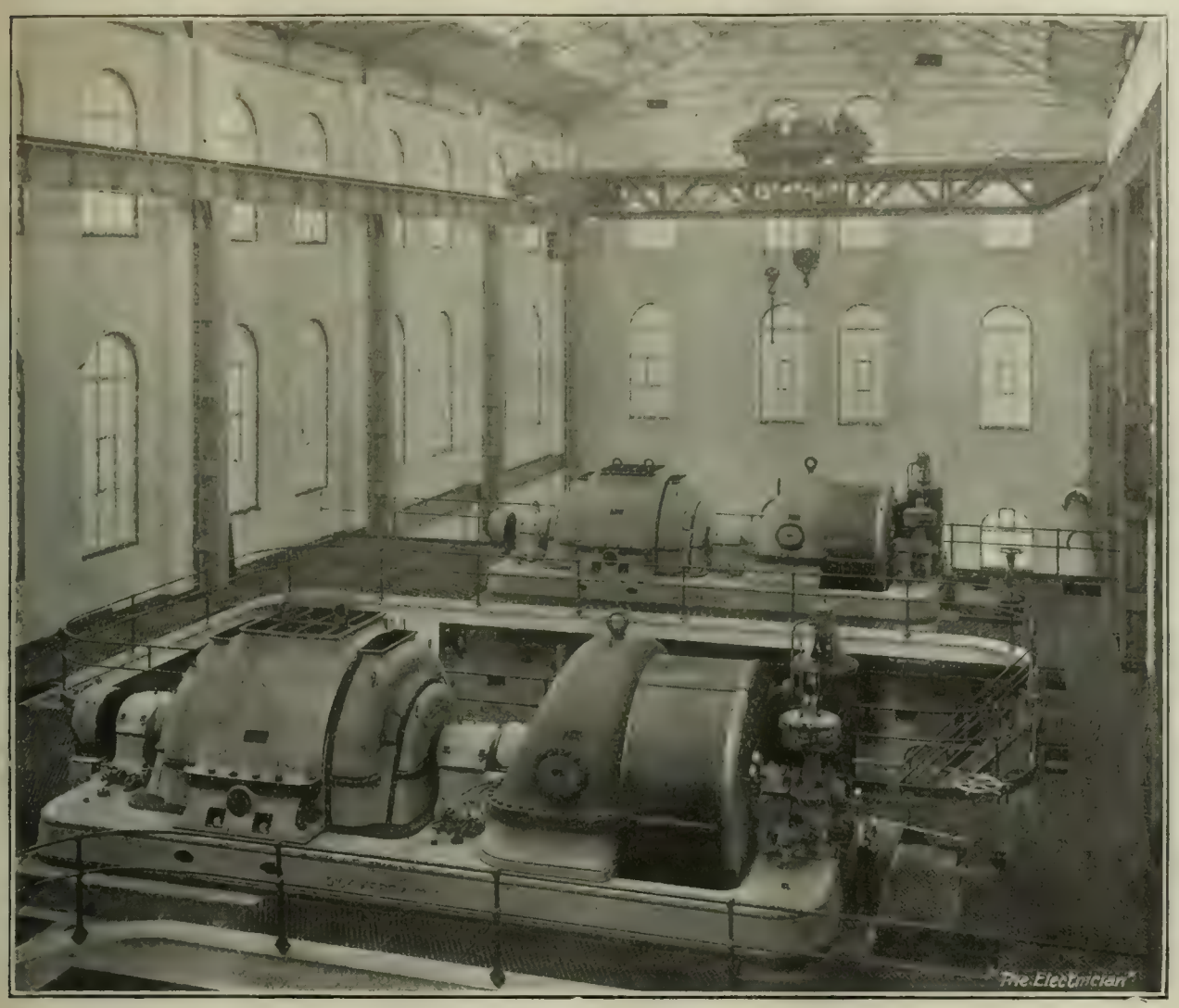


FIG. 7.—VIEW OF TURBINE ROOM.

There are three coal sidings for the exclusive use of the power station. Two are used for full and empty wagons respectively, having a capacity of 24 20-ton hopper waggons each ; the third siding is used chiefly for shunting purposes, and accommodates 16 20-ton



FIG. 8.—VIEW OF BOILER ROOM.

hopper wagons. Convenient connections are made with the up and down main lines, and the sidings are so arranged that unnecessary shunting is reduced to a minimum, and does not involve the main lines.

Turbine Room. The turbine room is 188 ft. long and 64 ft. wide. The turbine room floor consists of cast-iron non-slip grating. Suitable wells are arranged so that all auxiliaries in the basement, which is 20 ft. below, can be lifted directly by the crane. A 50-ton electric overhead travelling crane, made by T. Broadbent & Sons, of Huddersfield, is provided in the turbine room, having a span of 61 ft., and travels the full length of the building.

5,000 kw. Turbo-Alternator Sets. Two main generator sets, each having a normal capacity of 5,000 kw., are installed. The turbines were manufactured by Dick, Kerr & Co., of Preston. They are of the "Impulse" type, having a "Curtis" wheel at the high-pressure end, the remainder being on the "Rateau" principle. The speed is 1,500 revs. per min.

Each turbine has two rows of "Wolfram" steel blades on the velocity wheel, and 10 rows of brass blades on the low-pressure wheel, the axial and radial clearances being 5 mm. and 7 mm. respectively. The governor gear of each turbine is fitted with a small electric motor, enabling the gear to be controlled from the main switchboard. The total weight of each turbo-alternator is 115 tons 16 cwt.

Each alternator consists of a Dick-Kerr two-pole three-phase machine generating at 6,600 volts, 25 cycles, and is capable of carrying 25 per cent. overload for two hours and 50 per cent. overload for five minutes. The alternators are self-ventilated by means of fans fitted on the shaft at each end of the rotor. The air for ventilation passes through Heenan & Froude wet-air filters, each of which can deal with 25,000 cubic ft. to 30,000 cubic ft. of air per minute, the air passing through the filter at an approximate velocity of 1,500 ft. per minute.

Each turbo-alternator is complete with its own condensing plant, the latter being manufactured by W. H. Allen, Son & Co., of Bedford, and consisting of condenser, steam jet ejector, circulating water pump, kinetic air pump, extraction and delivery pumps, as shown in Fig. 12. The condensers are of the surface type, of sufficient capacity to deal with 82,000 lb. of steam per hour, and are capable of

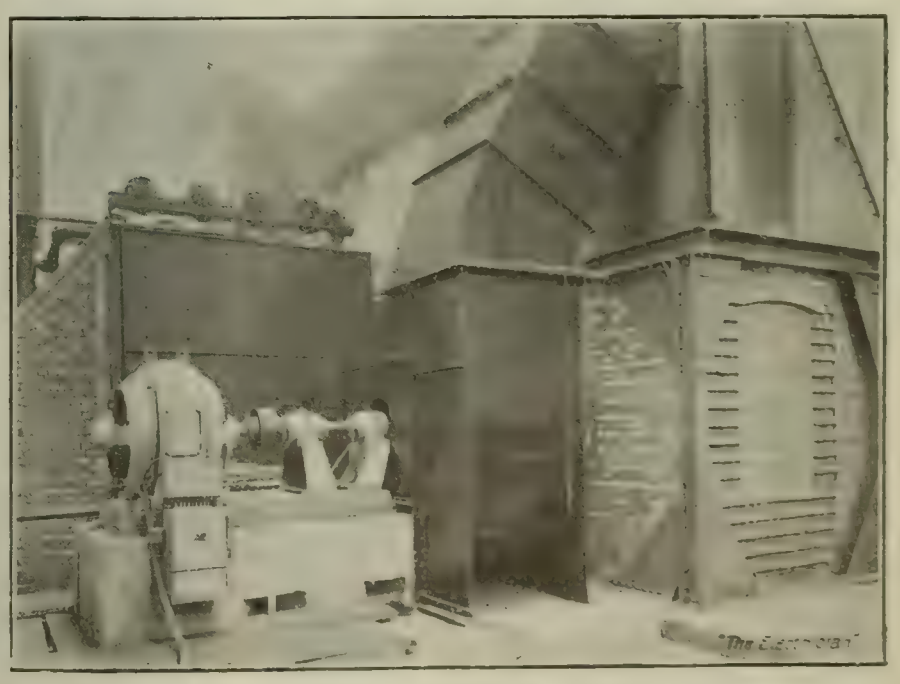


FIG. 9.—INDUCED DRAUGHT FAN AND MOTOR.

maintaining a vacuum of 28·1 in. (barometer 30) at full-load when supplied with cooling water at the rate of 6,700 gallons per minute at a temperature of 75°F. The condensers have a diameter of 80 in., and each is fitted with 3,464 tubes having an internal diameter of

$\frac{3}{4}$ in., the total cooling surface being 9,500 sq. ft. The weight of each condenser (exclusive of water) is 38 tons.

The circulating water pumps are of the "Conqueror" centrifugal self-regulating type, with 20 in. diameter suction and delivery branches, and are capable of delivering 6,700 gallons of water per

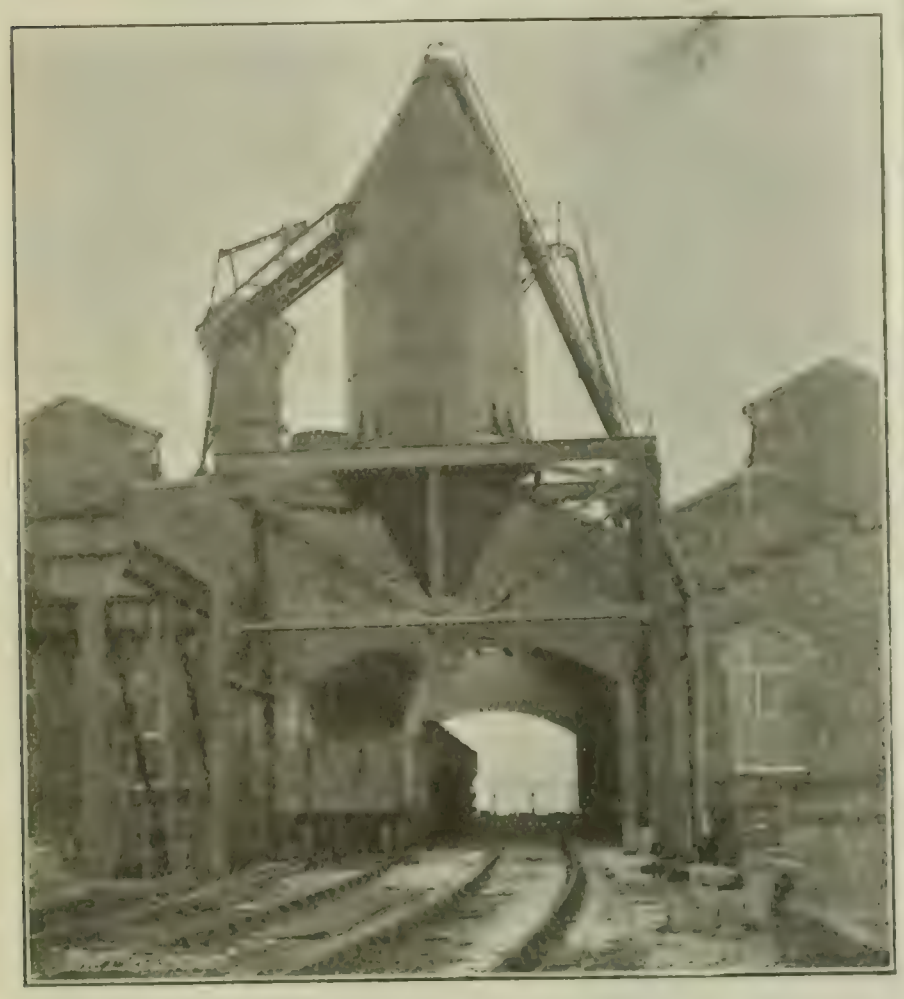


Fig. 10.—Ash Plant Receiver.

minute, against a 35 ft. head when running at 485 revs. per min. Each pump is directly driven by a Dick-Kerr slip-ring induction motor of 110 B.H.P.

The steam-jet ejector is supplied by a $1\frac{1}{4}$ in. steampipe, and the estimated steam consumption is 0·75 per cent. of the turbine steam consumption. When on full-load, this will take 465 lb. of steam per hour. The kinetic air pump (7 in. bore, 45,000 gallons per hour, 90 ft. head), extraction pump (5 in. suction, 3 in. delivery, 10,200 gallons per hour, 40 ft. delivery head), and the delivery pump (3 in. suction and delivery, 10,200 gallons per hour, 20 ft. head) are all mounted on one bed-plate, and are driven by means of a Dick-Kerr 45 B.H.P. slip-ring motor at 1,450 revs. per min.

500 kw. Geared Turbo-Alternator.—The power for the auxiliary apparatus is provided by a 500 kw. gear-driven turbo-alternator, built by the British Westinghouse Co. (see Fig. 13). This set which is complete with a surface condensing plant, generates power at 440 volts, 25 cycles, and the turbine is of the Westinghouse high pressure "Impulse" type, running at 3,600 revs. per min. The turbine has two rows of nickel steel blades on the velocity wheel, and 10 rows of nickel steel blades on the low pressure wheel, the axial and radial clearances being $\frac{1}{8}$ in. – $\frac{1}{16}$ in. and $\frac{1}{4}$ in. respectively.

The total weight of the turbo-alternator complete with gear and gear-case is approximately 30 tons. The gearing, which gives a speed reduction of 3,600 750 revs. per min., has been manufactured by David Brown & Sons, of Huddersfield. The gear wheel has a rim of special high carbon steel built up on a steel spider, and has 183 teeth. The pinion is made from solid nickel steel, and has 38 teeth, with a pitch of teeth 0·597 in. and a face width of 21 in.

The generator is of the Westinghouse alternating current engine type, capable of giving a continuous output of 500 kw. The con-

densing plant is on the Westinghouse-Leblanc patent system, and consists of condenser, circulating water pump, air-pump and extraction and delivery pump. A Westinghouse surface four-flow type condenser is used, which has a cooling surface of 850 sq. ft. It is capable of dealing with the turbine exhaust, and maintaining a vacuum of 27·5 in. to 28·5 in. (barometer 30 in.) on full-load when supplied with cooling water at the rate of 784 gallons per minute, at a temperature of 75°F. It is 6 ft. $8\frac{1}{2}$ in. between tube plates, and contains 652 tubes of solid drawn brass $\frac{3}{4}$ in. O.D. and 18 I.W.G. The total weight is approximately 5 tons.

The circulating water pump is of the centrifugal type, having 8 in. suction and delivery branches, and is capable of delivering 784

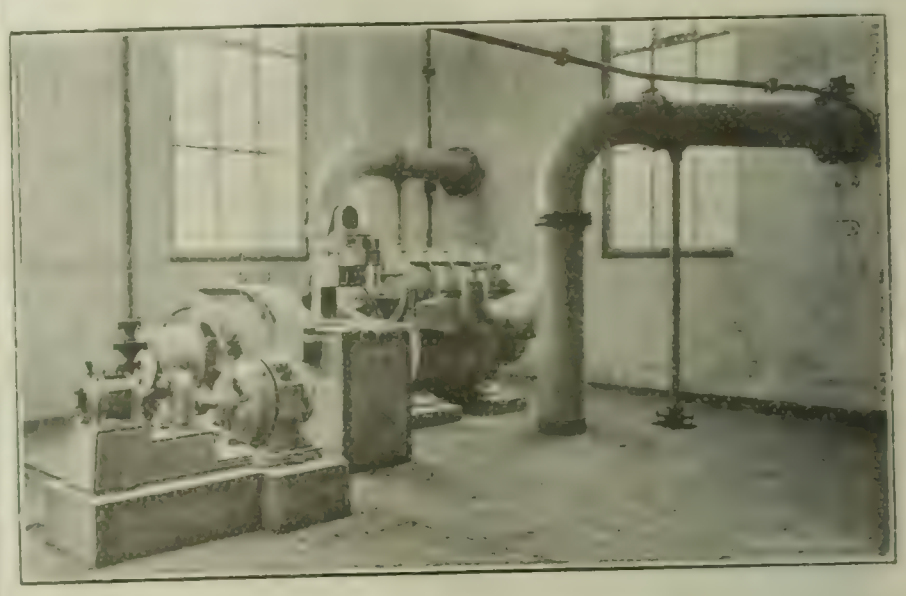


Fig. 11.—Ash Plant Blower.

gallons of water per minute against a head of 23 ft. when running at 1,440 revs. per min. The air-pump is of the Westinghouse-Leblanc rotary valveless dry-air type, with a 4 in. suction branch, and a 3 in. delivery branch. A centrifugal extraction and delivery pump is used, capable of delivering 11·6 gallons of water per minute against a head of 8 ft. when running at 1,440 revs. per min. All the three pumps are mounted on one common bed-plate, and driven by a 22 B.H.P. motor, the approximate total weight being 2 tons The arrangement of the circulating water pipes is seen in Fig. 14.

The hot-well is arranged centrally between the main generators, and is of liberal capacity, holding 1,460 gallons. It is divided into

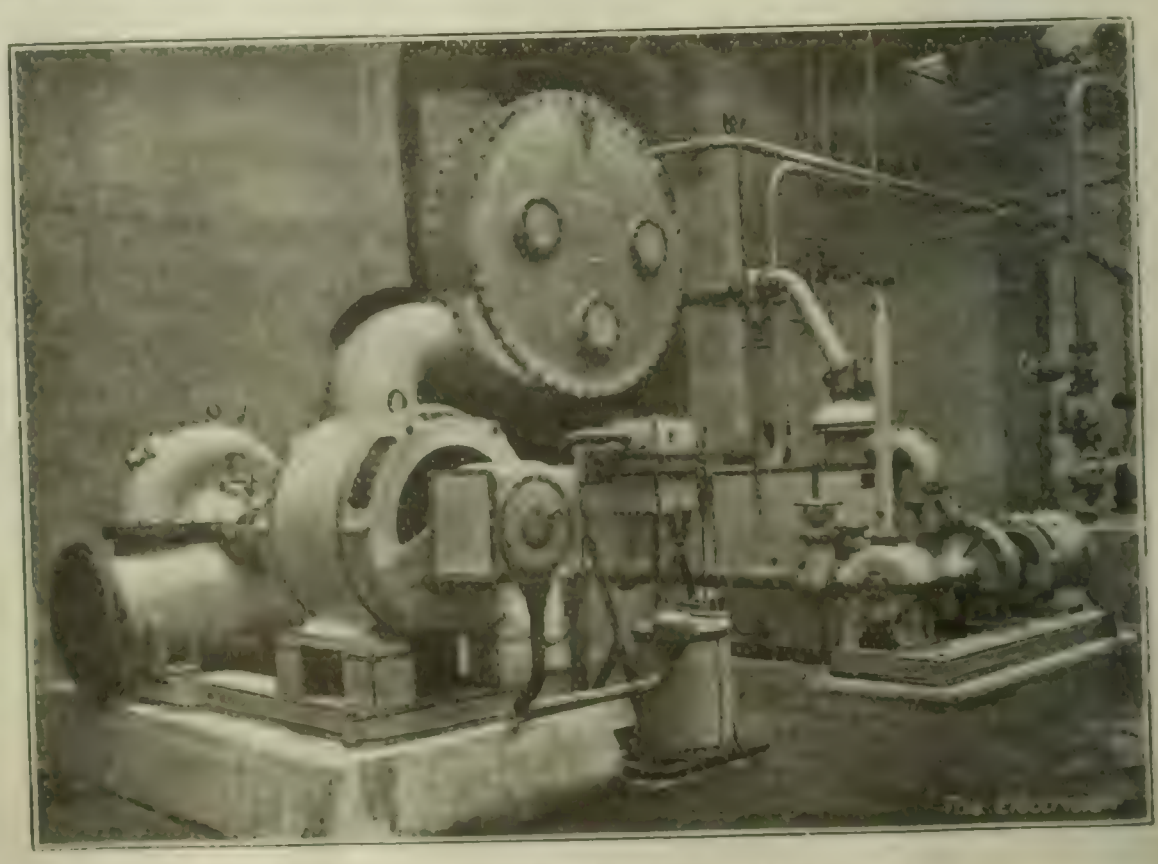


Fig. 12.—Condensing Plant, 5,000 kw. Turbo Alternator.

two compartments, so that the valves may be examined, and the tanks cleaned and painted, without putting it out of commission.

Provision is made for a supply of make-up water from an auxiliary tank, fed from the circulating water mains. This water is treated in a softener, and the supply regulated by a 3 in. float valve in the hot

well. An emergency connection is also taken from the town's main ; this also is controlled by a similar valve operating at a lower level in the hot-well. The condensate from the turbines is introduced at a point below the minimum water level in the hot-well, so as to prevent aeration. Connections are taken from the underside of the hot-well, one from each division, uniting in a common main to the feed pump suction. The water in the hot-well is heated by means of four 3 in. exhaust steam ejectors, the exhaust steam being taken from the turbine feed pump.

Two test tanks, mounted on weighing machines, are carried on the top of the hot well, and arranged to work alternately and independently of each other. The condensates from all the sets are so conveyed to the hot-well, that the condensate from any one set can be passed through the test-tanks, while the others are delivered directly to the hot-well.

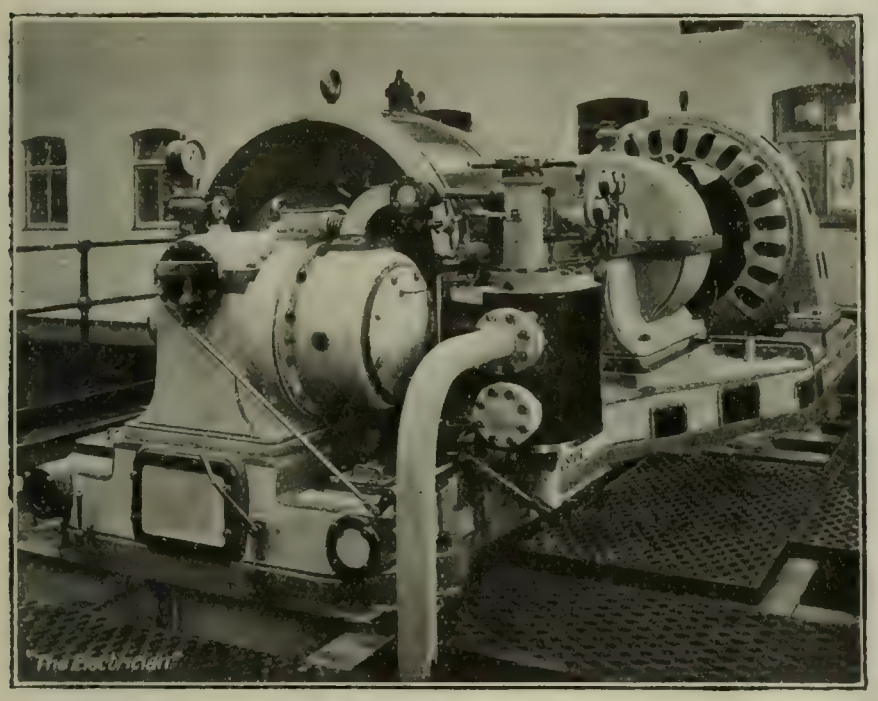


Fig. 13.—500 kw. Geared Turbo-Alternator.

A suitable tumbler, constructed to direct the flow of water into one tank or the other, is placed between and above the two tanks. By this means the water is diverted without interfering with the continuous delivery from the set under test. Each test-tank has a total capacity of 3,800 lb. of water, discharging through a 6 in. quick-acting valve directly into the hot-well below. The weighing machines are graduated to read zero when the tanks are empty.

(To be continued.)

THE PREDETERMINATION OF THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.*

BY PROF. MILES WALKER.

Summary.—The Paper opens with a discussion on general methods of calculating dynamo-electric machines and gives an outline of a method which is applicable to all types of such machines, whether alternating-current or continuous-current generators, motors, or rotary converters.†

Almost every electrical designer has his own particular method of calculating a machine and arriving roughly at its performance. Some of these methods are short, others are exceedingly elaborate.

Our ability to foretell the performance of an electrical machine, whether it be an alternating-current or continuous-current generator or motor, or a rotary converter, depends in the main upon our ability to calculate :—1. The magnetising current ; 2. The armature reaction ; 3. The losses in copper and iron ; 4. The temperature rise ; and, in the case of commutating machines, 5. The commutating conditions. This Paper will only deal with the first four of these.

Whatever the machine may be—alternating-current or continuous-current generator, induction motor, or rotary converter—the methods of calculating these quantities are in the main the same. It is, therefore, possible to have one general method of calculation for all these machines, and if we examine the methods of design described in text-books and in articles published in the technical journals, we shall see that they can be broadly divided into two classes :—

1. Those which take as the basis of the design the total flux per pole ; and

2. Those which take as the basis the maximum flux density in the air-gap.

For instance, in calculating the E.M.F. generated in the armature, one writes

$$E_g = K_t f S \Phi \times 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where f is the frequency, S the number of turns, Φ the flux per pole and K_t a coefficient depending upon the field-form and coil breadth.

Where the flux density in the air-gap is the initial quantity kept in view, the formula for the voltage generated in a single conductor takes the form

$$e_g = vBl \times 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where v is the velocity in centimetres per second, B the flux density in the air-gap, and l the length of iron in centimetres.

The first method has the advantage that, after fixing K_t, it only deals with the total flux, without troubling about the distribution of the lines of force in the air-gap ; but this very feature limits its application to those cases where we are content to know the mean E.M.F. generated. The first formula is, therefore, not so generally applicable as the second one. The author shows they may be combined as follows : If B is the flux density in the air-gap, r the radius of the rotor in centimetres, and R_{ps} the speed in revolutions per second, then the total flux passing into the rotor will be

$$B \times 2\pi r l,$$

and the total flux cut per second

$$B \times 2\pi r l R_{ps}.$$

Writing A_g for the total working surface of the armature (the area of the gap space)$=2\pi rl$, we have the E.M.F. e_g generated in one conductor :—

$$e_g = A_g B R_{ps} \times 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

or

$$e_g = A_g B R_{pm} \times (1/60) \times 10^{-8} . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The expression $A_g B$ gives us the magnetic loading of the frame.

If now, instead of a uniform air-gap and a constant flux density we have salient poles and a flux density varying from point to point along the gap, the formula for the average E.M.F. generated in the conductor becomes

$$e_g = K_f \times A_g B \times R_{pm} \times (1/60) \times 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where K_f is a coefficient depending on the ratio of the pole-arc to the pole-pitch. This coefficient, K_f, is in fact equal to the ratio of the area of the curve representing the field-form to the area of the rectangular field-form which we should have if the pole-arc were equal to the pole-pitch and the air-gap were perfectly uniform. Where a number of conductors Z_s are connected in series, as in the armature of a continuous-current generator, the formula for the total E.M.F. generated becomes

$$E_g = K_f \times A_g B \times Z_s \times R_{pm} \times (1/60) \times 10^{-8}. \quad . \quad . \quad . \quad . \quad (6)$$

Here $A_g B$ is the ideal magnetic loading of the frame ; that is to say, the magnetic loading which we could have if the pole-arc were equal to the pole-pitch. The coefficient K_f informs us what fraction of this ideal magnetic loading we have in the machine in question.

The author shows that for an alternating-current generator the formula is :—

$$E_g = K_e \times R_{pm} \times Z_a \times A_g B \times (1/60) \times 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where K_e takes account of the area and shape of field-form and also width of phase bands of armature conductors. He shows that $A_g B$ has a fairly definite maximum value for a given frame and the maximum flux density in the teeth is found by dividing this quantity by total tooth area.

Multiplying (7) by I_a the current in armature conductors we obtain a formula containing both the magnetic and current loading. Both these quantities being clearly before us during our consideration of alternative designs, we can observe how one decreases and the other increases in the fight for room which occurs between iron and copper.

The author next gives a general method of design, and with reference to field form and coefficient K_e refers to the Appendixes I. and II. He also refers to a typical calculation sheet.

Calculation of the Performance of a Three-phase Turbo-generator from the Dimensions of the Machine.—The machine chosen is a 2,700 k.v.a., 6,600-volt three-phase 50-cycle generator to be driven by a steam turbine at 3,000 revs. per min. The power factor of the load is 0·8 ; the amperes per terminal 236 ; the amperes per conductor 236 ; the permissible temperature rise 45°C (by thermometer).

It is not within the province of this Paper to give the considerations which fix the dimensions of the machine; the dimensions are supposed to be given, and the problem is to calculate the performance.

* Abstract of a Paper read before the Institution of Electrical Engineers on 13th inst.

† H. D. Symons and M. Walker : "The Heat Paths in Electrical Machinery," "Journal" I.E.E., Vol. XLVIII., p. 674, 1912.

The external diameter of the stator stampings is 122 cm.; the bore is 63·5 cm., and the gross length of iron 115 cm. The circumference of the working face is 192 cm., and the area 22,100 sq. cm. There are 21 radial air-vents in the stator, each 0·95 cm. wide, giving a net length of iron and paper of 95 cm., and a net length of iron in the armature of 84·5 cm. The depth below slots is 25 cm. The cross-section of the stator iron is 2,120 sq. cm., and the volume 645,000 cubic cm. There are 36 slots, the dimensions of which were given in the Paper, each containing six conductors 0·4 × 1·7 cm., giving a current density of 364 amperes per square centimetre. The voltage coefficient (see Appendix II.) is 0·392. There are 216 conductors in all the phases. The voltage formula reads as follows:—

$$6,600 = 0{\cdot}392 \times 50 \times 216 \times A_g B \times 10^{-8}$$
$$A_g B = 1{\cdot}56 \times 10^8.$$

The total cross-section of all the stator teeth (*see* Appendix I.) =10,600 sq. cm., so that the density in the stator teeth

$$= 1{\cdot}56 \times 10^8 \div 10,600 = 14,700 \text{ C.G.S. lines per sq. centimetre.}$$

From our iron loss-curve the loss is 0·1 watt per cubic centimetre, giving 4,400 watts in 44,000 cubic cm. The field-form constant K_f, amounts to 0·625 (see Appendix I.), so that the working flux per pole is $1{\cdot}56 \times 10^8 \times 0{\cdot}625 \div 2 = 48{\cdot}5 \times 10^6$.

As the cross-section of the stator iron is 2,120 sq. cm., we have the flux density behind the slots

$$= 48{\cdot}5 \times 10^6 \div 2 \div 2{,}120 = 11{,}400 \text{ lines per square centimetre.}$$

This gives a loss of 0·06 watt per cubic centimetre, or 39,000 watts in all, which, added to the loss in the teeth, gives a total of 43,400.

The resistance of all the armature conductors in series (see Appendix IV.) amounts to 0·15 ohm, or 0·05 ohm per phase. The increase in the armature copper-loss owing to eddy currents in the copper, worked out by the method given by Field,* amounts to 5 per cent. The total loss in a metre length of coil amounts to 107 watts. The cooling surface of a metre length of coil is 1,200 sq. cm., so that we have 0·088 watt per square centimetre. As the thickness of insulation is 0·27 cm., we have:—

$0{\cdot}088 \times 0{\cdot}27 \times 0{\cdot}0012 = 20$° C. difference of temperature between copper and iron.

Returning now to the losses to be dissipated by the stator surface, we find that the total armature copper loss amounts to 10,500 watts. Multiplying this by 115/265, we get 4,600 watts for the buried copper loss. The iron loss plus the buried copper loss thus amounts to 48,000 watts. To this we may add 10 per cent. for end-plate and other undetermined losses, making in all 53,000 watts to be dissipated by the surface of the stator. We are allowed 42° C. above the air, and we may, therefore, on the basis of figures given on p. 680, Vol. XLVIII. of the "Journal," take 25 (log. of the mean temperature difference between the air and iron in the air gap). The velocity of the rotor is 92 metres per second, so that we have

$$25 = \text{watts per square centimetre} \times 775 \times 0{\cdot}4 \times 0{\cdot}5,$$

(i.e., watts per square centimetre = 0·17).

Multiplying this by the area of the working face, 22,100, we get 11 kw. dissipated from the working face.

Next, as to the watts dissipated from the sides of the ventilating ducts, these may be taken at 0·1667 (see Appendix VI.). With an air supply of 4 cubic metres per second, the mean velocity, v, in the ducts may be taken at 8 metres per second.† This gives $k = 0{\cdot}0065$. The mean difference of temperature between the air and the walls of the ducts may be taken at 15° C. for a temperature rise of the iron of 45° C.‡ Thus the watts per square centimetre will be

$$15 = \text{watts} \times 0{\cdot}0065.$$

The total area of all the ducts = 150,000 sq. cm., which can get rid of a total of 23,000 watts.

The watts dissipated from the outside surface (see Appendix VI.) may be taken at $0{\cdot}15 \times 43{,}000 = 6{,}500$, giving a total of 30,500 watts; so that the temperature rise will be within 15° C.

At no load 6,600 volts the ampere turns on the pole projections are only 112; but with the increased leakage at full load they amount to 350. At 7,500 volts the increase is from 281 to 1,000 ampere turns. These ampere-turns as worked out according to the method given in Appendix I. amount to 2,600. To allow a margin we should design the winding to carry 20,000 ampere-turns.

As the part of the winding which projects from the slots is rather difficult to cool, it is sometimes made of greater cross-section than the part lying in the slots. In this case the field coils are made of copper strap measuring 0·305 cm. thick by 1·9 cm. wide. The part which is to lie in the slot is then milled down to 1·52 cm. wide. There are 720 metres of the smaller section and 372 metres of the larger. The resistance of the whole is 0·395 ohm, cold, or, say, 0·475 ohm, hot. The thickness of the wall of insulation in the slots is about 0·15 cm., and as the loss per square centimetre is about 0·18, we would expect to get $0{\cdot}18 \times 0{\cdot}15 / 0{\cdot}0012 = 22{\cdot}5$° C. difference of temperature between copper and iron.

Calculation of the Performance of an Induction Motor from the Dimensions of the Machine.—We must assume that the dimensions are given to us, and that it is required to calculate as nearly as possible the quantities required. We have chosen a 600 H.P., 10-pole motor, to work on a three-phase circuit at 2,500 volts and 50 cycles. The synchronous speed will, therefore, be 600 revs. per min. The outside diameter of the stator stampings is 127 cm.; inside diameter 100 cm.; gross length 46 cm. There are seven air ducts in both the stator and rotor, each duct 0·8 cm. wide. The net length of iron and paper is 39·4 cm.; taking 89 per cent. of this, we arrive at a net length of iron of 35 cm. The depth of iron below the slots is 9 cm. The cross-section of iron behind the slots is 315 sq. cm., and the volume is 117,000 cubic cm.

There are 120 slots in the stator, each containing six conductors, 0·36 sq. cm. in area. These conductors form coils lying in slots 1 and 16, 2 and 15, 3 and 14, 4 and 13, so that they form a normal full-pitch concentric winding. The total number of conductors in all phases is 720.

The first step in the calculation is to arrive at the total magnetic loading, $A_g B$; this is obtained from the formula

$$\text{Volts} = K_e \times R_{ps} \times \text{No. of conductors} \times A_g B \times 10^{-8},$$

or $2{,}450 = 0{\cdot}41 \times 10 \times 720 \times A_g B \times 10^{-8}$.

He next calculates the following quantities:—

$A_g B$ = magnetic loading	$= 0{\cdot}83 \times 10^8$
A_g = working face	= 14,400 sq. cm.
Tooth density	= 17,000 lines per square centimetre.
Total tooth iron loss	= 2,660 watts.
Flux per pole	$= 5{\cdot}5 \times 10^6$

Flux density in stator iron = 8,750 lines per square centimetre. Total iron loss 7,860 watts. Buried copper loss = 3,100 watts. Total iron and copper loss 10,960 watts. Temperature rise 30° C. Magnetising current 46·2 amperes. Rotor loss 5,760 watts.

The short-circuit current works out to 635 amperes. From the magnetising current, no-load loss current, and short-circuit current, we can work out the circle diagram in the usual manner. This gives us the power factor at full load as 0·88; the starting torque, 0·8 times full-load torque; the maximum torque, 2·7 times full-load torque; and the maximum horse-power, 1,500 H.P. The slip at full load is found by taking the ratio of the rotor losses to the rotor input. The output of the rotor at full load is 448 kw., so that the slip will be 1·27 per cent.

Appendix I.—Plotting and Calculation of a Cylindrical Field-Magnet with Highly Saturated Taper Teeth

In cases where the teeth of the field-magnet are tapered and highly saturated, the matter is somewhat more difficult, and it may be well to illustrate the process in the following example:—

The first step in the process of drawing the field form is to plot an "air-gap and tooth-saturation" curve; indeed, where the slotting of the rotor is not uniform all round, it is necessary to have such a curve for each kind of slotting. Thus, one of these curves is required for the part of the rotor which is uniformly slotted, and another curve is required for the polar projection, which may be regarded as one large tooth. These curves are shown in Fig. 1 and are marked F and G.

In Table I. are given the figures from which the "air-gap and tooth-saturation" curve for the slotted part of the rotor is plotted. In these curves it is well to take as abscissæ ampere turns per pole, and so estimate the flux density in the air gap on the middle line of the gap. The flux density on this line may be taken as the standard from which the flux density in an adjacent tooth may be calculated.

The length of the air-gap is 2·25 cm., and the air-gap coefficient* is 1·08; so that the ampere turns on the gap are equal to $B_g \times 2{\cdot}25 \times 1{\cdot}08 \times 0{\cdot}796$. Therefore, for 7,000 lines per square centimetre in the gap we have Ampere-turns per pole = 13,500.

This gives us the "air gap line" shown dotted in the figure. For the part of the air gap adjacent to the polar projections, where there are no slots in the rotor but only ventilating ducts the air gap coefficient is only 1·02. The air gap line of this part would, therefore, be slightly above the thick dotted line in Fig. 1.

For the purpose of finding the ampere turns expended on the teeth we shall consider three sections of the teeth; one, C, taken on

* A. B. Field.—"Eddy Currents in Large Slot-wound Conductors." "Transactions" of the American Institute of Electrical Engineers, Vol. XXIV., p. 761, 1905. See also M. E. Field: "Eddy Currents in Solid and Laminated Metals." "Journal" I.E.E., Vol. XXXIII., p. 1127, 1904.

† "Journal" I.E.E., Vol. XLVIII., p. 712, 1912.

‡ Ibid., p. 713.

* Hawkins and Wallis.—"The Dynamo."

Table I.—*Calculation of Ampere-turns on Taper Teeth.*

	l_2-l_1.	Section of teeth.	Section of iron and air.	K_s.	B_t/B_g	B_g=5,000. Apparent B_t.	$\int HdB \div 10^6$.	Difference.	Amp.-turns per cm.	Amp.-turns.	B_g=6,000. Apparent B_t.	$\int HdB \div 10^6$.	Difference.	Amp.-turns per cm.	Amp.-turns.	B_g=6,500. Apparent B_t.	$\int HdB \div 10^6$.	Difference.	Amp.-turns per cm.	Amp.-turns.
C		10,000	21,300	2·29	2·21	11,100	...	...	...	...	...	...	...	...	...	...	...	...	...	290
	4·5	...	...	...	...	13,150	...	...	8	36	15,800	...	...	32	144	17,100	...	...	64	...
D		7,300	18,800	2·56	3·04	15,200	0·1	...	...	...	18,200	0·2	...	...	...	19,800	0·35	...	...	...
	4·5	...	...	...	...	...	...	1·7	198	880	...	...	7·05	650	2,940	...	...	12·15	1,070	4,800
E		4,600	15,400	3·34	4·8	24,000	1·8	...	...	...	28,806	7·25	...	...	...	31,200	12·5	...	...	...
						Total				916	Total				3,084	Total				5,...

the surface of the rotor; another, D, half-way down the teeth; and another, E, at the root of the teeth. It will be found most convenient to make the calculation as if 42 teeth were cut on the rotor. Column 2 in Table I. gives the length l_2-l_1 between C and D, 4·5 cm., and between D and E, 4·5 cm. The third column gives the total cross-section of iron in all the teeth at the various sections. Column 4 gives the section of iron and air. From columns 3 and 4 we calculate the ratio K_s given in column 5.

The circumference of the middle air-gap line is $61{\cdot}25\times\pi=192$ cm. This multiplied by the gross axial length, 115 cm., gives us $A_g=22{,}100$ sq. cm. The apparent density in the teeth (that is, the density there would be if no flux leaked along the slots and vents) we will denote by B_t; this is most conveniently found by multiplying the density in the gap by the ratio of the section of the gap to the section of the teeth, which is given in column 6 under the heading B_t/B_g. It is convenient to make the calculation of the ampere-turns on the teeth for three densities in the gap; in this case, B_g=5,000, 6,000 and 6,500. In the seventh column will be found B_t at the three sections for B_g=5,000. It will be found that the ampere-turns on the part

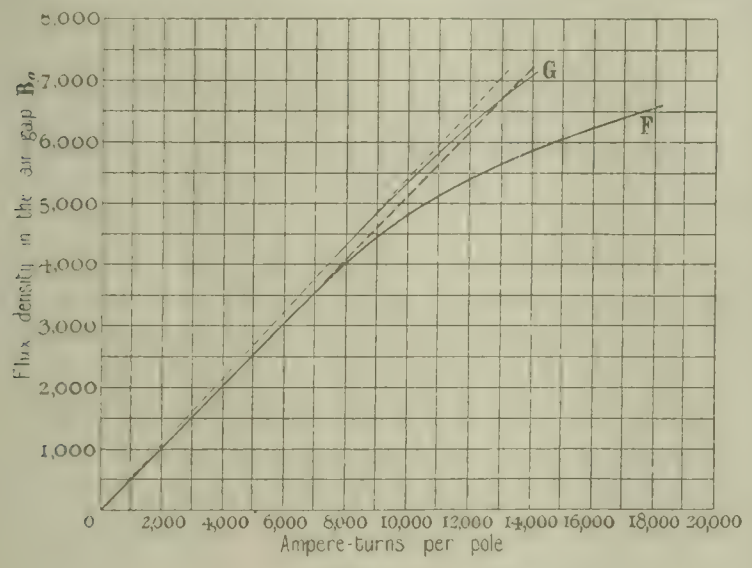


FIG. 1.

of the tooth lying between C and D are so small compared with the ampere-turns on the part from D to E that it is not worth while to apply Hird's method to the upper part of the tooth. It is sufficient to take the mean density, in this case 13,150, and find the ampere-turns per centimetre from the magnetisation curve of the iron, in this case 8 ampere-turns per square centimetre, which, multiplied by 4·5, gives about 36 ampere-turns on the part C, D. To find the ampere-turns on the part D, E, we find the value of $\int HdB$ for the value of B_t at D, equal to about $0{\cdot}1\times10^6$; and the value of $\int HdB$ for the value of B_t at the section E, equal to $1{\cdot}8\times10^6$. The difference, $1{\cdot}7\times10^6$, divided by the difference between the values of B_t, gives 198 ampere-turns per centimetre. This multiplied by 4·5 gives 880 ampere-turns for the part of the tooth from D to E; so that the total ampere-turns on the tooth are about 916. This is set off from the thick dotted air-gap line in Fig. 1, and gives us a point on the "air-gap and tooth-saturation" curve. Similarly, for B_g=6,000, the ampere-turns on the tooth amount to 3,080; and for B_g=6,500 the ampere-turns amount to about 5,090. Adding these figures to the ampere-turns on the air-gap, we get the "air-gap and tooth saturation" curve shown by curve F in Fig. 1.

The saturation curve for the polar projection may be obtained in the same way, except that in this case it is necessary to take into account the leakage flux, which may be estimated by any of the known methods. The magnetisation curve for this part is shown by the curve G in Fig. 1.

The method of obtaining the field-form at no load, full voltage, is necessarily one of trial and error, because until we know the field-form we do not know accurately the value of K_e, and we cannot find K_e until we know the maximum ampere-turns on the poles. The usual practice is to guess the value of K_e from experience of previous machines, and from it to obtain an approximate value for the maximum flux density in the gap. In this case one or two trials gives us a maximum density of 7,000 C.G.S. lines per square centimetre. From curve G we find that this requires 32,700 ampere-turns per pole. We now lay out the spacing of the slots in the rotor on the abscissa line as in Fig. 2, and write down 32,700 ampere-turns per pole for the part of the iron encircled by the conductors in slot 8, 12,000 for slot 7, 10,300 for slot 6, and so on.

Referring, now, to curve F, Fig. 1, we are able to plot the values of the gap density opposite to each tooth. It will be seen that Fig. 2 shows two curves; the inner dotted one gives the value of the flux density opposite to the tooth between slots 7 and 8 as 5,400, as obtained from Fig. 1. This would lead to a field-form which is too narrow across the top. In order to avoid this, a steel wedge is put

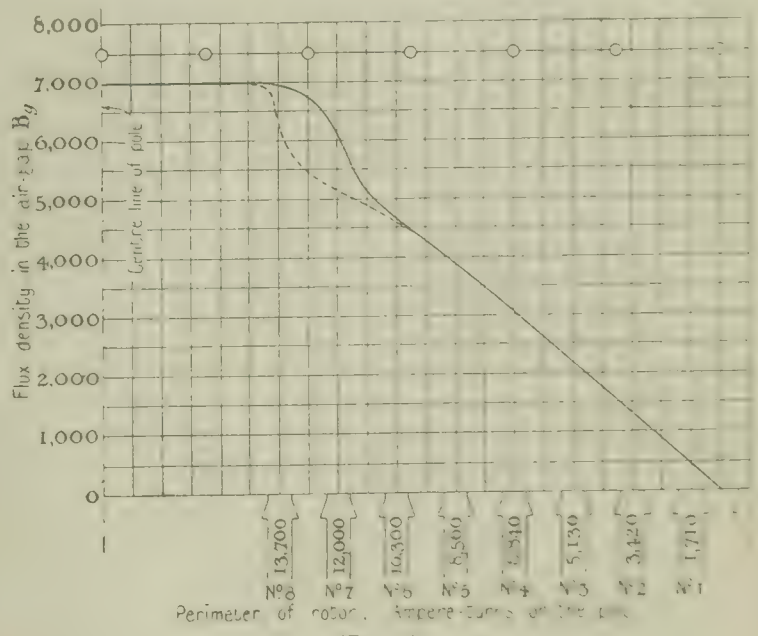


FIG. 2.

in the eighth slot, which avoids the super-saturation of the tooth between slots 7 and 8, and gives the field-form a broader top, as shown by the outer curve. The exact shape of this curve cannot be calculated. Oscillograph records show that the field-form on a cylindrical magnet of this kind has appreciable steps on the sides; but the smooth curve shown in Fig. 2 is sufficiently near the actual case for the purpose of finding K_e.

In order to calculate the total flux per pole it is convenient to use a coefficient which may be called the field-form coefficient, denoted by K_f, which gives the ratio between the area of the field-form and the area of the rectangle, the height of which is the maximum flux density in the gap and the base the pole-pitch. It is easily obtained in practice by running a planimeter around the curve in Fig. 2, and then around the rectangle indicated by the dotted line. The ratio between these areas in Fig. 2 is 0·625.

In order to plot the no-load magnetisation curve strictly one ought to go through this process of plotting the field-form for a number of different excitations and find the voltage generated in each case. In practice, however, it will be found that with this type of field magnet the value of K_e does not change very much with change in the exciting current. We may for practical purposes take the voltage as proportional to the maximum flux density in the gap. If this is done we can plot the no-load magnetisation curve from Fig. 2 for the ampere-turns on the central part of the pole for the voltages 6,000, 6,600 and 7,500. To find the ampere-turns at full load and 0·8 power factor one has recourse to graphic construction.

(To be concluded.)

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ELECTRIC LIGHTING, TELEGRAPHY AND OTHER APPLICATIONS OF ELECTRICITY IN 1915.

In electric lighting, notwithstanding the military regulations which have reduced street lighting to such small proportions, some progress has been made in the means of illumination. There has been a continued advance of the gas-filled lamp, and mention should also be made of the new Ediswan lamp. One of the interesting features of the latter is the fact that use has been made of the property possessed by heated bodies of emitting ions. This is a property which has become increasingly important during the last year or two, and is finding application in more than one direction ; for example, there is the "kenotron" of LANGMUIR, in which the same property is used for the rectification of very high-pressure currents. Another feature of the Ediswan lamp is the fact that the source of light is extremely concentrated, whence the name of "Pointolite" is derived. This concentration of the source of light in the newer lamps is introducing fresh problems in illumination, and these were discussed recently at some length at a meeting of the Illuminating Engineering Society. From some points of view the concentration of the light source is not the ideal at which to aim, and consequently it becomes necessary to use gas-filled lamps (and others of that kind) in such a way as to diminish this property.

One of the most important events during the past year in regard to lighting has been the report of the Departmental Committee appointed by the Home Office to consider the lighting in factories and workshops. In this report certain general recommendations were made, one of which is to the effect that the minimum illumination on the floors of factories should be 0·25 ft.-candle. Useful work on this subject is being carried out by the Illuminating Engineering Society, and we trust that before so very long the lighting

of factories and workshops will be placed upon a really satisfactory basis.

Although street lighting has been under a cloud owing to the war regulations, and there has, consequently, been no expansion of the lighting load on generating stations, there has, nevertheless, been a large increase in the power load in all parts of the country. This has necessitated the laying down of fresh plant in many cases at somewhat short notice, and recently the Government has adopted an attitude permitting local authorities to raise loans for this purpose on terms which are suitable to the peculiar circumstances which are now prevalent.

An item of scientific and practical interest was the publication by the International Photometric Commission of a research by Dr. E. Ott on the dependence of the light of the Hefner lamp on atmospheric conditions.

In telegraphy it is only natural that there should not be very much to record at the present time, as doings, more particularly in the field of submarine telegraphy, are kept under the seal of secrecy. The traffic at the present time is very much heavier than it was in times of peace, notwithstanding the curtailment of commercial requirements. In fact, it may be said that the traffic has increased threefold on submarine cables, and it has only been possible to handle this large volume of messages by the introduction of increasingly efficient means. Of all the companies, the Indo-European Telegraph Co. has been placed in a position in which it has experienced the most interference with its normal operations, owing to the fact that the Company depends upon European land lines to a considerable extent. Some of these are, of course, now in enemy hands; others are out of use, and the Russian lines have been placed at the disposal of the Russian Government. Fortunately, owing to the fact that the Company has a reciprocal working arrangement with the Eastern and Associated Telegraph Companies, the revenue has been maintained and the shareholders have not suffered. This Company is still experimenting with radiotelegraphy, and is making use of the Orling relay in this connection.

Attention may be called to the interesting Paper read by Col. G. O. Squier before the Physical Society, in which the submarine cable was regarded as a power transmission line, and the possibility was considered of using alternating currents at low frequency for signalling, the amplitude being varied in order to give dots and dashes. The system seems promising and created a good deal of interest.

Of general interest was the evidence taken by the Dominions Royal Commission (and published during the early part of last year), partly in regard to the possible leasing of one of the Western Union Co.'s lines across the Atlantic for the use of the Dominions Governments, and partly in regard to the future of radiotelegraphy.

In telephony the outstanding event has been the achievement of transcontinental telephony in the United States between New York and San Francisco. The distance is 3,400 miles, and the results appear to have been entirely satisfactory. This achievement has been rendered possible partly by means of Prof. Pupin's loading coils and partly by means of Dr. Lee de Forest's audion relay. By means of phantom circuits, three conversations can be carried on simultaneously between New York and San Francisco. Even so, the cost of the service must be enormous, as it is estimated that, when a conversation is being carried on, line equipment valued at £400,000 is temporarily out of use. Consequently, even though several telegraph messages can be sent over portions of the line at the same time, it would seem as if the present service could scarcely be described as of a commercial character.

Elsewhere, also, the loading of telephone cables has made further progress. An interesting example of this class of work is the cable from London to Birmingham, which was put into public use during the past year. This consists of 110½ miles, and will in due time be extended to Liverpool. In this case the loading coils are placed at intervals of 2½ miles. Mention may also be made of the phantom circuit system developed by the Western Electric Co.

Automatic telephony still appears to make progress. At the San Francisco meeting of the American Institute of Electrical Engineers it was stated by Mr. W. L. Campbell that the automatic system at Los Angeles, which started in 1902, now comprises 15 automatic offices and serves 60,000 subscribers' stations.

In wireless telegraphy there has been a notable advance in the use of the Poulsen arc. The 150 kw. arc at Darien appears to have proved quite successful, and it was recently announced that the Naval authorities in the United States were obtaining quotations for a 350 kw. arc generator to give 250 amperes in the antenna, the range of wave-length being from 4,000 to 18,000 metres without extinguishing the arc. So large a size seems extraordinary after the smaller sizes to which we have been accustomed. This particular set is to be installed at Honolulu, whence it is expected to communicate with the Philippines, a distance of 4,600 miles.

The preference which seems to be springing up for continuous waves is shown in the United States Navy and by the installation of a 150 kw. high-frequency alternator at Sayville, in the United States. In regard to radiotelegraphy generally, there is not a great deal to record. In the United States further experiments have been made by the Army with kites as a substitute for the ordinary aerial, a considerable extension of range being so obtained—namely, from six to sixteen times. As far as research is concerned, such work is necessarily at a standstill, though some interesting observations were published by the Committee on Radiotelegraphy of the British Association in regard to strays.

In wireless telephony, on the other hand, there has been a very marked advance in the distance that has been covered. In fact, this means of telephony has certainly developed into something approaching commercial success by departing from the carbon microphones and similar devices and taking advantage of ionic methods, as exemplified in Dr. Lee de Forest's audion. In the experiments in which transmission was effected between the United States and the Eiffel Tower 300 bulbs were used for the purpose of transmission.

There was also a remarkable performance in September by the combination of wire and wireless telephony when Mr. T. N. Vail spoke from New York to San Francisco, speech being transmitted by wire over 500 miles and then by wireless telephony the remaining 2,500 miles. Another record in wireless telephonic communication was created on the same day when speech was transmitted from Washington to Honolulu, a distance of 4,600 miles, 2,500 of which were over the American continent.

Among the various developments during the past year may be mentioned the further progress made in electric welding by means of what is termed percussive welding, due to Messrs. C. E. Skinner and L. W. Chubb. Considerable progress has also been made in industrial heating such as is required for the heating of metals in heat treatment, and, lastly, further progress is being made in Sweden in the electric smelting of iron ores.

NOTES ON THE IGNITION OF EXPLOSIVE GAS MIXTURES BY ELECTRIC SPARKS.*

BY J. D. MORGAN.

Summary.—The author refers to experiments by Dr. Thornton and Dr. Wheeler on the minimum current necessary to explode a gaseous mixture. He next deals with the "incendivity" of the spark, and considers the Home Office minimum of 25 volts for bell ringing in mines too high for safety.

General Theory.

It is a commonplace of ordinary experience that to produce ignition the temperature of the igniting means must not be below a certain definite value. This fact appears to have led to the belief that temperature is the determining factor in ignition. It is well known, however, that if the temperature is not accompanied by a sufficient quantity of heat, ignition will not occur. Without going into details it is at once apparent from the results already obtained that a greater amount of energy is required to produce an igniting spark by an alternating current than by a continuous current; and the relationship between the number of volts and amperes in the circuits immediately prior to the production of the sparks differs in character in the two cases. This fact is in itself sufficient to prompt the question: Does ignition depend upon some factor other than heat? A variety of experiments suggest a reply. If an iron wire heated by an electric current (continuous) be held over the disc of a charged electroscope it will be found that when the wire first becomes visibly hot there is no effect upon the electroscope and gas cannot be ignited. On gradually increasing the current a condition of temperature is attained at which the electroscope steadily discharges. It is at this temperature that ignition occurs. In a Paper by Prof. Thornton† a similar experiment with platinum wire is mentioned, and in the same Paper there is recorded the most interesting and important result found by Mr. J. R. Thompson, that "it is possible to ignite a cold explosive mixture by the incidence of X-rays on a platinum surface in it."

Another experiment bearing on the subject consists in so adjusting the spark-gap between a pair of pointed poles in the high-tension circuit of an induction coil that in neither air nor coal gas alone can a spark pass, but the poles emit a faint blue glow or brush discharge visible in darkness. If the poles are contained in a small chamber into which an explosive coal gas and air mixture is introduced, it is found that after an interval, which varies with the size of the gap, the gas explodes. The time can be made to vary from a fraction of a second to as much as two minutes. If the gap is too large no explosion can be produced.

Experiments such as those above described all suggest the ionic origin of ignition. It has been shown that where a hot wire or spark is the source, ignition only occurs when ionisation is produced, and ionisation alone without heat has been found to be capable of causing ignition.

In the summary of an investigation by Dr. H. F. Coward‡ of the limiting pressure for ignition with a high-tension sparking arrangement, the opinion is expressed that "the ignition of an inflammable gas mixture is largely governed by the two factors—namely, (*a*) its thermal conductivity, and (*b*) the energy degraded when the discharge is passed." He also states, however, "that the experiments (described in his Paper) do not prove whether the ignition is ultimately a thermal or an electronic effect." This quotation is given as showing that investigators of ignition phenomena are inevitably driven to suspect, if not to accept, the ionic origin of ignition. Whatever be the final decision, there is sufficient evidence, as above indicated, for stating now that ionisation alone is capable of causing ignition, and ionisation accompanies the common electrical methods of ignition.

In a general way it is well known that gas mixtures are only combustible when the proportions lie within certain limits. These limits for methane and air, have been carefully worked out by Dr. Wheeler, and the least single igniting spark for mixtures between these limits have been investigated by both Wheeler and Thornton. Mixtures of methane and air containing less than 5·6 per cent., and more than 14·8 per cent., of methane are incapable of ignition.

The author gives a curve by Dr. Wheeler showing the least continuous current necessary to ignite different percentages of methane and air. He also shows a curve obtained by Dr. Thornton, which, however, differs slightly from that obtained by Dr. Wheeler. Another curve by Dr. Thornton, in which alternating current is used to ignite similar mixtures of methane and air, is also given.

A common method of defining the least spark which will ignite a given gas mixture is by specifying the number of volts and amperes, or the number of amperes and the inductance in the circuit prior to the formation of the spark. On the assumption that this gives a measure of the ability of a spark to ignite a gas (or the "incendivity of the spark), the validity of the method has been rightly questioned. For both inductive and non-inductive circuits there seems to be no sufficient reason, as will be explained later, for the assumption that the energy associated with a circuit prior to sparking can be regarded as a measure of the incendivity of the spark.

The author finds that a single spark which when repeated slowly will not ignite a gas will, after a more or less definite interval, produce ignition when repeated rapidly. The element of time seems to him to be a factor of importance in ignition phenomena. If instead of a single-break device a vibratory make-and-break device (such as the trembler of a bell) be employed, it is found that the ability of a given spark to ignite a gas mixture depends upon the duration of the sparking as well as upon the circuit conditions recorded in the investigations above described.

Fig. 1 shows a typical result following the use of a trembler spark in an explosive atmosphere consisting of a 10 per cent. mixture of coal gas and air. The current was approximately 0·4 ampere throughout the range of the experiment. At 9 volts, ignition was obtained instantly. On reducing the voltage to 7, a single-break spark would not ignite the gas, even when repeated as rapidly as hand manipulation would permit; but when the trembler was allowed to vibrate normally, ignition due to the trembler spark occurred after one second. At 5 volts, ignition occurred after 10 seconds. This fact appears to be of practical importance in connection with that system of bell signalling commonly used in mines in which the circuit is closed by the application of a piece of iron to a pair of bare wires. Sometimes an old file or a knife is used, and whatever be the implement employed the surface is usually rough. In drawing this implement across the wires there is not obtained the single spark of carefully maintained laboratory apparatus, but a rapid succession of sparks approximating to that of the trembler.

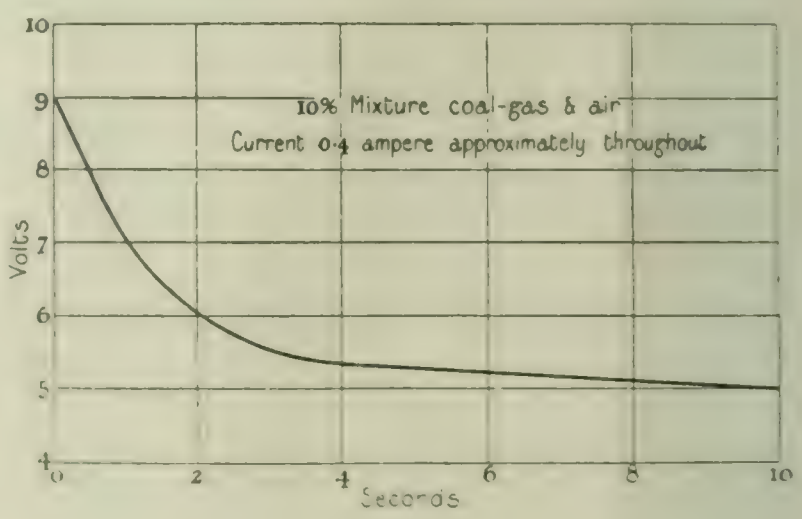


Fig. 1.

Reverting now to the question as to whether the measure of the circuit volts and amperes, or amperes and inductance, can be regarded as a measure of the incendivity of the spark, Prof. Thornton has stated that the energy of a break-flash (referred to sometimes in this Paper as a single spark) is proportional to the power of the circuit and is equal to $\frac{1}{2}Li^2$, where i is the circuit current.* In a recent leading article the "Electrical Review"† has gone a step further. Arguing from Prof. Thornton's work, and basing its calculation specifically on certain curves by Dr. Wheeler, it is stated that the igniting power of a break-flash depends on the $LC^{\frac{1}{2}}$, or approximately the L^2, of the circuit. Finally, it is stated that for every gaseous mixture there is a constant value of the product L^2, beyond which the break-flash will be capable of igniting the mixture. This is an interesting deduction, but the truth does not seem to be expressible in such a simple form. Igniting sparks can be produced in practically inductionless circuits carrying but a few amperes. These sparks, which may be termed "hot-point" sparks, are not included in an expression based on inductance.

* Abstract of a Paper read before the Birmingham Section of the Institution of Electrical Engineers.

† W. M. Thornton. "The Electric Ignition of Gaseous Mixtures." "Proceedings" of the Royal Society, A, Vol. XC., p. 272, 1914.

‡ H. F. Coward, C. Cooper and J. Jacobs. "The Ignition of some Gaseous Mixtures by Electric Discharge." "Transactions" of the Chemical Society, Vol. CV., p. 1069, 1914.

* W. M. Thornton. "The Least Energy required to start a Gaseous Explosion." "Philosophical Magazine," Vol. XXVIII., p. 734, 1914.

† "Electrical Review," Vol. LXXVII., p. 65, 1915.

When a pair of contact points in a non-inductive circuit are separated so that an arc is maintained between them it is true that the product $v \times i$ is a measure of the power of the arc. The value of $v \times i$ is not necessarily the same during arcing as when the contacts are together, and there is no reason for assuming them to be the same when the arc is only of momentary duration. Therefore $v \times i$ prior to sparking is not a measure of the power of a hot-point spark. Further, in non-inductive circuits carrying the same power, both igniting and non-igniting sparks can be produced by simply altering the shape or material of the contacts. Again, when the circuit is inductive and the above effect does not enter or is negligible, then the energy which produces the spark on separating the contacts is expressed by $\frac{1}{2}Li^2$. With the same energy either igniting or non-igniting sparks may be produced according to the shape or material of the sparking points.

The general conclusion to which the author has been led by a variety of experiments on the electrical ignition of gases is that it is necessary to distinguish between the energy which produces a spark and that quality of the spark termed by him "incendivity," which enables the spark to cause ignition, and that the magnitude of the one is not a measure of the other, although there may be a more or less regular relation between them when certain physical conditions are kept constant. Ignition seems to depend on the ionisation caused by the spark. During the interval of sparking the ionisation may be rapidly dissipated or neutralised. If the neutralising action predominates there is no ignition of a gas mixture. If there is little or no neutralising action ignition occurs immediately. Between these two limits there is a variety of intermediate conditions, which apparently accounts for the delay of ignition indicated by Fig. 1, and much of the great irregularity that is often experienced in experimental work on this subject.

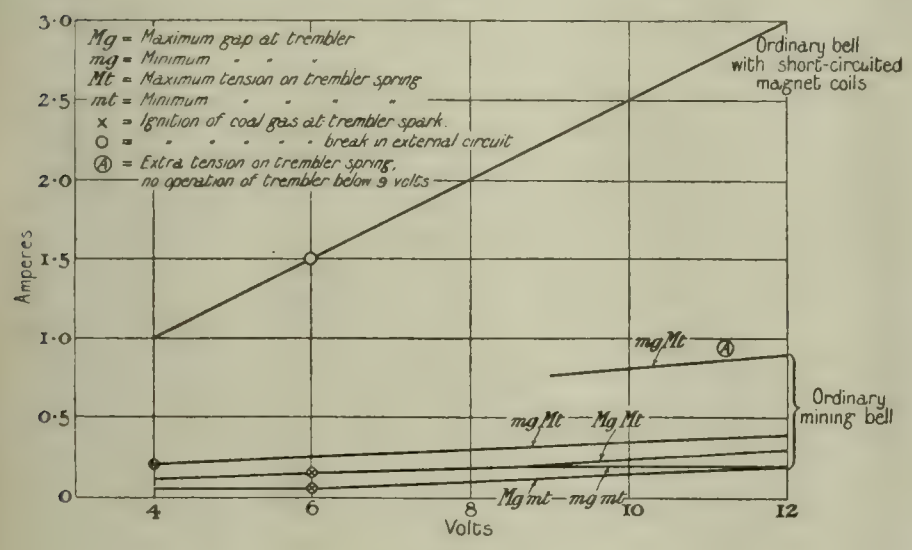


Fig. 2.

The prevention of ignition by sparks in the power and lighting circuits of mines has been thoroughly investigated, and, excepting accidental breakage of cables, no danger need be apprehended if the usual protective devices are maintained in proper condition. The open sparking on the bare wires of the bell systems has, however, been neglected, and an urgent necessity has arisen to render it harmless. Before dealing with this subject, a brief digression may advantageously be made on the protection of enclosed apparatus.

After touching upon the work that has been done on enclosed apparatus from the point of view of explosion, the author passes on to the question of electric bells.

Mine Bell-Circuits.

The danger associated with bare signal wires has, in the author's opinion, been somewhat exaggerated; nevertheless, some danger does exist, and it is well that the risk should be eliminated. Suggestions have been made to abolish bare-wire circuits and employ enclosed switches arranged at suitable intervals along insulated circuits, but the inconvenience of this is sufficiently evident to make it clear that miners will not abandon the bare-wire system unless it is shown to be irremediably dangerous. The facts appear to be that the system is not seriously risky and that what risk does exist can easily be removed. A very careful investigation of the subject has already been made by Dr. Wheeler, and his report contains valuable suggestions of a simple and practical nature.

The spark at the trembler of a bell is rightly regarded in a general way as more dangerous than the single-break spark which occurs on the bare circuit when a signal is given. To avoid the use of a trembler it has been proposed to use single-stroke bells; but the trembler bell is apparently preferred by miners as the liability to mistake in the interpretation of a signal is less with the trembler than the single-stroke bell.

The results of tests by the author on a mining bell in an atmosphere of coal gas are shown in Fig. 2. One object was to find the variation of current in the bell circuit with variation of voltage, and the manner in which these variations are affected by alterations of the bell adjustments. The other object was to find with what voltage and current ignition could be obtained both at the trembler and the break or contact in the external circuit. By adjusting the movable contact screw at the trembler so as to produce the minimum spark-gap when the armature was vibrated by the magnet, and reducing the resistance of the armature controlling spring to the minimum, the relation of volts and amperes indicated by *mg.mt.* was found. At 4 volts the current was 0·1 ampere, and at 12 volts the current was 0·2 ampere. Retaining the same tension at the spring and increasing the trembler gap to the maximum, the curve *Mg.mt.* was obtained. With this adjustment the current is 0·05 ampere, at 4 volts and 0·2 ampere at 12 volts. Keeping the gap at the maximum and increasing the spring tension to the maximum at which

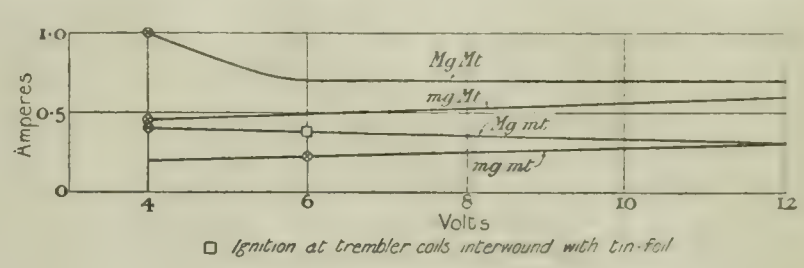


Fig. 3.

the bell could be actuated with a pressure of 4 volts, the relationship between volts and amperes is given by the curve *Mg.Mt.*, in which the current rises from 0·1 ampere at 4 volts to 0·3 ampere at 12 volts. Still keeping the maximum tension, but adjusting the gap to the minimum, there was obtained the curve *mg.Mt.*, which varies from 0·2 ampere at 4 volts to 0·4 ampere at 12 volts. A much higher current could be passed through the system by largely increasing the spring tension, but the bell could not then be actuated at a pressure below 9 volts. The result is shown in the short upper curve, which rises from 0·75 ampere at 9 volts to 0·9 ampere at 12 volts.

Repeating the above experiments in order to determine the conditions necessary for ignition of a coal-gas mixture, it was found that in the tests corresponding to the first three curves ignition could be obtained at 6 volts, but not lower; whereas when the spring tension was increased and the gap diminished, as above stated, ignition could be obtained at 4 volts. It is necessary to note that when the gas could be ignited at the trembler spark it could also be ignited (although sometimes only after a number of trials) at the single break-spark. In these tests, therefore, both sparks were equally dangerous. It is also necessary to note that the system which could be made to operate safely below 6 volts could be rendered dangerous by altering the trembler spring.

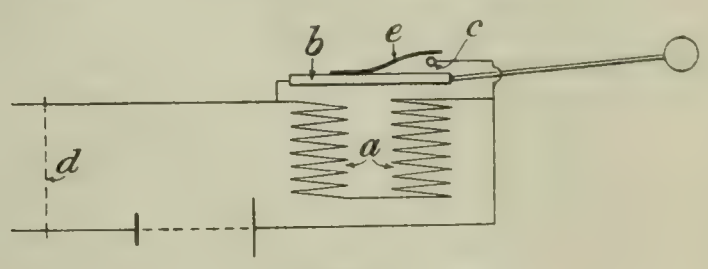


Fig. 4.

The above remarks are only true for coal gas. It may be rather severe to test a mining installation in coal gas, but if it can stand the coal gas test it is abundantly safe in methane.

To ascertain whether a large reduction in the strength of the magnet coils would reduce the capability of the trembler and break-sparks to ignite coal gas, a pair of weaker coils was arranged in conjunction with a vibrating armature contained within a small explosion chamber, the armature being controlled by a spiral spring instead of the flat or blade spring usually employed in bell construction. The results of tests are shown in Fig. 3. In all cases the current values are higher and the sequence of the curves is slightly different from that of the bell tests. With minimum gap and minimum tension, ignition was first obtained both at the trembler and the break at 6 volts. With the other adjustments ignition was obtained at 4 volts. It follows, apparently, that it is useless to reduce the inductance of the circuit to avoid dangerous sparking unless the value attainable by the current is also reduced. In his report Dr. Wheeler remarks upon the desirability of making the

resistance as high as possible, and the above experiments support this conclusion.

An obvious deduction from the foregoing is that for safe working the maximum voltage should be kept as low as possible. In the author's opinion the value permitted by the Home Office regulations, namely 25 volts, is much too high. Also the internal resistance of the batteries should be high in order to avoid a relatively large current in the event of an accidental short-circuit. Further, some additional precaution should be taken to abolish the spark or to reduce it to negligible dimensions.

An arrangement which has been found to give good results at both the trembler and the break is shown in Fig. 4. The action at the trembler is the reverse of the ordinary action. Instead of interrupting the circuit, the trembler short-circuits the magnet. The mining bell above referred to was converted, without altering the magnet coils, to correspond to Fig. 4, and the result of a test is shown by the top line in Fig. 2. It will be observed that the current taken by the bell was very considerably larger than that by the normal bell. At 4 volts the current was 1 ampere, and at 12 volts it was 3 amperes. Notwithstanding the relatively large amount of current, no ignition of a coal gas mixture could be obtained with any voltage at the trembler, but ignition could be obtained with 6 volts at the external break.

Notwithstanding the improvement obtainable by devices, the complete solution lies, in the author's opinion, in a suitable relay system. By using a small relay arranged to be actuated by a 4-volt battery, he obtained perfect operation of the bell with a current of 0·1 ampere in the relay circuit. Sparking in the external circuit of the relay was quite insignificant, and no ignition of coal gas could be obtained. It was necessary to increase the relay current to 0·6 ampere before ignition could be produced. At the relay contact the condition was the same as in the external circuit of an ordinary bell; but it is obvious that this could be avoided by the use of a condenser or non-inductive resistance at the relay contact and the employment of a short-circuiting trembler at the bell.

DISCUSSION.

Dr. Kapp said that the author had limited the investigation to the conditions which one would naturally regard as determinant on the question of ignition—namely, the voltage, current and power in the spark. One thing stood out clearly in the Paper, and that was the greater safety of alternating currents. The author stated that "the energy associated with a circuit prior to sparking can be regarded as a measure of the incendivity of the spark." If the author meant that the sentence should be read with the tacit understanding that the electrical conditions of the circuit remained unchanged, and only the energy was raised by increasing the voltage, then he (Dr. Kapp) agreed. The same idea also underlied his suggestion that the maximum voltage as fixed by the Home Office should be reduced. But he submitted that it was not the energy alone, but also the means employed to dissipate it which should be regarded as essential factors of the problem. He was opposed to the use of condensers for this purpose, and considered the author's device of working the bell on what may be called an inverted principle was preferable and quite successful. Thanks to the author's ingenious device the problem might be considered solved at the bell, but what about the danger of incendivity of the spark when contact was made and broken at any point along the two bare wires which the author told them that miners would not give up. He suggested that perfect safety might be obtained in a simpler manner by distributing condensers along the signal wires, and especially putting one at the far end. This expedient had the advantage that it could be applied to any existing installation and at very little cost. Calculations showed that, taking a line 1 mile long the E.M.F. might rise on breaking circuit to 140 volts and be dangerous. By distributing 10 mfds. along the line this voltage could be reduced to 4·4.

Dr. C. C. Garrard said he would like to know whether Mr. Morgan agreed with the general conclusion which he had arrived at—namely, that electric sparks in contact with the atmosphere of a mine under all conditions were dangerous and should be avoided. His own view was that all electric sparks in collieries should be regarded as dangerous, and should be enclosed in suitable boxes. This raised the question as to what was a suitable box for containing apparatus which may spark. The United States Bureau of Mines applied the term "explosion proof" in the same sense as British regulations used the term "freedom from open sparking." In his opinion a switch box for use in a colliery should be both explosion-proof and flame-tight—i.e., capable of withstanding any internal explosion without emitting flames or sparks which would ignite an explosive mixture outside the box. The presence of ethane increased the liability of explosion of methane and air mixtures. The presence of coal dust was also of importance. It had been found that without coal dust an explosion can be caused by sparks in an atmosphere containing only 4 per cent. of gas. Coming to the question of mining bells, Mr. Morgan advocated that if the system of bare contact wires is to be retained sparking must be entirely removed from them. By means of a relay combined with a condenser it was possible entirely to suppress the spark at the signalling wires. The only question was that if anything should go wrong with the adjustments of the relay sparking might still occur at the signal wires. He was inclined to think that a mechanical pull arrangement with the contact making device enclosed in an explosion-proof and flame-tight box would eventually replace the bare signalling wires hitherto used.

Dr. Railing referred to the apparent disagreement between those authorities who asserted that the process of ignition was entirely electrical or entirely thermal in its origin, and said he thought the disagreement was only apparent, and possibly both were right.

Mr. E. A. Watson, in a written communication, stated that the value of the energy required to ignite an explosive mixture was a subject of great importance, not only from the point of view of the danger of the production of unintentional explosions, as, for instance, in collieries, but also from that of the production of ignition in the cylinders of internal combustion engines. On the thermal basis of ignition it was comparatively easy to see how it may be possible for there to be a limiting value to the energy below which ignition would not occur. If they considered a small quantity of hot burnt gas surrounded on all sides by a shell of cold, unburnt explosive mixture ignition would only occur if the heat liberated by the burnt core was sufficient to raise the surrounding shell to its ignition temperature. They would further expect that the value of the minimum energy required would be affected by the pressure, and certainly by the temperature of the explosive mixture before ignition. Every motorist knew that it was easier to start an engine which was warm than one which was cold, and although the difference was doubtless to a large extent one of carburation it might also be in part due to the smaller amount of energy required. In that connection it was interesting to note the very large range of variation in the energy of the spark given by different makes of magnetos, and it was found that the energy per spark given by various single cylinder magnetos varied from 0·007 joule for a small American magneto to as much as 0·065 joule for a high-class English machine intended for very similar duty—*i.e.*, a range of output of very nearly 10 to 1. It would, therefore, seem that either the one machine or the other would be unsatisfactory. It was a well-known fact that a substantial increase in brake-horse-power could be obtained in most large high-speed engines by igniting the charge simultaneously at two points in the cylinder. Rough experiments on a small slow-speed gas engine with a magneto fitted with an electro-magnet, the excitation of which could be varied at will, gave a negative result. The experiments were, however, only very rough, and could not be considered as conclusive.

Mr. S. F. Walker, in a written communication, claimed to be one of the pioneers of signalling in mines, and had followed its development to the present. The question arose 25 years ago whether the spark on breaking circuit after ringing, by pressing the naked iron wires together, would ignite gas, and exhaustive experiments showed there was little chance. In the signals which he fitted up in mines they usually employed single-stroke bells. His view was that the single-stroke bell properly adjusted gave distinct signals, while the trembler bell did not. He believed the single-stroke bell was displaced by the trembler later on, because a number of very cheap trembler bells were placed upon the market. For complete immunity he was afraid that naked wires would have to be given up, and that connection for ringing would have to be made in explosion-proof cases. He was interested in the suggestion that relays should be used with batteries of small pressure. About 35 years ago he adopted the system at the Nunnery Colliery, Sheffield, but for a totally different reason—viz., leakage. The arrangement was completely successful. The leakage was reduced within reasonable terms, and instead of weak signals they remained loud and strong.

THE DESIGN OF HIGH-PRESSURE DISTRIBUTING SYSTEMS.

The following is a report of the discussion at the Manchester meeting of the Institution of Electrical Engineers on December 14, 1915. An abstract of the Paper appeared in our issue of December 17, 1915.

Mr. S. L. Pearce considered that the old line of demarcation between the trunk feeder and the distributing main had largely disappeared, and engineers operating these systems were well aware of the advantages of taking extra-high-tension supplies straight into sub-stations on the consumers' premises, although to do this in the case of consumers having only 100 kw. demand was perhaps open to question. The author's statement "that the cost of power is only a small proportion of the works cost" was not quite correct generally speaking, and surely depended upon the character of the works. He (the speaker) suggested that the use of reactances was not simply for the protection of any individual piece of switchgear or even an individual generator, but for the purpose of preventing the derangement of the whole system in the event of a local fault developing. He thought switches should be able to deal with any eventuality, and his figures regarding mains confirmed those of the author. He considered Fig. 4 of great interest as showing that the higher the pressure the greater the maximum current per phase, and also the more nearly cross-sections fixed by conditions of economy, and also by safe carrying capacity, approached one another. He agreed that, as the curve for a 20,000-volt cable was still inclined upward, there was a good *prima facie* evidence that this voltage of 20,000 was by no means the limit that could be usefully or commercially employed. The results would be of the greatest possible assistance to engineers laying out

new systems or carrying out extensions to existing systems. Regarding the lay-out of distributing systems, the author made out a very convincing case for the use of one or other of the balanced current protective systems, but it should always be understood that such a scheme was to be combined with a suitably chosen distributing voltage. The Callender-Waters system had been used on one of the new electrified railways in the south, and any details of this system would be very interesting. The speaker gave some details of the Manchester system, which was laid out about 14 years ago on the series radial plan. In the early days, with only 20 sub-stations, balanced current protective devices were unknown, but with the development of the area and industrial power load the number of sub-stations had increased to over 100. A rearrangement of the system became essential, and, wherever possible, existing mains were used to form ring mains with the balanced current protective devices, so that the copper would be more usefully employed. The author was correct in stating that reverse power relays were unsatisfactory. Regarding the cost of switchgear, the author's figures seemed to show an enormous difference in price between 20,000 and 30,000-volt switchgear; this did not agree with his investigations. In conclusion, he said the trend of experience with modern high-pressure distribution stations seemed to point to the necessity first of all of choosing a distributing voltage even in excess of 20,000. The second point was to employ the largest section of cable commercially possible. This would keep down the number of cables required for the system by the use of a balanced current protective system, and, again, by adopting fewer cables the total number of switching points was reduced; and it was desirable to dispense with as far as possible the number of step-down transformer points, which meant that the distinction between feeders and distributors was vanishing.

Mr. J. H. Palmer regretted that the author had made no reference to the recent developments carried out in connection with the balanced duplicate feeders which had been applied to a large scheme in London. A balanced system utilising reverse relays was a good one.

Mr. S. Ferguson said that on a 6,000-volt system the capacity of the generating plant did not materially affect the initial short-circuit current flowing to a sub-station with an average size feeder exceeding 1 mile in length. The speaker referred to short-circuit currents, and, taking the reactance of the generator and feeder resistance into account, gave 11,300 amperes and 11,700 amperes per phase respectively when the output was 20,000 kw. and 40,000 kw. Consequently, increasing the size of plant only meant a small increase in short-circuit currents of about 4 per cent. Increased voltage, however, made the short-circuit current more dependent on plant capacity. Regarding interlocks, the most important on any cubicle was certainly the one dealing with incoming feeders. The attendant handling the switchgear could ensure the feeder being dead from the bus-bar side, but he could not answer for the man at the other side. Means should be provided for earthing the feeder or locking the feeder isolating switch chamber. Potential transformers were certainly the weakest part of any switchgear system, and while the inclusion of an oil switch was quite a good system, the cost was prohibitive.

Dr. E. W. Marchant said that while a great deal of attention had been paid to the machinery of generating stations, far too little was given to distributing systems which, after all, represented a large percentage of the capital outlay, and therefore deserved equal consideration. Regarding the voltage drop with the split conductor system of protection, a very great difference might have been expected between this and a system of overhead lines run in the ordinary way. With overhead lines, of course, the inductive drop was dependent upon the distance between the wires and also upon the cross section. This was one of the few cases where aluminium showed a slight advantage over copper. Referring to the author's curves and remarks concerning the most economical section of mains, he said that working out the relationship which existed by what was generally known as Kelvin's law of economy, it would be found that the current density in a cable was entirely dependent upon the cost of the cable, the resistance of the material of which the cable was made up, and the cost of energy per unit. By calculation he obtained results confirming the author's table, and showing that the current density for maximum economy was constant. If the working pressure was sufficiently increased and there was adequate insulation, a point would be reached where the economical current density would correspond with the heating limit. Kelvin's law being founded on a basis of minimum total charge for energy distribution was unsuitable for determining the most economical current for a cable already laid. The best basis for such a cable was minimum ratio of total cost of producing energy to revenue earned. Using this basis it might be shown that the most economical current for a cable was that in which the cost of waste energy was equal to the total charge for interest and depreciation on the cable. On this basis the economical current density would be somewhat greater than that determined by Kelvin's law; as a rule, however, the difference was not very great.

Mr. G. Harlow said the provision of an adequate size of primary winding on series transformers was very often overlooked, and within the past two years he had known at least seven cases of serious short circuits due to this trouble. A case in point was that of a 50-kw. transformer situated about 1 mile from the power station, and protected by means of an oil switch actuated by a series transformer. A short at the transformer caused 6,000 amperes to flow through the 4-ampere winding, the current density being such as to raise the temperature of the copper to 1,200°C. in one second. Even assuming the switch to open in 0·2 second, the temperature of the copper would be in the neighbourhood of 400°C. An investigation of these short circuits had led to the adoption of primary windings at least equal in cross section to the main with which they were connected. Regarding potential transformers on bus bars, a protective oil-switch, as suggested by the author, was absolutely necessary with 100,000 kw. main plant or 50,000 kw. in sub-stations. A breakdown at the transformer terminals was a fearful business, but if it occurred half way down the winding the impedance prevented much trouble. The speed of opening oil-switches was one of interest, and perhaps the author could give a minimum figure, say, 15, 20 or 25 ft. per second. Some makers designed the moving parts of their switches as light as possible in order to keep down inertia and secure quick action, whilst others made a mechanically sound switch employing springs to give quick action. The latter appeared to be the correct principle. The author had stated that vent pipes did not increase the breaking capacity of a switch. They were nevertheless very desirable in order to get rid of the considerable amount of gas generated by the switch when clearing a fault. The question of interlocking was a matter for individual judgment, as often enough a man would fail and likewise a mechanical interlock would fail in course of time. He considered feeder reactance might be dispensed with in new stations. He did not agree with Mr. Ferguson's remarks regarding the capacity of oil switches, and did not consider the Ferranti-Waters system of protection sufficient, as it dealt with faults to earth, and not between phases. Mr. Thompson, of Battersea, had introduced a cable which was provided with a copper sheath between phases, and also surrounded by a similar sheath. The system dealt with faults between phases and to earth, and the only trouble that might arise would be the operation of the gear cutting off supply much more frequently than with the Merz-Price or split-conductor systems. He asked the author to state how much split-conductor was laid on the north-east coast system, and whether inductive reactance was still used.

Mr. A. F. W. Richards expressed interest in the curves showing the financial advantage of installing plenty of copper when laying mains, as it would be seen, after determining the most economical section, the cost (when reckoned in losses and interest per annum) of making ample provision for future requirements was almost negligible. Another outstanding point was that overhead mains at pressures up to 6,000 volts were not a paying proposition for transmitting power not exceeding 400 kw. or 500 kw., assuming, of course, that there were not other considerations to be taken into account, such as shortening route, &c. Regarding the 50 per cent. load factor he would like to know if the author ever experienced a 40 per cent. load factor. This was a matter of minor importance, as it had little or no bearing on economical section.

Mr. S. J. Watson spoke of the ease with which sub-stations could be set up when high-pressure distributing mains were adopted. In the past in connection with direct-current systems low-pressure mains were frequently run out a considerable distance from the power station, with consequent difficulties in regulating and giving proper pressure to consumers. High-pressure systems overcame these difficulties as sub-stations could be set up in the most advantageous positions. A feature worthy of consideration was the design of a cheap and reliable automatic regulator which could be used in the secondary windings of transformers, especially where the sub-station had to deal with an appreciable variable load. The available means of effecting this regulation were exceedingly costly, and consisted in taking tappings from the transformer secondary to a multiple-contact regulating switch, or as an alternative an auto-transformer with moveable fields could be used. Neither of these methods were automatic. Whilst appreciating the author's efforts, the speaker ventured to suggest that in many cases the section of conductor for both high-pressure systems was not worked out on the scientific methods set forth in the Paper. Most systems, whether high or low-pressure, usually started in a small way, and when mains were laid there was very little indication where the load would come from. The practice had been to fix on a good-sized section of copper and lay cables in the directions where load seemed most promising. The diagrams in the Paper showed clearly the difference between the actual practical lay-out and the various theoretical lay-outs. The generating station never by any chance became situated in the best position relative to the distributing system, and this fact appreciably affected not only the original lay-out, but also new developments. Regarding the use of loop mains and alternative methods of duplicate feeders, it might be said that systems of supply generally consisted of a central area more or less dense in demand, with other area jutting out into the wilds. In Bury, for example, the principal consumers were distributed in the form of a star. There was a fairly good demand adjacent to the main roads running out from the town, but between the tips of the star it was mostly waste land, and in an area of this kind a ring system could not be adopted on account of the cost and the large amount of idle cable. An important point was the small difference in cost (2½ to 5 per cent.), which enabled an engineer to increase the capacity of the cables by a very large percentage. A slight increase in copper was usually found to be a sound investment. In conclusion, the matter of laying out distributing systems in common with other designing work, was most ably summed up by the author, in stating that whatever care was taken in making calculations there were so many points bearing on the question that some little thing might be overlooked which would vitally affect the successful operation of the system as a whole.

Mr. F. Fernie asked whether the author excepted cables from the statement that no apparatus could be made immune from breakdown through external damage. It seemed rather deplorable in view of accumulated experience, if the confession had to be made that cables could not be made immune from breakdown, particularly as the author stated that where there was danger of subsidence of the ground overhead mains were used. It had been reported that Newcastle proposed to use some 11,000-volt cables at 20,000 volts. Perhaps the author would state whether this had been done, or whether the 20,000-volt line of under-

ground cable in Fig. 4 would coincide with the 11,000-volt line. This, of course, raised the question of factor of safety of a cable, and it was desired to know what minimum factor of safety the author considered permissible. The factor of safety would, of course, vary with the diameter of the conductor. Some of the 20,000-volt cables in the Newcastle district had a factor of safety of 7 to 8, whereas for 11,000 volts the figure was 10 to 15. By factor of safety was meant the ratio of the maximum stress at which the cable would break down to the maximum working stress. Referring again to Figure 4 some explanation was necessary to show why the inclination of the 20,000-volt line was different to that of the 11,000-volt line. Assuming the curves to be straight lines, which was nearly correct, and working out the equation $y = a + bx$ for each, the b factor for the three parallel lines was about 0·6, and for the 20,000 volt cable about 0·8. It was not clear why the factor b should be different for the 20,000-volt cable. He considered that for economical reasons alone the voltage would be raised above 20,000 volts. There was no reason at all, apart from the factor of safety demanded, why a cable should not be built for very much higher voltages and still be of practical dimensions.

Mr. BEARD, in replying to the discussion, said that individual supply to 100 kw. loads was not general, but in some cases it had been considered worth while to accept even 50 kw. loads. The author agreed with the correction regarding the cost of power being only a small proportion of the works cost. The statement was made having in mind colliery conditions, where the engineers did not realise the loss involved by interruption of supply. Reactance on generating plant were very satisfactory, on account of the perfection of modern automatic voltage regulations. There appeared to be some confusion regarding the Ferranti-Waters and Callender-Waters systems. They were quite distinct systems, the former being a parallel feeder protection, and the latter the split conductor type requiring a special cable. The Callender-Waters system was in actual use on the South Western Railway on 3,000-volt gear. Regarding the question of increased cost of switchgear, this had not yet been dealt with in connection with the 30,000-volt gear, but the curve would probably continue upwards at about the same slope on account of the spacing and thickness of insulation increasing more than proportionate to the voltage. This was very noticeable in cables. Mr. Palmer had referred to the balanced duplicate feeders, which presumably was the Ferranti-Waters system. No reference was made to this system, because it was not in actual use when the Paper was written. An actual case worked out on this system made the cost about 18 per cent. greater than any other system. This seemed inevitable with all systems using parallel feeders. Replying to Mr. Ferguson, 15,000 amperes at high voltage was as much as the best switch would do, and probably very much less would wreck many of the switches at present on the market. Reactances should not be necessary at the sub-stations, and only as a last resource on feeders. Mr. Ferguson's remarks on the question of interlocking were of extreme importance. Replying to Dr. Marchant, on the question of split conductors, the reactance of a three-phase circuit did not go down proportionately with the section of the wire. The breakdown of potential transformers was not appreciably affected by the size of the station, breakdowns taking place almost as readily on small stations as large ones. It should be a general rule never to put potential transformers direct on bus bars, even in sub-stations. Generally speaking they were not necessary in sub-stations, as the main transformer would meet all requirements. Regarding Mr. Harlow's remarks on the speed of operation of oil-switches, there was no best figure, as the greater the speed the better, provided the switch was not weakened thereby. Experiments made by the author had shown that to prevent explosions vent pipes were no use, but no doubt they served some purpose in liberating accumulated gas. Regarding the North East Coast system, there were 140 miles of split conductor, 385 miles Merz Price protected cable, and a balance of 185 miles of overhead cable which represented some systems not yet linked up. Approximately, half the original overhead protected Tyneside system had been changed over and this remainder would no doubt be included in due course. Inductive reactance had not been used on the split conductor system for the past two years, but there was still a number in commission and working perfectly satisfactorily. The remarks on connecting up high pressure sub-stations by Mr. Watson were very gratifying. There was no trouble about extensions upsetting existing protective gear.

CORRESPONDENCE.

THE WIRING OF ARTISANS' DWELLINGS.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS,—It appears from correspondence received and certain criticisms made, that there is some doubt about the efficiency of the wiring system described by me recently in THE ELECTRICIAN, and I shall be obliged if you will afford me space to explain more fully its advantages to those interested in electric progress, and also to reply to the misleading statements made in the "Journal of Gas Lighting," many of which emanated from the mind of the writer in that Journal.

The system used was that of the "Henley wiring system," which consists of separate rubber insulated conductors encased with a metal alloy which, although having all the advantages of lead, is in every way superior to it. It is not an untried system, for it has been in use for several years. My attention was first called to it at the last electrical exhibition at Olympia. Its greatest recommendation is that a metal cased cable of uniform high-grade quality is assured. It also has the maker's identification mark, laid up, throughout its entire length. The conductors have distinctive colouring, which facilitates their being picked out without testing through, saving much time during installation.

It is equally suitable for large and small installations, but especially adapted for work in houses during occupation and for surface work, to replace gas, without in any way defacing the walls. It has been used in all parts of the world, in every kind of building from palaces to artisans' dwellings, workshops, cathedrals to mission halls, country houses to bungalows; also in abbeys, colleges, schools, hotels and many large public institutions.

It was clearly stated in my article that "this experiment afforded an admirable opportunity for deciding whether a scheme of *high-grade work* could be made to pay in this class of house." The writer of the article in the "Journal of Gas Lighting," after reading the foregoing, wrote: "The methods of installing . . . are not the sort . . . considering safety, maintenance and appearance." This anonymous writer evidently does not know—how can he?—anything about the applications of electricity which worry him so much.

So long as the converts come in, as they are doing, and there is such a vast field awaiting our services, we need not heed the unregenerate, who are severely handicapped, whilst we are only concerned with spreading *the light*.—I am, &c.,

Brighton, Jan. 8. JAMES CLEARY.

[We have taken the liberty of abbreviating our correspondent's letter.—EDS. *E.*]

THE ELECTRIC LOCOMOTIVE.*

BY FREDERICK WILLIAM CARTER, M.A., ASSOC.M.INST.C.E.

The electric locomotive for use on main-line railways has already reached a high state of development in countries where conditions are favourable to electrical operation; the number of distinct types that have been developed is large, and it is somewhat difficult to classify them simply and satisfactorily; development has taken place along two lines, one based on tramway experience, and the other on steam-locomotive practice. Electric locomotives, suitably controlled, are capable of making very efficient use of their adhesive weight for developing draw-bar pull, and on this account electrical operation often shows to advantage where gradients are long and steep. Where such conditions prevail the question of the return of energy to the source, by using the motors regeneratively, becomes of interest.

Electric locomotives admit of a primary division into two groups, namely, those in which the axles are driven independently, and those in which they are coupled and driven collectively. With a few exceptions these two groups correspond with the continuous-current and the alternating-current systems of operation respectively, and have their origin in limitations of motor design. With the exception of the Pennsylvania Railroad locomotives, all important side-rod locomotives have been designed for alternating-current systems. With the exception of the Norfolk and Western locomotives, all driving through jack shafts have been designed to use single-phase commutator motors; with the exception of the later Lotschberg locomotives, all driving through Scotch yokes employ polyphase motors. Two methods are used for driving the axles independently, namely, the geared and the gearless; unless the driving is arranged to be effected through a spring-supported quill, both methods add to the dead weight carried by the axle; the amount of the additional weight is of interest from its bearing on the maintenance of the rails. Collective driving through side rods assumes several forms, but all result in considerable strains in the structure. Where the locomotive is driven by motors of uniform torque the main driving forces cause alternating stresses of low frequency in the structure, but where the driving torque is impulsive the resultant frequency becomes comparable with the natural frequencies of vibration of some

* Abstract of a Paper read before the Institution of Civil Engineers.

of the parts, and at certain speeds destructive vibrations are liable to be set up from resonance between the frequency of the main driving torque and the natural frequency of vibration of some part or parts; vibrations of smaller intensity and varying with the adjustment arise from indeterminateness in the application of the driving forces, and such vibrations are also met with in steam locomotives. The polyphase locomotive from its constant speed characteristics is less likely to be affected with vibration troubles than others.

The classification of locomotives according to wheel-arrangement has been adopted from steam practice, but hardly affords the same insight as to the type as in the case of the steam locomotive. Electric locomotives have not always been designed with due regard to the question of stability of the rolling motion of the wheels, and some run less smoothly than is desirable on this account. The tilting of the rails and the coning of the wheels causes the progression by pure rolling to assume a sinuous nature, and on the stability or instability of this motion depends the question whether the nosing effect tends to die down or to increase to the limits permitted by the wheel flanges. It can readily be shown that a locomotive carried on a rigid wheel base is in some circumstances unstable and may accordingly be expected to develop a nosing tendency if run at high speed; the same is true when the locomotive is divided into units each carried on a rigid wheel base; guiding wheels elastically centred to align with the main wheels tend, however, to stabilise the motion.

There are few available records of tractive-resistance tests on locomotive-drawn electric trains, but among the most complete are those taken by the General Electric Company in connection with the endurance test on the first New York Central and Hudson River Railroad locomotives. These were made on trains of two different types of passenger vehicle, and are of importance in showing very conclusively that, for a particular type of coach, the additional tractive resistance per additional coach is a function of the speed and is independent of the number of coaches, provided this is greater than two; the additional tractive resistance per additional coach was found to be a straight-line function of the speed within the limits of the tests. The effective locomotive-resistance when running with train was found to be smaller than that of the locomotive running alone.

LEGAL INTELLIGENCE.

Alien Enemy Patents.

The Patents Court recently heard an application by the British Thermit Co. for a licence to use eight patents owned by Thermit (Ltd.), necessary for carrying out the alumina-thermic process of fusing and welding the joints of tramway and other rails.

Mr. ROYSTON (for the applicants) said that Thermit (Ltd.) was a company registered in England, but with German shareholders. It was now a controlled establishment with a supervisor appointed by the Government. He urged that an alien company could not be allowed to remain in possession of the patents. Applicants must at least be put in as favourable a position for carrying out the process. To leave them in a position less favourable would be monstrous, and there was not the least doubt that they were in that position to-day. He contended that in view of the premier and advantageous position of the opponent company any royalty should be very small.

Mr. COLEFAX, K.C., in addressing the Court in opposition, referred to the rules laid down in the Act of 1914.

The CONTROLLER said it would take a good deal to convince him that it was not in the interest of the community that an independent, purely English company in which the profits went to English shareholders, should not be set up. The object of the whole of that legislation was that English trade might be fostered.

Mr. TURNER, managing director of the British Thermit Co., said that it was practically impossible to go on any further in view of the patents held by the competing company. If they had a licence to use those patents they would be able to weld tramway rails for corporations themselves. At present they could only sell "thermit," and corporations did not give them orders because they could not weld the joints owing to the patents held by the opponent company.

The CONTROLLER: At present the whole monopoly of carrying on this process is in the hands of this company?—Except where welding is done by other processes all the large corporations in this country use the thermit welding.

The CONTROLLER said that an English competing company could not be set up side by side with the other unless they got rid of those patents.

Mr. COLEFAX said that that showed bias on the part of the tribunal.

The CONTROLLER replied that, speaking personally, it was his desire to free trade. There ought not to be a monopoly by what was a purely German company in this country doing important work.

Mr. COLEFAX submitted that the needs of the country were satisfied by Thermit (Ltd.), that there was no grounds for apprehending that there would be a scarcity of the material, and that applicants were entirely incapable of doing the work.

Mr. TAYLOR, who was appointed by the Board of Trade and the War Office to supervise and control Thermit (Ltd.), said that 80 per cent. of the company's output was now munitions. They enjoyed a high reputation for quality, and the staff was all British.

Mr. JOHN B. HAMILTON, general manager of Leeds Tramways, said that welding joints was a highly skilled operation. He had found the "thermit" supplied by applicants to be faulty.

Mr. COLEFAX contended that it would bring discredit on British industries to give a licence to people who were incompetent. In the case of a royalty he suggested 2s. per joint as against 6d. suggested by Mr. Royston.

The Court reserved its decision.

Valuation Appeal.

In the Lands Valuation Appeal Court, Edinburgh, last week, the Urban Electric Supply Co. appealed against the valuation of their electric supply works and mains in the burgh of Hawick. The works were entered at £1,120 and the mains at £1,210, and appellants asked that the valuations should be reduced to £590 each. The parties were agreed that the "profits principle" should be the basis for calculating the assessed rent. The Burgh Valuation Committee reduced the valuation by £121 to £2,300 for works and mains.

In giving judgment, Lord SALVESEN said the most important question was whether certain machinery which was de facto in its nature heritable and was used for supplying power, must nevertheless be included in the tenants' capital so as to reduce the assessable value of the buildings belonging to the company. He was clearly of opinion that that claim was excluded by the Valuation Act. The machinery in question consisted principally of superheaters and mechanical stokers and was used for producing or transmitting first power, and although those were labour-saving appliances they could not be regarded otherwise than as heritable. The other question was whether the tenant was entitled to include in "tenants' capital" a sum of £500 which he kept in bank to meet current expenses and which earned no interest. The tenant required that sum to carry on his business, and accordingly he was entitled to a deduction of 5 per cent. on that sum, which meant a deduction of £25 from the rental. A third point dealt with the claim of appellants that four months' extra stock of coal should be treated as part of the necessary capital of the tenant. His Lordship was of opinion upon the facts that that extra stock was not necessary. The assessors had already allowed for five months' working expenses, which included the cost of five months' supply of coal, and appellants' claim that nine months' supply was a minimum had not been proved.

The other Judges concurred and the Court affirmed the valuation of the Committee except to the extent of £25, which was allowed.

Tramway Conductors' Holidays.

At Sheffield County Court last week before Judge Benson, James K. Hurt, tramway conductor, sued Sheffield Corporation for one week's wages as holiday pay. Plaintiff had been in the employment of the Corporation for some years. In 1906 the Corporation passed a resolution granting a week's holiday with pay to each of its workmen who had been in the employ of the Corporation for not less than one year, the holiday to be given each year between April and October. In 1914, owing to the war, it was not possible to grant all the men their holidays. Plaintiff had his holiday in May, 1914. In July, 1915, the Corporation gave plaintiff notice to leave, and plaintiff, not having had his holiday, claimed an extra week's pay.

His HONOUR held that, as plaintiff had worked 52 weeks without a holiday, he was entitled to recover a week's pay, and judgment was entered for plaintiff for £1. 16s. 10d. and costs.

Leave to appeal was granted.

Fraudulent Consumption of Electricity.

At Halifax Police Court on Friday last, John W. Scott, a motor engineer pleaded "guilty" to a charge of having fraudently consumed electricity at his premises.

It was stated that in October, 1911, defendant applied to the Corporation for a supply of electricity for power and they installed a motor. The charge for electric power was 2d. per unit, but current for lighting was 4d. per unit. In November an inspector of the electricity department went to the premises, and from the street he noticed that they were lighted electrically, but when the door was opened to him they were in total darkness. On Dec. 7 and 9 Mr. Love, the deputy electrical engineer, observed from outside the premises that they were lighted electrically, and on Dec. 10 he went inside and found four electric lights. Defendant's assistant informed him that those lights were supplied from the power motor, and that the temporary wiring of the lamps existed when he entered defendant's employ 12 months before. During the past year defendant had used 218 units, which, at the power rate would amount to £1. 16s. 4d. He believed that in some towns a light was allowed to each motor, but that was not so at Halifax. The four lights he found could not be classed as heating, the charge for which was the same as that for power.

Mr. WILKINSON (for defendant) pleaded that his client had offended unwittingly. The wiring for the lights was done by a former employee, who should have known it was improper. They had now been disconnected, and defendant had offered to pay to the Corporation at lighting rates for all the electricity he had used in the past year.

Defendant was fined £5, including costs.

PARLIAMENTARY INTELLIGENCE.

COMMERCIAL POLICY AFTER THE WAR.

In the House of Commons last week Mr. W. A. Hewins moved "That, with a view to increasing the power of the Allies in the prosecution of the war his Majesty's Government should enter into immediate consultation with the Governments of the Dominions, in order with their aid to bring the whole economic strength of the Empire into co-operation with our Allies in a policy directed against the enemy."

In the course of the discussion which ensued the President of the Board of Trade (Mr. Runciman) said he must make it clear that when peace came to be signed we would not permit the outbreak of an economic war which Germany would wage against ourselves and our Allies. He was not prepared to wait for the end of the war to take steps to deal with this matter. It had all along been the policy of the Board of Trade to capture German trade during the war. In the case of South America, we had since the war developed a trade with that part of the world which he hoped would continue long after the cessation of hostilities. British traders, in spite of difficulties, had worked wonders in trade development during the past 12 months. The German monopoly in optical glass, in dyes, in electrical apparatus, and in certain kinds of chemicals had been completely broken down. Electrical apparatus in some particulars was almost entirely in German hands. Every one of these—glass, chemicals, dyes, electrical apparatus, and he could name about a dozen others—were industries of vast importance, not only to us as a great commercial country, but as a fighting country. Without these glass articles, without some of the porcelain articles, which were essential for electrical construction, without the best type of magneto, without some of the best of our chemicals, and without a great range of dyes, which used to be manufactured in Germany, we were placed at a great disadvantage. Never again would they be renewed. The policy of the Board of Trade was that there should be no essential article for the arts of peace or war that we could not produce in this country or within the Empire. He put down as one of the first necessities of this country the improvement of research methods and the technical education of the rising generation. The extension of commercial banking, as distinct from the more conservative form of banking to which we were accustomed in this country might well be fostered. There was nothing that was likely to do English industry and commerce more good, or place it in a position in which it could compete with Germany, than the rendering of assistance to put firms on their feet. There were no institutions in the world that were more needed than our joint-stock banks, but the mere fact of their being centralised in London and having only managers, instead of partners, in the provincial centres had actually placed our traders and manufacturers and commercial men at a disadvantage compared with those who, in Germany, were in touch all over that country with more enterprising or, should he say, more adventurous institutions. Commercial banking must play a large part if we are to hold our own against Germany. The Board of Trade were looking ahead, and they would not be taken unawares at the end of the war. They must ask for the co-operation of the Dominions, and the control of many of the metals of the Empire should pass entirely from German hands. He had also in view the necessity for keeping the control of the world's coal, and of securing the control of the supply of oil. As regards shipping, we must see that foreign subsidised shipping should not have the free run of our ports to the disadvantage of our own shipping. He believed that while the war was on we ought to do everything in our power to destroy German finance and German credit, and to cripple her trade. The work of the Board of Trade now was to see to it that, after the war, Germany did not have an opportunity of reorganising her commercial system before our trade had begun to flow in ever-increasing volume.

The motion was agreed to.

Public Lighting of London.—In the House of Commons last week Mr. Hayes Fisher stated in reply to a question that the President of the Board of Trade was strongly in favour of any economy that could be effected in the electric lighting of London, and he understood that in a very large proportion of the public lamps the candle power had already been reduced. In some cases the type of lamp employed was such that to reduce the candle-power would involve a considerable amount of actual expenditure which would be thrown away in so far as it was not recouped by savings before the end of the war. He was informed that the employment of lamps of low candle power not blacked over, as suggested by the hon. member, would not fulfil the main object of the regulations.

EDUCATIONAL NOTES.

University of Liverpool.—The Lent term began on Jan. 11. The special matriculation examination or the entrance examination must be passed to secure admission to the courses of instruction in the Faculty of Engineering. Prospectuses and full particulars of the courses in electrical, civil, mechanical and marine engineering, design and drawing, mathematics, physics and inorganic chemistry may be obtained from the registrar, Mr. Edward Carey. There are well-equipped laboratories, and facilities for practical and research work are available.

University of London, University College.—A course of six lectures on "Electrical Production of Nitrates for Fertilisers and Explosives" will be delivered by Mr. E. Kilburn Scott, M.I.E.E., A.M.Inst.C.E., on Wednesdays at 5:30 p.m., beginning Jan. 26, 1916. The first lecture will be open to the public without fee or ticket. The course is open both to members and non-members of the University. Fee, £1. 11s. 6d. Application for tickets of admission to be made to the Secretary (Mr. Walter W. Seton, M.A., D.Lit.), Gower-street, W.C.

Sheffield University.—In view of the services rendered to the State by the pure and applied science departments of Sheffield University, and the depletion of the income from students' fees, the Council has been recommended to make special grants totalling £5,000 out of the revenue of the tramway undertaking.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

20,505 Soc. Anon. des Etablissements L. Bleriot. Regulation of electric installations comprising electric generators. (13/10/13.)

Means for regulation of an electric installation comprising a generator having a shunt field winding, said regulating means comprising an electro-magnetically operated switch device having a series operating winding which is operatively energised when the current output of the generator exceeds a certain value, the said device serving to increase the impedance of the circuit of said field winding of the generator, so as to lower the potential at the terminals of the generator.

22,609 Rouzet. Regulating device applicable to self-induction coils or to windings of Tesla transformers used in wireless telegraphy or other applications of high frequency.

Comprises an improved arrangement of contact plates and sliding devices which allows an extensive regulation equal to that produced with ordinary contacts directly touching the wires, and prevents short-circuiting of the spirals, and also reduces the connecting wires between the self-induction coil and the contacts to a minimum.

24,169 B.T.-H. Co. (G.E. Co., U.S.) Electrical measuring instruments of the thermal type.

Comprises a thermostatic spring having one end secured to a metallic stud and the other end connected to an indicating member, a heating element located within the stud, and a second thermostatic spring acting in the opposite sense upon said indicating member.

24,552 Curtis. Electrical resistances.

1915 Specifications.

1,751 Signal Ges. Subaqueous sound-signalling apparatus. (3/2/14. Addition to 3,934/13.)

3,241 Grocott. Ceiling roses and the like electrical accessories.

3,690 South Metropolitan Gas Co. & Buckett. Electric igniting apparatus for gas burners.

5,371 Marconi's Wireless Telegraph Co. & Mitchell. Manufacture of electrical condensers.

5,969 Moul. Thermostats.

7,607 Rosselli. Armouring for simple-core electric cables for alternating currents.

8,440 Giraud. Electric rivet heaters, welders and the like. (20/6/14.)

13,618 British Westinghouse Electric & Mfg. Co. (Westinghouse Electric & Mfg. Co.) Insulating airtight joints for terminals of vapour electric apparatus. on

15,083 Forrester. (Dunham.) Portable electric lamps. (Divided application 2,489/15. Feb. 16.)

APPLICATIONS FOR PATENTS

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked • are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 14, 1915.

17,466 Hogarth. Measurement and utilisation of radioactive matter in cereals and other products.

17,474 B[illegible] (Siemens & Halske Akt.-Ges., Germany.) Electromagnetic relays.•

17,475 W. R. Sykes Interlocking Signal Co., Harper & Sykes. Railway signalling.

17,497 Pieper & Pieper. Electric control mechanism. (15/10/15, U.S.)•

17,503 Millard. Auxiliary means for suspending electric lights.

December 15, 1915.

17,533 Richardson & Gill. Electrical devices to be used on taxi-cabs and the like.

17,537 Aktiebolaget Svenska Elektriska Aktiebolaget. Time lag relays. (9/1/15. Sweden.)•

17,539 L[illegible] & E[illegible] Electrically-operated horns.

17,542 B[illegible] Production of lamps for use with incandescent filaments (18/2/15, Germany.)•

17,551 M[illegible] Manufacture of. (Divided application on 82/15. Jan. 2.)•

December 16, 1915.

17,580 N[illegible] & H[illegible] Electron-emitting cathodes and process of manufacturing the same. (2/12/14, U.S.)•

17,581 C[illegible] & R[illegible] Automatic call distributing systems. (19/12/14, U.S.)•

17,[illegible] B.T.-H. Co. (G.E. Co. U.S.) Compressors.

17,595 M[illegible] Machines for generating and distributing electric currents.

17,602 L[illegible] Manufacture of electric transformers and like coil parts.

17,615 May & Sullivan Loading coils for superimposed telephone working and other purposes.

December 17, 1915.

17,629 B[illegible] & B[illegible] Regulating a light in lamps, electric lamps and [illegible] automatically [illegible]•

17,[illegible] B[illegible] Magneto systems.•

17,[illegible] [illegible] Reflecting [illegible]

17,[illegible] L[illegible] Suspending lamps.

17,664 B[illegible] Cook & Morley Electro-mechanical colour effects device for use in theatres and the like.

17,677 S[illegible] Transmitting electric impulses from a standard clock to impulse or [illegible]

17,690 Bristol Westinghouse Electric & Mfg. Co. Electrical protective devices. (Addition to 20,133/13. 2/12/14, U.S.)•

17,691 International Electric Co., Rouse & Le Noir Electric signalling. (Addition to [illegible])•

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	543	The Electrical Contractor's Dream. Illustrated	101
Imports and Exports of Electrical Manufactures	544	The "Osram" Electric Vehicle. Illustrated	101
Business Notices	544	A New Lampholder. Illus.	102
Bankruptcies, Liquidations, &c.	544	The Wickes Continuous Electric Blue Printing Machine. Illustrated	103
Electricity Supply	544		
Lighting and Power Notes	545	Miscellaneous Notes	547
Traction Notes	545	Tenders Invited	547
Telegraph and Telephone Notes	546	Tenders Received & Accepted	548
Empire Notes	546	Companies' Meetings and Reports	548
Foreign Notes	546	New Companies, &c.	549
The Round Table	99	City Notes	549
Turbine-Driven Centrifugal Pumps. Illustrated	100	Electrical Companies' Share List	549

COMMERCIAL TOPICS.

Trade and Business after the War. In its annual trade review for the past year the "Chamber of Commerce Journal" points out that at present it is obvious that manufacturers, with depleted staffs, are so fully occupied with urgent war requirements that, in many cases, they are precluded from accepting orders in the ordinary course of trade, but it is possible that in this respect matters may become a little easier in the near future. It is, therefore, a matter of vital necessity that immediate consideration should be given to the future of trade and industry when peace conditions once more obtain. It is, moreover, gratifying to learn that steps are being taken by qualified commercial bodies to come to a prompt decision on the practical issues which will then be raised, while there is evidence that the Government is at last waking up to the need for action in certain directions. The London Chamber of Commerce proposes to call a special conference of British Chambers of Commerce to consider this important question and it is to be hoped that it will receive the full and careful consideration it deserves.

A meeting of the Advisory Committee to the Board of Trade on Commercial Intelligence was held on Tuesday, and among the matters considered were proposals for safeguarding and promoting British trade after the war; the more systematic collection and exhibition of samples of German and Austrian goods competing with British manufactures in colonial and foreign markets; and questions relating to the work of the Commercial Intelligence Branch of the Board of Trade.

* * * *

Power Load in Sheffield. Many electric supply undertakings, more particularly those in industrial areas, have experienced during the past few years an increasing demand for electrical energy for power purposes. On the outbreak of war it was thought that electricity undertakings would be badly affected, but so far from this being the case it has brought greater prosperity to many. It is true that the lighting restrictions have affected the lighting load and the difficulty about coal supplies has added to the worries of station engineers. On the other hand, there has been a large increase in the demand for energy for power and heating, which has more than compensated for any falling off in lighting revenue. The popularity of the electric drive is well illustrated by the case of Sheffield, which has a typical, progressive and well-managed undertaking. At the end of December there were 3,423 motors, of an aggregate of 45,916 H.P., connected to the Corporation mains, compared with 2,971 motors and 34,422 H.P. in 1914, 2,513 motors and 26,338 H.P. in 1913, and 2,120 motors and 22,100 H.P. in 1912. At the end of 1908 there were only 1,036 motors of slightly more than 9,000 H.P. connected, so that it will be seen that there has been a continual and rapid increase in the power load.

Wall Plugs. Referring to our note on this subject in these columns last week, Mr. C. H. Wordingham points out in a letter to us that two representatives of the British Electrical & Allied Manufacturers' Association, specially drawn from the Association's section dealing with plugs, served on the panel which drafted the specification issued by the Engineering Standards Committee. Further, the B.E.A.M.A. as a whole, as well as firms outside that Association, were consulted by the panel. Mr. Wordingham expresses the view that it is not part of the functions of the Engineering Standards Committee to specify details of design, such as the mode of anchoring the flexible conductors to which we made reference. The specification aims chiefly at securing interchangeability, and this is assured if manufacturers work to the specification as drawn.

* * * *

Price of Copper. The Government, through the Ministry of Munitions, has notified consumers of copper in this country that they must not purchase more than 50 tons of copper in one lot, and must not pay more than £100 a ton for refined material. This step has been taken to suppress speculation on the market, and it should have the effect of relieving consumers of copper who are engaged upon war work. As much as £116 was paid one day last week for American refined for early delivery. The British authorities recently bought, mostly in America, about 100,000 tons of refined copper for delivery over the whole of the current year at about 21 cents a pound delivered. As soon as the Government's action became known there was a fall in standard copper prices on the Metal Exchange.

* * * *

Platinum Supplies. The Minister of Munitions has notified platinum dealers, &c., that in exercise of the powers conferred by the Articles of Commerce (Returns, &c.) Act (1914) he requires a return made to the Director of Materials of the Ministry of Munitions, Armament Buildings, Whitehall Place, S.W., of the whole of the stock of platinum, ores, residues or bars containing same on their premises or under their control. Any person buying, selling or dealing in platinum, or goods manufactured wholly or partly of platinum, or entering into negotiations for its sale or purchase, without a permit, is liable to the penalties provided for offences against the Defence of the Realm Regulations.

* * * *

Patents in 1915. During the year 1915 the number of applications for patents was 18,225, compared with 24,820 in 1914, and an average of about 30,000 per annum for the four preceding years. The falling off is partly due to the drop in the number of foreign applications. The number of applications from Germany, Austria, France, Belgium and the United States totalled 7,886 in 1912, 7,604 in 1913 and 5,986 in 1914. The most popular subjects of invention were electrical apparatus, ordnance and small arms, ammunition, internal combustion engines and motor vehicles.

* * * *

American Electrical Industry. According to the "Wall Street Journal" of Dec. 20, the big manufacturing electrical firms in the United States will be practically swamped with business in three or four months if contracts are booked at the rate at which they are at present being secured. It is stated that orders are coming in, not in amounts of tens of thousands of dollars but in hundreds of thousands, and it is believed 1916 will see orders for electrical goods booked in excess of previous record figures. An outstanding feature of orders at present is the demand for turbines, not only for land plants but for ships. The General Electric Co. is now building a 45,000 kw. turbine (which is the largest hitherto attempted) for the Detroit Edison Co., but this machine will be eclipesd by a new 50,000 kw. turbine. The Westinghouse Co. (through the Machine Co.) is reported to be doing a rapidly growing business in marine turbines with mechanical reduction gears and other auxiliary apparatus required in the engine room. This machinery ranges from equipment for battleships to passenger and freight steamships. Prices for electrical equipment have also been on an ascending scale in conformity with the rising costs of materials.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 3, 1916, *to* Jan. 8, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible] *France*. [illegible]
[illegible] *France*. [illegible]
[illegible] *France*. [illegible]
LONDON.—*U.S.A.*: Elec. machinery, £7,282; carbon candles, £215; [illegible] £673 [illegible] £75 [illegible] 96 [illegible] £492 272 [illegible] £250 [illegible] *France*. Carbon [illegible] £333; unenumerated, £266. *Japan*: unenumerated, £20 [illegible] £196 [illegible] machinery, £1,005.
[illegible] *France*. [illegible]

EXPORTS.

To AUSTRALASIA.—*Auckland*. Wire and cable, £1,102. [illegible] £250. [illegible] enumerated, £448. *Melbourne*: Wire and cable, £2,638; elec. machinery, £309; unenumerated, £314. *Sydney*. Elec. machinery, £112. [illegible] £374. *Wellington*. Wire and cable, £2,647; elec. machinery, £129; unenumerated, £355. *Adelaide*: Elec. machinery, £140. [illegible] £186. *Fremantle*. [illegible] merated, £50. *Perth*: Unenumerated, £306. *Christchurch*: Unenumerated, £30. *Napier*: Wire and cable, £84. *Dunedin*: Wire and cable, £286; unenumerated, £33. *Townsville*: Elec. machinery, £21. *Launceston*: Unenumerated, £164. *Lyttelton*: Wire and cable, £455. *New Plymouth*: Unenumerated, £30. *Wanganui*: Wire and cable, £329.

AFRICA.—*Durban*: Wire and cable, £735; elec. machinery, £189; unenumerated, £[illegible]. *Cape Town*: Elec machinery, £55; unenumerated, £200. *East London*: Unenumerated, £32. *Accra*. Unenumerated, £20. *Sierra Leone*. Telegraph material, £7.

SOUTH AND CENTRAL AMBRICA.—*Buenos Ayres*: Wire and cable, £150; unenumerated, £1,206. *Antigua*: Unenumerated, £11. *Probolingo*: Unenumerated, £146.

HOLLAND.—*Amsterdam*: Wire and cable, £352. *Rotterdam*: Unenumerated, £1.

DENMARK.—*Copenhagen*. Unenumerated, £142.

U.S.A.—*New York*: Elec. machinery, £958; unenumerated, £570.

WEST INDIES.—*Barbados*: Unenumerated, £78. *Trinidad*: Wire and cable, £21; unenumerated, £87. *Dominica*: Unenumerated, £54.

[illegible] *Sudan*: Elec. machinery, £203; unenumerated, £12. *Aden*: Telegraph material, £32; [illegible]
[illegible]

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay*: Elec machinery, £34[illegible] *Madras*: Elec. machinery, £353; unenumerated, £260. *Singapore*: [illegible] £359. *Ceylon*: Telegraph material, £23; unenumerated, £339. *Kilindini*. Unenumerated, £76. *Karachi*: Elec. machinery, £102. *Bangkok*: Unenumerated, £160. *Penang*: Unenumerated, £29.

JAVA.—*Samarang*: Wire and cable, £33. *Batavia*: Unenumerated, £84. *Sourahaya*: Wire and cable, £100.

CHINA.—*Hongkong*: Unenumerated, £56.

PORTUGAL.—*Lisbon*: Wire and cable, £100; unenumerated, £59.

[illegible] *Boulogne*: Unenumerated, £58.

FOREIGN GOODS (duty paid and free).

[illegible] £511. *Port Elizabeth*: Unenumerated, £45. *Bombay*. [illegible] £89. [illegible]

BUSINESS NOTICES.

The address of the Machine Tool Dept. of the Ministry of Munitions is now at Queen Anne's chambers, Dean Farrar-street, Westminster, London, S.W. Telegraphic address: Toolorgize, London; telephone: Victoria 8,224.

The telephone numbers of the London office of the Chloride Electrical Storage Co. are 442 and 443 Victoria.

The Electrical Supplies Co. have re-organised their engineering department, and have arranged for Mr. A. G. Ingleby (late of the Adnil Electric Co.) to take over control of same.

The company is now representing the Galloway firm in London and the South of England: The Keighley Electrical Engineering Co. for dc. motors and dynamos for capacities up to and including 120 k.w., and Messrs. Firth & Russell for a.c. motors for capacities up to 100 k.w.

Mr. A. J. Greenly and Theodore Denison have taken over Baldwin & Wills works, St. Albans road, Watford, and commenced business as manufacturing electrical and mechanical engineers under the style of Greenly & Denison.

The offices of the partnership are 37 & 38, Strand, W.C., and in addition to Government work which they have undertaken they are in a position to quote for small turning, boring, screw cutting, planing, die casting and wood working of every description.

The business known as Greenly Advertising Service will be carried on by Mr. Greenly as heretofore, and we are informed that steadily increasing business amongst engineering firms has necessitated an increase in the technical staff.

The Homogenous Lead Coating Co., 1, French street, Sunbury-on-Thames, are now making a specialty of lead lined acid tanks suitable for road or rail, the lead being attached to the steel cylinder by their special welding process.

Electric Horns.—The Benjamin Electric (Ltd.), 14, Rosoman avenue, London, E.C., are offering to supply the trade with best-built electric horns at 11s. 3d. each net. The offer is only open for 10 days from Jan. 21.

Sale by Auction.—Messrs. Horne & Co., 35, Old Queen-street, Westminster, S.W., will sell by public auction at the Holy Trinity Schools, Beresford-street, Woolwich, on Thursday, Jan. 20 at 11 a.m., by order of the Secretary of State for War, unserviceable and obsolete stores, particulars of which are given in an advertisement.

Plant Wanted.—An advertiser requires a second-hand booster set.

Patent Development.—The proprietor of patent No. 2,924/1914, relating to "An improved system of synchronising electric clocks," desires to enter into negotiations for the sale of the patent or for the grant of licences. Inquiries to Messrs. D. Young & Co., patent agents, 11 and 12, Southampton-buildings, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of Augustus Garbutt, electrical engineer, formerly trading at 2, Kirkstall-road, and 67A, North Hall-street, Kirkstall-road, Leeds, will take place to-day (Jan. 14) at 24, Bond-street, Leeds, and the public examination on Feb. 1 at the County Court House, Albion-place, Leeds.

Claims against the Parana Power Synd. (Ltd.) (in vol. liq.) are to be sent to Mr. L. Maltby, 4, London Wall-buildings, London, E.C., by Feb. 1.

The South Wales Wireless Training College (Ltd.) is being wound up voluntarily for the purpose of reconstruction. Mr. Geo. F. Willett, 92, Queen-street, Cardiff, has been appointed liquidator, with authority to enter into an agreement for the sale of the business to a new company to be called the South Wales & West of England Wireless Training College (Ltd.).

ELECTRICITY SUPPLY.

EXTENSIONS.

Birmingham.—As announced in our last issue the Corporation have decided to put down further generating plant at the temporary Nechells station.

The chairman of the Electric Supply Committee (Ald. Jepheott) pointed out that the Council sanctioned the erection of a temporary generating station at Nechells in order to meet the demand of manufacturers for electric current until the permanent station could be completed. The demand for current, however, had so greatly increased that the committee had had to refuse to supply new customers, but in order to meet the requirements of local industries they deemed it desirable to add to the output of the temporary station forthwith. It was hoped that much of the plant to be acquired for the temporary station would be transferred ultimately to the permanent power house.

Bo'ness.—The National Electric Construction Co. has dropped its proposal to carry out temporary extensions of plant at the electricity works, and the Town Council has been asked to sanction a permanent extension, by adding a 500-kw. steam turbine, boiler, &c., at a cost of about £14,000. The additional plant is necessary to meet the increased demand for power by public works. The Council propose to call in an engineer to report on the works and the necessity for the extension.

Halifax.—The Corporation have authorised the Tramways Committee to draw about 920 yd. of e.h.t. cable through existing conduits from the electricity works to the bottom of Hanson-lane, and application has been made to the L.G. Board for sanction to borrow £5,558 for additional plant required at the electricity works.

Luton.—The Council has decided to give a supply of electricity to a factory in the rural area, provided the consent of the Board of Trade can be obtained.

The L.G. Board have sanctioned a loan of £27,790 for extensions of the electricity undertaking. The Electricity Committee has applied for sanction to borrow an additional sum of £4,677, including £1,400 for a converter and transformer.

Sheffield.—The Electric Supply Committee has undertaken to bear the annual interest and sinking fund charges in respect of the capital expenditure incurred in laying a new feeder cable from Kelham Island Station to Newhall-road.

Mains are to be extended to various parts of the city, at a cost of £7,010, of which £2,265 will be spent on an e.h.t. feeder cable between Manor-street and Hedley sub-stations, while £1,745 will be spent on enlarging the cable in three streets.

The L.G. Board has sanctioned the borrowing of £2,500 to cover the cost of increasing the accommodation for coal storage at the Neepsend power station, and the installation of coal handling plant, &c., and £1,200 for rails, &c., crane track, sleepers and reinforced concrete retaining walls.

The committee has decided to lease a piece of land to Mr. Donald F.

Campbell for the erection of an electric furnace, and has granted him permission to place three 150 kw. transformers in the Forncett-street sub-station for supplying electrical energy to the furnace.

Stockton-on-Tees.—The Corporation have decided to purchase additional rotary converter plant for converting the energy supplied in bulk by the Cleveland & Durham County Electric Power Co.

Wolverhampton.—Application has been made to the L.G. Board for sanction to borrow £1,780 for mains extensions, and for permission to spend £670 out of the loans already raised in connection with the above extensions.

GENERAL.

Aberystwyth.—A serious fire broke out on Monday morning on the switchboard at the electricity works.

Much damage was done before the fire brigade succeeded in smothering the flames with sand, and supply has been cut off from the whole of the town throughout the week.

Berkhamsted.—The Urban Council have authorised the Chesham Electric Light Co. to erect poles and overhead wires to supply electric current to some buildings in the district.

Birtley.—Chester-le-Street Highways Committee have authorised the Newcastle-upon-Tyne Electric Supply Co. to erect a 20,000-volt cable from Beamish to works at Birtley, under certain conditions.

Burnley.—The Electricity Committee has increased the insurance on the generating station, sub-stations, &c., by £20,000.

Dewsbury.—Last week the Council adopted a recommendation to purchase a 500 kw. second-hand generating set for the electricity works, at a cost of about £3,000, the money to be provided out of the profits of the undertaking.

Councillor KILBURN explained that the plant at the electricity works was working very near to the margin of safety, owing to heavy demands, and if a breakdown occurred it would be a serious matter. The proposed purchase was a temporary expedient, to meet the immediate need.

Ald. MCCANN suggested raising the price of current or an arrangement with the Yorkshire Electric Power Co. to supply current, if needed.

In reply it was pointed out that there were responsibilities on the Council if they failed to carry out their contracts with consumers, and it was necessary to do something at once. Even if arrangements were made with the power company, there would be considerable outlay for converting plant.

The proposals of the Committee were carried.

Elland.—Last week the chairman of the Council (Mr. S. Lumb) explained that the increase in the price of electricity was due to the advanced price of coal. The Council had no option but to increase the price if they meant to conduct the works as a business concern.

Erith.—The Council have decided to make arrangements for obtaining an additional bulk supply of electricity for 200 new houses on the Colyer's-lane estate.

Leeds.—Last week the Corporation adopted a recommendation of the Electricity Committee to increase the salary of Mr. C. N. Hefford, manager of the electricity department, from £600 to £800 per annum.

The chairman of the committee (Mr. LUPTON) said Mr. Hefford was appointed three years ago on probation, and it was distinctly understood at the time that if he did the work well his salary would be raised to a figure commensurate with the duties of the office. His predecessor (Mr. Dickinson) was receiving £900 at that time, and he went to Liverpool for £1,000, since increased to £1,500. He quoted statistics showing how the undertaking had increased during the last three years. The capital had grown from £1,034,000 to £1,347,000, the sales revenue from £115,000 to £170,000 per annum, and the output from 18,000,000 units to 43,000,000 units per annum. That development had been carried out by Mr. Hefford under unparalleled difficulties. A year ago the Council decided upon a large extension of the station at a cost of £120,000. The engineering of that extension had been done by Mr. Hefford. While Leeds was sixth on the list of cities and towns in the United Kingdom in the output of current and third in cheapness of cost, it was twentieth in respect of the salary of the engineer. Since the undertaking was taken over by the Corporation it had yielded profits of £120,000 for the rates, and after allowing for sinking fund, depreciation and other charges, the amount handed over last year was £12,000.

Ald. KINDER moved, as an amendment, an addendum to the effect that the increase should not take place until the termination of the war, but this was rejected by a large majority, and the recommendation was adopted.

Lincoln.—Last week the Council adopted a recommendation of the Electricity Committee to increase the price of electric current by 20 per cent. to all consumers other than those taking current for power u de agreement.

Ald. WHITE, chairman of the Electricity Committee, said they had discussed the matter carefully and had unanimously passed the resolution. It was brought before the Council in committee, who discussed it at great length, and passed it with about three dissentients. He was disappointed that they should have to ask so early in the year for an advance of 20 per cent., but their financial position warranted it. The increase would represent in round figures about £1,500.

Councillor BRUNNING considered that the matter should be more seriously discussed, and he moved that it be referred back.

Councillor TAYLOR, who seconded, suggested that any increased cost in electricity should be paid out of the rates.

Councillor KILMISTER said small users of power for industrial purposes should be carefully considered in the matter. They should do all they could to prevent any handicap being put upon the industry of poorer people.

Ald. HARRISON hoped that the matter would not be referred back. Advances had taken place in almost every other town, and in many cases they were a good deal more than 20 per cent. The committee was not asking for a penny piece too much.

Ald. WHITE pointed out that large consumers, who were under contract, were, and had been for years, paying a very substantial advance on their contract prices. There were some in the city paying 50 per cent. above the price they agreed to pay on their contracts. On the other hand, the ordinary consumer had not been asked to pay a single penny more.

Eventually the amendment was put and lost by a large majority.

Sheffield.—A L.G. Board inquiry will be held on Jan. 21 at the Town Hall, Sheffield, to inquire into the application of the Corporation for a provisional order authorising the transfer of their Kelham Island tramway power station to their electricity supply undertaking.

Wallasey.—Owing to an accident to one of the turbines at the new generating station on Tuesday morning the electric supply was interfered with for some hours.

It was found possible to run only an intermittent service of tramcars during the greater part of the day, and on some of the routes the greatest inconvenience was experienced in the evening. In the early part of the evening there was no electric light throughout the district, but at about eight o'clock it was found possible to give a supply of electric current for lighting in a portion of the district, and to provide power to improve the tramway service. Later in the evening it was found possible to supply all the lighting requirements of the district, but the tramcars were stopped for a couple of hours, the service being resumed at 11 o'clock.

Walsall.—At the last meeting of the Council it was reported that owing to enlistments two shift engineers were required, and that the engineer and manager had been authorised to make the appointments.

Tenders have been obtained for a turbo-alternator set to replace commandeered plant, and these are under consideration. The committee has given instructions for the sale of certain obsolete plant.

Instructions have been given for a further reduction in the public lighting by about 300 lamps, and the Borough Surveyor has been authorised to negotiate with the Electrical Engineer as to the replacement of the high-power electric lamps in the centre of the town by lower power metallic filament lamps.

Watford.—The Urban Council has adjourned consideration of the question of public lighting until after the end of the current financial year, but £2,500 is to be paid on account to the Electricity Committee.

West London Linking-up Scheme.—Battersea Electricity Committee reports that the work of linking up the borough undertaking with Fulham has almost been completed, and that satisfactory tests of cables have been made.

The L.C.C. has intimated that they are prepared to advance £2,618 to cover the Borough Council's share of the cost of the scheme.

LIGHTING & POWER NOTES.

School Lighting.—Swansea Tramways and Electric Lighting Committee have agreed to extend their cables so as to supply electricity for lighting the Cwmbwrla schools, on condition that the Education Committee pay the interest on the estimated cost of the extension (about £800).

Train Lighting.—In consequence of the recent railway disaster at Jarrow, a resolution has been passed by the South Shields Labour Party urging the introduction of electric lighting on all trains.

Wharf Cranes.—At the new wharf, which the Dundee Harbour Board are constructing, there will be one 5-ton and a number of 30 cwt. electric travelling cranes, and the whole of the buildings will be lighted electrically.

TRACTION NOTES.

Bournemouth.—The Board of Trade have consented to the borrowing of a sum not exceeding £6,000 for the proposed re-construction of a portion of track between Bournemouth and Poole at Constitution-hill. The consent of the Treasury is not required as money is not to be raised by the issue of stock, bonds or bills.

Gateshead.—The Council have granted the application of the Gateshead & District Tramways Co. to substitute span wires suspended from side poles in Durham-road from Shipcote to the Low

Fell tramway terminus in place of the existing brackets, on certain conditions including the removal of the whole of the centre poles in Gateshead by the company within two years.

The company has also been authorised to lay a double set of rails in Sunderland-road, on condition that they pay £180 towards the cost of widening the roadway at Robber's-corner.

Glasgow.—Last week the Corporation adopted recommendations to increase the wages of motormen and male conductors and certain other workers in the Corporation tramways department by 2s. per week. Women conductors with six months' service received an advance of 1s. per week.

There are now 1,020 women conductors employed on the Corporation's cars and five women drivers, while 25 are being trained as drivers.

Gloucester.—The Corporation have sanctioned the employment of women as temporary conductors on the light railway cars at the same commencing wage as that paid to male conductors.

Ilford.—On the 1st inst. the Council introduced a scheme of parcel carrying on the tramcars.

A charge of 1d. per package is made for all luggage, parcels or packages (other than personal luggage not exceeding 28 lb. in weight, which will be carried free), and folding carriages or mailcarts accompanying a passenger except small packages that can be conveniently carried on the lap of a passenger, and which do not occupy a seat. All large packages and carriages accompanying passengers must be placed on the platforms at the rear or front of the car as convenient, and passengers are not to be allowed to take on a car any package that exceeds 4 ft. in length or 18 in. in width or depth approximately, while the following articles will not be carried: Bags of coal, soot, flour and manure, butcher's meat and fish (unless in baskets and covered in), open cans or pails of liquid, sweeps' brushes and bicycles.

Keighley.—In reply to some criticism of the tramway service at the last meeting of the Corporation, the chairman of the Tramways Committee (Mr. A. Smith) said that out of 57 men 45 had not one year's service.

Under present conditions it was practically impossible to give a thoroughly satisfactory service. Twenty-four of their best men had joined the Army and they had not been satisfactorily replaced. The electricity department was largely at fault in connection with the stoppages, but no doubt when that department got thoroughly equipped there would be a much better tramway service. They had considered the question of lady conductors, and he believed they would have to do something in that direction, though really they had not found so much difficulty in regard to getting the required number of men as in their quality.

The Board of Trade have extended for one year from Aug. 7, 1916, the time limited by the Keighley Corporation Act, 1912, for the completion of overhead equipment of trackless trolley route authorised by the said Act.

Manchester.—There are now over 200 women conductors in the service of the tramways department.

Rochester.—A section of the local residents have petitioned the City Council protesting against the stoppage of the tramway service on Strood-hill by the Chatham & District Light Railways Co.

The general manager of the company has pointed out the difficulties of maintaining the service owing to over 60 per cent. of the employes having joined the Colours. Partial service, however, could be given, but only by curtailing the Frindsbury-hill service. The general feeling was that the latter service was the more important, and in the result the company has intimated that an effort will be made to provide a modified morning service at Strood.

Rotherham.—The Corporation have agreed to refer to Mr. Jas. Dalrymple, tramways manager of Glasgow, a dispute with Sheffield Corporation tramways department as to the running of additional cars between Tinsley terminus and Messrs. Hadfield's works.

South Shields.—Last week the Council were recommended by the Electrical Committee to apply to the Treasury for sanction to borrow £1,850 for carrying out a scheme for hiring out motor vehicles and for the purchase of a motor wagon for use in connection with the electrical undertaking.

Mr. SYKES opposed the proposal. He said he was in favour of the scheme, but he contended that at this particular time it was neither urgent nor important.

After discussion the report was agreed to.

The Council have decided to purchase an electrically propelled vehicle for the use of the electric supply department at a cost of £850.

Electric Traction in Sweden.—It is announced that the Swedish State Railways management contemplate the adoption of electric traction on their whole system. Last year's experiments on the Ofoten railway have given excellent results, and hence the desire to adopt electric traction. The whole work is expected to be finished in 1924, and the estimated cost is about £2,500,000. Power will be taken from the great Porjus waterfalls in Northern Lapland. It is estimated that one result of the change will be that the import of about 500,000 tons of coal will be dispensed with.

TELEGRAPH & TELEPHONE NOTES.

Deferred Cable Service.—We are informed that, owing to the interruption of other companies' cable facilities and the suspension by them of their cheaper forms of service at the end of December, an extraordinary volume of deferred traffic was forced upon the lines of the Commercial Cable Co. This resulted in creating a delay on this class of traffic to such an extent that it was impossible to give a satisfactory service, and under these circumstances the company found it necessary to suspend temporarily this class traffic until such time as the situation again becomes normal.

Trans-Pacific Radiotelegraph Service.—It is announced that the Japanese Government recently notified the Marconi Wireless Telegraph Co. of America that the new wireless station at Funabashi, near Tokio, would be ready for Trans-Pacific communication soon after the New Year. Experimental work between Honolulu and Funabashi is being carried out, and, according to the reports, the system has worked well at both stations, which are 3,400 miles apart.

EMPIRE NOTES.

Australasia.—"Tenders" (Melbourne and Sydney) says the engineer of the Brisbane (Queensland) water supply and sewerage scheme recommends the adoption of electric pumping. The cost of the scheme with a five-million gallon reservoir is estimated as £59,000.

A proposal to utilise the water supply system in connection with a hydro-electric power scheme has been adopted by the Councils of Grafton and South Grafton (N.S.W.). The scheme is estimated to cost £23,000.

Gladstone (Queensland) Council have obtained an Order in Council authorising them to establish electricity works.

Tata Hydro-Electric Works (Bombay).—The first report of the Tata Hydro-electric Works, submitted at the recent meeting of the Tata Hydro-Electric Power Co., states that the major portion of the erection work is completed.

Mill equipment for all the mills of the original installation have been received. Ten mills are completely equipped and receiving power, and 17 are receiving power for partial requirements. These 27 mills have motors of an aggregate of 27,400 B.H.P. in service, in addition to the cotton and flour mills, which have contracted to take a supply from the company for 10 years. The company have entered into a contract with the Bombay Electric Supply & Tramways Co. for the energy required by them for two of their sub-stations. The directors have authorised the investigation of new areas on ghauts for the extension of the present scheme to meet any prospective demand for energy. Sites have been chosen, and considerable power will be made available on a highly satisfactory basis. The supply of electricity to the Bombay mills was commenced in February, 1915. Sir Dorab Tata, who presided at the meeting, said that of the original installation, planned to supply approximately an average of 30,000 E.H.P. to consumers in Bombay, fully three-fourths was in working order, earning a revenue of about 1¼ lakhs of rupees per month. That was being steadily increased as the mill drives were converted from the old method to the new, and it was anticipated that shortly after the end of 1915 the full demand would be met.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says Señor U. Alvarez, has been granted an electric lighting concession by the Municipality of Escobar (Province of Buenos Ayres).

There is a project on foot in Mar del Plata for the formation of a local co-operative electric light and power company with a capital of $.m. 200,000 m. n. (about £44,000).

Chili.—The "Review of the River Plate" says the copper mining industry of Chuquicamata in the barren Chilean pampa, 150 miles from Antofagasta, is being developed by the Chile Exploration Co.

The ore body has been worked on the surface by the natives, and also to a small extent by English companies. It is a large body of disseminated ore of considerable length and breadth and of unknown depth. The superficial area showing copper covers more than 150 acres. The electrolytic process for obtaining the copper having been decided upon, a great amount of electrical power was required. Owing to the scarcity of rivers or water from any source in this immediate section, it was found necessary to build a power plant on the coast at Tocopilla, and to transmit energy at 110,000 volts by a transmission line of 100 miles in length to the mill site at Chuquicamata. New types of towers and insulators are said to have been devised by the company's experts, who also overcome the problems attendant on the quick temperature rises and the high altitude. Water is applied by pipe lines from the mountain streams of the Andes.

MISCELLANEOUS NOTES.

Engineers' Wages.—The Committee of Production have decided to refuse the application of 30,000 engineers in Manchester district for an advance of wages of 6s. a week on time and 15 per cent. on piece rates, as they consider that no substantial case has been made out. Early last year an advance of 4s. a week was granted.

Immingham and Grimsby Tide Tables (1916).—We have received from the Great Central Railway Co. a copy of the Immingham Tide Tables for 1916. This neat booklet, which has been produced in pocket size, gives the high water and low water tides at Immingham for each day of the year, in addition to useful facts and figures, charges, &c., respecting these two East Coast ports. Copies of the tables will be sent free on application to Great Central Railway Publicity Office, 216, Marylebone-road, London, N.W.

Inquests.—An inquest was held at Manchester last week on a youth named H. Wharton, who was being trained in the work of an overhead crane driver in the local engineering works.

There were "live" electric wires above the cabin, but Wharton, who had no need to leave the cabin, was seen to place his hand on one of the wires and then to fall. A verdict of accidental death was returned.

The resumed inquest on the two men (Shadwell and Marshall) who were killed on Eastbourne sea front on Dec. 26 was resumed on the 5th inst.

The facts were given in our issue of Dec. 31, but much additiona evidence was given on the present occasion. The electrical adviser of the Board of Trade (Mr. A. P. Trotter) also attended.

Mr. J. KEMP BRYDGES, borough electrical engineer, said he received a telephone message, and he gave instructions to the attendant at the electricity works to keep off the electrical supply until he had visited the scene of the accident. He did so immediately, and saw the two deceased men against the motor car. The switchbox had been smashed and the pieces scattered about. The switchbox was made of cast iron and was very substantial. It was constructed according to the Board of Trade requirements, and contained switches which controlled three high-pressure cables. The car was right over where the box had stood. Witness found that the three cables were torn away from the switches, so that until the supply was cut off from the works one part was alive He supposed that that must have been touching the car and charged it with electricity. It had been suggested to him as a theory that one of the men might have stood on the cable when he was touching the car, and charged it with electricity. However, he was not prepared to say definitely that that really happened. At far as possible those cables were placed above ground, because it was dangerous to the employés to have them underground. The suggestion that the car was drawn to the box in some manner was absolutely impossible.

The CORONER: Is it conceivable that the steering gear of a car at such a distance as this car could be affected by the cable either underground or in the switchbox?

WITNESS: It is quite impossible at any distance whatever.

The CORONER: In the opinion of Mr. Trotter, the arrangements were in accordance with the Board of Trade regulations. It might be a question whether those regulations should be altered in the future, as he understood the accident had suggested possible improvements.

Mr. BRYDGES said there were underground boxes at Eastbourne, but they were dangerous.

To Mr. GLENISTER (for the owner of the car): If the chauffeur in this case swears on his oath he was drawn towards this box, you would say he was not? I say it is impossible.

Mr. TROTTER: If there were a leakage on the high-pressure wires, and if the apparatus in the works were defective so that the leakage could go on undetected, the result might be that people walking in the street over the wires might get a shock, but it was perfectly impossible that such a shock could be felt by the driver in a motor car with rubber tyres, or even by the driver of a traction engine.

HORACE SIMMS, the chauffeur, stated that he was driving the car to Pevensey, and he was travelling at barely 12 miles an hour, when all of a sudden the car swerved over to the switchbox. He was not attracted by anything at the time. He had hold of the wheel all the time, but it went against him.

The CORONER: Do you mean the wheel would not obey your hands?—I don't know; I did not have hold of it very tight. I did not have time to feel anything. When I felt the car going I jammed on the brakes. Witness said he had no explanation of the accident to offer at all, except that when a few feet from the box the car swerved into it. When he saw the men trying to move the car and receiving shocks he pulled them away, and was doubled up. Many men were burnt on the hands through trying to pull the car with a wire rope.

Mr. TROTTER: It was most unfortunate to use a wire rope. A hemp rope would have been all right.

WITNESS agreed with Mr. Niedermayer (for Mrs. Shadwell) that it mig ht have been electricity which caused him to go into the box, or it mig ht have been the moon!

The jury returned a verdict of "Death from misadventure," the foreman adding that the jury considered that the switchboxes should be placed further away from the side of the road, so as to be less likely to come into contact with anything which might be a source of danger.

Munition-Workers' Canteen.—An interesting function took place last week at the electrical instrument works of Mr. Robt. W. Paul.

The works are producing a variety of instruments for the Government. Since there are no local facilities for meals for the men and girls the Y.M.C.A. were asked to organise a canteen on similar lines to those at other industrial centres, but on a smaller scale. Mrs. Winston Churchill, who is actively engaged in this branch of the Y.M.C.A. work, soon got together an efficient and enthusiastic staff of local ladies. A suitable building having been erected at the works, she visited it on the occasion mentioned, and gave a brief but telling address to the voluntary workers. It was not easy to see all the links in the chain between the handing of a cup of tea to a workman and the firing of a shot, nevertheless the connection was complete and real..

Mr. Paul expressed the gratitude of the working staff for the assist ance rendered which made it possible to provide the good food which was necessary to enable good work to be done. He briefly demonstrated a few of the instruments which were being made at the works, and which played an important part in the military and naval air services. Much of the work was already being done by young women, and there was scope for many more in such work, even after the war. Mrs. Hancock, is honorary secretary and treasurer, and Mrs. Scrimshaw is honorary manageress.

Social Gathering.—On the 31st ult. Cryselco Limited entertained their employés in social intercourse, and a very pleasant evening was spent.

The works closed early, and at six o'clock the staff and employés (about 300 in number) sat down to a high tea. Subsequently the company indulged in games and pastimes. After a brief address of welcome from the managing director (Mr. H. S. Deacon), the party moved to the entertainment hall, where a bright and breezy programme was carried out by London artistes. At nine o'clock the company adjourned for dancing and recreation. Many of those present were in khaki. All the arrangements were carried out under the direction of Mr. A. R. Powell and Mr. A. R. Harrisson.

TENDERS INVITED.

Telegraph and Telephone Material, &c.

Tenders are invited by the Postmaster-General's Department of the COMMONWEALTH OF AUSTRALIA for the supply of Carbon and Manganese Powder, Manganese Chloride, Chloride of Ammonia, Porous Pots, Outer Jars for Cells, Carbon Blocks, &c. Tenders to the Official Secretary, Commonwealth of Australia, 72, Victoria-street, S.W., by noon Jan. 19. *Further particulars (as to quantities required, &c.) are given in an advertisement.*

The Deputy Postmaster-General, Adelaide, requires tenders by 2 p.m. Jan. 26 for 20 tons g.i. Wire (schedule No. 402) for AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification from the Deputy Postmaster-General, Adelaide.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Brisbane, also requires tenders by noon Jan. 26 for Telephone Instruments, Parts and Accessories. Tender forms, &c., from 72, Victoria-street, S.W.

Tungsten Filament Lamps.

The SOUTH AFRICAN RAILWAYS ADMINISTRATION require tenders by noon Jan. 17 for the supply of 19,266 Wire-drawn Tungsten Filament Lamps for various voltages, and 55,700 ditto for 24-volts for train lighting. Specifications from Secretary, Tender Board, S.A. Railway Headquarters, Johannesburg.

Carbons.

DUBLIN Electricity Committee require tenders by noon Jan. 21 for 50,000 pairs of Carbons for c.c. lamps and 62,000 pairs for flame lamps. Specifications from the City Electrical Engineer.

MIDDLESBROUGH Corporation require tenders by first post Feb. 7 for 12 months' supply of Electric Lamps, Bolts and Nuts, Oils, Paints, &c. Specifications from Borough Engineer.

Hydro-Electric Generator.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of . 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Electrical and Tramway Stores.

ISLINGTON (London) Council require tenders by Jan. 21 for one year's supply of Transformers, Meters, Cables, Terminal, Service and Network Boxes, Lamps, Sundries, Arc Lamp Globes, Oils and Lubricants, &c. Specifications, &c., can be obtained at the Town Hall, Upper-street, N.

CROYDON Corporation want tenders by 10 a.m. Jan. 24 for one year's supply of General Stores for their Tramways Department. Schedules (A to M) from the Tramways Manager.

PEMBROKE (co. Dublin) Urban Council require tenders by noon Feb. 7 for 12 months' supply of Electrical Goods, Oils and Colours, &c. Specification, &c., may be obtained at the Town Hall, Ballsbridge, co. Dublin.

MELBOURNE, BRUNSWICK and COBURG (Victoria) Tramways Trust invite tenders by Jan. 19 for Wheels and Axles (contract No. 30), and by Feb. 18 for Six Radial-type Trucks (contract No. 28). Specifications, &c., from the office of the Melbourne, Brunswick and Coburg Tramways Trust, Coburg, Victoria.

Electrically-operated Pumps.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1,301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Tramway Material.

JOHANNESBURG (Transvaal) Council require tenders by noon Jan. 25 for supply of (1) 800 pairs of Fishplates for girder Tram Rails (Contract 66); and 100, or alternatively 200 Rolled Steel Tramcar Tyres (Contract 69). Specifications, forms of tender, &c., from the Municipal Offices, Johannesburg.

Boiler Tubes.

JOHANNESBURG Council also want tenders (by noon Feb. 15) for supply of 250 18 ft. by 4 in. Tubes for Water-tube Boilers. Specification, &c., from the Municipal Offices, Johannesburg.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Electric Lamp Shades.

The COMMISSIONERS of H.M. WORKS and PUBLIC BUILDINGS require tenders by 11 a.m. Jan. 17 for White Earthenware Electric Lamp Shades. Forms of tender, &c., from the Controller of Supplies, 18, Queen Anne's gate, Westminster, S.W.

Electric Power and Lighting Plant.

Tenders will be received at the Negociado Quinto de la Segunda Sección (Material) del Estado Mayor Central de la Armada, Ministerio de Marian, Madrid, until Jan. 26, for the Construction and Installation in the Cadiz Naval Arsenal of an Electric Power Plant. Conditions of tender may be seen at the above-mentioned Negociado. Tenders (in Spanish), on paper bearing a 1 peseta stamp, must be accompanied by specifications and plans. A provisional deposit of 20,000 pesetas (about £800) is required to qualify any tender. Local representation is necessary.

SEGOVIA (Spain) Municipality require tenders by Jan. 20 for the installation and working for five years of an Electric Lighting System for the city. The contract will probably be awarded to a Spanish firm.

Electric Tramway.

Tenders will be opened on Jan. 28 at the Dirección General de Obras Públicas, Ministerio de Fomento, Madrid, for the Construction and Working, for 60 years, of an Electric Tramway in Madrid (Monte del Pardo district). Minimum rolling stock required, three motor coaches and three trailers. The concession is held by the Sociedad Tranvia del Este de Madrid.

TENDERS RECEIVED AND ACCEPTED.

SHEFFIELD.—The offer of the electric supply department to provide (for £185) the necessary switchboards and fittings for charging the electric vehicles of the Health department has been accepted.

CABLE SUPPLIES.—The Metropolitan Water Board has accepted the tender of F. Smith & Co., for a supply of copper cable (at about £175) for coal unloading plant.

LIVERPOOL.—The tender of the British Electric Transformer Co. has been accepted for the supply of transformers.

BIRMINGHAM.—The following tenders have been accepted for additional plant for the Nechells power station :—

Babcock & Wilcox, three boilers, superheaters, chain-grate stokers, induced draught fans, &c., £17,000; Herbert Morris (Ltd.), coal-handling plant (overhead telepherage system), £3,500; E. C. & J. Keay, structural steelwork, £5,800; Davenport Engineering Co., cooling towers, £5,550.

NUNEATON.—The Council have accepted the tender of the British Insulated & Helsby Cables for the supply and erection of an overhead copper line, at £436. 11s. 4d. There were seven tenders, ranging from £502. 7s. 6d. to £436. 11s. 4d.

ILFORD.—The Council have accepted the tender of W. T. Henley's Telegraph Works Co. (at £2,319. 8s. 10d.) for the supply of triple concentric cable and joint boxes.

SYDNEY (N.S.W.).—The Council have accepted the tenders of the British Westinghouse Co. for an 8 H.P. motor, at £50, and the Australian General Electric Co. for a 5 H.P. motor, at £36. 15s., for a new workshop; and British Insulated & Helsby Cables for 6,774 yds. lead-covered and armoured cable, at £201.

BROKEN HILL (N.S.W.).—The Broken Hill Associated Smelters Pty. has accepted the tender of Fraser & Chalmers, for two 2,000 kw. turbo-alternators.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

BUENOS AYRES LACROZE TRAMWAYS CO. (LTD.).—The report for year ended June 30 states that, notwithstanding the higher value of coal, the cost of which has risen about 40 per cent. above that of 1913-14, the percentage of working expenses has been lower owing to the economy practised in certain parts which has not affected either the efficiency of the services. The gross receipts were $6,100,652.99 m/n, a decrease of $321,820.04; working expenses were $4,709,781.33 m/n, a decrease of $222,882.13 m/n, leaving net profit of $2,339,870.67 m/n. Deducting debenture interests, amortisation of municipal concession, &c., the balance is $1,191,914.75 m/n, which with $10,875.12 m/n, brought forward, gives $1,205,789.87 m/n. The board proposes to pass 5 per cent. to reserve ($59,595.74), to pay 5 per cent. to directors ($59,595.74), 4 per cent. to sinnin ($85,959.57), and to pay to the shareholders, $1,000,000.00, leaving to be carried to next account $83,638.82.

GREENWOOD & BATLEY (LTD.).—The directors' report states that the works of the company were declared a "Controlled Establishment" as from July 12 last, and the directors submit the balance sheet as at July 11, 1915. After providing for debenture interest, management expenses, bank and other charges, and the excess profits liability under the Finance (No. 2) Act, 1915, the profit is £47,220, 9s. 11d., making with £6,417, 16s. 11d. brought forward, £53,644 6s. 10d. The directors have appropriated £20,000 to depreciation and £17,000 to reserve account, and they recommend that dividends for the period from April 1 to July 11, 1915, be declared at rate of 7 per cent. per annum on the cumulative preference shares issued, and of 2s. per share on the fully paid ordinary shares, and of 12s. 6d. per share on the £5 paid ordinary shares, leaving £7,906, 0s. 4d. to be carried forward.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD.)—For the year ended Dec. 31 (after providing for all expenses, including repairs maintenance and debenture interest) the net income is £29,310. 5s. 1d.; with £10,725. 2s. 1d. brought forward, the available balance is £40,035. 7s. 2d. After paying the 6 per cent. cumulative preference dividend (£12,027. 17s. 2d.) and allowing for depreciation, renewals, reserve fund, &c. (£12,962. 9s. 5d.), the sum of £15,045. 0s. 7d. was carried forward. 11,602,483 passengers were carried during the year and 1,763,702 car-miles were run, against 10,716,858 passengers and 1,778,509 car-miles respectively for the previous year.

NEW COMPANIES, MORTGAGES & CHARGES.

NEW COMPANIES.

JOHN LEVICK (LTD.) (142,497)—Reg. Dec. 22, capital £50,000 in £1 shares, to take over business of a metallic and other railway fittings manufacturer and sanitary engineer, general brassfounder and railway stores contractor carried on by J. Levick at Aston, Birmingham, and to carry on the same and the business of manufacturers of forgings, electrical fittings, electrical machinery, motor vehicles, &c. Private company. First directors are J. Levick (permanent governing director and chairman) and J. Levick, jun. Reg. office: 149, Alma-street, Birmingham.

OWEN, KING & CO. (LTD.) (142,600)—Reg. Jan. 1, capital £1,000 in £1 shares, to carry on the business of manufacturing electricians, makers and vendors of and dealers in all kinds of electrical appliances and apparatus, importers and exporters of cables and flexible lamps, fittings and accessories, bells, telephones, electric fires, heating and cooking appliances, &c. Private company. First directors are D. A. Owen (chairman), Mrs. E. Owen and A. A. King. D. A. Owen and A. A. King are permanent man. directors. Reg. office: 211, Shaftesbury-avenue, W.

PRODUCTIVE ENGINEERS (LTD.) (142,401)—Reg. Dec. 14, capital £1,000 in £1 shares, to carry on the business of mechanical, and electrical engineers and contractors, manufacturers of machinery, tools, ordnance and munitions of war, metal workers, machinists, &c., and to adopt an agreement with J. Lawson. Private company. First directors are C. E. Booth and J. Lawson (both permanent, subject to holding 250 shares each).

SOUTH WALES & WEST OF ENGLAND WIRELESS TRAINING COLLEGE (LTD.) (142,641.)—Reg. Jan. 6, capital £5,000 in £1 shares, to carry on a college or school for training and instruction in wireless telegraphy and telephony, and electrical and other engineering, and to adopt agreements with the South Wales Wireless Training College (Ltd.) and J. R. Schofield. Private company. Reg. office, Market-buildings, St. Mary-street, Cardiff.

THOS. WALKER & SONS (TEWKESBURY) (LTD.) (142,547).—Reg. Dec. 28, capital £1,000 in £1 shares, to take over the business of general engineers carried on at Tewkesbury (Glos.) as Thos. Walker & Sons, and to carry on same, and the business of electricians, manufacturers of malleable castings, agents for and dealers in motors, engines, dynamos, &c. Private company. First directors are: Mary H. C. Walker, J. R. Walker and A. E. Walker (all permanent).

C. A. VANDERVELL & CO. (LTD.) (142,593)—Reg. Jan. 1, capital £350,000 in 300,000 ordinary shares of £1 each and 1,000,000 deferred shares of 1s. each, to take over the business of an electrical engineer, manufacturer of dynamos, lighting equipments, accumulators and other motor accessories and Government contractor carried on by C. A. Vandervell as C. A. Vandervell & Co., and to adopt an agreement with the said vendor and A. H. Midgley. Private company. C. A. Vandervell is permanent governing director. Reg. office: Warple Way, Acton Vale, W.

MORTGAGES AND CHARGES.

BURT, ESCARÉ & DENELLE (LTD.)—Particulars of £7,500 debentures, created Dec. 22, 1915, have been filed, whole amount being now issued. Property charged, company's property, present and future. No trustees.

Memorandum of satisfaction in full on Dec. 30, 1915, of debenture stock dated April 14, 1911, securing £3,900, has been filed.

ELECTROLYTIC COPPER CO. (LTD.)—Particulars filed Dec. 30, 1915, capital £100,000 in £1 shares. Reg. in Guernsey in Sept., 1915. British address: Finsbury-pavement House, E.C., where A. W. Pearce is authorised to accept service. Directors: S. C. Magennis, H. S. Mackay, T. Huntington, D. A. Freeman, J. Q. A. Whittenmore and A. O. Cantley.

RESISTO ELECTRICAL MFG. CO. (LTD.)—Issue on Oct. 11, 1915, of £900 debentures, part of series of which particulars have already been filed.

CITY NOTES.

MEMORANDA (Jan. 12).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 59. Consols Pay Day, Feb. 2. Stocks and Shares Ticket Days Jan. 26 and Feb. 9. Pay Days Jan. 27 and Feb. 10. Price of silver, 27d.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have resolved to pay the following dividends to the close of the year 1915—viz., a balance dividend of £1. 10s. per cent. upon the ordinary consolidated stock for the year (less tax at 2s. 11d.), a balance dividend of £1. 10s. per cent. upon the preferred stock for the year (less tax at 3s. 2d.), and a first and final dividend of £1. 10s. per cent. upon the deferred stock for the year (less tax at 2s. 8d.). These dividends are payable on the 1st prox. and together with those already paid will amount to 3¾ per cent. on the ordinary consolidated stock, 6 per cent. on the preferred stock, and 1½ per cent. on the deferred stock for the year 1915. It is also proposed to pay a bonus of 1s. 9d. per cent. on the undivided ordinary stock, and 3s. 6d. per cent. on the deferred stock, tax free.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved to pay an interim dividend of 2s. per share (less tax at 3s. 2d.), being at rate of 4 per cent. per annum for the quarter ended Dec. 31, 1915.

DUBLIN UNITED TRAMWAYS (1896) CO. (LTD.)—The directors have declared a dividend at rate of 5 per cent. per annum on the ordinary shares for the past half-year. £5,000 has been placed to reserve and renewal fund, £18,000 allocated for renewal of rails and £13,045 carried forward.

KAMINISTIQUIA POWER CO. (LTD.)—The directors have declared a dividend of 1½ per cent. for the quarter ending 31st inst.

WESTERN CANADA POWER CO.—It is announced that the company has made default in payment of the coupon payable Jan. 1 on its 5 per cent. first mortgage bonds. A committee has been formed in Canada to protect the bondholders' interests. Holders of bonds should communicate with the Equitable Trust of London, 3, Lombard-street, E.C.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Jan. 11. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Jan. 11.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9 13/32	7 8 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9 13/32	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9 13/16	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 9	Jan, July
5	2/3	Do. 4½% Pref.	3 5/32	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	2 3/4†	8 8 8	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4 3/8	5 3 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	.%	City of London Elec. Lt. Ord.	12½	7 8 5	Feb Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St	5%	Do. 5% Deb. St.	99½†	5 0 6	Jun Dec
St.	4½%	Do. 4½% Debs.	98†	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	10 1/32	5 16 4	Feb, Aug
St.	4½%	Do. 1st Deb.	90½†	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	77	5 16 11	July
5	9%	Kensington and Knightsbridge Ord.	6 3/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79½	5 0 8	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 13/32	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80†	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99†	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/32	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3	6 13 4	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 5/8	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 7/8	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80†	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	84	5 6 10	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 3/32	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3¼†	6 0 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82 3/8	6 0 9	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70½	5 14 2	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	16	6 1 3	May. Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb. Aug
10	5%	London Electric Ry. Ord.	1 3/8	3 16 11	Jan, July
St.	4%	Do. 4% Pref.	60 3/8	6 12 0	Mar. Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	25½	3 18 5	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb. Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16 3/8	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May. Nov
St.	4½%	Do. 4½% First Pref.	69	6 15 0	Feb. Aug
St.	6%	Do. 6% Perp. Debs.	109½	5 9 7	Jan. July
St	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 1/8	..	..
1/0	..	Do. A Ord.	1 1/32	..	..
St.	6%	Do. 6% Inc. Debs.	106	5 13 2	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Jan. 11.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways —*cont.*			
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	83¾	7 5 8	Mar, Sept
..	4½%	Do. 4½% Bds.	99½†	4 10 0	Jan, July
5	..	Yorkshire W. Riding Ord.	¾		March
5	6%	Do. Pref.	4½†	7 1 2	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2½	5 12 0	Apl, Oct
1	6%	Do. 6% Pref.	1¼	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1¼	4 12 10	Mar
100	5%	Do. Prior Lien Debs.	90½†	5 10 2	Jan, July
1	6%	Do. 6% Pref.	⅝	7 2 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛	7 0 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5¼	5 17 1	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2¼	6 13 4	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69†	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅛	6 12 7	Jan, July
5	2/6	Do. 5% Pref	4⅛†	5 14 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98†	4 11 10	Jun, Dec
1	20%	Castner Kellner	3⅛	6 10 7	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	62½†	6 8 6	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 14 7	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	72½	5 10 4	Jan, July
10	10%	General Electric Ord.	10⅛	9 11 1	July
10	6%	Do, 6% Pref.	9⅛	6 6 9	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	⅜	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅛†	10 17 8	Feb, Aug
10	5%	Do. Pref.	7⅜†	6 13 4	Apl, Oct
100	4%	Do. 4% Debs.	93⅛	4 1 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	35	6 17 2	Mar, July
100	4%	Do. 4½% Debs.	93†	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	82½	4 17 2	Jun, Dec
St.	4½%	Do 4½% 2nd Debs	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 6	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	23⅛	6 10 5	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69½†	5 15 0	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	5⅝	6 16 2	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	128	5 19 5	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	66½	5 5 7	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81½	4 18 2	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12⅜	5 9 10	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. ex Coup. d.	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	46½	6 13 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛†	5 3 3	April
1	7%	Do. 7% Pref.	1⅜†	3 18 7	July
10	1%	West India & Panama Ord.	1⅛	8 19 9	May, Nov
10	6%	Do. 1st Pref.	7⅛†	7 11 9	May, Nov
10	7%	Western Telegh. Co.	12½†	5 11 2	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79†	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	98½	4 11 4	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap	134½†	5 18 9	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	75½†	6 13 1	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅛	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	100⅛	4 9 8	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79†	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅞	6 14 0	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4¼†	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90†	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10⅛	5 15 8	Sp,De,Mr,Jn
10	6%	Do. 6% Pf.	10⅛	5 17 3	Sp,De,Mr,Jn
100	5%	Mackay Companies' Common	8⅝	5 16 2	Ja,Apl,Jly,O
..	4%	Do. $100 Pref	67⅛	5 14 5	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	80⅛	6 3 11	Jun, Dec
St.	4½%	Do. 4½% Debs	77½†	5 16 6	Jan, July
St.	4%	Do. 4% Debs.	71½†	5 11 11	Jan, July
5	5½%	Do. 5½% 1st Pref.	4⅜	6 1 5	Jan, July
5	5½%	Do. 5½% 2nd Pref.	3⅝†	8 0 0	Jan, July
100	2%	Brazilian Traction Ord.	51	7 16 10	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	91½	6 11 4	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅛	6 14 3	Mar
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64½	6 11 9	..
5	9½%	Calcutta Elec. Trams. Ord.	5⅝	8 1 4	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	90	5 11 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4⅝	6 2 4	..
100	5%	Manaos Trams 5% Debs.	69⅛	7 4 11	Jan, July
..	..	Mexico Trams Common St.	42	..	Fb,M,Aug,N.
..	5%	Do. 5% Bds	49	10 4 1	May, Nov
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)..	94½	4 15 6	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 50 yr. Bds	78	6 8 4	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	7⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	92	5 6 3	Jan, Dec
10	6/-	Bombay E. S. & T. 6% Pref.	10⅛	5 14 3	..
St.	4½%	Do. 4½% Debs.	81⅛	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6⅛	7	Mch, Sept
5	5%	Do. 5% Pref.	4⅛	5 12 8	Mar, Sept
..	7%	Canadian Gen. Elec. Common St.	117½	5 19 11	Ja,Ap,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs	88	5 2 0	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	96½	5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	29½	..	Ja,Ap,Jly,O
..	..	Do. Pref.	3⅛	..	May, Nov
..	5%	Do. 5% Bds	46½	10 15 1	Jan, July
81½	5%	Shawinigan Water & Power 5% Bds.	103½†	4 16 9	Jan, July
..	6%	Do. Cap. Stock	136½	4 8 7	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96†	4 13 6	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	80⅛	5 12 0	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	..	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	91½†	5 19 11	Jan, July

* And 13⅓% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Jan. 11, the following as the present basis prices of

New Metals.	per lb.		per ton
Solid Drawn Brass Tubes	15½d.	English Lead	£32 0 0
Solid Drawn Copper Tubes	15½d.	Antimony	Nominal.
Brazed Copper Tubes	15½d.		
Brazed Brass Tubes	17½d.	**Old Metals.**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£79 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£73 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£59 0 0
Brass Sheets	14½d.	Old Lead	£26 0 0
		Old Zinc	£60 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£125 0 0	Black Pewter	£75 0 0
Spelter	£89 0 0	Gun Metal	£71 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Jan. 11, the following approximate prices of Scrap Metals:—

	per ton.		per ton
Aluminium Cuttings	£125 0 0	Old Lead	£27 0 0
Clean Mixed Brass	£60 0 0	Tea Lead	£25 0 0
Clean Copper	£80 0 0	Old Zinc	£62 0 0
Brazlery Copper	£74 0 0	Hollow Pewter	£115 0 0
Gun Metal	£72 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 5	2,152	+ 205	31	56,797	+ 3,416
Anglo-Argentine	,, 7	50,841	— 1,879	1	50,841	— 1,879
Ashton-under-Lyne	,, 1	508	+ 75	40	19,116	+ 1,418
Ayr Corporation	,, 8	305	+ 72	34	13,363	+ 805
Birkenhead Corporation	,, 9	1,458	+ 225	41	56,093	+ 4,677
Birmingham Corporation. Trams	,, 1	15,986	+ 355	40	566,490	+ 81,504
Birmingham Corporation. Buses &c.	,, 1	793	+ 140	40	33,443	+ 18,414
Blackburn Corporation	,, 5	1,199	— 20	41	52,000	— 302
Blackpool Corporation	,, 6	957	+ 223	41	69,943	+ 1,961
Blackpool and Fleetwood	.. 8	380	— 90	1	380	— 2
Bolton Corporation	.. 9	3,050	— 482	41§	110,099	— 1,191
Bournemouth Trams	.. 5	1,989	+ 136	40	84,819	— 4,106
Bournemouth Buses	,, 5	10	+ 2	40	934	— 92
Bradford Corporation	.. 1	5,982	— 143	39	257,240	+ 19,022
Brighton Corporation	.. 9	940	+ 53	41§	45,839	+ 541
Bristol Trams Trams	.. 7	4,695	+ 176	1	4,695	+ 176
Bristol Trams Buses,&c	.. 7	4,820	— 507	1	4,820	— 507
Burmah E. Trams & Ltg.	.. 8	R3,613	+ R76	1	R 3,613	+ R76
Burnley Corporation	,, 8	1,699	+ 180	14	32,742	+ 2,658
Burton Corporation	,, 9	316	— 22	41	11,694	— 328
Bury Corporation	.. 9	1,354	— 182	41§	55,247	— 116
Calcutta Tramways Co.	,, 8	R69,157	+ R3,030	1	R69,157	+ R3,030
Camborne-Redruth	.. 1	165	+ 31	52	7,211	+ 115
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 6	414	— 45	1	414	— 45
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	.. 8	1,098	+ 137	40	42,848	+ 1,607
Dover Corporation	,, 1	298	+ 38	39	12,414	+ 2,181
Dublin & Lucan Railway	,, 7	114	— 22	1	114	— 22
Dublin United	.. 7	6,171	+ 350	1	6,171	+ 350
Dundee Corporation	,, 5	1,704	+ 146	34§	46,226	+ 2,573
East Ham Council	.. 8	1,349	+ 51	40	52,978	+ 5,579
Exeter Corporation	.. 7	360	— 18	40	15,331	+ 811
Glasgow Corporation	.. 8	24,252	+ 3,157	32‡	693,396	+ 49,998
Glossop Trams	,, 8	134	+ 26	2	278	+ 58
Gloucester Corpn.	.. 5	331	— 10	40	13,393	+ 142
Halifax Corpn. Trams	,, 4	1,959	— 65	40	89,240	+ 639
Halifax Corpn. Buses	.. 4	46	— 1	40	1,966	— 12
Hastings Elec. Trams Co.	.. 7	825	— 110	1	825	— 110
Huddersfield Corpn.	..	..	..	..	..	..
Hull Corporation	.. 8	3,322	+ 202	40	125,066	— 1,946
Ilford District Council	.. 8	661	— 59	40	26,351	+ 2,988
Ilkeston Corporation	.. 5	129	— 21	40	5,399	— 21
Ipswich Corporation	.. 8	501	+ 110	39	22,313	+ 3,628
Isle of Thanet Co.	,, 8	268	— 1	14¶	3,719	— 966
Kilmarnock Corporation	.. 8	199	— 32	34	5,786	— 196
Lanarkshire Trams Co.	.. 6	2,448	— 88	1	2,448	— 88
Lancashire United	,, 5	1,883	+ 61	1	1,883	+ 61
Leeds Corporation	.. 8	9,119	+ 1,081	41	364,595	+ 28,216
Leicester Corporation	.. 8	3,279	+ 368	2	3,915	+ 68
Leith Corporation	,, 8	850	+ 153	34	26,318	+ 1,826
Lincoln Corporation	.. 8	145	+ 24	41	5,769	+ 668
Liverpool Corporation	..	..	..	..	..	..
Llandudno&Colwyn Bay R.	.. 7	178	— 3	5	995	+ 98
London County Council	..	..	..	..	..	..
Lowestoft Corporation	..	..	..	..	..	..
Maidstone Corporation	.. 6	214	+ 34	40	8,870	+ 334
Manchester Corporation	.. 8	18,334	+ 1,575	40	725,070	+ 24,065
Nelson Corporation	,, 8	191	+ 31	40	7,941	+ 1,240
Newcastle-on-Tyne Corpn.	,, 8	5,430	+ 210	41	253,108	+ 2,562
Newport(Mon.)Corpn.	..	..	..	..	..	..
Northampton Corporation	.. 7	716	— 134	40	29,433	+ 5,170
Nottingham Corporation	,, 6	3,713	+ 342	40	150,395	+ 11,186
Oldham Corporation	.. 9	2,343	— 413	42	98,500	+ 4,367
Portsmouth Corporation	.. 1	2,285	— 130	40	99,233	..
Preston Corporation	.. 5	1,052	— 235	40••	39,119	+ 1,885
Rawtenstall	.. 8	1,703	— 204	41¶	69,320	+ 3,244
Rotherham Corporation	.. 5	1,298	+ 298	40	47,175	+ 5,748
Salford Corporation	.. 10	5,241	+ 601	41‡	212,315	+ 8,717
Sheffield Corporation	,, 9	9,737	+ 1,772	40	373,430	+ 50,811
Southampton Corpn.	,, 8	1,527	+ 242	40	60,661	+ 6,928
Southend Corporation	..	..	..	..	..	..
South Shields	.. 1	799	— 27	39	31,590	+ 1,278
Stalybridge,Hyde,&c. Jt. B	..	..	..	..	..	..
Sunderland Corporation	.. 9	1,610	+ 306	41	61,646	+ 1,204
Sunderland District	.. 5	694	+ 109	10	1,849	+ 439
Swinton Corporation	.. 5	204	+ 32	40	7,989	— 724
Tynemouth Tram Co.	Dec. 29	545	— 22	26	15,470	— 686
Wallasey Corporation	Jan. 9	1,230	— 117	40¶	52,196	— 998
Walsall Corporation	.. 8	804	— 153	2	961	— 87
Walthamstow	..	..	..	..	..	..
Warrington Corporation	..	..	..	..	..	..
West Ham Corporation	.. 6	3,028	— 188	40	124,433	+ 10,710
Wigan Corporation	..	..	..	..	..	..
Wolverhampton Corpn.	.. 5	1,319	+ 157	14	15,713	+ 1,480
Yorkshire W.R. Trams	.. 9	1,697	— 288	2	3,496	+ 582

(a) The comparisons are with the corresponding period last year. • Partly electrical. † Including Sundays. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES..... 551
Arrangements for the Week.. 553
GEORGE TUCKER 554
The Principles and Systems of Electric Motor Control. By C. D. Knight. Illus. 555
The Double Dynamometer Wattmeter. By C. V. Drysdale, D.Sc. Illustrated.—*Continued* 558
Electrification of the Manchester to Bury Section of the Lancashire & Yorkshire Railway. Illustrated.—*Continued*..... 561
"THE TOWER WAS CALLED BABEL" 568
Eddy Current Loss in Dynamo Teeth. By F. W. Carter. Illustrated 569
The Predetermination of the Performance of Dynamo-Electric Machinery. By Prof. Miles Walker. Illustrated.—*Concluded* 570
CORRESPONDENCE 574
Earth Resistance (E. W. Marchant).
"The Electric Locomotive" (Pierre Weil).
Some Principles in Industrial Lighting. By J. S. Dow .. 574
The Design of High-Pressure Distribution Systems.—*Discussion* 576
LEGAL INTELLIGENCE 576
PARLIAMENTARY INTELLIGENCE 576
Educational Notes 576
The "Electrician" Commercial and Industrial Section .. 577–584

NOTES.

The Late George Tucker.

IT is with profound regret that we record on another page the death of Mr. GEORGE TUCKER, chief proprietor of THE ELECTRICIAN. By his death there is removed a familiar figure in the world of electro-technical literature. Although Mr. TUCKER was by profession a printer and publisher, he paid great attention to the articles appearing in our columns and to the detailed contents of the books published under his auspices, which, indeed, he generally read throughout. He thus gained a knowledge of electro-technical subjects enabling him to gauge with remarkable accuracy the value of technical literary work. It is, indeed, largely due to his breadth of view and to his realisation of the practical value of theoretical treatment that our columns cover so wide a field. Although the death of Mr. TUCKER removes the head of the firm to which THE ELECTRICIAN belongs, this journal will continue to be handled by the present staff, most of whom have been associated with it for many years, and will, as hitherto, deal with all the aspects of electrical engineering.

Reliability in Electricity Supply.

WE would call attention once again to the folly of running electricity works with an insufficient reserve of plant. Breakdowns are becoming more frequent as time goes on, and among recent examples we may mention those at Halifax, Wallasey and Wigan. If a station is running with fully loaded plant, so that the overhauling of the sets at stated intervals is impossible, a breakdown must occur sooner or later, and the result of any such breakdown is at least a temporary curtailment of the power that is available. In the case of Dewsbury the electricity department is getting over the difficulty for the moment by purchasing second-hand plant; but this at best is an expedient that is undesirable unless the conditions are very special. Although the price paid may be a reasonable one per kilowatt of plant, the total expenditure is likely to prove unsatisfactory when the cost of foundations and erection is taken into account, coupled with the fact that the life of the plant is considerably reduced below that which it would have been if the plant had been purchased new. While we quite realise the limitations imposed by present circumstances, we would earnestly impress upon the interested Government departments the desirability of permitting supply undertakings (or, indeed, forcing them) to obtain plant for extensions sufficiently in advance of the time when such extensions must inevitably be required.

Alien Patents.

IN our last issue we gave an account of an application by the British Thermit Co. for a licence to use eight patents owned by Thermit, Limited, a German controlled company, protecting this well-known method of welding tramway rails. The proceedings were of more than usual interest, owing to the fact that evidence was given supporting the view that, even if such a licence were granted, the applicants would not be able to carry out welding with satisfactory results. This brings out a point which is often not realised by the man in the street—namely, that it is one thing to be given a patent specification and quite another to work properly the process that is described. Not infrequently it is the object of the patentee to avoid describing in the specification details which have enabled the best results to be obtained. Otherwise the information published might be, from his point of view, undesirably useful to his competitors. This is, of course, contrary to the spirit and letter of our patent laws, but it is not easy to devise a complete remedy for cases of this kind. However, it appears to us that in a case of this character, where a royalty is to be paid for the use of a patented process, the arrangement should carry with it a full and complete disclosure of all the methods that are employed; otherwise payment is made for a process which cannot be properly carried out, and the arrangement is little short of being a fraud.

Systems of Motor Control.

THE Paper entitled "Principles and Systems of Electric Motor Control," read by Mr. C. D. KNIGHT at a recent meeting of the American Institute of Electrical Engineers, and given elsewhere in this issue, deals with the elementary principles of automatic control. This is a subject on which depends the success and extension of the motor drive. Notwithstanding the remarkable development of automatic control during the past few years, there are still many motor users who stick to unsuitable types of starter, thereby losing many of the advantages of the electric drive and running up maintenance costs to an unduly high figure. The problems connected with the design and construction of a satisfactory contactor type of starter are many and varied, and from every point of view it

is advisable for the user to place orders with firms of repute specialising in the work, giving full particulars of the service required. At the same time it is desirable that the user should be conversant with the elements of the subject, and we believe that Mr. KNIGHT's article will be helpful in this direction. From small beginnings the contactor-switch has become a piece of engineering work of an exceedingly high order, and it will be found to play at least as important a part in industrial motor control as it has played in electric traction. Of the numerous applications of magnet-switch control, steelworks machinery, cranes and hoists, machine tools, and printing presses stand out prominently; but it is suitable for practically all applications of the electric motor to intermittent duty where the burden of the service is thrown on the controlling apparatus.

Steam Generator Development.

So rapid has been the development of electric generators and prime movers during the last decade that one is apt to overlook the corresponding development of the steam generator. Although power station engineers know that the balance-sheet depends upon the boiler room, we doubt whether the manufacturer realises the extent to which the boiler room affects manufacturing costs. We believe that a careful study of the methods practised in the boiler room of a modern power station would go a long way towards convincing those who are inclined to question the cash-value of applied science. As the price of coal advances the user will be compelled either to use it more economically or to purchase power from those who are in a position so to use it. The figures given recently by Mr. A. D. PRATT relating to the Chicago Edison Company serve to indicate how the modern high rating of boilers is due to improved methods of firing and to improved design of boiler furnaces. In 1915 only about 50 per cent. more boiler horsepower was provided for 30,000 kw. units than for the 7,500 kw. units installed in 1903.

Lifting Magnets.—The "Iron Age" recently referred to magnets made by the Cutler Hammer Clutch Co., Milwaukee, Wis. They claim that a 62 in. magnet has by improved design had its lifting power increased from 2,600 lb. to approximately 4,000 lb.

Municipal School of Technology, Manchester.—The "Journal" of the school contains some 18 Papers by students or members of the teaching staff. Seven of these are on chemical subjects, two on dyeing, two on electrical matters viz., "Electrolytic Methods of Preventing Corrosion" and "Apparatus for Improving the Power Factor in Alternating-current Circuits." The remainder of the Papers are on mechanical subjects or are addresses. Altogether the volume is nicely got up, and contains much interesting reading.

Electric Plant at the Works of the Minnesota Steel Co. A recent issue of the "Iron Age," U.S.A., describes the power plant at the above works. It consists of four Allis Chalmers 3,000 kw. gas-driven generators, delivering current at 6,600 volts to six sub stations, where it is stepped down to 440-220 volts and 110 volts. Practically all the gas from the blast furnaces is used in this installation. All the gas used passes through two 20 ft. dust catchers, then through 10 ft. Brassert whirlers, and then into 18 ft. grid spray primary washers. Finally, it is washed in a battery of Ernst secondary washers. One of the main features is a 28 in. iron rail-mill driven through bevel gearing by a 6,000 h.p. motor.

Synthetic Rubber. In a recent issue of the "Horseless Age" there is a short article on this subject. It appears that in 1905 Harries determined the chemical formula of natural rubber, and in 1909 Hofmann and Conteile made rubber by heating isoprene in a closed tube. It has also been produced from butanes and from dimethyl butanes. The resulting rubbers vary very widely in their properties and as regards solubilities, elasticity and susceptibility to vulcanisation. The annual world production of rubber is about 100,000 tons, and would require for its synthetic duplication the planting of an area of corn or potatoes many times the area now in rubber trees. Another feature in synthetic rubber is that it is a mixture instead of a uniform compound, and until that difficulty is overcome it will always remain inferior to the natural article.

Poulsen Arcs.—Referring to the Leading Article in our last issue, in which we mentioned the action of the United States naval authorities in asking for quotations for a 300 kw. arc generator, the British & Overseas Engineering Synd. (Ltd.) write saying that for the past two years arcs of 100 kw. and 200 kw. have been installed and are operating across the North Atlantic, and that there is no difficulty at all in the construction of arcs of much larger sizes. During the last two years considerable experience has been gained in connection with these large arcs, and a good many new patents have been taken out in connection with them.

20-Ton Derrick with Roller Bearing Mast.—In a recent number of "Engineering News" a fully illustrated description was given of a 20-ton derrick having a 101-ft. mast and an 88-ft. boom with a horizontal reach of 90 ft. Both mast and boom are of box lattice construction. Detail drawings are given of the steelwork and of the shoe and mast-head roller bearings. The boom has its foot seated on a $3\frac{1}{2}$ in. pin in the mast shoe, and can be raised to a vertical position against the mast. Its head has a 22-in. sheave for the hoisting cable and two shackles for the attachment of the blocks for the luffing and hoisting tackle. The mast has two sheaves at the bottom, one for the $\frac{5}{8}$-in. hoisting cable running to the head of the boom and the other for the $\frac{5}{8}$-in. luffing cable, which runs over another sheave at the head of the mast. The derrick is served by a 50-H.P. electric hoist. An interesting feature of the design is that both the mast and boom have two 14-ft. removable sections.

Best Primary Capacity for Tesla Coils.—It has generally been assumed that to produce a maximum voltage on the secondary terminals the resonance relation $L_1C_1=L_2C_2$, as proposed by Drude, was sufficient, these symbols referring to the inductance and capacity of the primary and secondary respectively. Recently, however, Dr. Taylor Jones has shown that the above condition does not apply if the primary capacity alone is varied. If the coupling coefficient has the value $k^2=0{\cdot}36$, favoured by Drude, the best capacity is at least twice as great as the resonance value. Mr. W. Morris Jones, B.Sc., in an interesting communication to the "Philosophical Magazine," has experimentally tested these results. With $k^2=0{\cdot}348$, this value nearly agreeing with that which Drude recommends, he found that the maximum was obtained with a ratio of $3{\cdot}3L_1C_1=L_2C_2$, and the primary capacity was much greater than for the resonance value given by the expression first referred to above. He also found that the experimental curve differed considerably from the theoretical curve.

Hamilton Electric Incline Railway.—The "Electrical Review and Western Electrician," U.S.A., has in a recent issue a description of this incline railway. This railway was installed by the Hamilton Mountain Park Co. (Ltd.), Ontario, Canada, for transporting passengers, freight, trolley cars and teams up the "mountain," as it is called. This mountain is the "escarpment" of Niagara, and the difference in level between the city and back of the bluffs is 325 ft. The electric hoist consists of a double fixed drum, double-geared arrangement operating two large platform cars in balance, on an incline 800 ft. long with a gradient of 40·27 per cent. The driving power is three-phase 25-cycle alternating current, and a motor-generator transforms this into direct current. This consists of a 2,200-volt induction motor driving a direct-current generator giving 165 amperes at 550 volts. The generator end is designed with a special drooping characteristic by means of a reversed field, so that fluctuations of load are thrown on a floating battery. With an average load of 7·5 tons the current is 470 amperes for 10 seconds, followed by 440-230 for 80 seconds, the voltage being approximately 550.

Steam Generator Development.—Before the International Engineering Congress at San Francisco, Mr. A. D. Pratt read a Paper entitled "The Boiler of 1915." The modern tendency toward demanding more capacity from boiler heating surface was clearly indicated by a comparison of the boiler horse-power supplied for successive generating units in use in one of the largest and most modern plants in the United States. The Commonwealth Edison Company of Chicago installed, in 1903, a 5,000 kw. turbine which had a maximum rating of 7,500 kw. For this unit eight boilers were supplied, each containing approximately 5,000 sq. ft. of heating surface. Later, a 12,000 kw. (maximum) unit was installed and for its operation eight identical boilers were supplied. Still later, a 14,000 kw. machine was installed and the boiler power supplied was again a duplicate of that furnished for the 7,500 kw. set in 1903. In 1910, this company installed two 20,000 kw. machines for each of which there were supplied ten 500 H.P. boiler units, or 5,000 nominal rated horse-power. In 1913, two sets were installed with maximum outputs of 20,000 kw. and 25,000 kw. respectively. For each of these two sets, four boilers each containing 12,200 sq. ft. of heating surface, or 4,880 nominal rated horse-power were supplied. In 1915 a 30,000 kw. set was installed for which there were supplied five 1,220 H.P. boiler units. From these figures, it appears that where, in 1903, 4,000 rated boiler horse-power were considered necessary for a unit whose maximum output was 7,500 kw., in 1915, for a unit four times as large, but 50 per cent. more boiler horse-power is deemed necessary. Of course, there is a considerable difference in the efficiency of the two generating sets, but the difference in boiler horse-power supplied is so widely varied as to furnish conclusive evidence of the tendency toward increased boiler capacities. Since there have been no radical changes in the designs of the pressure parts of the boiler within recent years, the success in securing the modern high rating must be attributed almost entirely to improvements in the methods of feeding fuel to the furnace and in the design of this furnace.

OBITUARY.

AUGUSTUS EDEN.—The death is announced of Mr. Augustus Eden, a retired engineer of the Post Office telegraph system. From 1904 until his retirement in 1907 Mr. Eden was superintending engineer of the Northern District.

ARNOLD MORLEY.—The death is announced of the Right Hon. Arnold Morley, who was Postmaster-General from 1892 to 1895.

PERSONAL.

Mr. J. A. Pease, M.P., has been appointed Postmaster-General in succession to Mr. H. Samuel, who has become Home Secretary.

Second-Lieutenant A. R. Courtenay (late acting-manager of the publication department of the General Electric Co.) has now sailed for the Mediterranean. After about two months' active service in France with the Royal Naval Air Service, Armoured Car Aeroplane Support (Royal Naval Volunteer Reserve), he transferred to the Army Service Corps, and it is as a Second-Lieutenant in this Corps that he is now seeing service.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

London Electrical Engineers : Sapper Geo. S. H. Cox, Private Archibald D. Hedgcock (from Honourable Artillery Company) and Lance-Corporal Gerard A. Wadham (from Royal Fusiliers) to be Second-Lieutenants.

Tyne Electrical Engineers : E. V. Baldwin, E. Harrison and Private C. B. S. Micklan (from Provl. Battalion) to be Second-Lieutenants. Capt. Norman H. Firmin to be major. Lieuts. Jas. Young, Rowland Sharp and David A. Williamson to be temporary captains.

APPOINTMENTS VACANT AND FILLED.

The Council of the Indian Institute of Science invite applications for the post of assistant professor of electrical technology. Salary, 625 rupees per mensem, with a house. Further information from Messrs. Jeremiah Lyon & Co., 4, Lombard-court, London, E.C., and applications must be sent to the Director of the Indian Institute of Science, Bangalore, India, by Feb. 15. *See also an advertisement.*

The Council of the Metropolitan borough of Southwark invite applications for the position of charge engineer at their electric supply station (salary £3 per week); also a junior engineer (salary £2 per week). Applications to the town clerk (Mr. P. H. Gray), Walworth-road, S.E., by Jan. 24.

An electrician is required for private lighting plant of large country house. *See an advertisement.*

A firm of switchgear manufacturers advertise for a foreman.

A shift engineer is required at Walsall Corporation's electricity works. Applications to the Engineer and Manager by Jan. 27.

Mr. Wilfrid Saunders has been appointed Professor of Chemistry at the Engineering College, Sibpur (India).

INSTITUTIONS AND SOCIETIES.

The Institution of Electrical Engineers.—The Council have passed the following resolution :—

"The Council are of opinion that Clause 41 of the Articles of Association provides sufficient means for the expulsion of undesirable persons (whether alien enemies or not) from the Institution consistently with making the thorough investigation of the circumstances of each case which is essential in order to avoid the risk of doing grave injustice to individuals."

The Council have also under consideration the question whether the Institution should obtain further powers for the expulsion of alien enemies.

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of the Association was held on Friday, the 14th inst., at the Municipal and County Club, Whitehall Court, Whitehall, S.W., when the following were present : Messrs. Ullmann (East Ham), chairman ; Schofield (Leyton), vice-chairman ; Moffet (West Ham) ; Harvey (Ilford) ; Mackinnon (London United) ; and Goodyer (Croydon), hon. secretary.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Jan. 21st (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. Meeting at the Institution of Civil Engineers, Great George-street, Westminster. Paper on "The Flow of Air Through Nozzles," by Capt. Thomas B. Morley, B.Sc.

SATURDAY, Jan. 22nd.

ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

4:30 p.m. Joint meeting with Colliery Managers and Mining Institute of Scotland at Royal Technical College, Glasgow. Paper on "Electrical Shaft Winding," by Prof. D. Burns.

TUESDAY, Jan. 25th.

INSTITUTION OF CIVIL ENGINEERS.

5:30 p.m. Meeting at the Institution, Great George-street, S.W. Discussion (continued) on "The Electric Locomotive."

THURSDAY, Jan. 27th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street, Piccadilly, W. Lecture on "The Utilisation of Energy from Coal. Fuel Economy from a National Standpoint." By Prof. W. A. Bone, D.Sc., Ph.D.

FRIDAY, Jan. 28th.

PHYSICAL SOCIETY OF LONDON.

5 p.m. Meeting at the Imperial College of Science, Exhibition-road, S.W. Second Guthrie Lecture, by Mr. W. B. Hardy, Sec. R.S., on "Some Problems of Living Matter."

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding : Lieut.-Col. C. B. CLAY, V.D.

Orders for week commencing January 24th, 1916 :—

Drills : 6:25 to 7:25. 7:25 to 8:25 p.m.

Monday, January 24th.—Sections 1 and 2, Technical ; Sections 3 and 4, Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, January 25th.—School of Arms, 6 to 7 p.m.

Thursday, January 27th.—Shooting for Sections 1 and 2 and Signalling Class.

Friday, January 28th.—Sections 3 and 4, Technical ; Sections 1 and 2, Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, January 29th.—Uniform parade, 2:45 p.m.

Sections for Technical parade at Headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for shooting parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate Hill, as soon as possible.

Payment for uniforms to be made to the Adjutant.

GEORGE TUCKER.

Our beloved chief is dead. Only those who knew him well can fully understand what such a statement means to those whose privilege it was to work under him. It is with the utmost difficulty that we write of one whose principal work was essentially connected with the conduct of this journal; the record of his life is to be found in its columns.

The late George Nathaniel Goldsmith Tucker was born at Islington on June 21, 1852, and he was, therefore, at the time of his death, on Saturday last, the 15th inst., in his sixty-fourth year. He was associated with THE ELECTRICIAN from the commencement of the publication of the second series in 1878, and became manager of "The Electrician" Printing & Publishing Co. (Ltd.) on its formation 10 years later. In 1906 he acquired practically the entire holding of this Company. He was a Freeman of the City of London, and a member of the Goldsmiths' Company.

The subject of our memoir was a man of good business capacity, with considerable breadth of view, quick to observe the trend of things, and, above all, one whose principal desire was to see the British electrical engineering industry in the foremost rank. To attain this end he laboured incessantly, sparing himself least of all. In the very early days of the electrical industry he became convinced of the necessity of placing and keeping before the public authoritative accounts of the most recent electrical inventions and developments. His ambition was that everybody of note in the electrical world should have an opportunity of contributing to the sum total of our knowledge by writing in the columns of this journal. To George Tucker's interest and friendly counsel many men whose names to-day are household words in electrical and allied science owe their start in life. Now that he is dead it may be written of him that he was to many a young man at the outset of his career what the Brothers Cheeryble were to Nicholas Nickleby, and the world is all the better for such men.

From 1878 to 1888, electricity supply being then in its infant stages, telegraphy represented the most important branch of the electrical industry, and while Mr. Tucker did the fullest justice to submarine and land telegraphy, he also endeavoured to put on record every development of the science. It was fortunate for British electrical industry that during this period leading men in the submarine cable world lent able support to the effort.

It was Mr. Tucker's particular desire that every scientific discovery and electrical invention should be fully described and its importance emphasised. He realised that the theory of to-day might be the practice of to-morrow. Not only did he encourage those who had something to write on current topical subjects, but he frequently undertook to publish articles which were somewhat in advance of their time, and from which there could be no immediate prospect of a monetary return. He was more interested in the advance of knowledge and in the progress of electrical science than in securing a return on the outlay incurred in their publication. As an instance we might mention Mr. Oliver Heaviside's series of articles on "Electromagnetic Theory." The publication of these articles was undertaken with little general encouragement, but time fully justified Mr. Tucker in the opinion he formed of the fundamental importance of Mr. Heaviside's brilliant work. He used to relate how he had to wait till compositors came back who, tired of "Heaviside," had been engaged on lighter work. On one occasion he endeavoured to persuade the author to send in the remainder of his manuscript by threatening to break up the type, and a reply came back that "Mr. Tucker would do nothing so foolish."

Amongst the pioneer works on electrical engineering and allied subjects published by Mr. Tucker may be mentioned Gore's "Electrolytic Refining of Metals" (1888), Fleming's "Alternate-Current Transformer" (1892), Carter's "Motive Power and Gearing" (1893), Lodge's "Signalling Across Space Without Wires" (1894), and Ewing's "Magnetic Induction in Iron and Other Metals" (1894).

Mr. Tucker was one of those who desired to see the British electrical industry not only in the first rank but also quite independent of all outside sources of supply, and it was with the object of assisting home-manufacturers that he undertook the publication of Pritchard's "Manufacture of Electric Light Carbons," and Jehl's "Carbon Making." He took a particular interest in "'The Electrician' Electrical Trades' Directory and Handbook," and under his fostering care this well-known work of reference has kept pace with the expansion and development of the electrical industry. Keenly alive to the numerous legislative and fiscal obstacles in the way of electrical progress in this country, he devoted considerable time and trouble, in conjunction with the late Sir W. H. Preece and others, to an effort to devise some strong national organisation which would eliminate, or at least minimise, some of the disadvantages under which the industry suffered. Unforeseen difficulties arose, and although he failed in his efforts on that occasion, nevertheless it redounds to his credit that he recognised the necessity for organisation, a necessity forcibly brought home to us in these latter days.

Shortly before his fatal illness he was busily engaged on plans for the future of this journal, and for his several other publications. Among his many activities, he was editor of the "Fruit-Grower." Even during his illness he was at work; and death, which, as we have said, took place on Saturday, the 15th inst., came to him still in harness, as he wished it to come. If in this memoir we have referred frequently to THE ELECTRICIAN we would remind our readers that for many years George Tucker was at the helm. A brief reference to the ship is neither to be avoided nor is it out of place at the time when we have to drop the pilot.



THE LATE GEORGE TUCKER.

1852—1916.

THE PRINCIPLES AND SYSTEMS OF ELECTRIC MOTOR CONTROL.*

BY C. D. KNIGHT.

Summary.—After describing several types of resistor the author explains the various forms of magnetic control for both direct- and alternating-current motors, and describes the characteristics embodied in contactor or magnet-switch design.

In the first part of the Paper the author briefly considers the different types of resistor and states the limitations of each. The resistor units dealt with are: Tube type, bar type, ventilated wire type, edgewire type, plate type and cast grid type.

A resistor limits the current in a circuit by transforming a portion of the electrical energy into heat, which may be stored temporarily in the resistor but is ultimately dissipated to the surrounding medium, which is usually the atmosphere. When a resistor at atmospheric temperature is connected in a circuit, so as to carry current, it absorbs energy which is manifested as heat. As this absorption of heat causes the temperature of the resistor to rise, the difference in temperature causes the resistor to dissipate heat to the surrounding medium. If the current is maintained constant for a sufficient time, the temperature of the resistor will rise to a value sufficiently above the surrounding medium so that the heat can be dissipated as fast as developed. The property of absorbing energy is referred to as the thermal capacity of the resistor, and the property of dissipating absorbed energy is often referred to as radiating capacity.

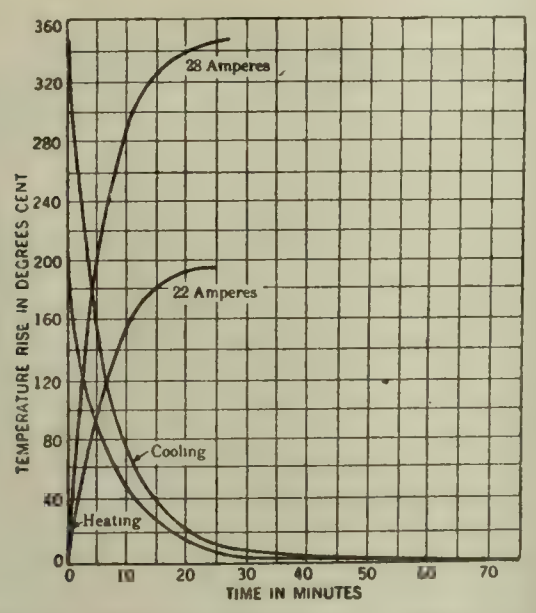


FIG. 1.—THERMAL CHARACTERISTICS OF A 0·22Ω GRID RESISTANCE UNIT.

As heat cannot thus be dissipated, except by an increased temperature of resistor above the surrounding medium, and as the temperature of the resistor cannot be raised except by storing heat in it, it follows that all resistors have, to some extent, both thermal capacity and dissipating capacity, although the relation of these two characteristics differs in units of different design. For instance, Fig. 1 shows the heating and cooling curves for a grid rated at 22 amperes at 200°C. and 28 amperes at 350°C. rise, while Fig. 2 shows the heating and cooling curves of another grid unit rated at 100 amperes and 130 amperes at a temperature rise of 190°C. and 300°C., respectively. As the material of the units is the same, the units have relatively the same thermal capacity.

The only advantage of a unit with high thermal capacity over a unit with low thermal capacity is that it can carry comparatively infrequent heavy loads of short duration. But as a unit with high thermal capacity will take longer to reach final temperature, it will also take a correspondingly longer time to cool down to room temperature after the circuit is opened, so that where frequent overloads are liable to occur, a unit with additional dissipating capacity must be used.

With reference to temperature coefficient, the ideal resistor for most motor controlling apparatus would be one with a zero value. There are certain kinds of wire with negligible temperature coefficient. In the case of cast-iron, the temperature coefficient is 0·0007, which, from a practical point of view, is satisfactory when operating within normal temperature conditions. The danger point is reached when a material is used with an extremely high temperature coefficient, which would cause the resistance to increase to such a value that when frequently starting a heavily loaded motor, the amount of current allowed to flow would be insufficient to permit it to accelerate. This might cause the resistance to burn out, and is a condition which must be very carefully guarded against. Under these circumstances the operator can cut out steps of resistance until sufficient current flows to start the motor. This will naturally leave very few points for accelerating, and under some conditions, it might result in opening the protective devices, or if they were set too high, a flashing over of the motor might result.

Manual control, consisting of either dial-type rheostats or drum controllers, was considered satisfactory for nearly all requirements of electric motor control until a few years ago. In recent years, for motors of large size requiring a more or less complicated control, and for motors which must be started, reversed or stopped very frequently, it has become necessary to use contactors and auxiliary devices, which have to a large extent replaced the hand control apparatus. The dial type rheostat and drum controller are comparatively simple, and are well known. We will consider briefly the different methods used to obtain automatic acceleration by the use of contactors.

The contactor, or magnet-operated switch, is the basic device of almost all automatic motor control systems. Though motor- and solenoid-operated dial switches, liquid rheostats, and other types of self-operated control mechanisms find certain specific applications, contactor control is the type generally employed, especially where severe service is demanded.

Contactor control is largely used with the motors operating steel works machinery, ore bridges, large cranes, hoists of all kinds, reversing planers and other machine tools, printing presses, railway cars and locomotives, and in fact with almost all applications of the electric motor to intermittent duty where the burden of the service is

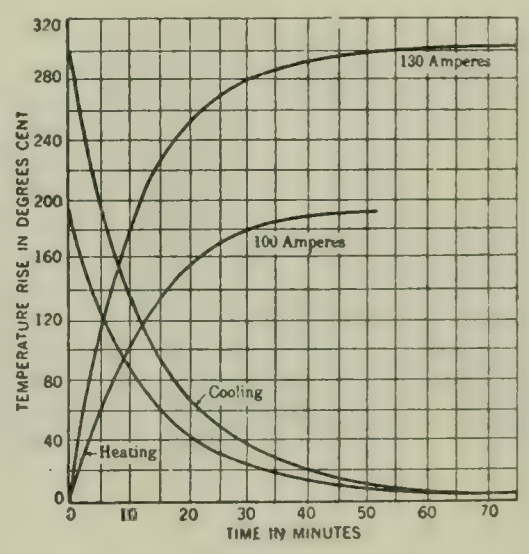


FIG. 2.—THERMAL CHARACTERISTICS OF A 0·02Ω IRON GRID RESISTANCE UNIT.

thrown on the controlling apparatus. This, of course, means that the contactor must be equal to such service with a reasonable amount of attention and occasional renewal of wearing parts.

The essential and common parts of all contactors are: contacts, blow-out, magnet, frame and pivot bearings.

Contacts.—Experience has shown that the best practice is to use solid copper contacts on which the current is both carried and ruptured. The contacts should close with a slight rolling motion to prevent the first rush of current from welding them together. Two heavy copper contact tips, backed by a sufficient spring pressure, will carry a surprising amount of current and furnish the best arc-rupturing means when placed under the influence of a suitable magnetic blow-out.

Carbon or other auxiliary contacts serve no really useful purpose on contactors which are subjected to severe and constant duty. In fact, they only complicate the construction of the device and add to the possible sources of trouble.

Laminated brushes for carrying current are also a source of trouble and can be profitably used only on contactors of such large capacity that the solid copper contacts will not carry the current. Such large contactors (above 1,000 amperes) are not often called upon for such frequent operation as the smaller sizes.

Blow-out.—The blow-out coil is in series with the circuit through the main contacts and the latter are between the poles of the blow-out. This part of the contactor demands very careful design, as the instant suppression of the arc, forcing it out in the right direction and without injury to the insulation, is of prime importance in the life of the device.

Magnet.—The requirements as to the magnet are that it will, when energised, not only promptly and positively close the contacts, but

* Paper read before the Am. Inst. E.E. Slightly abbreviated.

will do this on a range of voltage which may be anywhere from 20 per cent. below to 10 per cent. above normal. (These percentages apply to industrial work. The variation is considerably greater in railway service.) The coil must be, for the sake of economy, made as small as possible to do its work, and as any number of voltages and frequencies (if alternate-current) enter into the problem it can be readily seen that the design of the magnet for any contactor entails considerable study. The insulation of the winding must stand considerable heating, and the coil should be impregnated against the attacks of moisture, acid, &c. A shunt contactor magnet should preferably be designed to stand continuously across the full control circuit potential. It is possible to " soak " the coil and then introduce by means of an auxiliary contact a resistance in series when the contactor is closed. This added complication, however, is a weakness which experience has shown should be avoided.

Frame.—The contactor frame is designed with the following factors in view: Mechanical strength, capacity for the magnetic flux developed by the coil, permeability of the core and, in the case of alternating-current contactors, laminated structure. It is, of course, essential when the coil is de-energised, that the magnetism breaks by means of a resistor or an auto-transformer. A resistor transforms the energy of the excess voltage required for starting the motor into heat, while an auto-transformer acts as a step-down transformer down instantly and permits the contactor to open in the quickest possible time.

Pivot Bearings.—The nature of service necessitates having bearing pins in the main pivot of the moving member and in the pivots of the contact tips. These parts should be readily removable for

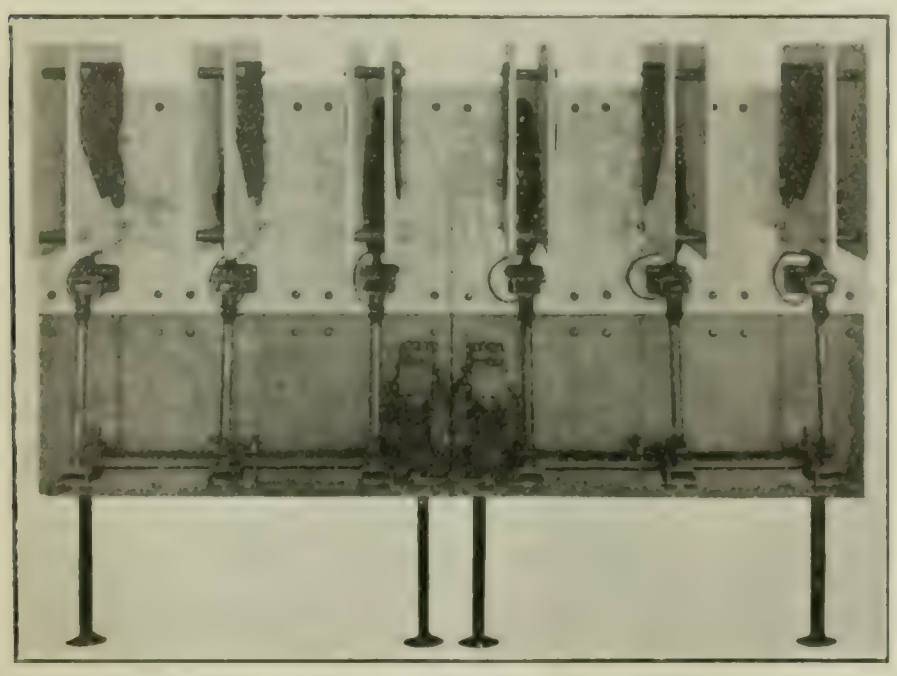


Fig. 3.—Two Mechanically Interlocked High-voltage Treble-pole Contactors.

inspection and repair. In fact, all parts of the contactor are so put together as to permit quick taking apart and equally quick re-assembly.

Auxiliary Parts.—These are mechanical interlocks with other contactors, electric interlocks and other auxiliary contacts, current-limit interlocks, shunts for the pivots, terminals, &c. All play a part in the determination of the design of any contactor.

Various Types of Industrial Contactors.

Direct-current Shunt Contactor.—This, as the name implies, is operated by a magnet connected across the control circuit, which is usually the same as the circuit on which the motor operates. Shunt contactors are used as line contactors, also for accelerating, in which latter case they are brought into action by means of current-limit relays, time-limit relays, or some kind of pilot controller.

Shunt contactors provided with adjustable air-gap are used for accelerating with their magnets connected across the motor terminals.

Series Contactors.—These are provided with a series coil only, and are so designed that the contactor will hold open above a predetermined current setting, and will close as soon as the current falls to, or below, that value. Series contactors are used for accelerating points on direct-current motor control. They cannot be used for partial speed control by means of a master-controller as their coils are in circuit with the motor armature.

Alternating-current Contactors.—Alternating-current contactors are generally operated by a coil connected across the control circuit, which is usually taken from one phase of the circuit if polyphase. On two- and three-phase circuits double-, triple- and four-pole contactors are employed, energised in each case by a single magnet. For high-voltage service, a potential transformer is used to reduce the voltage of the control circuit, as the coils cannot feasibly be designed to operate directly on voltages above 550. For automatic acceleration, alternating-current contactors are connected electrically with current-limit or time-limit relays which insure proper sequence and limit the rate at which the acceleration is accomplished.

For voltages exceeding 1,000, two types of contactors are used: either the air-break or oil-immersed. Air-break contactors have been developed for heavy duty, such as mine hoist operation for which in some cases they are called upon to operate once or even twice every two minutes under the most severe conditions. This type has been designed and operated up to 6,600 volts. (*See* Fig. 3.) For infrequent operation, oil-immersed contactors are in successful

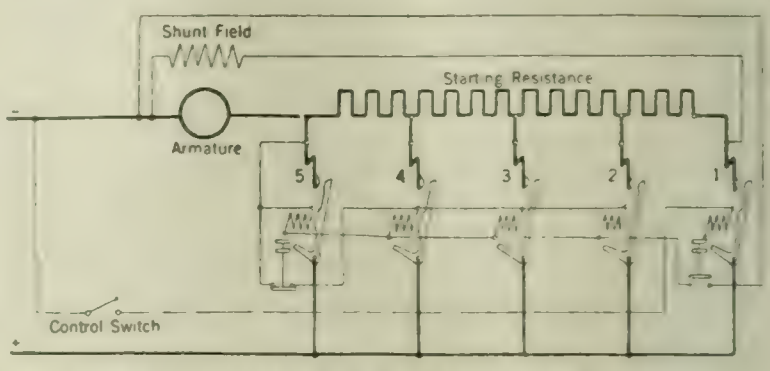


Fig. 4.—Counter E.M.F. Method of Control.

operation at potentials as high as 3,300 volts. Where employed on heavy duty cycles, the carbonisation of the oil is a great handicap, making it necessary to replace it frequently, adding greatly to the operating expense.

Direct-Current Control.

For direct-current motors, several methods of automatic control are used, as follows:

Counter E.M.F.—This method of control is more satisfactory for use with shunt than with series motors because the counter E.M.F. of the latter depends upon the current as well as the speed, and it might be possible, if the motor is starting under heavy overload, to obtain sufficient counter E.M.F. to close all the contactors before the motor has had time to accelerate properly. The proper closing of the contactors used to short-circuit steps of starting resistance is accomplished by connecting the contactor coils in multiple across the armature, the contactors being adjusted to provide different air-gaps between the core and the armature of the contactors in the open position. As the motor accelerates, the contactor having the smallest air-gap will close first, short-circuiting a portion of the resistance,

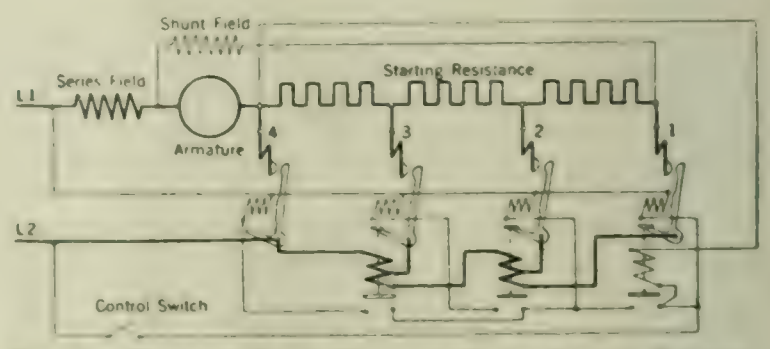


Fig. 5.—Current Limit Control Using Series Relays.

which continues the acceleration of the motor. As the counter E.M.F. increases, the next contactor will close and this is repeated until all the resistance is short-circuited. Sometimes instead of adjusting the air-gap between the core and armature, contactor coils are used which have different ampere-turns. A typical connection for counter E.M.F. control is shown in Fig. 4.

Since the counter E.M.F. of a shunt motor varies directly with the speed for a given field strength, it is necessary that the speed be fairly constant in order that the contactors will operate properly.

Current-limit Method of Control.—There are two general methods of obtaining current-limit acceleration, one using a number of current-limit relays, which control the closing of accelerating contactors, and the second method using series contactors, which combine within themselves the functions of current-limiting relay and accelerating contactor. The first method, as generally used for direct-current motor control, depends on current-limiting relays, which may be mechanically connected to the contactors so that after the contactor

closes, its relay is released for operation after the armature current has dropped to a predetermined value, due to acceleration of the motor. (Fig. 5.)

Series contactors, so called because the contactor-coil winding is in series with the motor armature, can only be used for the accelerating points, making it necessary to close the main circuit by means of a shunt-wound contactor, knife switch or equivalent. (Fig. 6.)* This method has all the advantages of the current-limit relay scheme, using individual current-limit relays, and the wiring is much more simple, as shown by reference to the wiring diagrams.

Alternating-Current Control.

For alternating-current motors, different methods of control are required, depending on the type of motor.

Squirrel Cage Type of Motor.—The proper starting current is obtained by reducing the primary voltage impressed on the motor, with very little loss of energy. On the auto-transformer (compensator) coils are provided with several taps to give different starting-current values. Two coils are used for two-phase motors

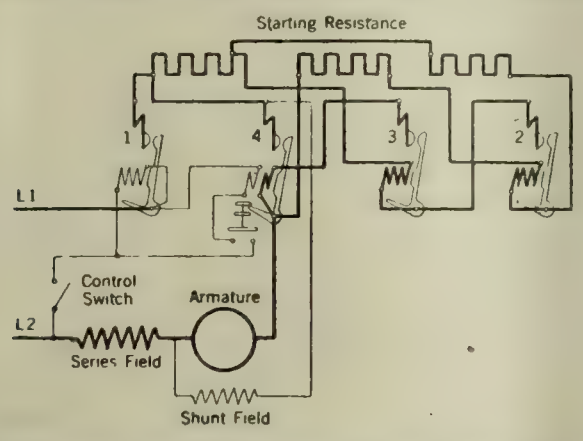


Fig. 6.—Current Limit Control Using Series Contactors.

and two or three coils may be used for a three-phase motor. For automatic control using either a resistance or an auto-transformer, contactors are used for first connecting the motor to the line through the starting element, and after the motor has accelerated, the second contactor is closed, connecting the motor directly to the line

All sizes of motors require but one starting point, because of the fact that any voltage which will start the average low-resistance motor will bring the motor nearly to normal speed. Either a time-limit or a current-limit relay may be used to energise the second contactor. Fig. 7 shows the wiring of a resistance starter, and Fig. 8 the wiring of an auto-transformer.

For use with 2,200-volt motors, the contactors are immersed in oil to provide better insulation and to help rupture the arc. A potential

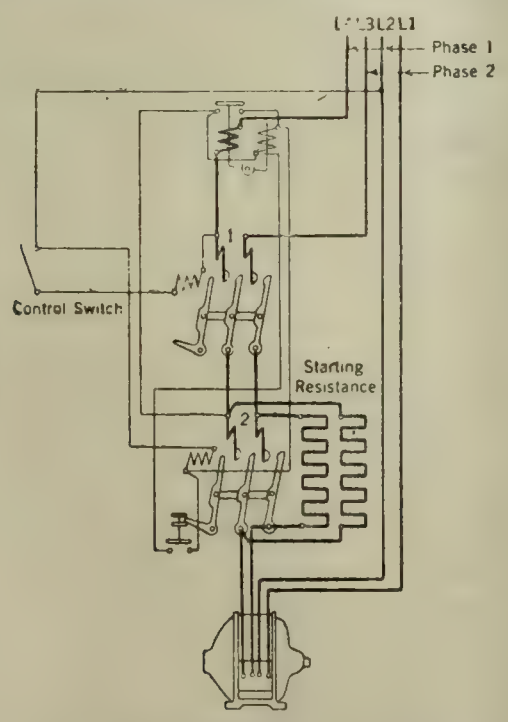


Fig. 7.—Connections of Resistance Type Self-Starter for Two-phase Squirrel-cage Motor.

transformer is used to reduce the voltage of the control circuit and a current transformer for operating the time-limit or current-limit relay.

Slip-Ring Type of Motors.—These motors are started by means of a resistor connected to slip-rings on the motor shaft, which in turn are connected to the secondary circuits of the motor. As a general rule, both two- and three-phase motors are designed with a three-phase secondary and the resistance per phase is divided into steps, the number depending on the size and application of the motor.

The closing of the accelerating contactors which short-circuit the resistance in the secondary circuit is generally controlled by means of two, or more, current-limiting relays, except in the case of

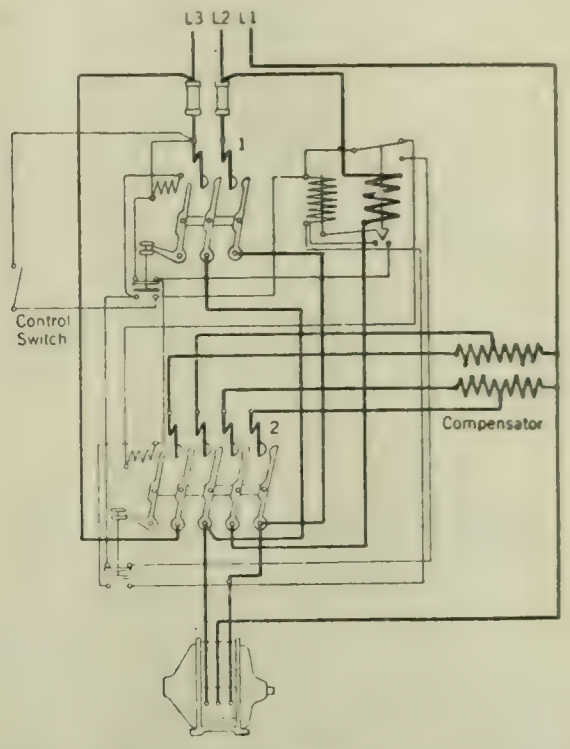


Fig. 8.—Connections of Current Limit Control of Auto-transformer or Compensator for Use with Three-phase Motor.

small motors requiring but one step of resistance, where but one relay is necessary. Fig. 9 shows the connections of a four-point starting panel.

For use with 2,200-volt motors, the primary contactor is immersed in oil to provide better insulation and arc rupturing capacity. A potential transformer is used to reduce the power circuit voltage to 500 volts or lower.

Time Limit Method of Starting.

Another method sometimes employed for starting both direct-current and alternating-current motors makes use of some form of

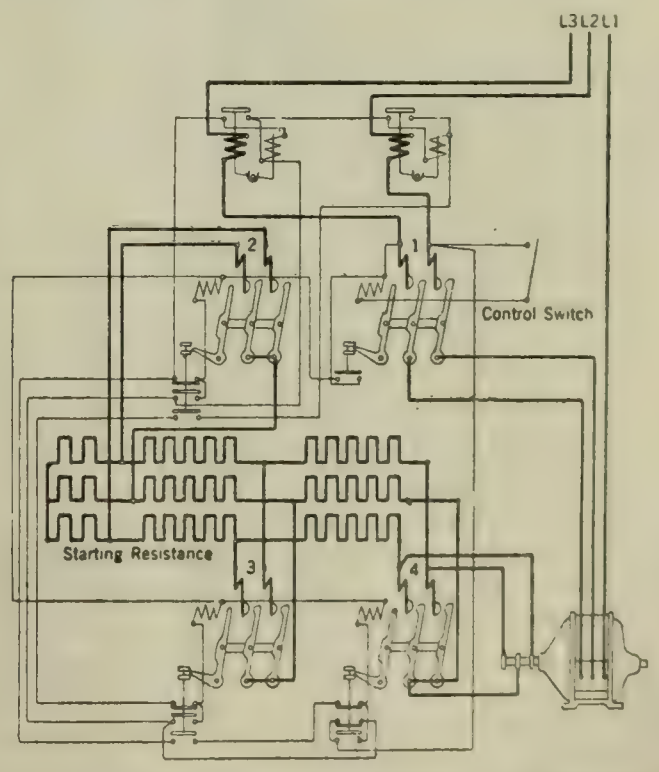


Fig. 9.—Connections of Contactor Panel for Use with Three-phase Slip-ring Type Induction Motor.

time-element device for governing the time required for cutting the starting resistance out of circuit. This may be a solenoid-operated switch retarded by a dash pot or its equivalent, or it may be a motor-driven switch. For small and medium size motors, the switch will handle the motor current directly, and for large motors the switch is used as a master switch for energising the coils of magnet switches or contactors. This method of starting is recommended for use with

* *See* A.I.E.E. "Transactions," Vol. XXX., 1911.

motors liable to be stalled or to become overloaded during the starting period, such as a plunger pump liable to become clogged or frozen, where with the current-limit type of starter, the current would not fall to the point where the next accelerating contactor could close, but with a time-limit self-starter the fuses or circuit breaker would open after the starting resistance had been cut out.

Dynamic Braking.

One very important feature peculiar to the direct-current motor is the possibility of operating the motor as a generator for quick stopping or for limiting the lowering speed when overhauled by a suspended weight as in crane service. For this purpose a resistor is connected in the armature circuit, which dissipates the stored energy as heat. This method is called "dynamic braking." For quickly stopping an alternating-current motor use is sometimes made of a low-voltage direct-current circuit, which is connected to two of the primary phases, after the motor has been disconnected from the line. The more usual method called "plugging" is to reconnect the motor and apply power in the opposite direction, but the circuit must be opened as soon as the motor has stopped or the motor will run in the reverse direction.

THE DOUBLE DYNAMOMETER WATTMETER.

BY C. V. DRYSDALE, D.SC.

(*Continued from p.* 525.)

Summary. The author refers to wattmeter corrections and to the double wattmeter. He next deals with these instruments for measuring three-phase power, and discusses the errors involved including that of interference between coils. Some examples of their use in testing are then given and a new form of instrument is described.

Technical and Experimental Data.

The following are some of the data concerning the double standard wattmeters, which have been constructed up to the present for maximum currents of 1, 5, 10, 50, 100, 200 and 250 amperes per phase.

Main Coils. The wattmeters are normally made with 500 ampere turns per coil or 1,000 per phase, and the following are the observed resistances between the main terminals (including the commutator and contacts), for two of the larger sizes :—

	50-ampere wattmeter.			250-ampere wattmeter.				
Combination.....	10/1	5/2	2/5	1/10	10/1	5/2	2/5	1/10
Max.amp. per ph.	5	10	25	50	25	50	125	250
Resistance ,,	0·23	0·055	0·01	0·003	0·028	0·0075	0·0015	0·00045
Voltage drop ,,	1·15	0·55	0·25	0·15	0·7	0·375	0·188	0·11
Watts wasted ,,	5·75	5·5	6·25	7·5	17·5	18·8	23·5	27·5

The actual power waste inside the instrument case is only about a tenth of the above per phase, the bulk going in the contacts and the connections under the base. The heating inside the case is therefore fairly small, and the economy of power over the electrostatic wattmeter, in which a drop of 2 or 3 volts is desirable, is very great.

Swinging Coils. Resistance of each coil about 50Ω, made up to 100Ω with manganin.

Inductance about 1·9 millihenries.

Normal working current 0·02 amperes per coil, 5,000Ω for 100 volts. With both moving coils in series, current 0·01 ampere, and resistance 10,000Ω for 100 volts.

Power waste 2 watts for each 100 volts, or 1 watt with coils in series.

Phase displacement at 50 ~ with 5,000Ω resistance = 0·0001 2 radians which produces a maximum error of 0·06 division on sinusoidal supply with full volt-amperes. This is somewhat higher than in the earlier non-astatic form, but an astatic arrangement must have greater inductance for the same torque.

Total weight of double moving system 17·7 grammes.

Periodic time 6·7 seconds.

Damping. When disturbed to strike against stops the pointer comes sensibly to rest in five swings, but readings can be obtained considerably within that time as a rule by manipulating the torsion head.

Tests on Load.

Proportionality of Spring and of Commutator.—Fig. 7 shows the results of a series of tests on a 50-ampere wattmeter, in which the current was kept steadily at 0·02 ampere in the moving coil by including the latter in series with the battery circuit of a potentiometer, which same potentiometer was used to measure the current through the main coils. This is the method which has been employed by Mr. Tinsley for the standardisation of wattmeters, and is certainly the most accurate and convenient. The tests show that the deflections deviate on either side of strict proportionality by about half a division. Investigations made at the Bureau of Standards at Washington have shown that Hooke's law does not appear to hold rigidly for springs, and the curve in Fig. 7 may be taken as fairly typical of their behaviour. Four sets of readings were taken with the commutator set for the different ranges, and it will be seen that all the points lie practically on the same curve showing that the ratios given by the commutator are as closely in accordance with theory as can be read. It has not been found possible to detect any error due to the commutator if the contacts are kept fairly clean.

Constancy of Zero.—With the torsion head turned completely round (500 divisions) in one direction, and afterwards in the opposite direction the change of zero was imperceptible. A slow change of zero up to one division was found when the instrument had been on full load for some time, due to heating of the spring, but no viscous yield or "creep" could be observed.

Equality of Strands.—As a further indication of the accuracy to be expected from the series-parallel grouping, the magnetic

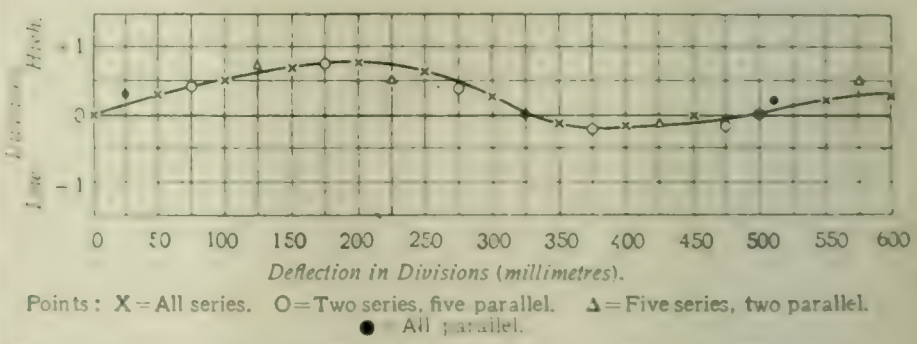


Fig. 7.—Proportionality Curve for 50-ampere Double Wattmeter.

effect of each individual strand was tested by balancing it against the other system. The following is the result obtained with currents of 0·02 ampere in the moving coils, and 10 amperes in each of the main coils corresponding to a deflection of 100 divisions in either system separately :—

Strand		1	2	3	4	5	6	7	8	9	10
Deviation from mean per cent.	D.C.	+1·2	+·3	+·4	+·7	+1·3	−·3	−1·1	−1·2	−1·0	−·1
	A.C. 60 ~	−1·1	+·3	+·4	+·7	−1·2	−·3	−1·2	−1·3	−1·1	−·2

It will be seen from the above, firstly, that the magnetic effect of any single strand does not differ from that of the whole of them in parallel by more than 1·3 per cent, so that even were one contact so bad as to deprive one coil of current entirely, the error caused would not be more than 1·9th of this or 0·11 per cent. Secondly, as the results for 60 ~ alternating current as compared with the mean correspond very closely, this shows that there is no appreciable "skin effect" up to this frequency.

Stability of Systems and Interference. In order to test this a current of 0·02 ampere was passed through either moving coil or the two in series, and the full working current through the main coils in series. The following results were obtained :

Lower system only	500·0	divisions.
Upper ,, ,, ...	501·0	,,
Top main, bottom moving coil.....	−1·0	,,
Bottom main top moving coil.....	−1·0	,,
Both systems assisting (0·01 ampere in moving coils)	499·5	,,
Both systems opposing (0·01 ampere in moving coils)	0·25	,,

The small interference between the systems is due to the astatic construction, which causes the field of one system to affect the other, even when the systems are accurately perpendicular. Approximate compensation of this interference can be effected by manipulating the rising leads to the coils.

There is another exceedingly pretty method of compensating for interference between the systems of a double wattmeter devised by Dr. Weston and employed in his double deflectional wattmeters. It is simply to include a third small resistance between the junction of the pressure circuits of the two watt-

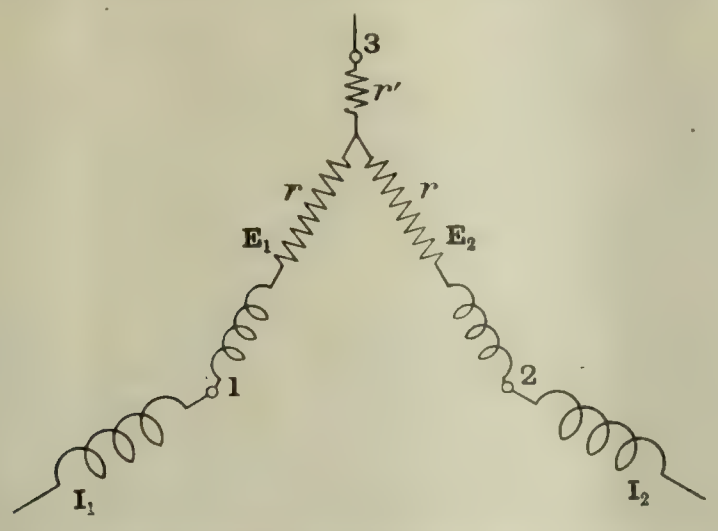
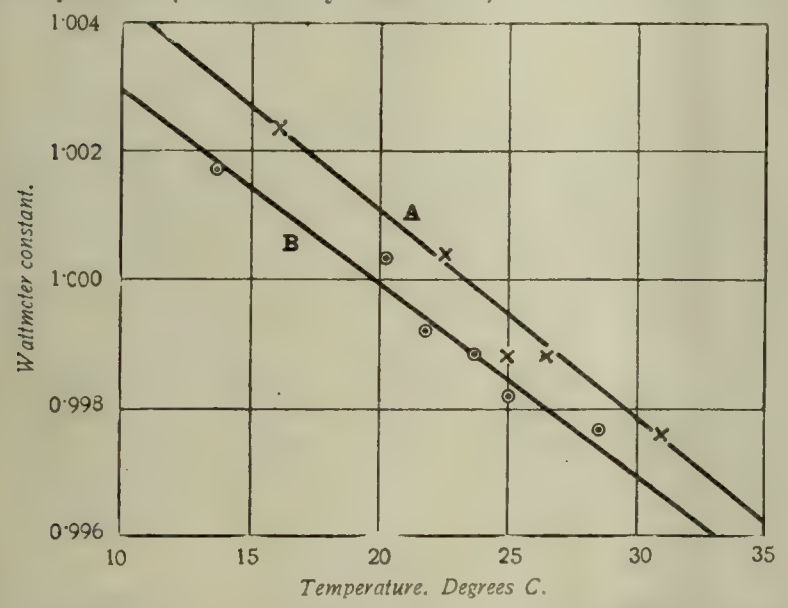


Fig. 8.—Weston Method of Interference Compensation.

meters and the third lead, as in Fig. 8, instead of joining them both directly to the main itself as in Fig. 2. The writer has not seen any theory of the method, and has worked out the following which may be of interest :—

Instead of taking the wattmeter reading $w=E_1I_1+E_2I_2$ as before, let it be $w'=E_1(I_1+KI_2)+E_2(I_2+KI_1)$, where K is a small fraction representing the amount of interference between the systems (assumed symmetrical). Let r be the resistance



A=25-ampere double wattmeter temperature variation −0·033 per cent. per 1°C.
B=250 ,, ,, ,, ,, ,, −0·030 per cent. per 1°C.

Fig. 9.—Change of Wattmeter Constant with Temperature.

of each pressure circuit (including the resistance box), and r' the small resistance between their junction and lead 3, R being taken as $r+r'$, and $K'=\frac{r'}{R}$.

Then it is readily seen that instead of the current in shunt 1 being $I_1=\frac{E_1}{R}$, it is $I_1=\frac{E_1-E_2r'/R}{R\{1-(r'/R)^2\}}$,

or the equivalent voltage

$$E'_1=\frac{E_1-K'E_2}{1-K'^2}.$$

Hence the wattmeter reading becomes

$$w'=\frac{1}{1-K'^2}\{(E_1-K'E_2)(I_1+KI_2)+(E_2-K'E_1)(I_2+KI_1)\}$$

$$=\frac{1}{1-K'^2}\{(1-KK')(E_1I_1+E_2I_2)+(K-K')(E_1I_2+E_2I_1)\},$$

which reduces to $E_1I_1+E_2I_2$ if $K'=K$ or if $\frac{r'}{R}$ equals the ratio of the interference reading to the normal. This correction although small cannot be perfect at all points of the scale in the case of a deflectional instrument, as K must vary somewhat

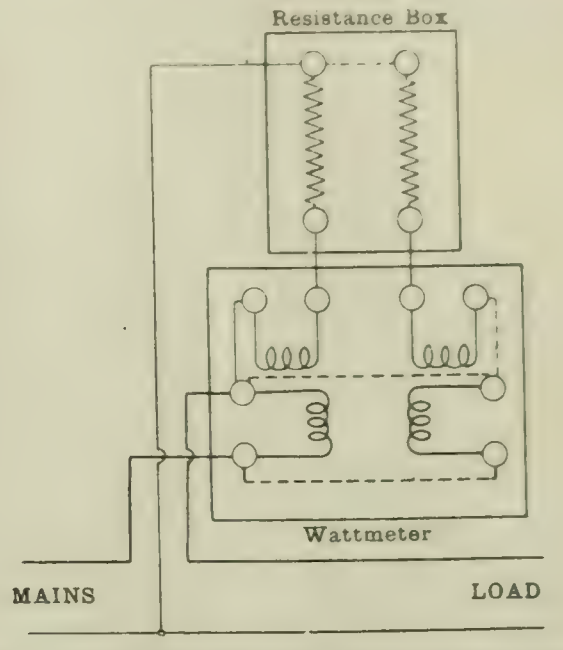


Fig. 10.—Single-phase One System. Dotted Lines=Two Systems in Parallel for Double Current.

with the position of the moving coils, but it is absolutely correct for a zero reading instrument if the interference of each system on the other is the same. For example, in the wattmeter under consideration, the interference reading in each case is 1 division compared with 500 divisions for the system itself If therefore instead of the two 5,000 ohm resistances used for

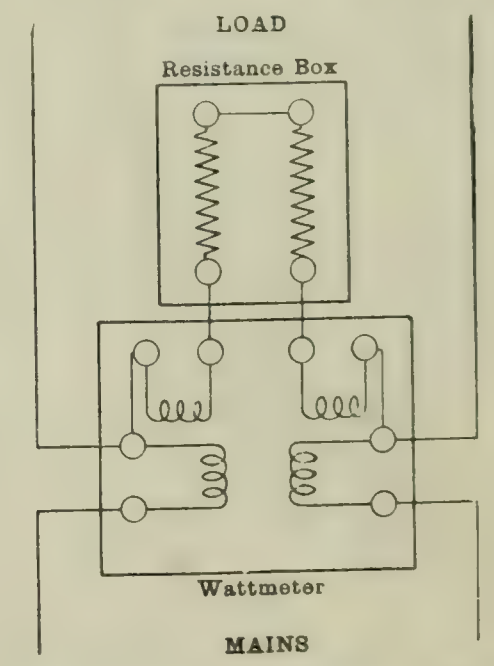


Fig. 11.—Single-phase. Two Systems in Series Shunt Current=0·01 Ampere.

100 volts, two of 4,990 ohms were used, with a third coil of 10 ohms in series with the arrangement, the compensation should be perfect, if the main and shunt coils of one system were reversed to make the interference positive.

Effect of Temperature. Fig. 9 shows the results obtained by Mr. Tinsley on heating two of the wattmeters in an electric oven, constant currents being maintained in the main and swinging coils during the test. These show that the sensitiveness of the instrument increases by about 3 parts in 10,000 for each 1°C., due probably to the alteration of elasticity of the spring modified to a slight extent by changes in the dimensions of the coils with change of temperature.

In addition to this, however, there is a liability to variations of about 1 division at full load, or of 0·2 per cent., due probably to convection currents rising from the coils to the spring, and which are being eliminated by fixing a horizontal partition just above the coils and ventilating the upper part of the case,

so as to maintain the spring as nearly as possible at the outside air temperature.

Applications of the Double Wattmeter.—The applications of the instrument are, of course, numerous, and comprise single-phase tests of all kinds, including the direct determination of losses in the case of transformers or motor generators by differential employment of the two systems, as well as the

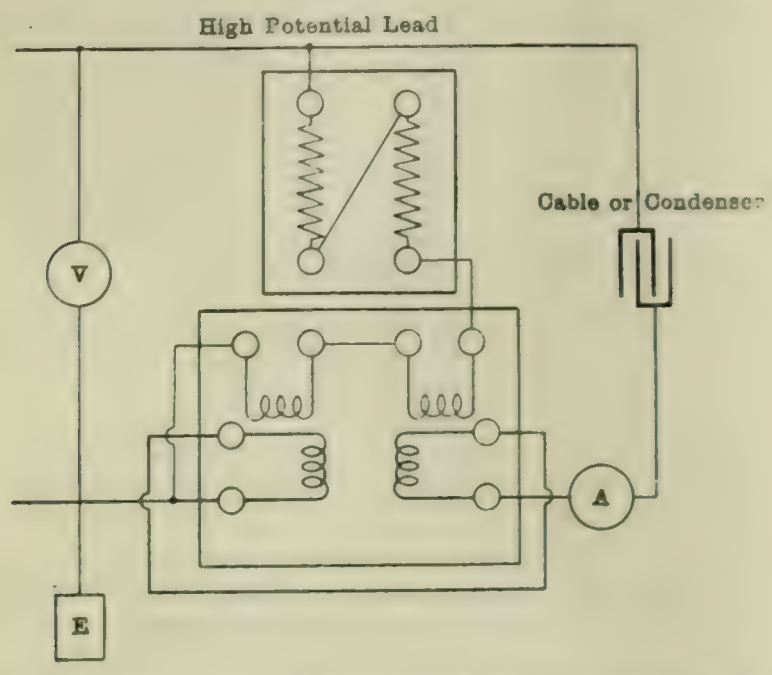


Fig. 12. Single-phase Connections for Dielectric Tests.

measurement of power or phase on two-phase or three-phase three-wire supply, the testing of polyphase supply meters, &c. A few specimen methods of connection and results may be included.

Figs. 10 and 11 show connections for single phase testing, and require no explanation. It is worthy of notice, however, that with single phase supply the current range of the instrument can be doubled by connecting the main coils in parallel as shown,

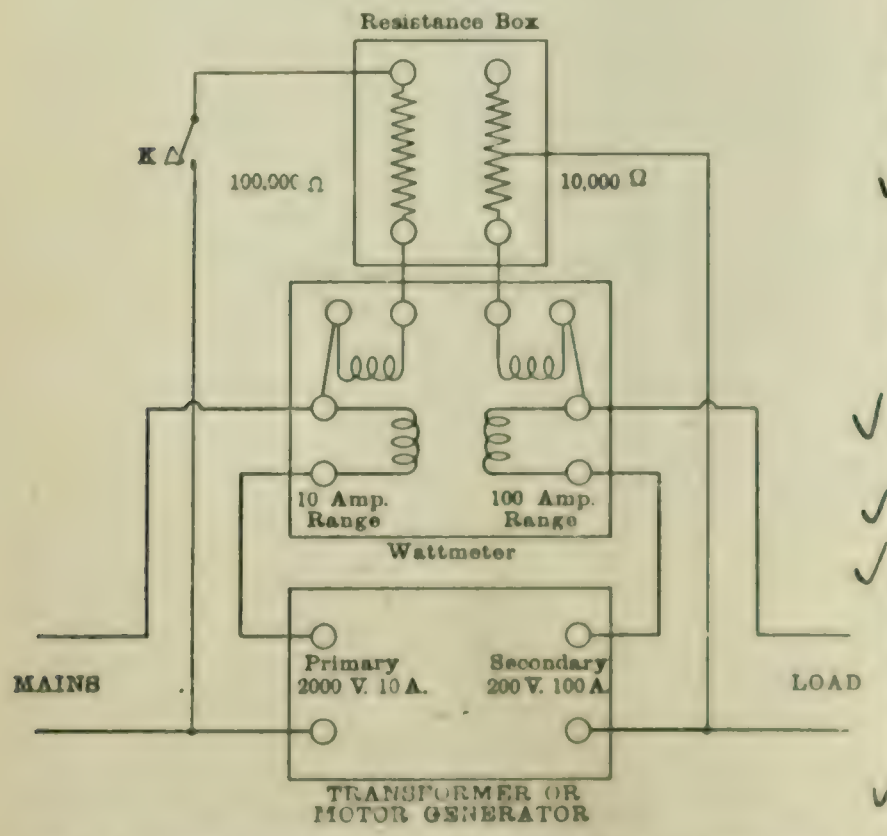


Fig. 13. Differential Testing of Losses and Efficiency of Transformer or Motor-generator. Direct or Alternating Current.

so that the 250-ampere wattmeter will serve up to 500 amperes. In some cases also it is convenient to connect the two systems in series, thus reducing the shunt current.

Testing Dielectric Losses in Cables and Condensers.—The latter method of connection, or better that shown in Fig. 12, where both systems of the wattmeter are at the potential of one main, is very suitable for the testing of dielectric losses, and the first measurements made with the single-phase wattmeter of this type* were made on cables and condensers in connection with the discussion on Mr. Mordey's Paper on "Dielectric Losses" at the Institution of Electrical Engineers in 1901. With this arrangement and the two resistances of 100,000 Ω in series, tests at pressures up to 6,000 volts (or up to 11,000 if the resistances are immersed in oil) can be made, and it is possible to read to an accuracy of $\frac{1}{4}$ to $\frac{1}{2}$ per cent. on power factors as low as 0·03. No special precautions need be taken even at these pressures, if the resistance boxes are placed on insulating supports, and the lead connected to the main coils is well earthed as shown.

Testing Phase Displacements in Resistances and Transformers. A large number of useful tests can be made with the wattmeter with the help of a condenser in the moving coil circuit, which brings the shunt current nearly into quadrature. Some of these have been described in earlier Papers.†

Differential Testing of Losses and Efficiency.—Fig. 13 shows the connections suitable for determining the losses and efficiency of any kind of transforming device, such as ordinary transformers, motor generators, mercury vapour and other rectifiers or valves, &c. The series resistance and commutator of each system must be set to give the same constant, as is indicated above for the case of a 2,000 to 200-volt transformer. With the key K open, a reading w is obtained which is clearly the secondary load, as the primary wattmeter is then out of service; but when the key K is depressed a negative reading w' is obtained indicating the difference between the primary and secondary power, or the total losses in the transformer directly. The efficiency is then given by the relation $\eta = 1 - \frac{w'}{w}$ and is obtained with much greater accuracy and convenience than by measuring the input and output.

(*To be continued.*)

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"An Introduction to the Principles of Physical Chemistry," by Edward W. Washburn (London: Hill Publishing Co.) Pp. xxv. + 445. 15s. net.

"Principles of Direct-current Machines," by Alexander S. Langsdorf. (London: Hill Publishing Co.) Pp. xxiii. + 404. 12s. 6d. net.

"The Electric Railway," by A. Morris Buck, M.E. (London: Hill Publishing Co.) Pp. xi. + 390. 12s. 6d. net.

"An Elementary Manual of Radiotelegraphy and Radiotelephony for Students and Operators," by J. A. Fleming, F.R.S. (London: Longmans, Green & Co.) Pp. xiv. + 358. 7s. 6d. net.

"Aeroplanes and Airships," by W. E. Dommett. (London: Whittaker & Co.) Pp. 106. 1s. net.

"Catalysis and its Industrial Applications," by E. Jobling, A.R.C.Sc. (London: J. & A. Churchill.) Pp. viii. + 120. 2s. 6d. net.

"Mechanical World" Electrical Pocket Book for 1916. (Manchester: Emmett & Co.) Pp. 298. 6d. net.

"Proceedings" of the Physical Society of London. Vol. XXVIII., Part 1. (London: "The Electrician" Printing & Publishing Co.) Pp. 87. 4s. net., post free 4s. 3d.

"The Principles of Dynamo Electric Machinery," by B. F. Bailey, B.S. (London: Hill Publishing Co.) Pp. xv. + 313. 12s. 6d. net.

"Resolution of Planck's Constant and Rydberg's Constant and the Origin and Inter-relations of Spectra Series," by J. Stewart. (Paisley: J. & R. Parlane.) Pp. 16. 1s. net.

"Practical Electrician's Pocket Book and Diary, 1916." (London: S. Rentell & Co.) Pp. lxiv. + 477. 1s. net.

"Annual Report of the Smithsonian Institution, 1914." (Washington: Government Printing Office.) Pp. xl. + 729.

* "Dielectric Losses in Condensers and Cables," The Electrician, April 5, 1901.

† "Some Measurements on Phase Displacements in Resistances and Transformers," The Electrician, Nov. 16 and 23, 1906. "The Testing of Transformer Regulation," The Electrician, July 29, 1910.

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE & YORKSHIRE RAILWAY.

(*Continued from p.* 531.)

Boiler Feed Pumps.—The station is at present equipped with two boiler feed pumps, supplied by Mather & Platt (Ltd.), of Manchester; one a turbine pump and the other a reciprocating pump, both capable of delivering 10,000 gallons of feed water per hour against a head of 217 lb. per square inch. It is interesting to note that the reciprocating pump is the only reciprocating machine in the station. It is intended that the turbine pump should be used in service and the reciprocator as a stand-by. Both pumps are situated near the hotwell, and at such a level that they are always flooded.

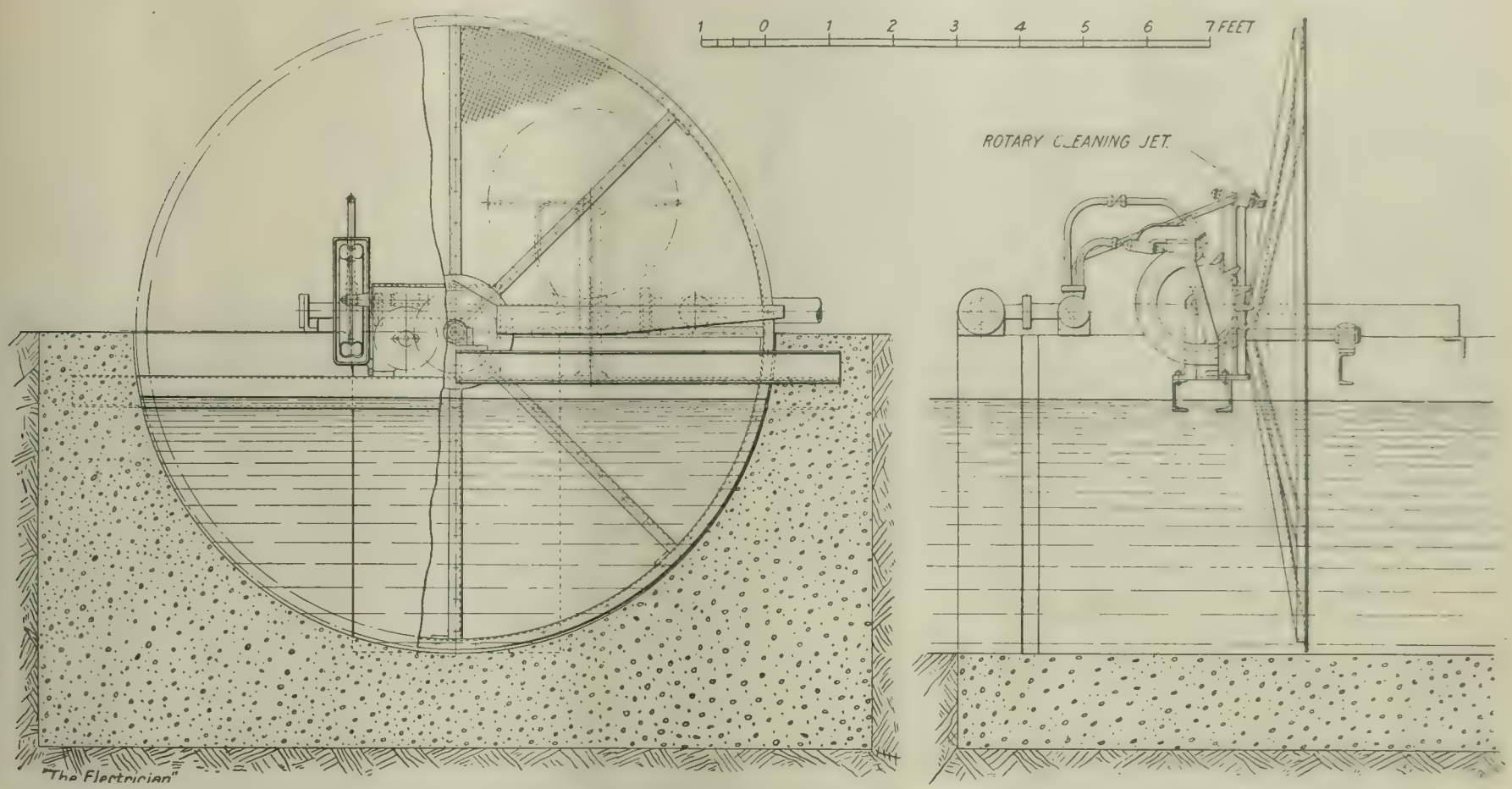


FIG. 15.—ELEVATIONS OF ROTARY SCREENS.

The turbine pump is of the high-lift multiple-chamber type, absorbing 40 B.H.P. It has a 5 in. suction and a 4 in. delivery, and is driven by a 45 B.H.P. high-pressure turbine of the horizontal "Curtis" type, made by the British Thomson-Houston Company, and runs at 3,000 revs. per min. The weight of the combined set is approximately 1 ton. The reciprocating pump is double acting and makes 13 double strokes per minute. Its chief dimensions are: Cylinder 10 in. diameter, 24 in. stroke; suction branch 6 in. diameter and delivery branch 4 in. diameter.

Spray Pumps.—Two spray pumps are installed for the purpose of dealing with the cooling of the circulating water. These pumps, with their motors, are exactly similar to the circulating water pumps for the main sets. Condensing water is obtained from the canal, and it passes first through a bar screen, which stops the entrance of the larger pieces of floating matter, and then through rotary screens, which check the smaller weeds, &c., before reaching the cooling

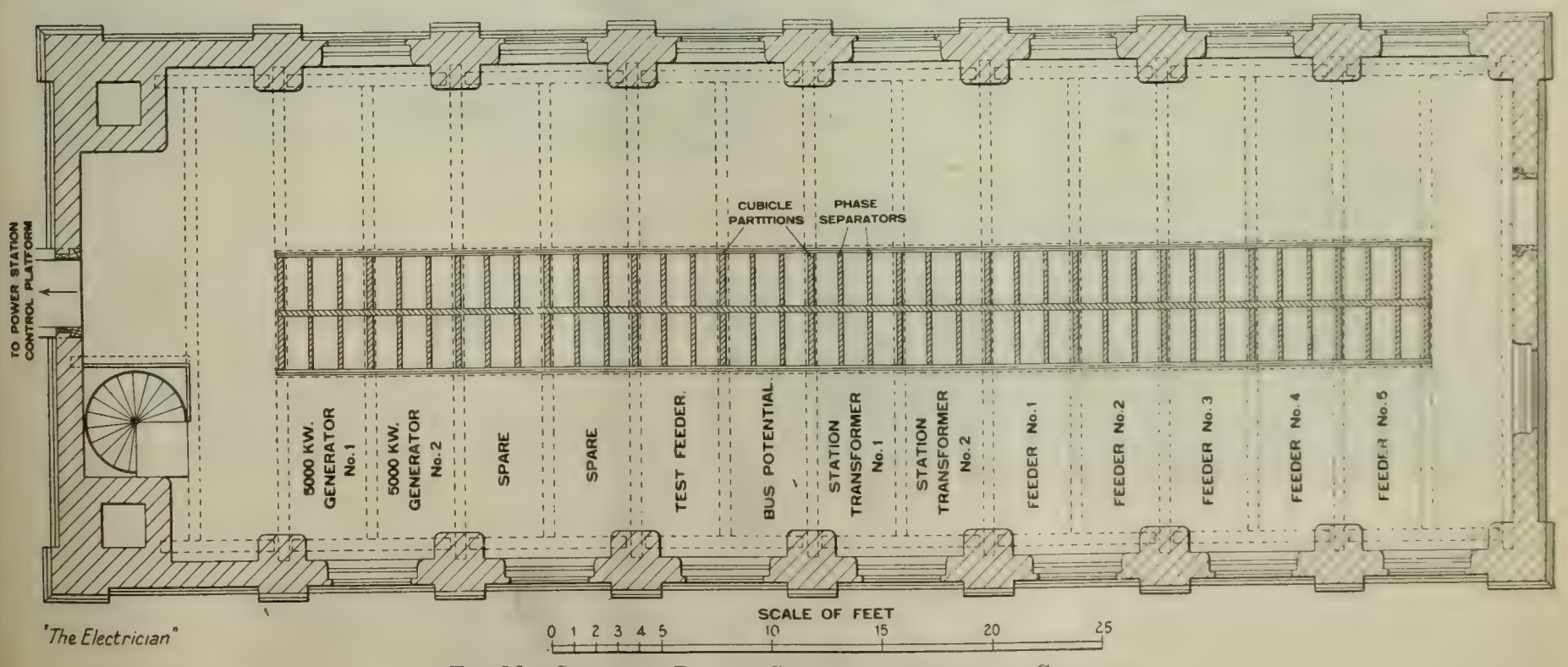


FIG. 16.—SECTIONAL PLAN OF SWITCH-HOUSE, SHOWING CUBICLES.

pond. The rotary screens, which are shown in Figs. 15 and 17, are two in number, each 10 ft. in diameter, and rotate at 1 rev. per min. They are driven by "Pelton" wheels through worm-gearing, the water for driving them is obtained from the spray pump discharge and is under a head of 18 ft. When the spray pumps are not working, the water is obtained from the auxiliary tank. The screens are cleaned by means of rotating jets, which spray on the exposed portion of the screens on the side away from the incoming supply of cooling water.

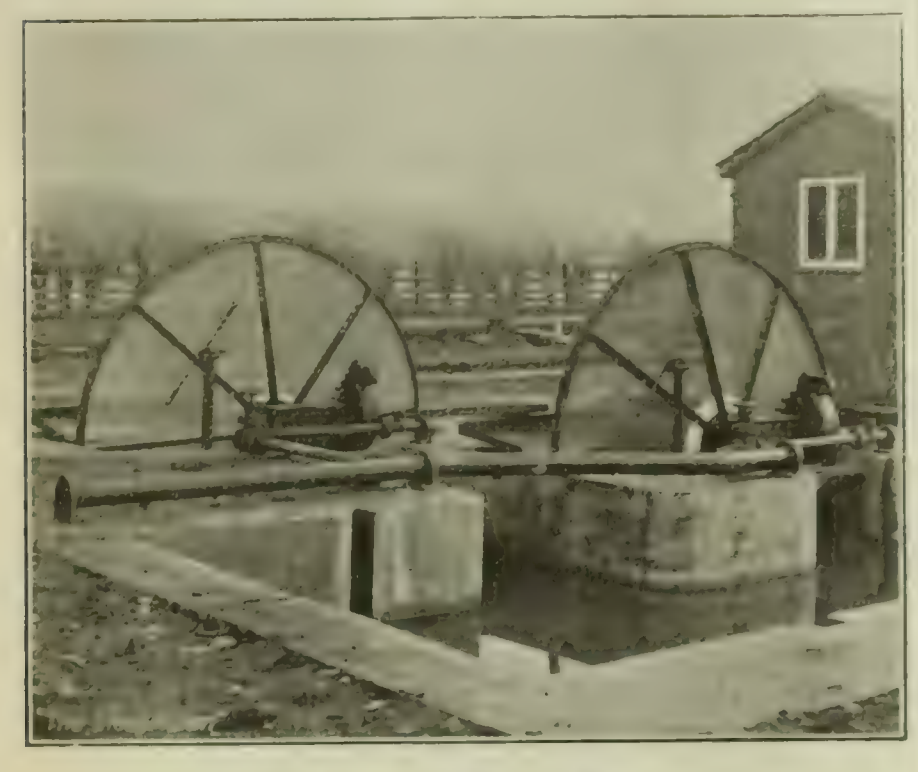


Fig. 17.—View of Rotary Screens.

The water flows from the cooling pond into a brick-lined collecting pit, and thence by gravity down a 45 in. pipe into the circulating water suction main. This suction main has a maximum diameter of 62 in., and is of sufficient area to supply the demand of the whole station when extensions are completed. The present pipe supplies the two main condensers, the auxiliary condenser, also the water to the auxiliary tank, and is capable of easy extension as required.

Water, having passed through the condensers, flows by gravity into a hole 62 in. diameter discharge main running parallel with the suction main. This pipe is fitted with suitable branches for future extensions, and discharges into a concrete channel running parallel



Fig. 18.—View of "H" Poles and High Tension Transmission Line.

with the canal, having outlets at convenient points. Connections are taken from the discharge main to the spray pumps, so that the hot circulating water can be pumped back to the cooling pond through the spray nozzles. Thus, two methods of cooling are available, or a combination of both methods can be used at the same time. The discharge pipe from the spray pumps to the cooling pond is 32 in. diameter, and runs alongside the 45 in. diameter delivery pipe from the pond.

Cooling Pond.—The cooling pond is 408 ft. long, 109 ft. wide and 2 ft. 6 in. deep. The spraying arrangement has been supplied by Harrison, Son & Jobson, of Middlesbrough, and is capable of cooling 402,000 gallons of water per hour from 95°F. to 75°F. under normal atmospheric conditions, being so arranged that slight extension to the pipework will double the capacity to 804,000 gallons per hour.

The piping is constructed in four separate units, each unit being controlled by a valve situated in a convenient position on the pond side. Each unit is divided into three lengths of parallel piping 32 ft. apart. Screwed in each pipe are 24 brass nozzles spaced 3 ft. apart, thus making a total of 288 nozzles for the present plant. Each nozzle orifice has an area of 0·39 sq. in., and is capable of passing 1,396 gallons of water per hour at a head of 18 ft. The circulating water pipes were manufactured by Clayton, Son & Co., of Leeds, and at the railway company's works at Horwich.

Auxiliary Water Supply.—An auxiliary water supply has been installed to meet the demand for water other than that required from the town main. This water is delivered into a storage tank from the circulating water suction main, by means of a "Mather & Platt" turbine pump, situated in the turbine room basement. This pump has a capacity of 12,000 gallons per hour, against a head of 50 ft. when running at a speed of 1,420 revs. per min. It has a 5 in. diameter

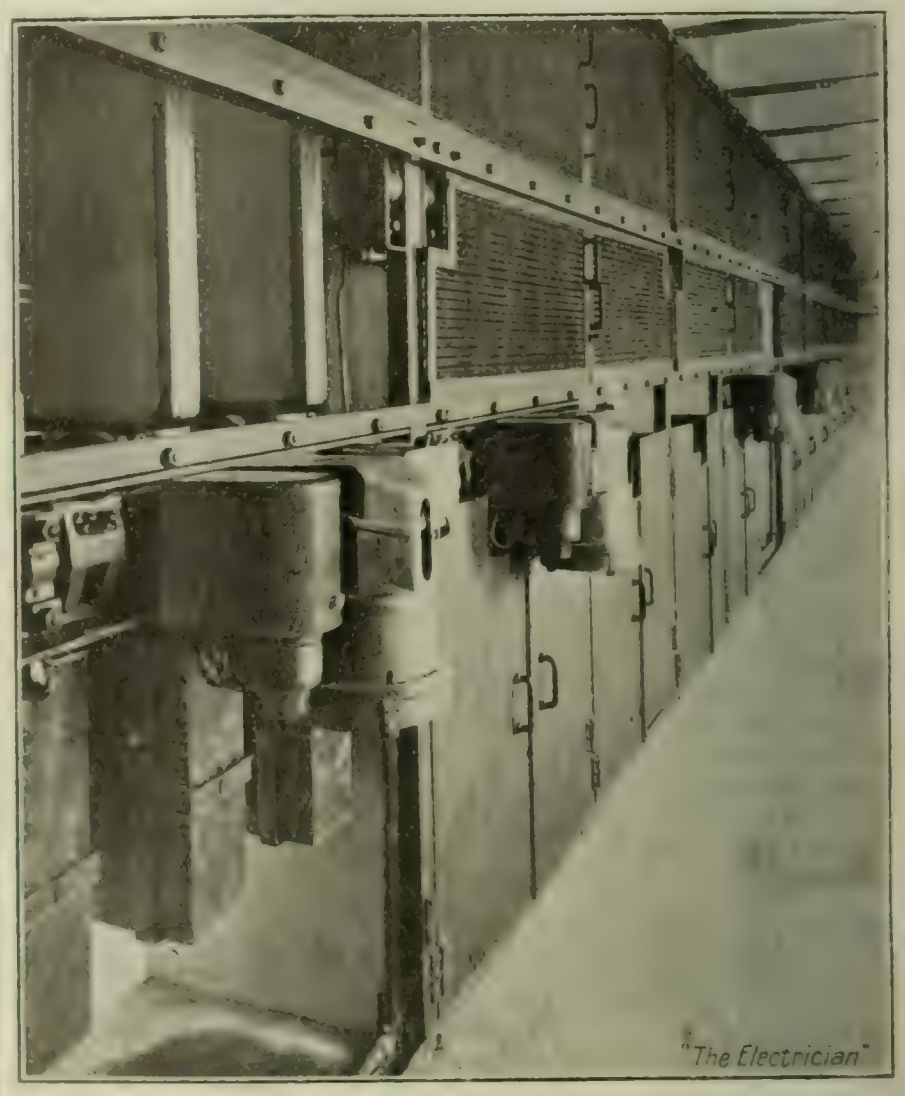


Fig. 19.—View of Second Floor of Switch-house, showing Oblique View of Oil Switches.

suction, and a 4 in. diameter delivery, and is driven by a 6 H.P. induction motor. The pump and motor are mounted on one common bedplate.

The auxiliary tank is situated above the economiser floor, and has a capacity of 2,900 gallons. The delivery water from the pump is controlled by a 5 in. float valve in the tank. An emergency connection is taken from the town main, and is controlled by a 3 in. float valve operating at a lower level than the 5 in. valve. The auxiliary tank supplies water to the hotwell for make up, to the main condensers for flooding purposes, to the oil coolers, bearings and numerous smaller details both in the turbine room and the boiler room.

Water Softener.—The water softener, manufactured by Bowes, Scott & Western, of London, has a capacity of 1,000 to 1,500 gallons of water per hour. It is 20 ft. 6 in. high, with a diameter of 6 ft. 3 in.; the decanter has a settling tank capacity of 3,940 gallons.

At the end of the station are arranged stores, offices, and switchboard platform. The stores are alongside the main entrance on the basement floor, and immediately above them on the turbine-room floor are arranged the offices for the operating staff. The control switchboards are placed on a gallery above the offices, overlooking the

turbine room, and the control wiring is accommodated in the cable room between the ceiling of the offices and the switchboard gallery.

There are three separate switchboards :—

1. The main control board for operating the main units and feeders.
2. 440-volt alternating-current board operating the station auxiliaries.

control type. The main switchgear is housed in a separate building (*see* Fig. 6 in our last issue), access to which is obtained by a foot-bridge from the turbine room floor The switch-house consists of a four-storey building, on the ground floor of which is housed the battery consisting of 70 cells. The first floor is the cable room, the second floor the switch-room, and the third floor the 'bus-bar room.

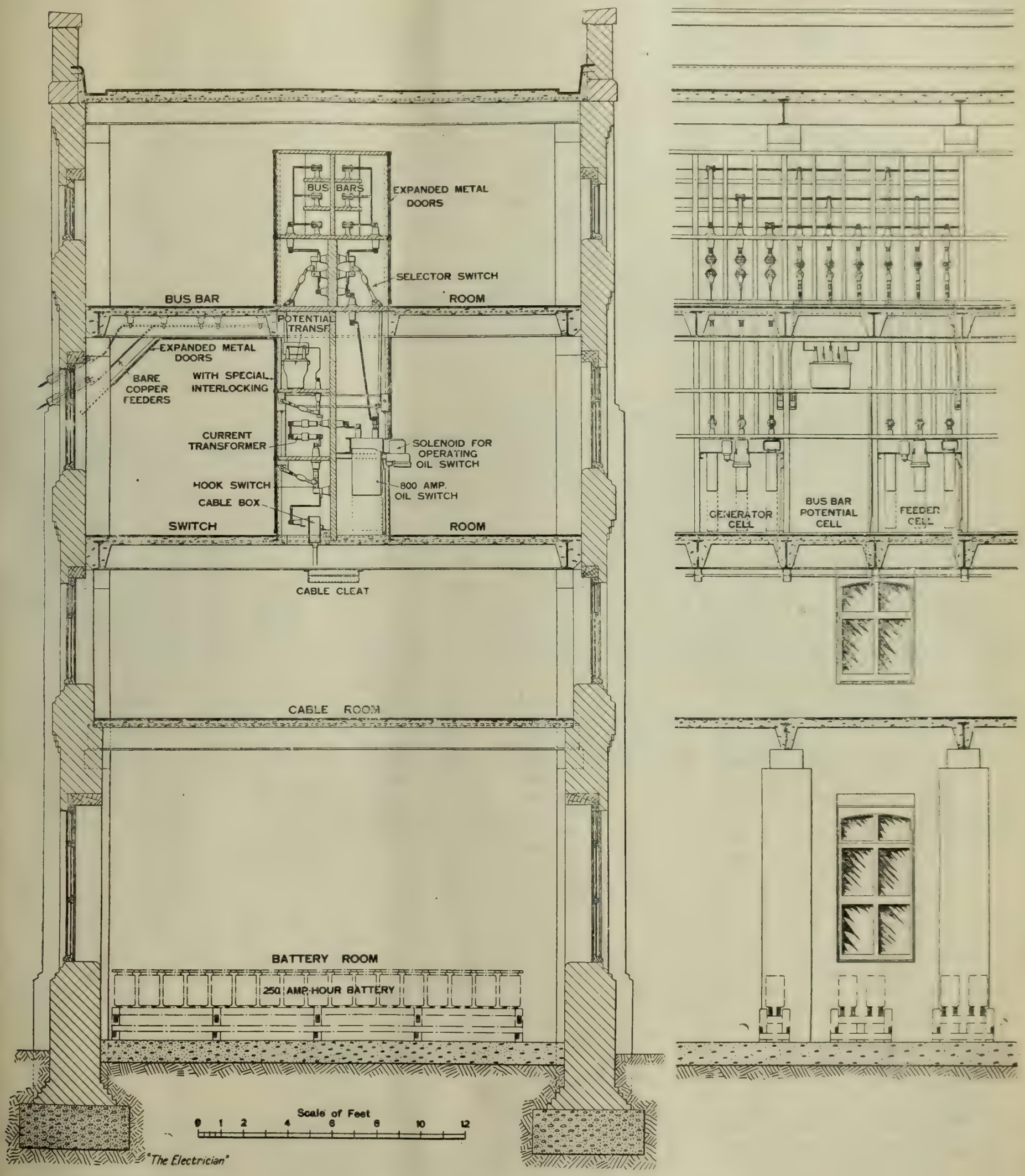


FIG. 20.—CROSS-SECTION AND PART ELEVATION OF SWITCH-HOUSE.

3. Direct-current board, controlling the control circuits, lighting, cranes and stand-by battery for the control circuits.

Switchgear.—The switchgear, manufactured by the British Thomson-Houston Company, is of the solenoid operated remote-

A plan of the switch-house is shown in Fig. 21, and a cross-section in Fig. 20.

The control board on the gallery consists of 13 panels, on which are mounted the necessary equipment for controlling the main switch-

gear for the two 5,000 kw. generator equipments, with two blank panels for future extensions; five 300 kw. feeder equipments, two 250 kw. transformer equipments, one test feeder equipment, and one synchronising equipment.

The 440-volt three-phase switchboard consists of five panels, on which are mounted hand-operated oil switches and the necessary gear for controlling two 250 kw. transformer equipments, one 500 kw. generator, two rotary converters equipments, and two feeder panels

The direct-current board consists of five panels, two controlling the direct-current side of the rotary converters, one the 125-volt battery, and two feeder panels for the main control, lighting and crane motors.

The main switchgear in the switch-house is contained in cells built up of moulded stone, as seen in Fig. 19, each phase being separated throughout with barriers of the same material. The 'bus bars, with the 'bus-bar isolating switches, are placed on the floor above the switch room, the cell construction being of a similar character to the above.

The fronts of the cells are covered by expanded metal sliding screens, these screens being interlocked with isolating switches, so that it is impossible to open out any cell until the isolating switches controlling the apparatus in that cell have been opened. The cells containing the oil switches have metal doors, which are not interlocked.

The main cables are suspended from the footbridge, which gives access to the switch-room, and enter the cable-room immediately beneath the switch-room, being taken up to their respective cells as required. The outgoing feeders are carried from their respective cells and supported by insulators from the ceiling, passing through the wall of the switch-house by means of leading-in tubes to the overhead line outside.

The 'bus bars are in duplicate and so arranged that any machine, or any set of feeders, can be connected to either set of 'bus bars, but no machine, or no particular set of feeders, can be connected to both sets of bars at the same time, the isolating switches for the 'bus bars being interlocked to prevent this. By this means one set of 'bus bars can be used for power purposes, whilst the other at the same time can be utilised for general test purposes. The order of the cells is exactly the same as that of the control switchboard.

The main oil switches are operated by means of "pull type" switches on the control board, which energise relay switches mounted on the oil switch. Relays have been adopted in order to restrict the size of the cable required between the control board and the switchgear.

An indication of the position of the switch is given by red and green lamps, which are placed vertically above and below the "pull type" switch. The controlling switch for the lamps is operated by the movement of the oil switch itself. The pressure of the control current is 125 volts.

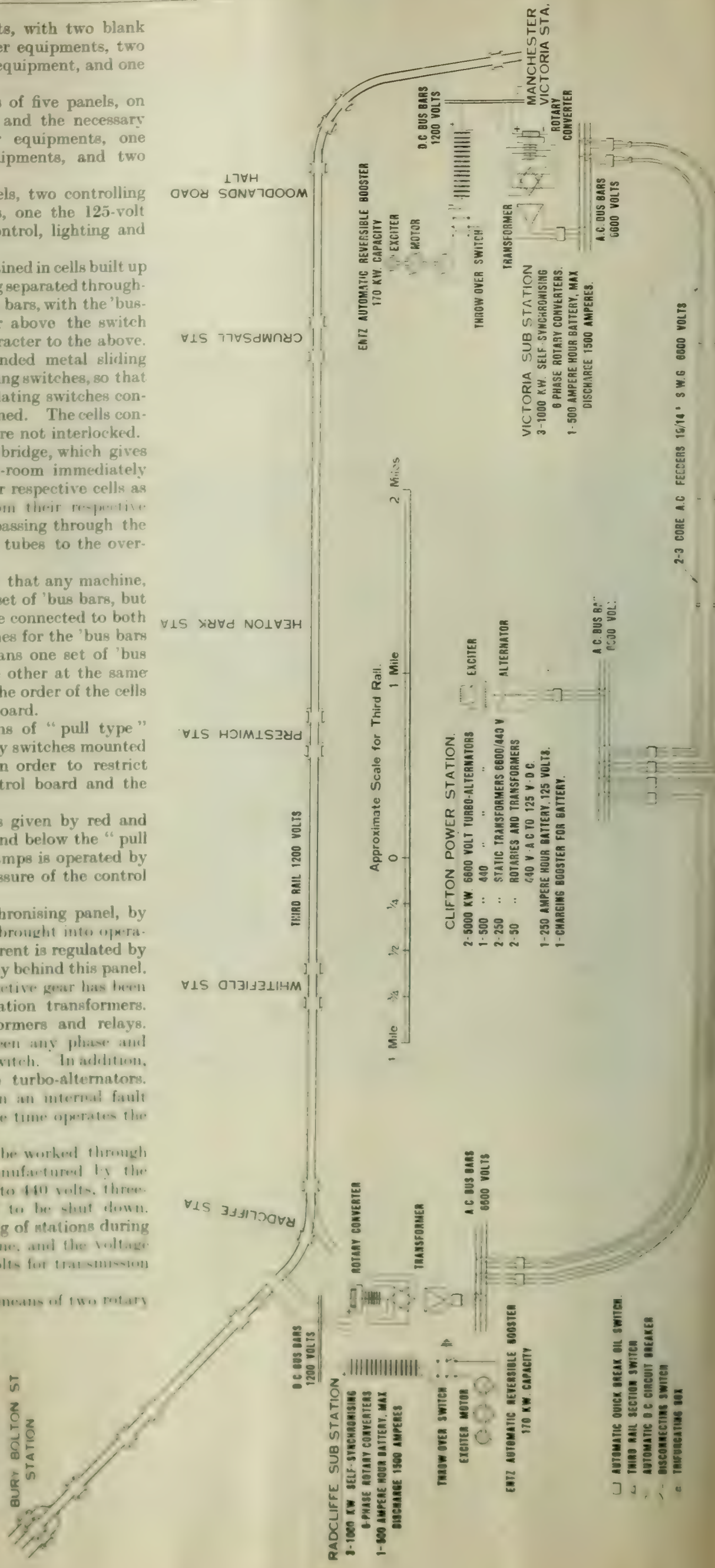
A throw-over switch is provided on the synchronising panel, by means of which an emergency excitation can be brought into operation should the exciters fail. This excitation current is regulated by means of a rheostat, which is mounted immediately behind this panel.

With the switchgear a system of balance protective gear has been provided for the turbo-alternators and the station transformers. This is operated by means of current transformers and relays. Should a fault occur between phases, or between any phase and earth, these relays operate, and trip the main oil switch. In addition, automatic field switches are provided for the turbo-alternators. These open the field circuit automatically when an internal fault occurs in the turbo-alternator, which at the same time operates the protective gear and trips the main oil switch.

In normal running the station auxiliaries will be worked through two station transformers of 250 kw. each, manufactured by the British Transformer Co., converting from 6,600 to 440 volts, three-phase, and enabling the 500-kw. auxiliary set to be shut down. During periods of very light load, such as lighting of stations during the night time, the auxiliary set can be run alone, and the voltage raised through the same transformer to 6,600 volts for transmission to the various stations or goods yards.

The direct current at 125 volts is obtained by means of two rotary converters operating through transformers from the 440-volt supply. Each of these converters has a capacity of 50 kw. and were made by the British Westinghouse Co. They are used in conjunction with a 70-cell battery (made by the Chloride Electrical Storage Co.) and a small booster.

All drainage from the station is treated by a drainage plant situated at some distance from the building. After treatment the drainage is dealt with by means of a vertical spindle "Sunturbo" pump, manufactured by Peter Pilkington, Ltd., of Bamber Bridge.



This pump is capable of dealing with 80,000 gallons of water per hour, against a total head of 32 ft., when running at a speed of 715 revs. per min., and is driven through vertical shafting by a four-pole 20 H.P. three-phase motor. The weight of the combined set is approximately $1\frac{1}{4}$ tons.

2. The south line, $4\frac{1}{4}$ miles long, runs from the power station to Manchester, Victoria sub-station, via Pendleton New.

Both these feeders are of the same capacity, and consist of overhead conductors, of three cables in duplicate, and three-core cables, paper-insulated, lead-covered, and armoured with steel-galvanised

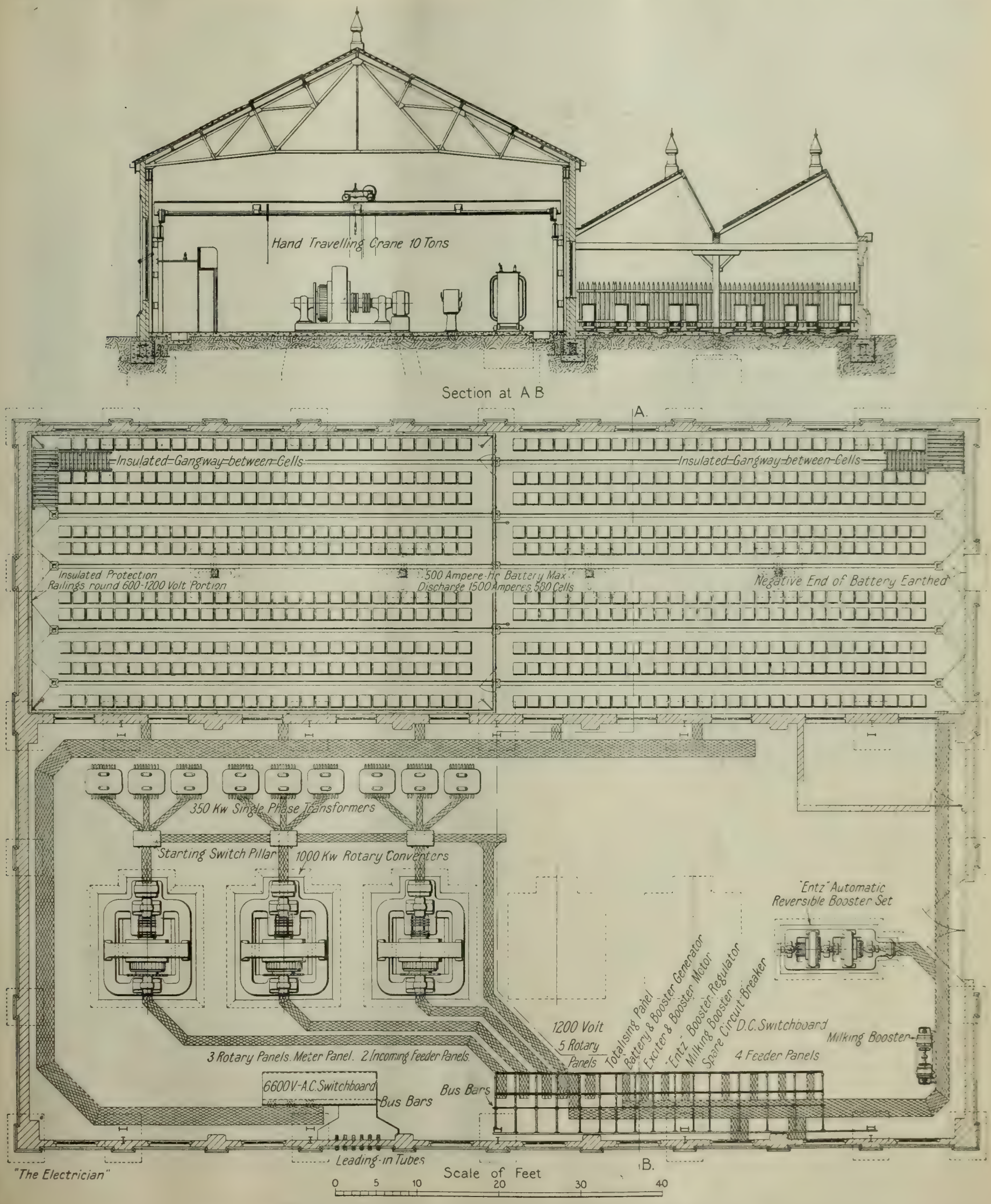


FIG. 22.—PLAN AND CROSS-SECTION OF RADCLIFFE SUB-STATION.

HIGH TENSION TRANSMISSION LINE.

Two main feeder lines are used to convey the power from Clifton Junction power station :—

1. The north line, 4 miles long, runs from the power station to Radcliffe sub-station, via Ringley-road.

wires, in duplicate. The overhead cable, supplied by The British Insulated and Helsby Cables, Ltd., and Thomas Bolton & Sons, Ltd., consists of 7/10 S.W.G. per phase ; the three-core of 19/14 S.W.G. per phase was manufactured by W. T. Henley's Telegraph Works Co., Ltd.

The outer diameter of the three-core cable is 2·293 in., the armouring 0·1 in. and the thickness of the lead 0·14 in. The joints are of the plumbed "lead-sleeve" type, and the conductors are insulated with paper sleeves, the boxes being filled in with compound.

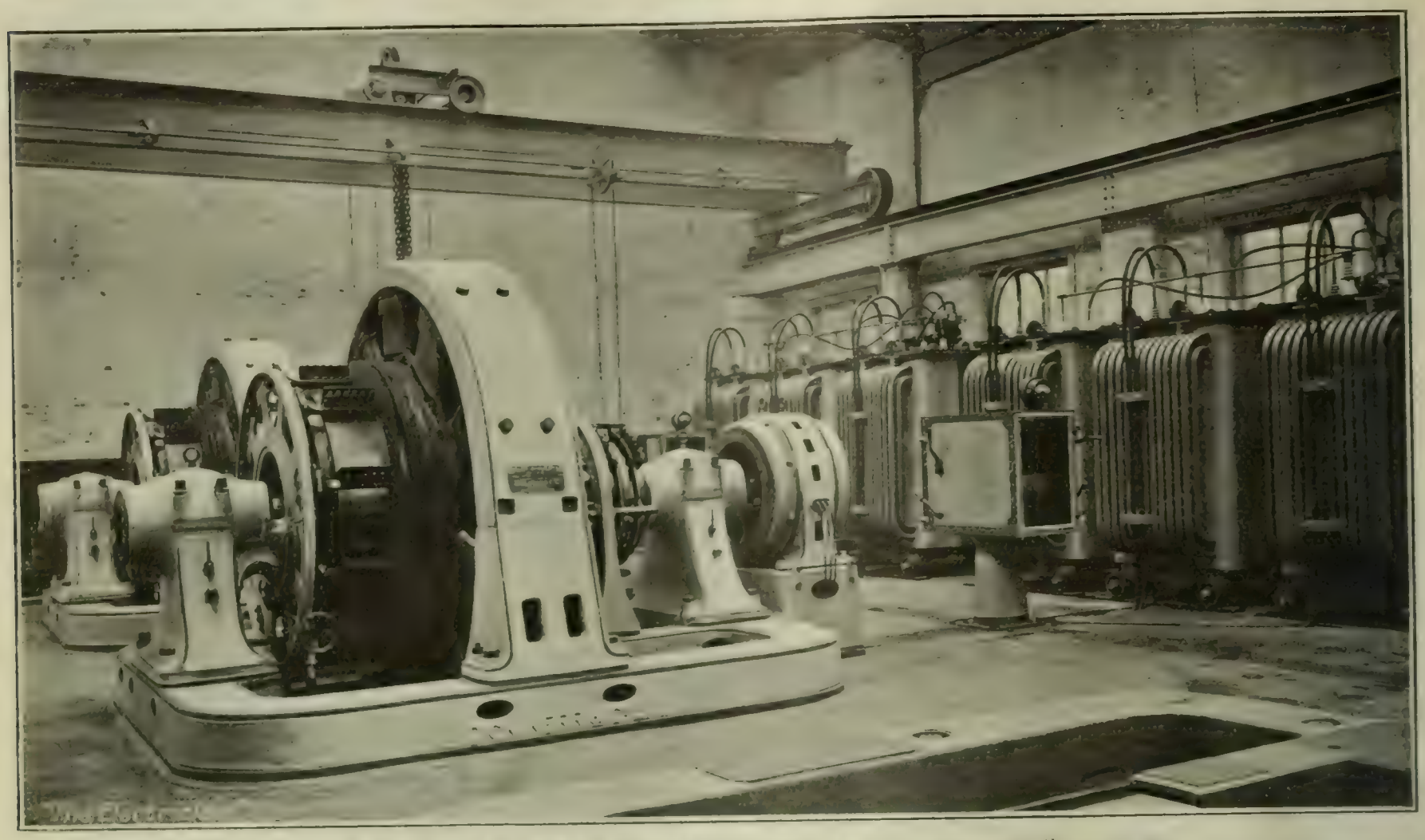


Fig. 23.—View of 1,000 kw. Rotary Converters and Transformers, Sub-stations.

The north line is practically all overhead, cable only being used when passing under public bridges. The south line consists of 1¼ miles of overhead and 3½ miles of cable. The overhead is carried throughout on "H" poles, as seen in Fig. 20, the conductors being arranged three on each side of one pole, the other being left for future extensions. The standard span used is 70 yds. The three-core cable is carried on posts and where convenient on wall brackets. Both lines are in duplicate, and under ordinary working conditions will both be in use.

The "H" poles consist of two fir poles of an average diameter of 10 in. 6 ft. from the butt. The cross arms supporting the insulators are of channel iron, 4 in. by 2 in. by ½ in., clipped on to the pole. The pole is also braced with wooden struts and bolts, but no anchor stays are used except at points where the line makes an angle. The whole of the armouring, and also the ironwork on the poles, is earthed to copper earthing plates at ¼-mile intervals.

No lightning arresters are used, but at the points where the cables enter the power station and sub-stations choking coils are provided

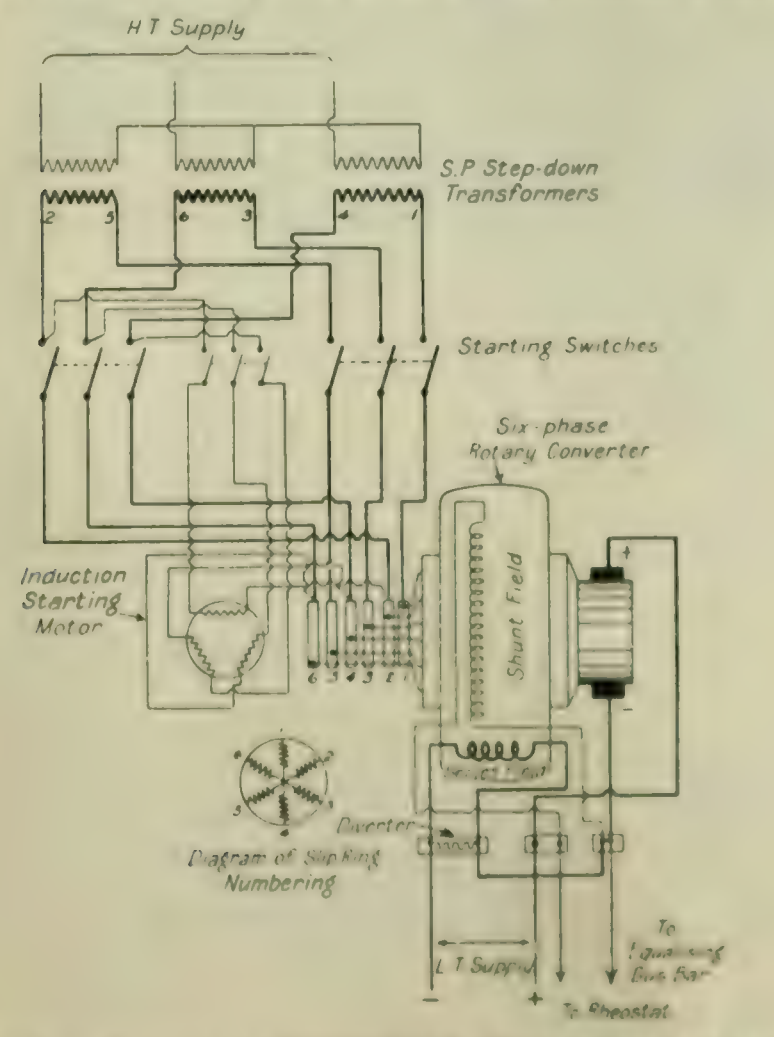


Fig. 24.—Diagram of Connections of Rotary Converter and Starting Motor.

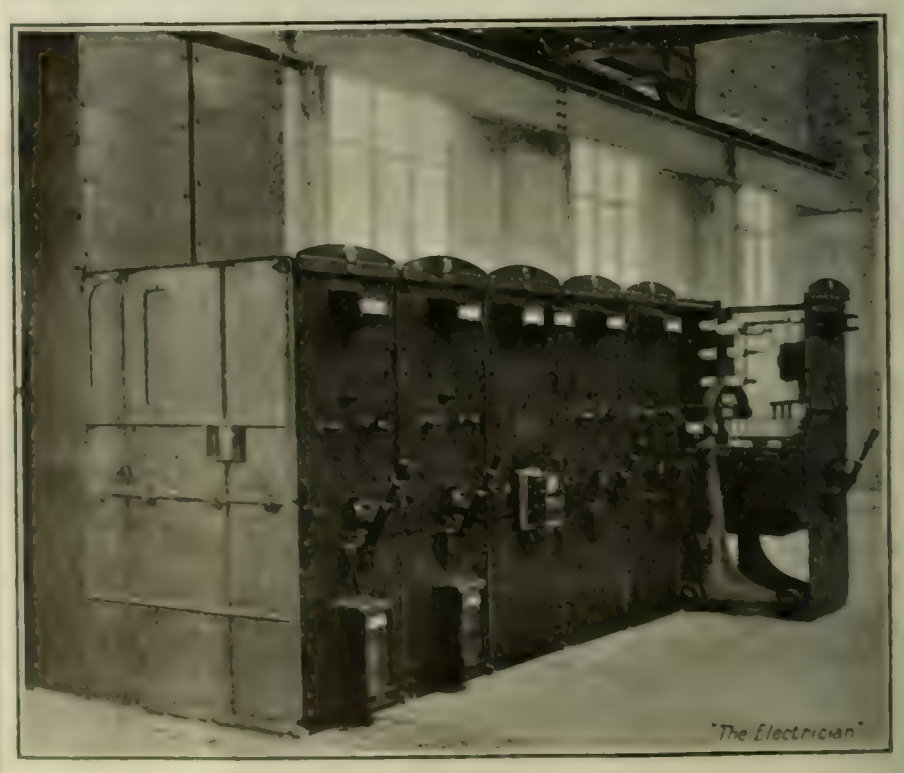


Fig. 25.—The Alternating-current Switchboard.

Sub-stations.

There are two sub-stations, situate at Manchester (Victoria Station) and Radcliffe. Fig. 21 shows a diagram of the transmission from the

power station to the sub-stations and thence to the live rail. Each sub-station is a combined rotary and battery sub-station, the equipment in each being identical, though the arrangement at Manchester is modified slightly due to its being placed in an existing building. Fig. 22 gives a plan and elevation of the sub-station at Radcliffe.

Rotaries. — Each sub-station is equipped with three rotary converters, manufactured by Dick, Kerr & Co., Preston, of 1,000 kw., six-phase, 25-cycles, 10-poles, 300 revs. per min. Fig. 23 shows one of these machines. The overload capacity of each is 100 per cent. momentarily, and they can be run continuously at 25 per cent. overload. They are arranged with an induction motor on the end of the main shaft for starting and self-synchronising. No arrangements for starting from the direct-current side are provided.

Three transformers, also supplied by Dick, Kerr & Co., are used for each rotary converter, each 350 k.v.a., and wound for a ratio of 6,600/900. They are of the oil-cooled type and enclosed in sheet-steel welded cases fitted with external tubes for radiating the heat and circulating the oil. The tubes are welded into position, and this gives a perfectly oil-tight case. The terminals for both primary and secondary leads are brought up through porcelain insulators at the top of the case, and connections are made on the high-tension side through short leads and trifurcating boxes to the three-core cables from the high-tension switchgear. The low-tension leads are taken to the starting pillar and thence to the rotary. The diagram of connections is shown in Fig. 24.

Battery.—An "Entz" booster of the automatic reversible type with carbon regulator, made by Mather & Platt, Ltd., for the Chloride Electrical Storage Co., is installed in the rotary room. This consists of three continuous-current machines, booster, motor and exciter, coupled together and mounted on one bedplate, giving an output of 900 amperes, 185 volts continuously, and will give 2,000 amperes at 190 volts for 15 seconds. Its output for charging the battery is 300 amperes at 300 volts continuously, and the voltage can be raised to 400 for over-charging. These latter ratings are obtained by hand regulation. The motor is capable of driving the booster at all loads when running off a 1,200-volt circuit at the speed of 520 revs. per min. The speed can be raised to 650 by means of a shunt regulator in order to obtain the overcharge voltage. The set is provided with a device suitable for breaking the circuit of the motor when the speed of the set exceeds a definite amount.

All the cables from the switchboard to the rotaries, transformers, boosters, &c., are carried in concrete ducts in the flooring of the sub-station. These ducts are covered in by steel non-slip plates.

The battery, which is housed in a separate building outside the rotary building, consists of 580 "Plantide" cells, manufactured by the Chloride Electrical Storage Co. The capacity is 500 ampere-hours on the one-hour rating, and the charging current can be raised up to 1,500 amperes for 15 seconds.

Each cell is contained in a pitch pine-box lined with sheet lead, and this box is of such a size that the capacity of the battery can be increased ultimately to 800 ampere-hours by the addition of more plates. The positive plates are of the "formed" type and the negative plates are of the "box" type.

Each battery is divided into two portions, which are connected through an isolating switch. The high voltage portion (600/1,200) is partitioned off by wooden railings with gates, which are kept locked so that access can only be obtained by authorised persons. The cells of this portion are protected by wooden rails mounted on insulators; wooden gangways, which are also mounted on insulators, are placed between the cells. This arrangement has been carried out to prevent accidental shock at over 600 volts. When it is required to carry out work on this portion of the battery the isolating switches are used, which reduces it to the same condition as the low-voltage half.

A combined charging and milking booster, manufactured by Mather & Platt for the Chloride Electrical Storage Co., for the battery is also installed in the rotary room, and consists of two continuous-current machines—one motor and one generator—coupled together. This set is capable of charging the cells, 50 in number, which are connected to the "Entz" booster, in two hours a day, charging 25 cells at a time and giving 45 amperes at 40–70 volts. The motor is suitable for working on a 1,200-volt circuit, and the booster is arranged for exciting from the cells to which the "Entz" regulator is connected. The set is also capable of milking the cells with an output of 200 amperes at 2 to 14 volts.

Switchgear.—The switchgear (seen in Figs. 25 and 26) has been supplied by the British Thomson-Houston Co., Rugby, and is in two parts, one of the "cubicle" type controlling the high-tension feeder and transformer leads, and the other of the "flat-board" type controlling the direct-current rotaries, battery, booster and live rail. Both boards are placed on the ground floor of the station.

The high-tension apparatus is contained in six cubicles, Nos. 1 and 2 controlling the duplicate feeders, No. 3 being the 'bus-bar potential feeder, and Nos. 4, 5 and 6 controlling the transformers for the three rotary converters.

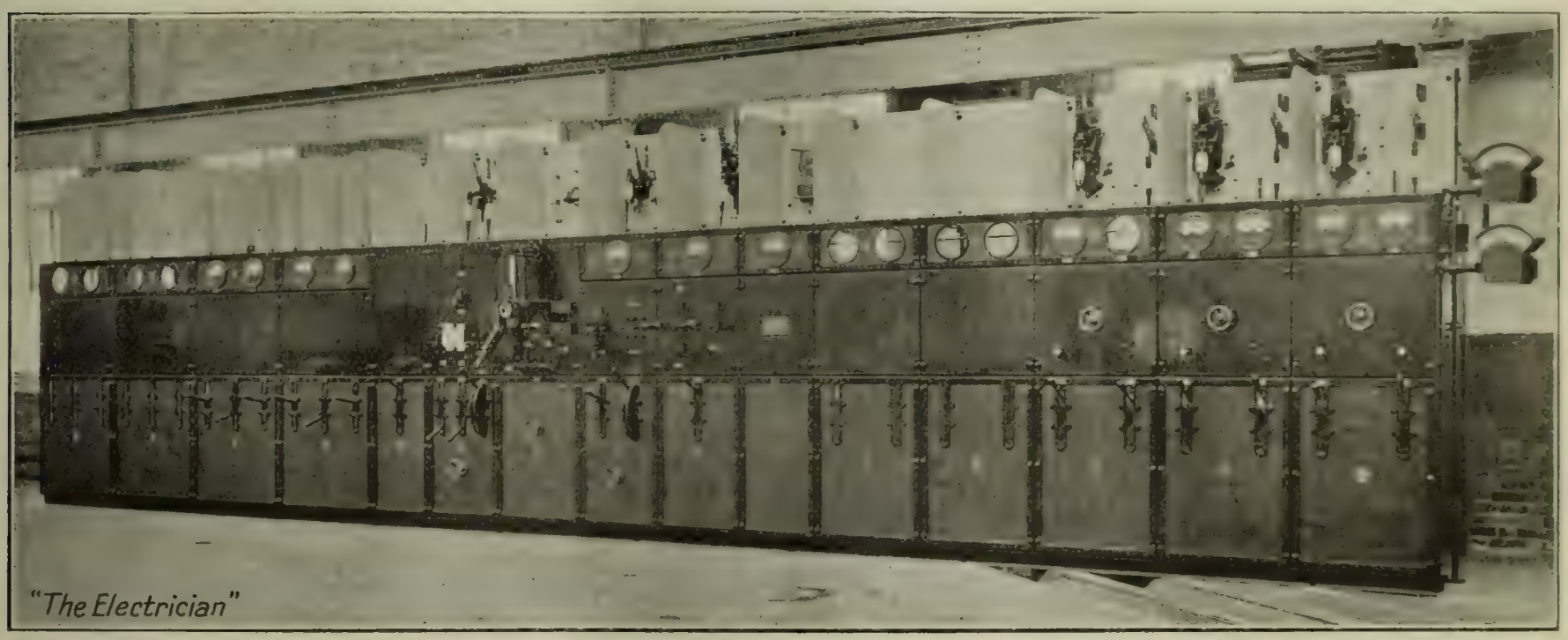


FIG. 26.—THE CONTINUOUS-CURRENT SWITCHBOARD.

The feeder and high-tension cubicles each contain a hand-operated oil-switch, the connections to the 'bus bars being made through switch clips at the back. The arrangement is such that the whole of the apparatus can be withdrawn from the cubicle for inspection purposes, interlocking devices being used to prevent the apparatus being withdrawn or replaced when the oil switch is closed.

The direct-current board, being for 1,200 volts, is arranged so that there is no live contact on the front of the board, the main switches and circuit breakers, and all 1,200-volt apparatus being placed above the board in cubicles divided from each other by partitions, as seen in Fig. 26. This board consists of 15 panels, 41 ft. long by 15 ft. high. All the switchgear is mechanically operated by insulated levers on the lower panels.

The rotary panels each include a circuit breaker, a single-pole quick-break switch, a field ammeter, a main ammeter and rheostat. The total output panel includes an intergating wattmeter and a main ammeter. The feeder panels are two in number; one controls the live rails on one side of the station and the other the live rails on the other side of the station. The up and down live rails in each case are independently controlled by a knife switch, but one circuit-breaker governs both up and down live rails in one direction. The battery booster panels contain the necessary switchgear for operating the booster and the main battery, also the milking booster.

(*To be continued.*)

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"THE TOWER WAS CALLED BABEL."

In Genesis it is written that an attempt was made to build a tower whose top should reach unto heaven, and the language of those who attempted to build was confounded, so that they did not understand one another's speech. The tower was called Babel.

The lesson conveyed by this record of man's beginning must have been uppermost in the thoughts of many men during the past year, for hardly a week has passed without some scheme being propounded for capturing the trade of the enemy and for placing our industries on a firm foundation. Parenthetically we would remark that up to the present no scheme has been proposed which has as its object the getting back of some of the trade which has been captured from us by our friends. We are not alone in the opinion that the latter will have to be accomplished if we are to continue to be a great industrial nation. Thinking men can discern a shadow over the future at least as deep as that which clouds the country at the present time. It must not be forgotten that manufacturers in the United States are busily engaged in organising industry, and that they have the advantage of fair weather conditions. In other words, they have got a long handicap.

In a Paper read last week before the Institute of Industry, Mr. J. TAYLOR PEDDIE dealt with the influence on industry of education, production, research, transportation and banking. We were pleased to note that the importance of education and research was strongly emphasised by various speakers. But we must confess that to us the objects of the Institute, as set out in the memorandum of association, are far too ambitious, and we warn the founders that no single institution can hope to deal effectively with such matters as education, production and research. Otherwise, Parliament would be an excellent institution for the work. Such matters, to be handled properly, must be dealt with by each and every trade. At the same time, we believe that the Institute could be made to act as the mouthpiece of existing

organisations and could successfully deal with the questions of transportation, banking and kindred subjects. Since there is already a Board of Trade we do not understand why a Ministry of Industry should be created. If words have any meaning, surely Board of Trade, Bureau of Commerce and Ministry of Industry are synonymous. Although many successful business men know that they have succeeded in the past in spite of the Board of Trade, we should be sorry to see a new department started whilst there is a likelihood of reform in the established department. Strenuously as we oppose the Board of Education, on account of inefficiency, we should be the last to suggest the formation of a Ministry of Knowledge.

Not for a moment do we doubt the sincerity of purpose of those who have formulated these schemes, but we are very much afraid that each is a law unto itself, and that the promoters do not as yet understand one another's speech. The several schemes affecting the engineering industry, and the electrical engineering industry in particular, have already been described in our columns. A careful examination and comparison of these leads us to believe that a round table conference would enable a fusion to be effected, the more so since in each the endeavour is being made to reach a common goal. In the engineering trades and, in fact, in all trades, the bulk of the machinery already exists for executing the necessary reforms. We use the word reform advisedly, for prosperity such as we enjoyed prior to the outbreak of war most certainly needs no revolution to secure its continuance on the declaration of peace. Such reforms should be applied gradually lest the whole structure of industry be wrecked in virtue of its inertia, and it is well to remember that, as a rule, the older, bigger and more stable an industry or institution the larger is the inertia. The product of mass and acceleration applies to reform as well as to engineering design, and we urge caution to those on whose shoulders rests the burden of carrying out reform of any kind. It is more than conceivable, it is a patent fact, that lack of caution now in the reform of industry instead of developing might annihilate it by rending asunder elements that are not yet perfectly combined.

In engineering, the machinery for executing reform exists because every side of every branch is already organised. Much of the trouble is traceable to the folly of organising the several branches in watertight compartments, each provided with collision bulkheads, the operation of which, although giving certain trifling advantages to the few, effectively prevents the many coming together. These bulkheads have been put into operation far too frequently in the past. We venture to think that with relatively little effort, in comparison with the effort of organising in the beginning, and with small expenditure of capital, the whole of the engineering trades could be not only highly, but homogeneously, organised.

Builders of bridges; men who dam the Nile and harness Niagara; who link Continents together; who burrow deep into the earth; who make our planet fit for habitation; who equip armies and navies for the Armageddon, and who fight and conquer the forces of Nature are called engineers. Such men require no Acts of Parliament to enable them to be industrious.

In the specifications for the proposed re-modelling of the structure of engineering industry it shall be written that the foundations shall be examined and strengthened where necessary to secure stability; as a precaution during re-construction, the old bulkheads, compartments and buttresses shall be retained till the structure is complete. All members shall be amply proportioned to carry the loads imposed upon them, and all joints shall be securely riveted so as to develop the full strength of the members. Secondary members shall be introduced to relieve the main members of undue stress. The design shall be such that every part of the structure is accessible for purposes of inspection, cleaning and repair. Provision shall be made for the renewal of any member without endangering the structure. Materials and workmanship shall be the best of their respective kinds, and the structure shall carry with it a guarantee. The completed structure shall be tested under all conditions of loading, and under the worst conditions no member shall show any signs of weakness or distress. The whole of the material, labour and tackle required for the manufacture and erection of the structure shall be supplied by the engineer. He alone knows the meaning and importance of these things, and his experience teaches him to recognise the worth of a specification. He can *do* these things.

EDDY CURRENT LOSS IN DYNAMO TEETH.

BY F. W. CARTER.

The abstract of Mr. Press' Paper given in your issue of August 27th reminds me that I have for some years employed a simple rule in the calculation of eddy current loss in dynamo teeth, which is readily justified, although it does not appear to have been published. The rule is, that the eddy current loss calculated in the ordinary manner—that is, on the assumption that the magnetisation varies with the time according to a sine law—should be multiplied by the ratio of the pole pitch to the interpolar space, or divided by one minus the ratio of pole arc to pole pitch; since the multiplier is of the order of three or four its effect is to reduce appreciably the gap separating accountable from actual iron losses.

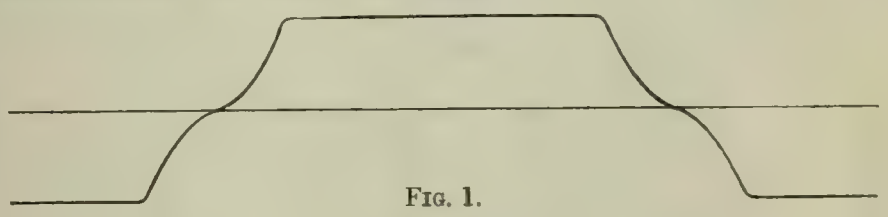


FIG. 1.

If h is the thickness of the core plates and ρ their specific resistance, B the maximum flux density, and f the frequency of reversal, the eddy current loss per unit volume is, to a close approximation :—

$$W=\frac{\pi^2}{6}\frac{f^2h^2B^2}{\rho}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Here all quantities are supposedly expressed in absolute units, and this equation, transformed to more convenient units, yields the usual eddy current formulæ. Equation (1) is based on the assumption that the flux density is a sine function of the time—that is, that there is only one frequency in question—whereas in a continuous-current machine at no-load the flux density in the teeth varies somewhat as shown in Fig. 1; as is well known such a law of variation can be expressed by means of a series of terms of progressively increasing frequency, so that if B is the maximum flux density as before, and b the flux density at any instant, the general form of b is :—

$$b=B\Sigma_1^{\infty} An \sin(2\pi nft+\alpha_n). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

It can readily be shown that the eddy current loss due to the variation of b is the sum of the losses due to the several components, so that in accordance with equation (1) its true value is :

$$W'=\frac{\pi^2}{6}\frac{f^2h^2B^2}{\rho}\Sigma_1^{\infty} n^2A_n^2.. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Actually, at high frequency the formula of equation (1) requires modification, but the effect of this is inappreciable until a frequency of the order of thousands is reached, and it is not necessary to consider it in the present connection.

Accordingly, if the loss W is computed from the usual formula, the true loss is given by :—

$$W' = KW, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where :— $$K = \Sigma_1^{\infty} n^2 A_n^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, if the curve of flux variation, having maximum unity, has as its equation :—

$$y = \Sigma_1^{\infty} A_n \sin (nx + \alpha_n).$$

the value of K is given by :—

$$K = \frac{1}{\pi} \int_0^{2\pi} \left(\frac{dy}{dx} \right)^2 dx. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Thus, if, as in Fig. 2, the transition from the zero to the maximum value follows the curve :—

$$y = \tfrac{1}{2}(1 - \cos 2qx),$$

where q is the ratio of the pole pitch to the interpolar space :

$$K = \frac{1}{\pi} q^2 \int_0^{\frac{\pi}{2q}} \sin^2 2qx \, dx,$$

$$= q. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Again, if the variation follows the curve of Fig. 3, the value of K is

$$K = \frac{4}{\pi} \left(\frac{0{\cdot}25^2}{\frac{\pi}{4q}} + \frac{0{\cdot}75^2}{\frac{\pi}{4q}} \right),$$

$$= \frac{10}{\pi^2} q. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Actual curves of variation of flux at no load are sufficiently near to the examples of Figs. 2 and 3 to render the rule given at the commencement of this note a convenient approximation for the ordinary use of the designer, whilst anomalous cases can be readily treated by the aid of equation 6. The additional loss due to loading the machine may be computed by similar methods.

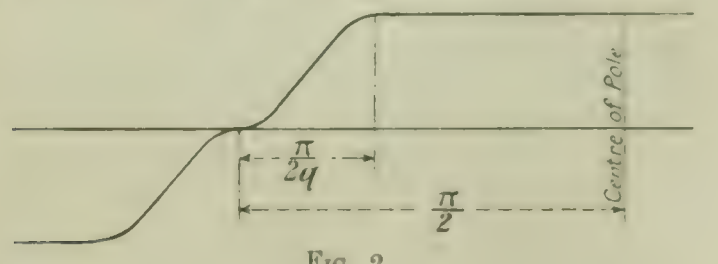


Fig. 2.

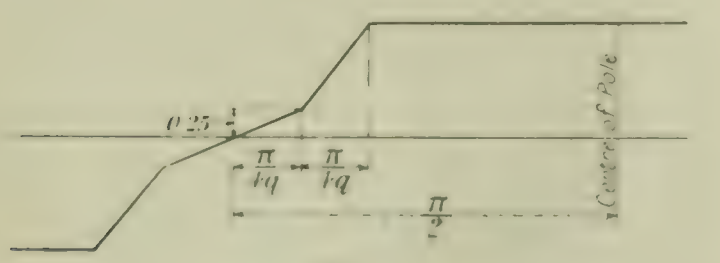


Fig. 3.

THE PREDETERMINATION OF THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.*

BY PROF. MILES WALKER.

(*Concluded from p.* 452.)

Summary.—The Paper opens with a discussion on general methods of calculating dynamo-electric machines and gives an outline of a method which is applicable to all types of such machines, whether alternating current or continuous-current generators, motors, or rotary converters.†

Appendix II.—The Calculation of the Value of K_e.

Referring to Fig. 2 the author takes the flux density opposite any of the eight circles marked on the diagram and calculates the voltage for each of them for a three-phase star connected armature. Adding the eight voltages a figure is obtained proportional to the instantaneous voltage; next shifting the field magnet through the space of one conductor will give another set of voltages. By adding and subtracting these a series of figures is obtained, and when plotted give the wave-form. The value of K_e is the ratio of R.M.S. voltage actually generated in the eight conductors with the field-form shown in Fig. 2 to the value of the voltage one would get in a machine having a flux density equal to the maximum calculated with 12 conductors in series.

Appendix III.—Calculation of the Magnetising Current.

Where a magnetic circuit is excited from a three-phase winding, the method of calculating the ampere-turns on the circuit has been fully dealt with by Dr. Kloss* and by Dr. S. P. Smith and W. H. Barling.† The author finds it is convenient to express the results in somewhat different terms from those used by these authors. If I_m is the virtual value of the magnetising current, Z_a the total number of conductors on the three-phase armature, and p the number of pairs of poles, then the effective value of the ampere-turns per pole is $0{\cdot}43\ I_m Z_a/2p$. Where the number of slots per pole is not great, the coefficient in this expression is somewhat increased. In the case where there are only six slots per pole the coefficient becomes 0·437.

Ampere-turns on the Air-gap.—The usual formula is :—

$$\text{Ampere-turns on the gap} = B \times l_g \times K_g \times 10/4\pi,$$

where l_g is the length of the gap in centimetres, and K_g is the air-gap coefficient,‡ the introduction of which may be necessary on account of the presence of open slots in the rotor or stator.

Ampere-turns on the Teeth.—No difficulty arises in calculating the ampere-turns expended on iron teeth where the sides of the teeth are approximately parallel. In this case one usually takes the density in the iron at a point one-third of the tooth-length distance from the narrowest part of the tooth. One-third is chosen instead of one-half, because the bending over of the magnetisation curve leads to the main part of the ampere-turns being expended on the narrow part of the tooth.

A convenient method of calculating the apparent flux density in the teeth is to divide the total magnetic loading $A_g B$ by the total section of all the teeth. If we are dealing with teeth on a revolving armature, the process of finding the cross-section at a distance two-thirds of the tooth length from the perimeter is as follows :—

From the diameter subtract four-thirds of a tooth length, and multiply by π; this gives what may be called the mean circle. Subtract from this the product of the width of the slots × the number of slots, and obtain the sum of the widths of all the teeth. This multiplied by the net length of iron gives the total section. Where we are dealing with the stator, it is usual to take the section of the teeth at one-third of a tooth length from the stator surface. In this case we add two-thirds of a tooth length to the diameter and get the diameter of the mean circle. It is convenient to have curves giving the relation between the apparent flux density and the actual flux density for different values of K_s; K_s is the ratio of the section of the iron plus the section of the air to the section of the iron. Curves of this kind are easily plotted for any material, the magnetic properties of which are known.

Appendix IV.—Armature Reaction.

The amount of the armature ampere-turns can be calculated in the manner given by Dr. S. P. Smith and W. H. Barling in their Paper referred to above. The author prefers the result in the form:

$$\text{Total ampere-turns on the armature} = 0{\cdot}43 I_a Z_a,$$

where I_a is the virtual value of the armature current, and Z_a is the total number of conductors in a three-phase armature.

Armature Inductance.—Two machines built to the same drawings will sometimes show, on test, a difference as great as 7 per cent. in their short-circuit currents. It would seem that some intermediate method which, while being short, yet takes into account all the most important quantities that control the result, is of most service in practice. The following method of calculating the leakage flux is employed by the author.

The leakage flux may be divided into four parts :—

1. The leakage across the stator slots.
2. The leakage across the rotor slots.
3. The zig-zag leakage.
4. The leakage around the ends of the coils both on rotor and on stator where they project from the iron.

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* Abstract of a Paper read before the Institution of Electrical Engineers on 13th inst.

† H. D. Symons and M. Walker: "The Heat Paths in Electrical Machinery," "Journal" I.E.E., Vol. XLVIII., p. 674, 1912.

* "Elektrotechnik und Maschinenbau," Vol. XXVIII., p. 53, 1910.

† The Electrician, Vol. LXXIV., p. 42, 1914.

‡ See Papers by F. W. Carter, "Journal" I.E.E., Vol. XXIX., p. 205, 1900, and Vol. XXXIV., p. 47, 1905; also "Electrical World and Engineer," Vol. XXXVIII., p. 884, 1901. C. C. Hawkins and R. Wightman, "Journal" I.E.E., Vol. XXIX., p. 436, 1900. H. S. Hele-Shaw, A. Hay, and P. H. Powell, *Ibid.*, Vol. XXXIV., p. 21, 1905.

In addition to these there is a certain amount of leakage which interlinks with both stator and rotor windings where the magnetomotive force of one does not balance that of the other.

Slot Leakage.—The calculation of the amount of effective leakage across the slots is most easily carried out by means of the formula

$$\lambda_d = \frac{1}{3} \cdot \frac{h_c}{b},$$

where h_c is the depth of the slot after a deduction has been made for the thickness of the insulation between the copper and the bottom of the slot, and b is the breadth of the slot. By λ_d we denote the lines across the slot per centimetre of axial length of slot for unit magnetomotive force. To this must be added the leakage across the mouth of the slot.

Whether the slot is open or semi-closed, the permenance across the mouth of the slot can be found from Fig. 3. This figure is so constructed that a designer can tell at once from inspection the effect of changes in the shape of the lips upon the permeance. The shape of the lip is indicated by shading, as shown in the figure, and the shading may extend either to the line OA as shown, or to the line DC, or to the line 0·2B. The position of the small face p may be varied, so that the fraction (mouth of slot)/(width of slot) has any value between zero and 1. In Fig. 3 the lip is supposed to be of the shape indicated by the shading, the value of (mouth of slot)/(width of slot) being 0·375. If we carry up the perpendicular from p to the curve A′, we find that the permeance in C.G.S. lines per centimetre length of iron is 0·98. Had the lip been of a deeper design, so as to extend up to the dotted line DC, we should have carried our perpendicular up to the dotted curve C′, and the permeance would then be found to be 1·2. If the lip is of a special shape, or has the angle of one of its

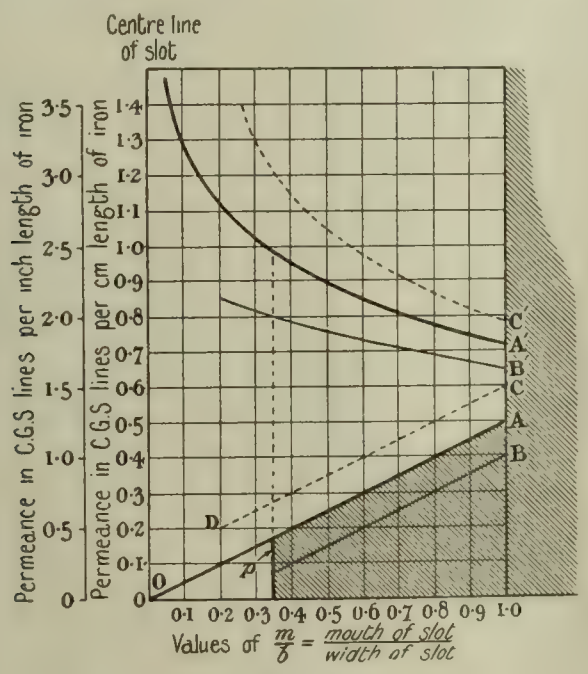


FIG. 3.

faces different from that shown in the figure, it is easy to sketch on our figure a lip having the same permeance and having face angles enabling Fig. 3 to be instantly applied.

Take the rotor slot belonging to the 600 H.P. motor. Here the value of h_c=3·0 cm., and b=0·96.

$$d = \frac{1}{3} \cdot \frac{3}{0{\cdot}96} = 1{\cdot}05.$$

The ratio m/b=0·3/0·96=0·31. Therefore, λ_m=1·2, and $\lambda_d + \lambda_m$=2·25. Now there are 120 slots in the stator and 150 in the rotor, so that the total permeance of stator and rotor slots is

$$1{\cdot}93 + \frac{120}{150} \times 2{\cdot}25 = 3{\cdot}73.$$

Zig-Zag Leakage.—For roughly estimating the zig-zag leakage, a simple rule is given here, which works well enough in practice; though by reason of the fact that it does not take into account all the factors which affect the result, it cannot be regarded as strictly accurate. As we said before, if a method is not short, it is of no use in practical design. The rule here given sacrifices all the minor refinements in order that it can be applied in 30 seconds.

The reluctance of the path of the zig-zag leakage is in the main proportional to the length of the air-gap.

If we assume that the dimensions of the teeth and the mouths of the slots are such as one generally finds in practice, it is possible, roughly, to take into account the changing width of the leakage path by means of a coefficient, K_z, and we may write

$$\lambda_z = K_z \times \frac{\text{pitch of slot}}{2} \times \frac{1}{\text{length of gap} \times K_g},$$

where λ_z denotes the lines of zig-zag leakage per centimetre axial length of slot, for unit magnetomotive force applied across the mouth of a stator slot. The values of K_z which may ordinarily be employed in practice are given in Fig. 4 as a function of the ratio (No. of stator slots) : (No. of rotor slots).

The slots in the 600 H.P. motor are 120 slots in the stator (six conductors per slot) and 150 slots in the rotor. To find the permeance due to zig-zag leakage per centimetre length of slot we have 120/150 = 0·8; and, from Fig. 4, K_z = 0·34.

$$\lambda_z = 0{\cdot}34 \times \frac{2{\cdot}6}{2 \times 0{\cdot}2 \times 1{\cdot}2} = 1{\cdot}87.$$

Leakage around the End-windings.—The only really accurate way of finding the value of the end leakage of an induction motor is by experiment on the winding in question. If we have two motors built on the same frame with the same type of winding, but one machine much longer than the other, we can, by measuring the short-circuit current on each machine, calculate with some accuracy what part of the leakage reactance in each machine is due to the end-windings.

The whole matter is so complicated by accidental circumstances that it is useless to attempt any accurate calculation. In order to arrive at some rough idea to serve as a basis of calculation, we may divide the types of end windings into four separate classes, as shown in Table II.

Table II.—*Values of K_L for End Leakage of Three-phase Motors with Normal Full-pitch Windings.*

Type of rotor winding.	Type of stator winding.		
	Barrel.	Mesh.	Concentric.
Squirrel-cage	1·8	2·6	2·8
Barrel	1·4	2·4	2·45
Mesh	2·2	3·1	3·2
Concentric	2·45	3·2	3·5

Example.—In the 600 H.P. motor the pitch of the poles, l_p, is 31 cm. and the average overhang, a_v, of the coils is 12·5 cm. There are four

FIG. 4.—VALUES OF K_z FOR ESTIMATING ZIG-ZAG LEAKAGE.

slots per phase per pole, and three conductors per slot, so that for 1 ampere per phase we have the virtual ampere-turns per pole = 4×3×1=12.

The type of winding is "concentric" on the stator and "barrel" on the rotor; and from Table II. we get K_L=2·45. Therefore, the end leakage per pole is

$$\Phi_e = 2{\cdot}45 \times 43{\cdot}5 \times 24 = 2{,}560 \text{ C.G.S. lines.}$$

If the stator and rotor windings had no resistance and the short-circuit current were only limited by the reactance caused by the leakage flux, the value of the short-circuit current would be that value which would be great enough to produce a leakage flux equal to the working flux. If we denote the total leakage per pole produced by 1 ampere by the symbol $\Phi_l = \Phi_i + \Phi_e$, and if we denote the working flux per pole by Φ_w, then the value of the short-circuit current assuming no resistance would be Φ_w/Φ_e.

In the motor in question we have

$$\frac{5{\cdot}5 \times 10^6}{8{,}020} = 680 \text{ amperes per phase.}$$

The volts per phase are 1,430, and the reactance per phase is, therefore

$$\frac{1{,}430}{680} = 2{\cdot}1 \text{ ohms.}$$

APPENDIX V.—LOSSES IN COPPER AND IRON.

The methods of calculating the copper losses in electrical machines are fairly well standardised, and it is unnecessary to consider them here. Attention should be drawn to the necessity of calculating the

eddy-current losses in solid conductors, and for this purpose the curves given by A. B. Field in his Paper before the American Institute of Electrical Engineers* are of very great service in shortening the work.

In most electrical machinery the field is partly rotating and partly alternating, and we may certainly take it that the hysteresis loss does not increase at all at high flux densities such as are used in the teeth of continuous-current generators. It thus comes about that for low frequencies the curves giving combined loss take a shape somewhat like the curve shown in Fig. 5, a curious inflection occurring at B=about 20,000. These curves are plotted for ordinary dynamo steel of a thickness of 0·04 cm. and subjected to as careful treatment as is consistent with ordinary shop processes.

Iron-loss tests taken on completed machines will generally show greater losses than are given by these curves, particularly at high flux densities. It would appear that when the teeth of a machine become saturated, the flux from the poles bulges out sideways and attacks the armature from the ends, making eddy currents in the end-plates, so that the loss sometimes increases in ratio greater than the square of the flux density. This end-plate loss should really be allowed for separately, as its amount will depend upon factors different from those taken into account in calculating the true iron loss. A good deal of experimental work still remains to be done

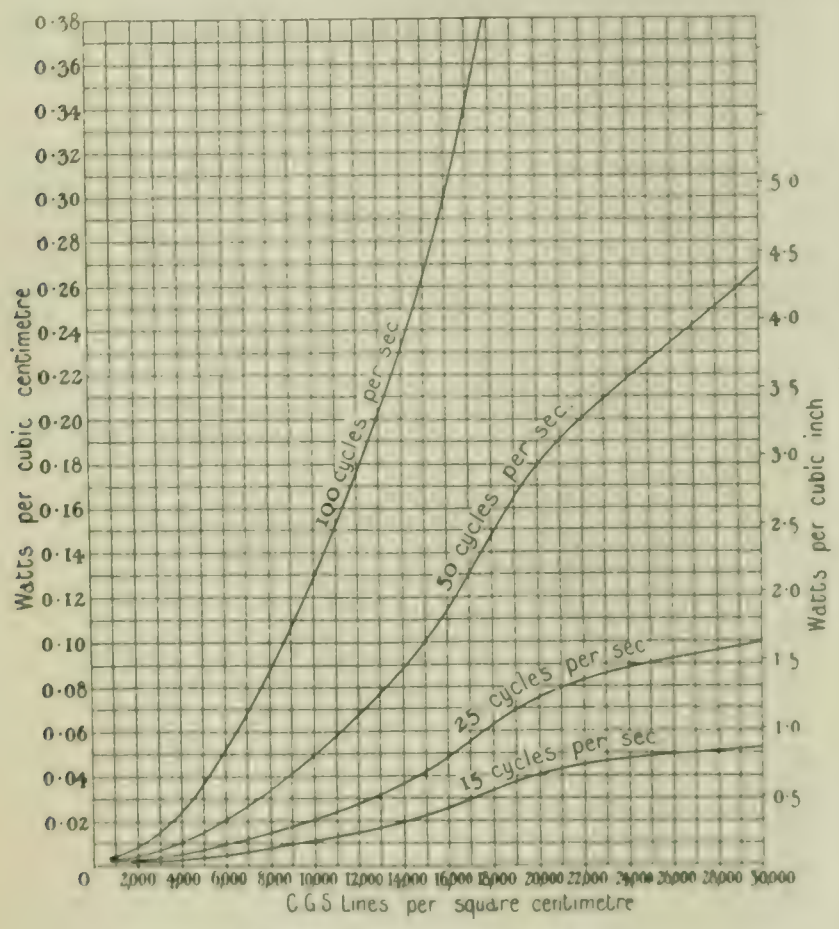


Fig. 5.—Iron-loss Curves.

before we can formulate a method of calculating these end-plate losses.

Where special silicon steel† is employed, the losses may be reduced by 40 per cent. when working at a flux density of 10,000 per square centimetre at a frequency of 50 cycles, the thickness of the iron being 0·05 cm.

Appendix VI.—Predetermination of Temperature Rise.

The temperature rise of the stator iron of an alternating-current generator or motor may be roughly predetermined in the following manner: There is (1) the cylindrical working face or internal bore of the stator, over which the air is in rapid motion; (2) the surface of the ventilating duct, through which the air moves at a much lower velocity; and (3) the external surface, part of which is presented to the cast-iron frame and part exposed to the slowly moving external air.

1. *The Heat Dissipated from the Cylindrical Surface.*—This depends very greatly upon the peripheral speed of the machine. Experience shows that we may adopt the rule:—

$$\text{Watts per square centimetre} = \frac{\text{temp rise C.} \times (1 + 0{\cdot}1v)}{333}$$

where v is the peripheral velocity in metres per second of the moving armature or field.

2. *The Heat Dissipated from the Ventilating Ducts.*—Two different kinds of ducts are commonly found in electrical machines. There is (*a*) the radial duct made by putting a ventilating plate or spacing plate between the stampings allowing the air to pass in a radial direction from the air-gap to the external frame; and (*b*) the axial ventilating duct, consisting of a round or oblong hole in the stampings enabling the air to travel in a direction parallel to the axis of the machine.

Experiments with both types of duct indicate that the specific cooling constant, h_v, is dependent not only upon the mean velocity through the duct, but also depends upon the character of the motion of the air. Where the air moves in even stream-lines from one end of the duct to the other, the cooling conditions are very much poorer than where the air is broken up into eddies.

The curves given in Fig. 6 show the results arrived at by various inquirers who have sought to determine the relation between h_v and the mean velocity of air passing along a ventilating duct. In most cases no distinction is drawn between narrow ducts and wide ducts, though there is no doubt that the width of the duct is quite an important factor.

If we denote the flow of heat from the walls of the ventilating duct, expressed in watts per square centimetre per degree C. difference of temperature between wall and air, by the symbol h_v, then we find that over a wide range of speed $h_v = K_v v$, where v is the mean velocity of the air in the duct measured in metres per second, and K_v is a constant depending on the character of the duct. K_v is very much affected by the amount of baffling of the air in the duct. A circular duct 2 in. in diameter gave a value of K_v as low as 0·00033 when the air passed through with long steady stream lines, but the addition of baffles brought the value up to 0·0011.

Cooling of the External Surface of Stators.—The cooling of the iron

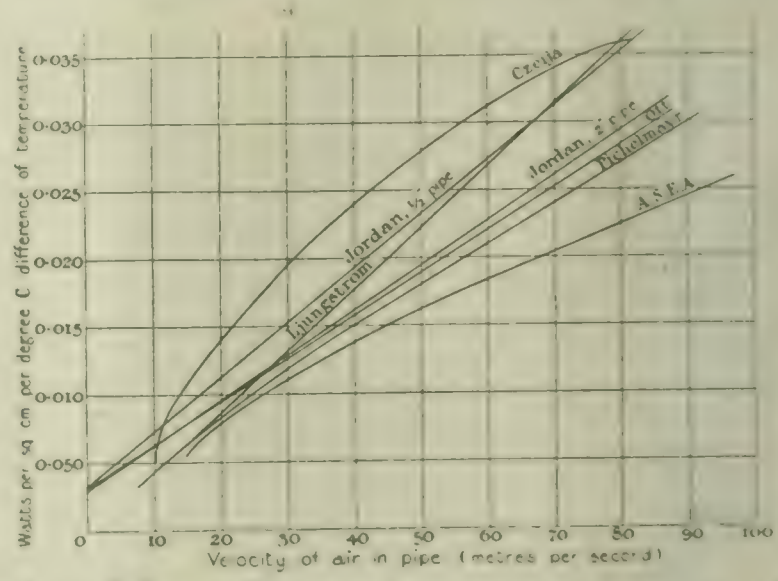


Fig. 6.—Relation between Heat Dissipated and Velocity of Air.

of the stator is considerably helped by the conduction of the heat into the cast-iron frame, from which it is passed by radiation and convection to the surrounding air.

It is generally impossible to make an accurate calculation of the amount of this conduction, and yet one must make some allowance in the case of machines with shallow iron. Perhaps the simplest rule in machines of normal construction is to allow a certain number of watts per square centimetre of external surface.

DISCUSSION.

Prof. Silvanus P. Thompson, in opening the discussion, said one almost felt inclined to think Prof. Walker had gone too minutely into the problem. Formulæ which went down to the third place in decimals were provided; this meant an accuracy of one part in a thousand in the methods of calculation. Yet steel makers would not guarantee iron to within 1, 2 or possibly 3 per cent. of what it was supposed to be, and there was difficulty in getting exactly the same kind of iron over and over again, and consequently very accurate formulæ were invalidated. In spite of these difficulties, however, it was, perhaps, well to have the details of the theory well in hand. He appreciated the paragraph wherein the author stated that "Any general method of design should, in its nuclear form, be exceedingly short and capable of reaching rough results in the course of a few minutes. . . . Moreover a general system of calculation should be founded upon sound principles, and not merely built upon empirical rules." The whole of that paragraph could not be better. It was some sense of this which a dozen years or more ago made him anxious to put certain useful, true and generally known empirical rules upon a more

* A. B. Field: "Eddy Currents in Large Slot wound Conductors." "Transactions" of the American Institute of Electrical Engineers, Vol XXIV., p. 761, 1905.

† S. Guggenheim: "The Magnetic Properties of Iron Alloys and their Uses in Alternate-current Design," The Electrician, Vol. LXIV., p 539, 1909.

scientific basis. In particular, he would refer to the rule stated almost 30 years ago, and brought before the Institution, by Mr. W. B. Esson—a fundamental rule—that the output of a machine at a given speed was proportional to the square of the diameter into the length of the core—the d^2l rule. Esson experimented upon different machines of different sizes, speeds and outputs, and found there was a proportion. After dealing with the basis of some of the author's coefficients Prof. Thompson proceeded to consider the meaning of pole span. With machines with split poles, poles with teeth in them and different numbers of windings round the different parts, what were the pole pitch and the pole span? In evaluating his constant K_e the author took a hypothetical uniform (homopolar) flux over the whole base of the wave form curve. He (the speaker) preferred to take as an equivalent rectangle one having its height the full height of the wave form curve, and a base correspondingly reduced. This base might then be looked upon as the equivalent pole span. Prof. Thompson then proceeded to show how the connecting of armature conductors in series tended to the production of a true sine wave, whatever the form of the flux curve. That result was due to the fact that although the elimination of the fundamental could only be accomplished by running in series conductors which were placed 180 electrical degrees apart, the wiping out of harmonics was accomplished by a correspondingly smaller spacing. Thus with a number of spaced conductors in series only the fundamental tended to survive. Referring to the design sheets given in the Paper, he was doubtful whether it was wise to attempt to use the same design schedule for machines of all kinds. It seemed to him one lost as much as one gained. It was true the printers only had to set up one form, but the designer was apt to be cramped in designing induction motors, alternating-current and direct-current motors with the same data and the same pictures. It would be better, he thought, to lay out a schedule for one kind of machine, and not to put all one's eggs into one box.

Mr. A. R. Everest thought uniformity of calculation methods seemed desirable, but he was afraid it was impossible until those who wrote textbooks and Papers would adopt uniform methods and uniform nomenclature. One found articles by Steinmetz with his method, by Boucherot, by Thompson and Walker, and other valuable Papers from Continental sources with other methods, and one had to translate them into the language and symbols understood by the particular reader. But the standardisation of symbols was not so difficult. Prof. Thompson used Z for turns, whereas it used to be T for turns and C for conductors. Prof. Walker also used Z. With regard to the suggested use of a single calculation sheet for a number of different machines, he agreed with Prof. Thompson that it was really not advisable. If a universal design sheet were used one would only be using a portion of the sheet in any one case, and it would be unduly crowded. The cross-section of the machine ought to appear prominently, and the factors that went to make up the cross-section. In some cases illustrated by Prof. Walker there was one coefficient which contained really several co-efficients. He thought it better to keep the various quantities separate throughout. He also preferred using the total pole flux to the maximum air gap density as the basis of design, and for the density figure he preferred the mean density across the total pole pitch which was obtained by dividing the pole flux by the pole pitch. That gave the value for the magnetic loading, which was the really important figure.

Mr. H. Burge said designers were still occasionally worried by specifications stating the limit of the current density in the armature and the current density to be adopted in the field winding. The current density did not seem to be mentioned in this Paper. The temperature rise, however, had really nothing to do with current density. It depended on the ventilation and how the conductors were massed. There was a good deal to be said for the boiling down of the E.M.F. formula to one general form for all kinds of machines, but he thought the arguments in favour of it by the author were somewhat doubtful. As far as direct-current machines were concerned every frame had a fixed number of poles, and consequently every frame always had the same flux per pole. Flux per pole in that case was as easy to memorise as the total magnetic loading. In working out the tooth density the author referred to the difficulty of estimating the number of slots lying under a pole. That was due to the bevelling of the pole tips. The coefficient K_f also depended on the bevelling of the tips, so he did not think that argument applied. He thought the total number of slots chosen did not play a sufficiently prominent part in the author's formulæ. A machine with very few slots would really show a much poorer performance than the author's formulæ suggested.

Mr. C. C. Hawkins said he thought almost all classes of electrical machinery could be designed on similar lines, and that it would be an advantage to employ a common sheet or, at least, one based on a common system. He was not convinced, however, that the comparison of the quantities on the design sheets of radically different types was of much economic value. Each type had its own losses, and must be designed in accordance with them. The first part of the Paper was a plea for the retention of the B_g equation, which was based on the total flux, and he thought the author had advanced strong reasons for its retention, but he lost sight of the maximum flux density by so doing. Those in the factory using the particular frames might keep it in their minds, but he thought that point should be attended to. With regard to the flux in the teeth, one should not speak so readily of slot leakage. In some cases slot flux was very useful, as in the case of two of the teeth adjacent to a solid pole centre. The reluctance of a solid pole centre was negligible as compared with the reluctance of the teeth at either side of it. It was cheaper for the lines of flux to pass by the pole centre, and so avoid the highly saturated root of the tooth. In this case the slot leakage was valuable and this applied to part of the steel wedge mentioned by Prof. Walker.

Dr. S. P. Smith said he would be glad if they could find a method of designing machines to which they could agree. He was sorry the author put more in the Paper than was contained in the first two pages, because if he had not the discussion would have been devoted practically entirely to the method of design. He (the speaker) preferred to start with the fundamental equation giving the force on a conductor carrying a current in a magnetic field, and to develop the dynamo formulæ from this. He admitted that they must have the maximum value for calculating certain parts of the design, but the mean value was more fundamental generally in laying out the design. In his formula Prof. Walker dealt with total quantities, but in ordinary affairs they could only appreciate specific quantities. One wanted as constants the diameter and length and also an equation by which machines could be compared. It was the same in mechanics. If there were 20 tons on a beam the stresses could not be calculated without knowing the section of the beam, and the material of which it was composed. It was the same with currents in wires. He would design not only from a given frame, but from first principles, fixing the diameter and length from experience.

Mr. H. Rottenburg said the Paper seemed to be an attempt to save unnecessary work in comparing results. The first step towards that would be to get designers, teachers and others to adopt a standard system of units or symbols. He also suggested that when a number appeared in a Paper for the first time—say a constant—it should be printed in heavier type. Mr. Rottenburg then drew some diagrams which he said he had found useful in teaching.

Prof. Walker, after replying to one of the points that had been raised, reserved his reply for the "Journal."

DISCUSSION AT BIRMINGHAM.

Mr. R. Orsettich said that Prof. Walker's calculation sheet was the shortest he had ever seen, and in his opinion it was cut down too far and omitted some items which were desirable. For example, the formulæ used in obtaining the various calculations should be inserted, because different designers used different methods, and if the result only is stated the figure is not easy to check at a subsequent date. He also thought the design sheets should be drawn up to include results of tests. He considered that some reference should have been made in the Paper to observations of temperature rises by means of detectors, as information on this subject was of great importance in connection with the predetermination of the performance of an electrical machine.

Prof. G. Kapp said that he had suspected for a long time that a flat cooling slot was not satisfactory. He found that the conduction across a group of laminations was about 100 times less than along the laminations, hence the cooling along a radial slot was not much good. A tube cutting across the laminations was more satisfactory.

Mr. W. Marden said that probably the more correct criterion for deciding if the thermal limit of the frame size had been reached would be the product of A_gB and I_aZ_a, a term proportional to the output per revolution, though this also would not be constant where a large range of speed was covered on the same frame. The ratio of the magnetic loading to the current loading would also differ when, for convenience, the same frame was used both as a synchronous generator and an asynchronous motor, due to the necessary change in magnetising characteristics. The advantage of the author's calculation sheet over the methods in which the flux per pole was dealt with was not marked, since in this case also it was usual to employ as a guide the value either of the total armature current turns per centimetre of periphery, or the figure for this value corresponding to the particular pole-pitch. It was to be noted that the author embodied also on his sheet the actual ampere-turns per centimetre as a suitable guide. Apart from this, the author's method suffered from the fact that his constant K_e was a combination of various factors, each of which could be separately influenced by changes of design. The fact that the actual value did not change largely for a given type (direct-current generator, alternator or asynchronous motor) was perhaps fortunate; but in the writer's opinion it was better to keep well in view each of the separate factors that were subject to change, although it might only be necessary to consider the design in such detail for special cases.

Mr. R. G. Jakeman said that in calculating the magnetising current of induction motors Prof. Walker advocated the use of the maximum flux-density. It was well known, however, that if the field-form constant K_f was taken the same throughout this method gave entirely wrong results if there was high saturation in the magnetic circuit. Hence it was necessary to take a different value of K_f (which was the ratio of the mean density to the maximum) according to the amount of saturation. It was his (the speaker's) experience, however, that the method published by Dr. Kloss and Dr. Smith, which considered the density one-third of the way along the pole-pitch, instead of in the middle, gave excellent results for the magnetising current, and was entirely independent of the saturation. In this connection also, in determining the flux-density in the teeth of an alternator or direct-current machine, the author had said that it was not a simple matter to estimate the virtual number of teeth per pole if the total flux was taken as a basis. When the ideal flux A_gB was used, however, the factor K_f took this question into account, and had a different value for different bevellings of the poles. It seemed to him it was quite as easy to estimate the virtual number of teeth per pole as to estimate the value of K_f, since the latter could not be worked out in each case.

CORRESPONDENCE.

EARTH RESISTANCE.

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: I have only just seen the very interesting letter by Mr. Peters, in which he proves the relation between the resistance between two electrodes in a conducting medium and the electrostatic capacity of the condenser formed by the same bodies embedded in a dielectric. Prof. Howe pointed out at Manchester that Prof. Kennelly had used this relation to determine the capacity between electrodes of irregular shape, by measuring the resistance between them when immersed in a solution of copper sulphate. Mr. Peters has, I think, somewhat missed the point of my suggestion of using what I called "the equivalent length of an earth" as a criterion of the effectiveness of an earth connection. The advantage of using this quantity is that it indicates the effectiveness of the earth plate *per unit area*—that is, it enables one to find whether the material used is being employed in the most effective way. For example, if a length of copper strip is to be used to form the earth, one could find from the "equivalent length" of various forms of earth plate which arrangement would give the lowest earth resistance. The table given by Mr. Peters may be used as an illustration. For a pipe 1 ft. long the equivalent length in his table is 5. For a pipe 10 ft. long the equivalent length is 8—that is, the resistance per unit surface of a pipe 10 ft. long is 1·6 times the resistance per unit surface of a pipe 1 ft. long. The actual earth resistance for the 10 ft. pipe will therefore be, not 0·1 of the resistance of the 1 ft. pipe, but 1·6/10 of it. One may say, therefore, that it would probably be better to have several well-spaced pipes driven 1 ft. into the ground rather than one 10 ft. pipe driven into the ground, to form the earth. Whether this is actually so or not will depend upon the "equivalent length" of a number of pipes fairly widely spaced as compared with that of a single pipe driven deeply into the ground. The equivalent length, as I defined it, is an indication as to whether the material of the earth plate is being used to the greatest advantage.—I am, &c.,

Liverpool, Jan. 12. E. W. MARCHANT.

"THE ELECTRIC LOCOMOTIVE."

TO THE EDITORS OF THE ELECTRICIAN.

SIRS: Referring to the abstract of Mr. Carter's Paper on the above subject, which appears on page 540 of the present issue of your journal, I note that the author states that "collective driving through side rods assumes several forms, but all result in considerable strains in the structure."

I think some distinction should be made here, as there is no doubt that in one well-known form of side rod drive the said strains are to a very great extent eliminated, and in fact, the conditions may be said to approximate very closely to those existing in steam locomotives.

I refer to the Kands drive as employed on the Valtellina and Simplon locomotives, which consists of an inverted triangular frame driven by two motors, the lower apex being slotted and exerting a driving effort on the crank pin of one of the driving wheels *in a horizontal direction only*.

Mr. Carter refers to a "Scotch yoke," and, although this term is not familiar to me, it occurs to me that this is possibly identical with the device described above. This belief is supported by Mr. Carter's statement that it is employed on polyphase locomotives. In passing, it should be noted that the Kands drive may be used with any system, so long as two motors are employed—or perhaps we should say two primary driving agents—as it is easy to conceive one motor doing the work by means of a pinion and two spur wheels.

It has always seemed to me that the real reason why the troubles that occur in electric locomotives equipped with jack shaft and side rods do not occur in steam locomotives is that in the latter, when the connecting and coupling rods are on their dead centres—*i.e.*, in line with their cranks—*no rotatory driving effort is exerted on the crank pins*. This is the great outstanding difference between the rod and crank drive of steam locomotives and that of electric locomotives of the jack-shaft type. In the latter, both the *motor to jack shaft* driving rods, and the *jack shaft to driving wheels* coupling rods, are subjected to a rotatory driving effort when on their dead centres, and it requires no explanation for engineers to perceive at once that this is bound, sooner or later, to cause trouble, since the crank pin at one end of the rod is being driven round whilst the pin at the other end of the rod tends to remain at rest, so that the rod *tends to pivot* about the second pin without driving its crank. This effect is, of course, most pronounced when starting with a heavy train.

The worst case in point is obviously a vertical *motor to jack shaft* drive, as exemplified in the 4-4-2 locomotives on the Dessau-Bitterfeld section of the Prussian State Railways, and it is certainly a wonder that such a fundamentally unmechanical job was ever allowed to emerge from the shops. Troubles of all sorts were, of course, legion, and the machines were always in for bearing repairs and heavy structural reinforcements. A certain, but only slight, degree of improvement is attained by adopting an oblique drive for *motor to jack shaft*, but it would appear to me, speaking as a perfectly impartial and disinterested engineer, that the only practicable crank and rod drive for electric locomotives is the Kands drive. As far as I am aware, no troubles from bearing and structural strains due to the drive have been experienced on the two railways mentioned above.

In view of the great and growing importance of the question of side-rod drive for heavy service on main lines, the opinions and experiences of experts would be highly interesting and valuable.—I am, &c.,

Ealing, Jan. 17. PIERRE WEIL.

P.S.—The Kands drive was, I believe, originally introduced by Ganz & Co., of Budapest, on the Valtellina locomotives some dozen or so years ago.

SOME PRINCIPLES IN INDUSTRIAL LIGHTING.*

(With special reference to the First Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops.)

BY J. S. DOW.

The author, after referring to Vol. III. of the Report, said:—

As a starting point, it is convenient to recall the definition of "adequate and suitable lighting" applying to the suggested general statutory provision "*requiring adequate and suitable lighting in general terms in every part of a factory and workshop.*"

Adequate and suitable lighting, it is suggested, should comply with the following requirements:—

1. Adequacy.
2. A reasonable degree of constancy and uniformity of illumination over the necessary area of work.
3. The placing of shading of lamps so that the light from them does not fall directly in the eyes of an operator when engaged on his work, or when looking horizontally across the workroom.
4. The placing of lights so as to avoid the casting of extraneous shadows on the work.

In addition, there are the provisions 2–7 in the report, relating mainly to the minimum degree of illumination (0·05–0·4 ft.-candles, according to circumstances), which is considered necessary in the interests of safety.

Provision of Required Illumination.—The author refers to the fact that the Committee had not specified illuminations suitable for all classes of work. It would appear also, from previous discussion, that the general illumination in factories is over estimated, and a general illumination of 3 ft.-candles is extremely rare. Before leaving the question of the minimum intensity of illumination required from various standpoints, reference may be made to two publications in which this question has been discussed. There is, firstly, the well-known booklet on "Industrial Illumination," issued some years ago by the National Electric Light Association, in which the usual practice for various trades is summarised in a very admirable manner. After examining these figures closely one is inclined to think that perhaps it is hardly necessary, with our present knowledge, to attempt to discriminate quite so closely between

* Abstract of an Introduction to a discussion at a meeting of the Illuminating Engineering Society, held on January 11, 1916.

the requirements of different operations as in this production. The following rough classification, contained in the recent code prepared by a committee of the American Illuminating Engineering Society might perhaps serve as a useful guide :—

Class of work.	Minimum illumination (ft.-candles).	Desirable illumination (ft.-candles).
Storage, passage-ways, stairways and the like	0·25	0·25— 0·5
Rough manufacturing and other operations	1·25	1·25— 2·5
Fine manufacturing and other operations	3·5	3·5 — 6·0
Special cases of fine work	...	10·0 —15·0

The first value happens to be identical with that suggested in the report of the Departmental Committee for the illumination necessary in the interests of safety. It should be particularly noted, however, that merely specifying a certain illumination on the work is not enough to secure "adequate and suitable lighting." The illumination must also comply with the requirements stated above as regards uniformity of illumination over the working area, avoidance of glare and avoidance of inconvenient shadows.

Avoidance of Glare.—The next consideration, the avoidance of glare, is an exceedingly important one. This is the requirement which, of all others, is apt to be disregarded in factory lighting, and Vol. III. of the Home Office Report contains frequent objections to installations on this ground. Yet, so far as those who scheme out factory installations are concerned, there is now general agreement that glaring points of light within the range of vision should be avoided, and the explanation of defective installations lies more often in the indifference of the public, who have not yet learned that exposed brilliant lights are necessarily wasteful, and even insist on them.

Avoidance of Inconvenient Shadows.—The last requirement, relating to the avoidance of inconvenient shadows, is clearly one whose application will have to be studied by practical experience.

Prediction of Illumination.—The author referred to the effect of low ceilings, and to the curves given by manufacturers enabling calculations to be made, and mentioned the following rough rule, given in the American "Code on Factory Lighting," as worth bearing in mind :—

"With modern lamps, roughly 1 c.p. per square foot produces an effective illumination of 3 ft.-candles when the lamps are arranged according to the uniformly distributed overhead system, with mounting heights ranging from 12 ft. to 16 ft. above the floor, and when the light is directed from the lamps to the work in an efficient manner."

The writer, as the result of tests in average interiors during recent years, has been accustomed to reckon general lighting installations on the following approximate basis. Naturally these data only apply to cases in which an even general illumination is aimed at, and typical properly designed lighting units are used; they are also subject to some modification when one is dealing respectively with very large or very small interiors. But they are fairly useful as a rough preliminary guide :—

Illuminant.	System of lighting.	Specific consumption per lumen on working plane.
		Cb. ft. per hr. per ft.-candle. per sq. ft. illuminated.
Gas	Direct—	
	Low pressure	0·01 —0·02
	High pressure	0·003—0·1
	Indirect—	
	Low pressure	0·02 —0·04
	High pressure	0·005—0·02
		Watts per ft. candle per sq. ft. illuminated.
Electricity	Direct—	
	Tungsten lamps	0·2 —0·3
	White arc and half-watt lamps.	0·1 —0·2
	Flame arc	0·05—0·1
	Indirect—	
	Tungsten lamps	0·4 —0·6
	Arc and half-watt lamps	0·2 —0·4

In these cases the illumination referred to is that on the working plane—*i.e.*, the level of the tables and benches where work is carried on; but it must not be inferred that the light directed on the surroundings is wasted. In many cases where the illumination of large vertical surfaces, diagrams, shelves, &c., is important the additional illumination shed in these directions by indirect and semi-indirect systems is a compensating advantage for the relatively lower illumination, for a given energy expenditure, on the working plane.

General, Local and Localised General Lighting.—Both in framing rules for the calculation of illumination and in devising recommendations regarding the arrangements of lamps with respect to work, the avoidance of glare, &c., one has to draw a distinction between general and local lighting. There is no doubt that the line of demarcation between these two methods has shifted considerably during recent years, and it occurred to me that it would be of interest to conclude this Paper with a few remarks on this subject.

Local lighting is still regarded as essential in cases where the work is of a specially delicate or complicated character. The rise in the standard of illumination during recent years, and the development of better types of reflectors, has certainly resulted in general lighting being applied in many cases where local lighting would once have been considered necessary; but there still remain many operations where a local light is needed, chiefly cases where the illumination must reach an exceptionally high value—such as could not economically be provided throughout the entire room, or when the efficiency of the work depends on the play of light and shade, and the craftsman likes to alter the position of the material with regard to the light in order to detect small irregularities on its surface. A good example of the transition stage from local to general lighting is afforded by offices.

It is sometimes said that the so-called "localised general" lighting is destined to disappear entirely, and that presently we shall have only local or general illumination, or a combination of the two. At the present time, however, there seem to be classes of rooms where something resembling localised general lighting is inevitable.

As an instance of an industry where local lighting seems likely to be replaced by general illumination one may take clothing factories. Here we usually find that an entire room is occupied by rows of sewing machines doing almost identical operations, but the illumination requires to be exceptionally high, especially when dark materials are used, and local lighting has, therefore, been hitherto largely employed. In one of the very latest factories, now working on khaki material, general lighting with half-watt lamps has been adopted.

In one room the consumption was 1·25 watts per square foot of floor area, and in another 0·75 watts per square foot, the illumination being 7–9 ft.-candles. With sewing machine work, small lamps of 5·5 c.p. and reflectors placed near the needle are sometimes used.

Another circumstance that has favoured the use of general illumination for factory lighting is the simplification of machinery and diminution of shafting and belts, owing to the application of local electric driving. Generally speaking, in machine shops where there are a large number of moving belts and overhead shafting general lighting is inapplicable, owing to the interruption and flickering shadows caused by these moving objects; local lighting must therefore be used. The same applies to weaving rooms in textile mills, except that the method in this case might more fitly be described as localised general lighting, seeing that one light is commonly allotted to two or four looms. But here again, in the very latest mills, the obstruction to light from above has been diminished, and a well-diffused system of general lighting might in this case be practicable. There are many points in connection with industrial lighting, such as the choice of large or small units, the effect on the illumination of deposits of dust on the lighting units, the need for correct colour discrimination in certain trades, &c. In order to keep this introduction within reasonable limits, I have also confined myself to artificial illumination. I should, however, like to conclude these remarks by reference to one other matter—the importance of reflected light from the surroundings. This reflected light is most valuable in strengthening the illumination in parts of the room most remote from the lamps, and keeping it above the minimum necessary for safety. In addition, it is now recognised that most objects cannot be completely seen unless they are illuminated from many different directions. It is the absence of these reflected rays which makes outdoor lighting such a difficult matter, even when the illumination is from a photometric standpoint relatively high and uniform. So well is this recognised that in some factories in the United States not only the ceiling and walls, but also the floor and the non-moving parts of machinery, are painted in a light colour.

DISCUSSION.

The CHAIRMAN (Mr. Goodenough) pointed out that in sorting letters at the Post Office the operators found it restful to glance occasionally into the darker portions of the room. They actually requested moderation in the illumination.

Mr. H. P. WHEAT exhibited a great number of photographs of lighting of different types, and dwelt on the importance of diffusion.

Mr. C. C. PATERSON referred to the importance of indirect lighting, and spoke of the exacting conditions in examining fabrics. He also referred to the necessity for a "diversity factor" in illumination.

Mr. A. CUNNINGTON agreed that 0·25 ft.-candle as a minimum was practically correct. He referred to the contrast between a whitened floor and the article lying on it as an assistance to work. However, when a

railway company began making steps white they accepted responsibility for this, which was a serious matter.

Mr. S. W. WILLCOX referred to the necessity for a light resembling daylight. One should be unconscious of it. He referred to the physiological effect produced by the pupil dilating admitting more light into the eye. He also thought the contrasts should not be too severe.

Mr. GRIGSBY agreed regarding the 0·25 ft.-candle as being high enough for a minimum standard of lighting.

Mrs. CLOUDESLEY BREBETON referred to the exhilarating effect of good lighting, and stated that it was also conducive to cleanliness in factories. Possibly, also, it had a good effect on the spirits of the work-people.

Mr. PITMAN dealt with the Moore tube system of lighting, and referred to the necessity of the light being of a penetrating nature.

THE DESIGN OF HIGH-PRESSURE DISTRIBUTION SYSTEMS.

The following is a report of the discussion on Mr. J. R. Beard's Paper at the Edinburgh meeting of the Scottish Local Section of the Institution of Electrical Engineers on Jan. 11, 1916. An abstract of the Paper appeared in our issue of Dec. 17, 1915 :—

Mr. A. PAGE said the increased application of high-tension distribution could not be dissociated from the influence of the turbine. Among the essential characteristics he was inclined to place freedom from interruption of supply second, and to relegate suitability of supply to the last place. As to the cost of operation they were employing girls in Glasgow as switchgear attendants. The most important point in switchgear was the circuit-breaker which should be capable of dealing with heavy short-circuit currents. He would like to know the author's experience with switches fitted with air cushions and vent pipes open to the atmosphere. Also if the Hunter-Shand switch was commercially developed and what results had been obtained. Interlocking gear was apt to lead to complications and such gear would not prevent the operator switching in an alternator dead out of phase. The most interesting part of the Paper was that referring to the economical section of mains. He was afraid the results obtained by the author, although interesting, would not be of much practical use. The many attempts to imitate the Merz discriminative protective gear was a sign that engineers wanted an interconnected system. This system, besides saving copper, led to economy in large power stations where without it there would be a tendency to run the station in four or five sections so as to avoid trouble when faults developed outside. Regarding the North-East coast system he wished to know what instructions were given as to the distribution of wattless current between power stations; how was the load between sub-stations ascertained so as to avoid serious overloading of some cables. Were ammeters or indicating wattmeters installed on every feeder panel?

Mr. F. H. WHYSALL gave an account of his personal experience with protective gear and said that the Merz-Price gear was satisfactory on account of its applicability to systems already in existence.

Mr. D. A. STARR said that after personal experience with 50 miles of 11,000 volt overhead mains he was satisfied that such mains well designed and regularly patrolled were as reliable as underground mains, and where ground subsidences abounded they were particularly suitable.

Mr. W. C. BEXON asked what apparatus the author would use for keeping the voltage constant in outlying districts.

Mr. W. W. LACKIE pointed out that with regard to the different lay-outs of mains, there was a difference in the saving effected. In another case the whole supply depended on four mains so that if one broke down the others were overloaded by 33 per cent. The Glasgow problem was different from that assumed in the Paper, as they had individual sub stations with a plant capacity of 5,000 kw. to 6,000 kw. necessitating at least one feeder to each sub-station.

Mr. J. R. BEARD, in reply, said the Hunter Shand switch had not been sufficiently long in use to warrant the expression of any definite opinion. Some of the interlocking arrangements recently adopted were not very complicated. In taking the cost of the distribution system and estimating the value of the losses he took two-thirds of the fixed charges not two-thirds of the cost. The regulation of wattless current between stations was carried out by the whole operation being centred in one man who was called "the system engineer."

PARLIAMENTARY INTELLIGENCE.

ELECTRIC LIGHTING OF TRAINS.

In the House of Commons last week Mr. Pretyman stated, in reply to a question, that the Board of Trade had been in frequent correspondence with the railway companies on the subject of substituting electricity for gas in the lighting of trains, and they had recently asked the companies what further steps they could take to accelerate the change on main line express services. The replies received showed that the companies generally had made considerable progress in effecting the change, but the work had been interfered with owing to shortage of labour and material caused by the war. The Board of Trade were fully alive to the importance of the matter, and it would continue to receive their careful attention.

LEGAL INTELLIGENCE.

Taylor & Farley v. West Bromwich Corporation.

This case was again before Mr. Justice Neville on Friday.

Mr. WM. MACKENZIE (for plaintiffs) said that an interim injunction had been granted restraining the Corporation from discontinuing or curtailing the supply of electrical energy for power to plaintiffs. By an agreement (made in 1914) plaintiffs were entitled to a supply of electrical energy for five years, but recently the Corporation had sent a letter threatening to cut off the supply of energy during certain hours.

Mr. WHEELER (for the Corporation) said there was a difficult question of law to be decided on the contract, and that could be best dealt with at the trial. Until then the Corporation would give an undertaking in the terms of the order made over that day. They would not discontinue or curtail the supply at any time, during night or day. But plaintiffs should give an undertaking that if defendants succeed at the trial they would pay for power supplied to them at the same rate as other consumers.

His LORDSHIP : I don't like that form of undertaking. Let it be in the usual form.

Damaging Electric Planing Machine.

At Govan Police Court last week Robert Duncan was charged with having damaged an electric planing machine at which he was engaged in an establishment in which Government work was being done. It was stated that he had caused the damage because he was irritated at being transferred from one machine to another. He was fined £10, or 60 days' imprisonment.

Re Cedes Electric Traction (Ltd.)—A debenture holders' action by the Austrian Daimler Motor Co. against this company was mentioned to Mr. Justice Neville on Friday upon a motion by plaintiffs for the appointment of a receiver and manager on the ground of jeopardy. A petition to wind up the Cedes Co. had been presented, and it would be necessary to find money to pay the week's wages.

Mr. WARD COLDRIDGE, K.C. (for defendant company), said there was sufficient money at the bank to pay the full amount of the company's indebtedness and wages. But the petition had created difficulties in getting at the money. The company had important and remunerative contracts running.

His LORDSHIP appointed a receiver and manager, with liberty to borrow enough to pay the week's wages, if necessary. But he recommended the parties to lay their heads together, and come to some disagreement, so that the petition could be got rid of before the hearing of the winding-up petition on Tuesday.

EDUCATIONAL NOTES.

University of Liverpool.—The Lent term began on Jan. 11. The special matriculation examination or the entrance examination must be passed to secure admission to the courses of instruction in the Faculty of Engineering. Prospectuses and full particulars of the courses in electrical, civil, mechanical and marine engineering, design and drawing, mathematics, physics and inorganic chemistry may be obtained from the registrar, Mr. Edward Carey. There are well-equipped laboratories, and facilities for practical and research work are available.

Royal Technical College, Glasgow.—In the annual report of this college it is stated that "the manipulation of tools is not included in the curriculum of the college," the governors being of the opinion that this kind of knowledge is best obtained in the workshop. At the request of the Ministry of Munitions they have, however, established courses for the preliminary training for munition workers. The effect of the war is seen in the reduction in attendances, the number of day students having fallen from 669 in the session 1913-14 to 445 in 1914-15. During the same period the evening students decreased in numbers from 4,342 to 2,583. There are 1,819 members, students and past students now in the King's service. The roll of honour is a long one, and amongst the distinctions awarded we notice the Victoria Cross, the D.S.O. and five Military Crosses.

Jamaica Telephone Service. The "Gleaner" (Jamaica) states that the negotiations between the directors of the Jamaica Telephone Co. and the Government, for the extension of the licence of the company, have resulted in the grant to the company of a licence for 10 years.

From time to time suggestions have been made that the Government should acquire the Kingston telephone plant. The company recognised that improvements were necessary, but as these would involve considerable expenditure, they would not undertake them unless they were granted a licence for a lengthened period. The matter has now been settled, and the directors will take up the question of improvements.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	577	New Radiators. Illustrated	109
Imports and Exports of Electrical Manufactures	578	Pope Lamp Shades	109
Business Notices	578	Calendars, Diaries, Novelties, &c.	110
Bankruptcies, Liquidations, &c.	578	"Ensign" Fires. Illustrated.	110
Electricity Supply	578	A New Lamp Lock. Illus.	111
Traction Notes	580	Cable Capacity Gauge	111
Telegraph and Telephone Notes	580	Switching Competition	112
Empire Notes	580	Leasing Motors on Trial Service	112
Foreign Notes	580		
The Round Table	105	Miscellaneous Notes	580
The "Ferranti" Water Heater. Illustrated	106	Tenders Invited	581
Slate and Tube Rheostats	106	Tenders Received & Accepted	582
Monometer Furnaces	107	Municipal Accounts	583
Universal Test Clips. Illustrated	108	Companies' Meetings and Reports	583
		City Notes	583
		Electrical Companies' Share List	583

COMMERCIAL TOPICS.

Electric Vehicles in India. It is interesting to note that, following the example of a number of English electricity undertakings, in adopting electric battery vehicles for service in connection with the commercial and mains staff, the subject of their employment in India is receiving consideration. It would appear that the rickshaw is generally employed, not only for passenger service but also for purposes of goods transport. We notice that our contemporary "Indian Engineering" is calling attention to the modern design of electric battery vehicles, and is eulogising its suitability for service in Indian cities where electrical energy is available. Manufacturers and agents for these vehicles should take note of these recommendations, and put themselves into touch with what will doubtless prove to be a large and profitable market. In many of the Indian cities the streets are steep and narrow, but this fact will prove no deterrent to the employment of battery-driven cars, whether they are intended for use as commercial or passenger vehicles. Our contemporary suggests that some form of regenerative control might be introduced on cars for use in exceptionally hilly districts.

* * * *

Gas Opposition to Electricity Supply. A case of what we consider unreasonable opposition on the part of the gas interest to a proposal to extend electricity supply recently occurred at Newport, Mon. The Corporation were invited to put forward proposals for supply to the Maesglas Works of the G.W.R. Co., and for this purpose they took the usual steps, and were successful in obtaining the necessary way-leaves and sanctions of the interested parties, including the South Wales Electrical Power Distribution Co. The Gas Company, however, instituted a very vigorous opposition to the whole proposal, and took advantage of their statutory rights to oppose the application to the Board of Trade (in accordance with their long standing policy regarding the municipal electricity undertaking). The Board of Trade decided to hear them, and a full inquiry was held in London on Wednesday last, at which the Chairman of the Committee (Mr. John Moxon), and the borough electrical engineer (Mr. A. Nichols Moore), gave evidence on behalf of the Corporation. After a somewhat protracted hearing the Board intimated that it was their intention to accede to the Corporation's application and grant them the necessary order to carry out the proposed extension.

* * * *

Progress of South Shields. The borough electrical engineer at South Shields, Mr. H. S. Ellis, has lost no time in applying for sanction to borrow money to put into operation the powers which have been conferred upon the South Shields Council by their 1915 Act for hiring electric motors and cooking and heating apparatus. The full details of this scheme are set out in another column. A point of considerable interest is that which deals with the sale of apparatus and the carrying out of wiring work through electrical contractors. The arrangement proposed will, we feel sure, give complete satisfaction to the electrical contractors in the town, and also to the Electrical Contractors' Association. Mr. Ellis is anxious to get on with the connecting up of electrical apparatus other than lamps, and evidently he appreciates the importance of avoiding a quarrel with a section of the industry which can be most helpful to him in the attaining of his object. When the electricity consumer applies at the Corporation showrooms he will be informed that the direct sale of new apparatus which he may be pleased with and wish to purchase can only be effected through a contractor. In many cases an electrical contractor may be an immediate neighbour of his, and where this is so he will naturally place the business in his direction. If he is not familiar with any contractors, the Corporation will furnish a list from which he can make a selection. It will be noticed that the prospective consumer will pay list prices for his apparatus, and of the trade discount a proportion will go to the Corporation and the remainder to the contractor. This, however, applies only in those cases in which the consumer goes to the Corporation in the first instance without reference to a contractor. The whole of the trade discount is, however, taken by the contractor if he introduces the consumer direct. Mr. Ellis is, of course, under no obligation under the Act to work with the local contractors, but it transpired at a meeting of a representative number of local contractors that they were in complete agreement with the arrangement whereby the Corporation should be credited with a sum equal to 10 per cent. of the list price on all articles sold at the showrooms, whether by the showroom staff or one of the contractors.

In regard to hiring motors, Mr. Ellis has particularly in view the smaller class of power user who run factories or small works, for which electric driving is ideal, but which are unable to make the initial outlay necessary for the purchase of a motor outright. He has, therefore, provided in his scheme not so much for the larger power user, represented by the shipyard firms, but for the more modest manufacturer to whom we have referred. The rates for motor hiring are being fixed upon a basis which will be mutually advantageous, and there can be no doubt that the power load of the undertaking will enormously benefit in the near future. We must congratulate Mr. Ellis upon the energy with which he is applying himself to the commercial development of his undertaking, in spite of restrictions imposed by the war, and we feel sure that he will shortly be able to point to a greatly increased energy consumption from a class of consumer who helps to flatten out the peaks in the load and contributes to the economical operation of the system.

* * * *

Trade with Hong Kong. It is announced by the Colonial Office that, according to telegraphic information from the Governor of Hong Kong, complaints are being received there that some merchants in the United Kingdom are declining to complete or undertake orders from Hong Kong merchants, on the ground that such merchants are not on the white list of persons and bodies of persons to whom articles to be exported to China may be consigned under the terms of the Proclamation of September 24, 1915. This Proclamation does not, however, apply to Hong Kong, which is not affected by the white list regulations.

* * * *

Coal Supply for Municipal Electricity Works. Probably there is no subject of such vital importance to electricity supply undertakers as the maintenance of a regular supply of coal, and it is questionable whether the step contemplated by the Government will improve matters. At all events the Electricity Supply Committee of the Marylebone Council state that they understand that the Government contemplate introducing measures to effect the pooling of the whole of the railway wagons owned by traders in the coal industry of the country and placing them under public control. The Council usually enter into contracts for coal with factors who own considerable numbers of wagons, which enables them to supply with greater expedition. If this proposed pooling were carried out an adequate supply of coal to their works would be made more difficult, and inasmuch as the maintenance of the supply of power for lighting the public thoroughfares

and the supply of power and light to factories in many cases engaged in the manufacture of goods necessary to the war, public institutions, hospitals, nursing homes and nearly 10,000 general consumers depends upon prompt deliveries, the Council would undoubtedly be placed in a precarious position. They recommend that the Council send a communication to the President of the Board of Trade protesting against the introduction of such measures, and that the Parliamentary representatives for the borough be asked to support the protest.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 10, 1916, *to* Jan. 15, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

BRISTOL.—*France:* Elec. lamps, 22 pkgs.
FOLKESTONE.—*France:* Unenumerated, 11 pkgs.
GRIMSBY.—*France:* Unenumerated, 10 pkgs.
HULL.—*U.S.A.:* Electrodes, 11 pkgs.
LIVERPOOL.—*U.S.A.:* Electrodes, 177 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £2,082; carbon candles, £98; elec. lamps, £310; telephone material, £120; wire and cable, £31; lamp parts, £95; unenumerated, £5,663—265 pkgs. *Holland:* Elec. lamps, £2,896—505 pkgs.; lamp parts, £132; wire and cable, £1,650; unenumerated, £528. *France:* Carbon candles, £549; elec. lamps, £58; electrite crystals, 5 bags; unenumerated, £532. *Japan:* Unenumerated, £386. *Sweden:* Telephone materials, £670. *Switzerland:* Elec. machinery, £230; carbon candles, £1,410; unenumerated, £1,150. *Italy:* Wire and cable, £1,119; unenumerated, £48. *Canada:* Unenumerated, £13. *Melbourne:* Elec. lamps, 3 pkgs. *Victoria:* Telephone materials, £81.
SOUTHAMPTON.—*France:* Unenumerated, 46 pkgs.

EXPORTS.

TO AUSTRALIA.—*Auckland:* Wire and cable, £176; elec. machinery, £78; unenumerated, £236. *Melbourne:* Wire and cable, £2,149; elec. machinery, £929; unenumerated, £445. *Sydney:* Elec. machinery, £347; elec. glow lamps, £133; wire and cable, £81; unenumerated, £546. *Wellington:* Wire and cable, £295; elec. machinery, £122; glow lamps, £502; unenumerated, £360. *Adelaide:* Unenumerated, £112. *Fremantle:* Unenumerated, £157. *Perth:* Unenumerated, £145. *Christchurch:* Unenumerated, £275. *Napier:* Unenumerated, £25. *Dunedin:* Elec. machinery, £118; unenumerated, £56. *Lyttelton:* Wire and cable, £64. *New Plymouth:* Elec. machinery, £118. *Jesselton:* Wire and cable, £34. *Invarcargil:* Wire and cable, £176; unenumerated, £12. *Nelson:* Unenumerated, £1.
AFRICA.—*Durban:* Elec. machinery, £190; unenumerated, £399. *Cape Town:* Unenumerated, £157. *Port Elizabeth:* Elec. machinery, £59. *Tangier:* Telegraph material £22. *Delagoa Bay:* Elec. machinery, £142. *Accra:* Unenumerated, £167. *Secondi:* Elec. machinery, £18; unenumerated, £14.
SOUTH AND CENTRAL AMERICA.—*Para:* Unenumerated, £1,325. *Puerto Columbia:* Unenumerated, £73. *Montevideo:* Wire and cable, £1,000; unenumerated, £73. *Pernambuco:* Unenumerated, £20. *Bahia:* Elec. machinery, £45; unenumerated, £193.
HOLLAND.—*Amsterdam:* Wire and cable, £94; unenumerated, £40. *Rotterdam:* Wire and cable, £53; unenumerated, £113.
SWEDEN.—*Gothenburgh:* Wire and cable, £178; unenumerated, £1,800. *Stockholm:* Wire and cable, £81; unenumerated, £81.
DENMARK.—*Copenhagen:* Wire and cable, £2,161; unenumerated, £189.
FRANCE.—*Bordeaux:* Unenumerated, £20.
NORWAY.—*Christiania:* Wire and cable, £522; unenumerated, £139.
U.S.A.—*New York:* Unenumerated, £47.
CANADA.—*Montreal:* Elec. machinery, £410; unenumerated, £177. *Quebec:* Unenumerated, £16. *St. John:* Unenumerated, £24.
WEST INDIES.—*Jamaica:* Unenumerated, £13. *St. Lucia:* Unenumerated, £33.
EGYPT.—*Alexandria:* Wire and cable, £100.
ASIA.—Unenumerated, £24.
JAPAN.—*Yokohama:* Unenumerated, £4. *Japan:* Unenumerated, £172.
INDIA, CEYLON, STRAITS SETTLEMENTS, CHINA AND JAPAN.—*Bombay:* Unenumerated, £207. *Calcutta:* Elec. machinery, £134; wire and cable, £7; unenumerated, £1,131. *Madras:* Elec. machinery, £141; wire and cable, £2; unenumerated, £94. *Rangoon:* Wire and cable, £63; unenumerated, £18. *Penang:* Unenumerated, £118. *Port Swettenham:* Unenumerated, £3. *Singapore:* Wire and cable, £113; unenumerated, £58. *Java:* Elec. machinery, £50; unenumerated, £22. *China:* Wire and cable, £1,000; unenumerated, £123. *Hong Kong:* Wire and cable, £3; unenumerated, £488. *Tientsin:* Unenumerated, £130. *Harbin:* Unenumerated, £179.
PORTUGAL.—*Lisbon:* Elec. machinery, £19. *Oporto:* Wire and cable, £16.
PERSIA.—*Bushire:* Unenumerated, £42. *Persia:* Unenumerated, £26. *Bandar Abbas:* Elec. machinery, £40. *Muscat:* Wire and cable, £10; unenumerated, £67.

FOREIGN GOODS (duty paid and free).

Denmark: Unenumerated, £131. *Russia:* Unenumerated, £54. *Japan:* Unenumerated, £67. *Mexico:* Unenumerated, £4. *West Indies:* Unenumerated, £16. *Peru:* Unenumerated, £14. *Germany:* Unenumerated, £61.

NOTE.—The large number of items on these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The business of the Wilson Apparatus Co. at Dudley Lane, Hendon, N.W., will be carried on in future under the style of the Globe Radio Apparatus Co., with head offices at 18, Old Bond-street, London, E.C. The works address will remain as at present.

Wm. Wright Nicholas and Arthur Rowland Meek, consulting engineers, Hull, have dissolved partnership. Debts by Mr. Nicholas, who continues in business as W. W. Nicholas & Co., at Trinity House-chambers, Trinity House-lane, Hull. Mr. Meek will continue in business on his own account at Deddington-chambers Bowlalley-lane, Hull.

Plant Wanted.—An advertiser requires a second-hand booster set.

Increase of Prices.—The Bastian Meter Co. notify that owing to the effect of the war on the cost of labour, raw material, carriage and other items, they are unable to maintain the reduction introduced in July, 1914, and, therefore, they are reluctantly compelled to revert to their pre-war prices as under:—

Size 1 (20 amperes), 36s.; size 2 (10 amperes), 30s.; size 3A (5 amperes), 20s.; size 3B (5 amperes), 22s. 6d.; and sizes 4A and 4B (3 amperes), 15s. Prices for export can only be given in response to definite inquiries specifying destination of goods.

Patent Exploitation.—The proprietor of patent No. 4,228/1909, for "Improvements in electric cut-outs," desires to make arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton-buildings, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

An application for the discharge of Geo. J. T. J. Parfitt, consulting electrical engineer, 4, Priory-road, Keynsham, Somerset, will be heard on Feb. 25 at the Guildhall, Bristol.

Claims against Wm. Carey Wild, electrical engineer, 57, Rhodes-street, Halifax, are to be sent by Feb. 2 to Mr. W. Durrance, 12, Duke-street, Bradford, preparatory to the payment of a dividend.

Meetings to receive accounts of the winding up of Easton & Co. (Ltd.) and Easton, Anderson & Goolden (Ltd.) will be held at the offices of Sir W. B. Peat & Co., 11, Ironmonger-lane, London, E.C., on Feb. 15.

A meeting of creditors of Inventions & Appliances (Ltd.) (in liq.) will be held at 36, Church-street, West Hartlepool, on Jan. 21.

The Ilkeston Motor & Electrical Engineering Co. (Ltd.) is being wound up voluntarily, and Mr. Alan Boaler, accountant, Nottingham, has been appointed liquidator.

Adjudication Annulled.—The adjudication in bankruptcy of Wm. Harry Wass, metallurgist, 283, Attercliffe-road, Sheffield, has been annulled, it appearing that all debts have been paid in full.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bolton.—The Corporation have received sanction to borrow £2,215 for the electric supply undertaking.

Darwen. The Corporation have applied to the L.G. Board for sanction to borrow £3,000 for mains extensions and services.

Nuneaton.—The L.G. Board have sanctioned the borrowing of £5,222 for additional generating plant.

Pembroke.—An inquiry will be held on Feb. 2 into the application of the Urban Council for sanction to borrow £15,000 for extensions of the electricity department.

Stalybridge. The Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity Board have applied to the L.G. Board for sanction to borrow £20,000 for additional plant at the generating station, extensions of mains, &c.

GENERAL.

Aberystwyth Fire.—In reference to the fire which occurred at the electricity works on the 10th inst., we are informed that the cause of the outbreak, which apparently started in or near the cable trench between the machines and the switchboard, has not been ascertained.

The fire was discovered about 4 a.m., and was promptly overcome by members of the staff, but it must have been burning for some time, as all the machine cables were destroyed, together with the wires and cables at the back of the centre panel (neutral) of the board, the cables from the battery and the ends of the outgoing feeders. The amount of damage has not been fully estimated, but it amounts to several hundred pounds. The supply of electrical energy was resumed on the afternoon of Wednesday, the 12th inst.

Brighton.—The Lighting Committee have presented another report on the proposal to make a further increase in the charges for electric current. The engineer and manager (Mr. John Christie) has now prepared a detailed report on the matter, in which he points out that the cost of coal has risen from 17s. 3d. (the price paid before the war) to 13s. 9d. per ton, and in addition there are other factors which are likely to operate adversely on the revenue.

Mr. Christie says there is little doubt there will be a deficit on this

year's trading, and that next year the position of the electricity undertaking will be most serious unless the revenue is substantially increased. A revision of the charges made to the consumer is, therefore, inevitable. He also states that in many previous reports he has expressed the hope that one day it would be possible to abolish the numerous tariffs which are at present in force, and adopt one uniform flat rate as the initial charge to all consumers, and by giving special rebates for quantities common to all classes alike still afford large users a supply at a reasonable price. The present exceptional conditions offer an excellent opportunity for making this change, and he would strongly recommend the abolition of the maximum demand system and all other special rates, and the adoption of a flat rate of 5½d. per unit to all classes of consumers (other than power users) inside the borough, but subject to rebates in proportion to the quantity taken on the following scale: For first 1,000 units consumed per annum, 5½d. per unit (no rebate); for following 1,000 units, 5d.; for following 1,000 units, 4½d.; for following 1,000 units, 4d.; and for all over 4,000 units consumed per annum, 3½d. per unit. For consumers outside the borough, a flat rate of 6½d. per unit. The rate for supply through prepayment meter to be 5½d. within and 6½d. per unit outside the borough. The power rate should not be further increased at present. The street lighting charge should also remain as at present. The tramway supply should be raised from 1·35d. to 1·4d. per unit. Provided the sales for private lighting do not fall below 3,000,000 units per annum, the revised charges will yield annually £12,500 more than the charges in force before the war. The suggested increase to the tramways undertaking is estimated to produce an additional annual income of £340.

The Committee recommend that the charges should be revised accordingly, and take effect at the expiration of the current quarter. No alteration is to be made in the charge to the Hove Corporation for the supply of electricity in bulk to the parish of Aldrington—viz., 5½d. and 1¼d. per unit.

Hackney (London).—The L.C.C. has informed the Electricity Committee that it cannot see its way to accede to the request to suspend during the period of the war the periodical inspection of the Borough Council's electricity pressure testing stations.

The County Council had sent this same intimation to all the metropolitan Borough Councils which petitioned in favour of the suspension. Hammersmith Electricity Committee is still of the opinion that the undertakings might be saved the testing fees and the services of the officers engaged in collecting the records, and they have asked Hackney Council to convene a conference of the authorities concerned to further consider the suggestion, with a view to making further strong representations to the County Council in favour of the suspension of the inspections.

Halifax.—There was an interruption in the supply of electrical energy for traction on Monday, and the tramcar service was interrupted for nearly an hour and a half. An accident to a generating set was the cause of the interruption.

Huddersfield.—Ald. Mossland and Mr. T. Shires have been elected chairman and deputy-chairman respectively of the Electricity Committee.

Manchester.—The scheme of the Electricity Committee to erect and equip a new power station at Barton is referred to in the annual report of the Employers' Parliamentary Association.

The Association supported the application to borrow £768,000 for the new generating station, and as the result of the Local Government Board inquiry the Treasury sanctioned the borrowing of £432,470. The report points out that the national importance of the matter will be appreciated when account is taken of the great engineering and textile firms in or about Manchester who are dependent upon the Corporation for their supply of power. As an example of the great part played by Manchester at present it may be stated that 80 per cent. of the khaki dye manufactured in this country is supplied by a Manchester firm.

Newport (Mon.).—The Corporation were recently notified by the Gas Company that they would oppose the application for leave to give a supply of electric power to works just outside the borough. As there was a good supply of gas the company thought there was no justification for the expenditure of money on the extension of the electric supply mains. However, the Board of Trade thought otherwise, for they have authorised the proposed extension of the supply mains.

St. Annes-on-the-Sea.—The electrical engineer (Mr. J. H. Clothier) reports that there is still a decrease in the units sold for lighting and traction, but the heavy increase for both industrial and domestic power more than compensates for this.

In regard to the coal supply, Mr. Clothier says the question is causing great anxiety. In their case, one contract ran out at the end of the month, and although he had sent out a great number of inquiries, he had not been able to secure a renewal or offers for any quantity, with the exception of a 100-ton lot. He anticipated that when fuel was purchased it would be at very enhanced prices.

Skelton and Brotton.—At the recent Council meeting it was reported that there were 368 private consumers of electrical energy, while 23 were awaiting connection.

South Shields.—The Corporation recently approved a scheme, prepared by the borough electrical engineer (Mr. Harry S. Ellis), for hiring electric motors, cooking and heating apparatus, &c., and application has been made for sanction to borrow £1,000 for the scheme.

The power to engage in this important work has been conferred upon the Council by their 1915 Act. Sales of apparatus and wiring work are to be carried out through contractors. Mr. Ellis points out that when a consumer visits the municipal showroom and wants to purchase a motor or an electric oven he will have to be informed that the sale can only be effected through a contractor. If he knows of a contractor he can instruct the electricity department to make the necessary arrangements with the contractor for the transfer of the apparatus from the Corporation to him. If he does not know a contractor, they, the department are at liberty to give him a list of contractors and let him decide for himself as to who should have the order. As a rule, if he is a consumer, he will want the order to go to the contractor who carried out the installation work for him; the other case will probably only arise when he is a prospective consumer who has not hitherto had dealings with either the electrical department or a contractor. The purchaser would pay ordinary list prices for any apparatus bought, and the Corporation would retain a portion of the trade discount to cover their showroom and working expenses; the remainder would go to the contractor. On the other hand, if the contractor introduced the consumer then the whole of the profit might go to him. Many contractors had no showroom, and many did not even keep any stock, and therefore it paid the Corporation to keep a showroom and invite contractors to make use of it. They had been doing that during the past two years, but although they had sold all sorts of apparatus they had never had any commission, and much of the apparatus would never have been sold but for the showroom and their own efforts. He had no doubt they would be able to come to some such arrangement as he had outlined above with the contractors, and he trusted with the local contractors, although the Act did not bind them to work with local contractors. At a meeting with a representative number of local electrical contractors they decided unanimously that it was only fair that the Corporation should have a reasonable commission to set against their showroom expenses, and they agreed that the Corporation should be credited with a sum equal to 10 per cent. of the list price of all articles sold at the showroom, whether by a member of the electrical department or by a contractor.

The Corporation had full powers to hire out electrical apparatus, such as motors, heaters, cookers, irons, grills, hot-plates, vacuum cleaners, &c., all of which articles were reliable and popular. Such a scheme was simple, because they had powers to deal with the consumer direct. He considered those to be the most valuable powers which they had obtained through the Act, because they would enable them to secure consumers who would otherwise not be secured owing principally to their inability to lay down a comparatively large sum of money for, say, a motor, cooker, or vacuum cleaner. He was prepared to recommend them to allow him to start hiring out alternating current motors right away. He did not include direct-current motors, because these were used principally by the larger works, shipyards and dry docks, &c., in most of which cases the owners were in a position to purchase the motors outright, and probably preferred to do so. Of course, if at any future time it was felt that there was scope for such a scheme he could report further on the matter. The class of people he proposed to cater for were those who could make good use of a motor but who were not prepared to purchase same. They had had several inquiries already about motor hiring, and if such a scheme was started he felt sure they should be able to secure some consumers right away. Another point in favour of the scheme was that motors were now more or less standardised, and any motors purchased would be almost, if not quite, as good and as efficient in 10 years' time as they were to-day. Owing to the proved long life of a motor the hire charge could be made a reasonable one. For instance, a motor costing £10 could be hired out for about £1. 10s. per annum, which would cover the repayment of the cost of the [illegible] plus interest on money outstanding at 5 per cent., and left a small amount to cover maintenance. £1. 10s. was equal to 15 per cent. of £10, so that whatever the cost of the motor might be it would only be necessary to calculate the hire charge on the basis of 15 per cent. of the net cost (the resultant figure to be an even one for the sake of simplicity). He had been in communication with a firm engaged in the manufacture of motors, and they were prepared to send them a few motors on sale-or-return conditions, so that they should always have some stock to meet requirements, and they should not need to purchase them until they had made all arrangements with the hirer.

Sowerby.—The Parish Council have accepted the local electric lighting company's revised offer for the electric lighting of the district.

Tottenham.—The acting Engineer has been directed to report as to the cost of installing an electric motor at the refuse destructor.

West Hartlepool.—The South Durham Steel & Iron Co. has asked for an additional supply of electric power and the supply sub-committee has been authorised to deal with the matter.

Wigan.—At the recent meeting of the Council, Ald. Grimshaw, in moving the adoption of the Electric Light Committee's minutes, said they had made a purchase of 16,000 tons of coal at the price of 14s. 6d., which was of the same quality that they bought in March last for 11s. 6d.

Replying to the discussion on the report, he said he quite appreciated what had been said with regard to the vice-chairman and himself having

had an anxious time. They had more than an anxious time; they had had a very difficult time, and were not through it yet. They had not lost sight of the discussion on Lancashire boilers. Whether they would be adopted was quite another matter. They had to discard the Lancashire boiler on the suggestion of an inspector of the L.G. Board. He did not think they could put down Lancashire boilers at Bradford-place, as they would take all the room they had at their disposal. However, they would not lose sight of the suggestion, which had also been made to him by people living in the district. There was a very good prospect before the Committee. In the last two years they had increased their supply by nearly 2,000,000 units, and they had customers waiting to be linked up which ought to increase their output to 3,000,000—that was if they had the material to supply them within the next 12 months—so that their output within the next 18 months ought to be 10,000,000 units per annum, which was a remarkable record. It would involve great consideration on their part to get the best, efficient and most economic plant possible.

TRACTION NOTES.

Birmingham.—The construction of the Acock's Green tramway has been completed by the contractors, Messrs. Dick, Kerr & Co., and trial trips have been made over the route this week.

The Tramways Committee reports that there are now 700 women acting as conductors on the municipal tramways, and that their work has given satisfaction.

Dudley.—A tramway accident occurred on Sunday evening last, resulting in one person being killed and 15 persons being injured.

A double-decked car was started without the driver, and travelled a quarter of a mile before the discovery was made that the driver was not on the platform. The car had by this time got up a good speed on a slight gradient, and before the conductor could get to the brakes the car jumped the points, tore up the roadway for 10 or a dozen yards and then overturned.

London Electric Railway.—The London Electric Railway Co. have applied to the Board of Trade for an order to extend to Aug. 15, 1917, the time limited by the Company's Act of 1913 for the compulsory purchase of lands, &c.

TELEGRAPH & TELEPHONE NOTES.

Deferred Telegrams.—The Eastern Telegraph Co. announce that cheap rate deferred plain language telegrams are still accepted for transmission over their lines to the Colonies and other countries where this service applies; also week-end E.F.M. (Expeditionary Force messages) telegrams to and from soldiers, sailors and nurses. In the case of Australasia and South America, telegrams are transmitted without undue delay; telegrams exchanged with other parts of the world served by the company's system are subject to delay owing to the large volume of traffic.

Telegraph Service With Roumania.—The Great Northern Telegraph Co. announce that they have introduced urgent service with Roumania.

The rate is triple ordinary rate—viz., 1s. 3d. Urgent telegrams receive priority of treatment over other private telegrams, but a rapid service cannot be guaranteed.

Hull Telephone System.—At the meeting of Hull Telephone Committee on Monday the City Accountant presented a summary of the accounts of the telephone system for the past year in connection with the original Corporation system, and, in the case of the National Telephone system, which was taken over from the Government from Jan. 1, 1912.

The income was £138,675. 2s. 9d., working expenses £95,101. 18s. 6½d., war bonus, &c. £226. 4s. 4d., marriage dowries and pensions, and one year's contribution to staff fund £5,629. 2s. 1d., total £100,957. 4s. 11½d. Interest, sinking fund charges, &c., absorbed £32,328. 6s. 8d., making the total expenses £133,285. 11s. 7½d., and leaving a net balance of £5,389. 11s. 1½d. The loan repayment charges (£10,689. 6s. 1d.) are for one year for the original undertaking, and as regards the old National undertaking from the date of borrowing (May 6, 1914). After paying the expenses of the removal of officers consequent upon the transfer, and meeting cost of replacement of switchboard cables, there remains £11,084. 7s. 7d. in reserve fund. A balance of £5,511. 12s. 10½d. also stands to credit of appropriation account at the end of the year. The net capital expenditure (£198,183. 4s. 6d.) includes the purchase of the ex National undertaking and £3,664 certified by the manager as capital expenditure since Jan. 1, 1912. The total capital outlay, irrespective of the agreed amount for depreciation, is £313,112. 5s.

Radiotelegraphy in Australia.—It is stated that the capital expenditure on the Australian Commonwealth's radiotelegraph station at Canberra will be about £18,500.

Wireless Apparatus in New York Harbour.—It is announced that it has been officially decided that all belligerent ships entering New York harbour must dismantle their wireless apparatus, which shall remain sealed until the vessels are again on the open ocean.

EMPIRE NOTES.

Australasia.—The ratepayers of Gisborne (N.Z.) have authorised the municipal authorities to raise loans for works in connection with water supply and sewerage £50,000, tramways £30,000 and electric light and power extensions £10,000.

India.—"Indian Engineering" says the Government took over the electric lighting undertaking at Nuwara Eliya, Ceylon, from the Board of Improvement on Jan. 1.

Electric Vehicles for India.—"Indian Engineering" points out that as the borough electrical engineers in England have mostly taken the initiative in the use of electric vehicles, and this should be a stimulus to municipal and other engineers in charge of electric installations in India to follow their example. There seems no reason why small electric vehicles should not displace the rickshaw in hill stations. At Simla the rickshaw is used universally, and is, with its four refractory coolies, a source of perpetual annoyance. Electric vehicles are now in the market that will take most of the gradients found in and about Simla. The overall dimensions of the car need not exceed about 11 ft. by 5 ft., which would be inappreciably larger than the present single-seated rickshaw. The conditions in a hill station are ideal for regenerative control.

FOREIGN NOTES.

Argentina.—Authorisation to operate as a joint-stock company has been conceded by decree of the National Government to the Compañia Argentina de Lamparas Electricas Z.

The local electricity supply company have discontinued the supply of electricity to the municipal authorities of San Antonio de Areco in consequence of the non-payment by the municipality of $22,000 (nearly £2,000) due to the company. The public, it is said, are disgusted at the awkward situation, which is due to municipal maladministration.

Japan.—H.M. Vice-Consul at Osaka reports that a company has been formed in Osaka, with a capital of about £35,700, for the manufacture of caustic soda.

The company intend to use an electrolytic process, and will erect a factory at Kyushiu, where hydro-electric power is fairly cheap. The machinery is to be Japanese. The plans, however, have not so far progressed beyond the discussion stage.

Swiss Electric Railways.—The Federal Government has decided to electrify the whole of the Swiss railways. A start will be made on the Erstfeld-Bellinzona section of the St. Gothard line. The cost of electrifying the Federal railways is estimated at £20,000,000, which will be raised by the issue of 5 per cent. Federal bonds.

MISCELLANEOUS NOTES.

Empire Fair.—Messrs. Brockie, Haslam & Co., 23, Fleet-street, E.C., have been appointed sole official advertising agents of industries of the Empire Fair.

It is stated that it is proposed to erect an exhibition building which will cover an area of 610,000 sq. ft. (3½ times the size of Olympia). This building, which will be known as the Palace of Industry, will be opened early in 1917 at Willesden Green. Between 2,000 and 3,000 exhibitors and upwards of 70 distinct trades will be represented, and there will be 16 different sections, a prominent position amongst these sections being allotted to our business. The Advisory Council of the Industries of the Empire Fair consists of representatives of the principal trade associations and manufacturing houses of Great Britain. The administrative offices are at Lincoln House, High Holborn, London, W.C.

German Control of British Industries.—Some time ago an article by John Briton appeared in the "Sunday Chronicle" on German influence on the electrical industry of this country. The article dealt more particularly with the ramifications of the A.E.G. of Berlin, and among its "allied and subordinate" companies was mentioned the British Thomson-Houston Co., of Rugby. We are informed that legal proceedings were at once commenced by the British Thomson-

Houston Co., and in the issue of the "Sunday Chronicle" for the 16th inst. the same contributor writes as follows :—

I did not say that this company (the B.T.-H. Co.) was owned or controlled by the A.E.G., but this inference has been drawn from my article, and I therefore desire to say that it is unfounded. The truth is that the B.T.-H., of Rugby, is mainly controlled by the General Electric Co., of Schenectady, which in its turn is a descendent of the Thomson-Houston Co. of America. The Thomson-Houston Co. in its day sold its European patents to a number of companies on this side of the Atlantic, some of which in due course were absorbed by the A.E.G. and some by the G.E. Co. The British Thomson-Houston Co. belongs, as I have said, to the latter category. It is true that the A.E.G. purchased the German rights under the patents of the G.E. Co. and B.T.-H. Co. in exchange for the American and British rights under its patents, but I am glad to be able to state that the German company has no control over, or interest in, either the American or British company, and I regret if any other meaning has been read into my article, and if any harm has been done to the B.T.-H. Co. thereby. I am also able to state that the A.E.G. has no control over the electric lamp business in this country, but, on the contrary, by reason of British patents it was obliged to purchase from British companies all such lamps as it sold here.

Inquest.—An inquest was recently held upon Richard T. Akers, who was killed at the works of the Efandem Electrical Co. at Fallings Park, Wolverhampton.

Evidence was given that deceased came into contact with a live electric wire which had been blown down by the gale.

Mr. F. T. RIDGEWAY, electrical engineer, said that when work was resumed on the Tuesday after Christmas he had all the fuses withdrawn and the plant was rendered safe. For the wire to be "alive" the fuse must have been put back, but who did that witness did not know. He had no idea that the wire was hanging until his attention was directed to it. It had been looped up. Two or three men had asked him about light, but witness told them they could not have any: he suggested torches. He did not know who replaced the fuses, but it would not require a deal of knowledge for anyone to do it.

ALBERT HOOPER, head of the battery shop, said he did not notice the wire hanging. He had no idea who could have replaced the fuses.

The jury found that death was due to "electrocution" as the result of an accident.

Municipal Contracts with Alien Enemy Firms.—Belfast Corporation have adopted the following resolution :—

No contract shall be entered into with any person of German or Austrian nationality; no contract shall be entered into with any firm or company whose subscribed capital (whether by way of shares or otherwise) is held or controlled to the extent of one-third or upwards by persons of German or Austrian nationality, or with any other person whosoever who acts for or represents either directly or indirectly any German or Austrian firm, merchant or traveller, and that any such contracts now in existence should be terminated as soon as possible.

"Willing's Press Guide."—We have received a copy of the 43rd (1916) edition of this publication.

It contains the usual features, which include a general alphabetical list of newspapers, annuals and other periodicals, a British classified section, an alphabetical list of Metropolitan newspapers, a list of the same papers grouped according to the periods of publication, London and suburban papers under the districts served, London addresses of provincial papers, provincial papers under towns, under counties, &c., Colonial and foreign papers and London addresses of same where such exist. As usual, the price of this useful work of reference is 1s., and it is issued by Messrs. James Willing (Ltd.), 125, Strand, London.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during December, 1915, and (*b*) the aggregate figures from Jan. 1 to Dec. 31, with the increases or decreases compared with 1914 :—

Electrical machinery, (*a*) £126,688 (including generators and motors other than for aeroplanes, motor cars and cycles, £11,050, and electrical machinery unenumerated, £115,638 (decrease £398,49), (*b*) £1,521,549 (including generators and motors other than for aeroplanes, motor cars and cycles, £251,687, and electrical machinery unenumerated, £1,269,862) (increase £588); telegraph and telephone cables, submarine (*a*) £2,778 (increase £2,778), (*b*) £3,089 (increase £1,320); other than submarine, (*a*) £538 (decrease £1,612), (*b*) £28,823 (decrease £20,460); telegraph and telephone apparatus, (*a*) £13,487 (decrease £14,839), (*b*) £122,481 (decrease £99,821); other electrical wires and cables, rubber insulated, (*a*) £9,828 (decrease £5,032), (*b*) £96,348 (decrease £1491,39); with other insulations, (*a*) £2,692 (increase £1,623), (*b*) £46,554 (decrease £14,156); carbons, (*a*) £6,473 (decrease £3,910), (*b*) £141,170 (increase £16,356); glow lamps, (*a*) £20,463 (increase £14,013), (*b*) £154,113 (increase £33,563); arc lamps and electric searchlights, (*a*) £39 (increase £1), (*b*) £2,839 (decrease £254); parts of arc lamps and searchlights (other than carbons), (*a*) £5,518 (decrease £441), (*b*) £84,645 (decrease £5,680); primary and secondary batteries, (*a*) £21,182 (increase £14,275), (*b*) £165,196 (increase £16,947; meters and measuring instruments,* (*a*) £5,596, (*b*) £34,276; switchboards,* (*a*) £190, (*b*) £5,630, electrical goods and apparatus unenumerated, (*a*) £23,219, (*b*) £211,061. Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £112,003 (increase £22,087), (*b*) £1,096,234 (decrease £146,536).

Exports.—The exports of electrical machinery, material, &c. (*a*) during December, 1915, and (*b*) from Jan. 1 to Dec. 31, with the increases or decreases compared with 1914, were as follows :—

Electrical machinery, (*a*) £97,331 (including railway and tramway motors, £7,090, generators and motors other than aeroplanes, motor cars and cycles £58,996, and electrical machinery unenumerated £31,245) (decrease £8,641), (*b*) £1,400,200 (including railway and tramway motors £586,684, generators and motors other than for aeroplanes, motor cars and cycles, £699,416, and electrical machinery unenumerated, £586,684 (decrease £736,537); telegraph and telephone cables, submarine (*a*) £5,870 (decrease £10,701), (*b*) £359,231 (decrease £30,597); other than submarine, (*a*) £41,085 (increase £18,534), (*b*) £446,450 (increase £131,573); telegraph and telephone apparatus, (*a*) £15,576 (increase £4,392), (*b*) £217,639 (decrease £29,279); other electrical wires and cables, rubber insulated, (*a*) £33,050 (increase £11,478) (*b*) £365,607 (increase £25,364); with other insulation, (*a*) £50,924 (increase £26,604), (*b*) £519,599 (increase £115,087); carbons, (*a*) £374 (decrease £84), (*b*) £8,577 (increase £870); glow ,lamps, (*a*) £10,688 (increase £2,630), (*b*) £157,014 (increase £22,368); arc lamps and searchlights, (*a*) £2,684 (increase £2,181), (*b*) £9,645 (decrease £4,011); parts of arc lamps and searchlights (other than carbons), (*a*) £1,456 (increase £1,251), (*b*) £22,220 (decrease £299); primary and secondary batteries, (*a*) £15,066 (decrease £3,425), (*b*) £196,255 (increase £18,025); meters and measuring implements,* (*a*) £12,896, (*b*) £152,831; transformers,* (*a*) £12,732, (*b*) £74,470; switchboards,* (*a*) £4,411, (*b*) £59,309; electrical goods and apparatus unenumerated, (*a*) £52,000 (decrease £8,460), (*b*) £591,962 (decrease £273,522). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £258,792 (increase £74,429), (*b*) £3,180,809 (increase £162,209).

* Not enumerated separately in previous years.

TENDERS INVITED.

Oil (or Gas) Engine, Generator, Accumulators, &c.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Feb. 28 for the supply of an Oil or Gas Engine, Generator, Accumulators, Power Board, Distribution and Fuse Cases and Test Table Tablet (schedule 370) for Townsville Post Office, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from the Deputy Postmaster-General, Brisbane.

Electric Generator and Water Turbine.

The Public Works Office, Wellington (N.Z.), invite tenders for the supply of the following plant and material for use in connection with the LAKE COLERIDGE electric power scheme: Until noon Feb. 11 for Pipe Line and Accessories (section 60); until noon March 8 for supply at Lyttelton of 3,000 kw. Generator (section 61); until noon on March 8 for supply at Lyttelton of 4,300 H.P. Water-turbine (section 62). Drawings, specifications and conditions of contract from the Public Works Office, Wellington, N.Z. Specifications and forms of tender can be seen at the Office of the High Commissioner for New Zealand, 13, Victoria-street, Westminster, S.W.

Wiring and Fittings.

SWANSEA Education Committee require tenders by noon Feb. 7 for the Electric Lighting of Brynmill Infant School. Specifications from the Clerk, 9, Grove-place, Swansea.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Hydro-Electric Generator.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Electrical and Tramway Stores.

CROYDON Corporation want tenders by 10 a.m. Jan. 24 for one year's supply of General Stores for their Tramways Department. Schedules (A to M) from the Tramways Manager.

PEMBROKE (co. Dublin) Urban Council require tenders by noon Feb. 7 for 12 months' supply of Electrical Goods, Oils and Colours, &c. Specification, &c., may be obtained at the Town Hall, Ballsbridge, co. Dublin.

BERMONDSEY (London) Guardians require tenders by 6 p.m. Feb. 10 for one year's supply of Electric Lamps, Oils, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

HALIFAX Corporation require tenders for 12 months' supply of Lighting Fittings, Lamps, Switches, v.r. Cables and Telephone Wire, e.h.t. 6,600-volt Cable, l.t. Lead-covered and Armoured Cables, Meters, &c., for their electricity department. Forms of tender from the Electricity Department, Foundry-street, Halifax.

MIDDLESBROUGH Corporation require tenders by first post Feb. 7 for 12 months' supply of Electric Lamps, Bolts and Nuts, Oils, Paints, &c. Specifications from Borough Engineer.

MELBOURNE, BRUNSWICK and COBURG (Victoria) Tramways Trust invite tenders by Jan. 19 for Wheels and Axles (contract No. 30), and by Feb. 18 for Six Radial-type Trucks (contract No. 28). Specifications, &c., from the office of the Melbourne, Brunswick and Coburg Tramways Trust, Coburg, Victoria.

Electrically-operated Pumps and Motors.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with the necessary Switchboards, Starters, &c., and spare parts. (Contract No. 1,301.) Specification and form of tender from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Boiler Tubes.

JOHANNESBURG Council want tenders (by noon Feb. 15) for supply of 250 18 ft. by 4 in. Tubes for Water-tube Boilers. Specification, &c., from the Municipal Offices, Johannesburg.

Freight Car Transferrers.

SYDNEY HARBOUR TRUST COMMISSIONERS require tenders by 2 p.m. Jan. 31 for three electrically-operated Railway Freight Car Transferrers (contract 15/30). Specifications, &c., from the Commissioners' Offices, Circular Quay, Sydney, N.S.W.

Electric Tramway.

Tenders will be opened on Jan. 28 at the Dirección General de Obras Públicas, Ministerio de Fomento, Madrid, for the Construction and Working, for 60 years, of an Electric Tramway in Madrid (Monte del Pardo district). Minimum rolling stock required, three motor coaches and three trailers. The concession is held by the Sociedad Tranvia del Este de Madrid.

Distribution Boxes and Fuses.

Tenders are required for the supply of Fuse Distribution Boxes and Fuses (contract No. 26,111) for the VICTORIAN STATE RAILWAYS. Specifications from Messrs. John Coates & Co. (Ltd.), 115, Victoria-street, London, S.W. Tenders to the Agent-General for Victoria, Melbourne place, Strand, London, W.C., by 11 a.m. Feb. 2.

Ash-Handling Plant.

MANCHESTER Electricity Committee require tenders by 10 a.m. Jan. 28 for Ash-handling Telpher Plant for Stuart-street Station. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

TENDERS RECEIVED AND ACCEPTED.

BERMONDSEY (LONDON).—The following tenders have been received by the Borough Council for motors for lightning crusher plant: J. Evans & Co., £689 10s. or £612. 10s. without space heaters (alternative, enclosed pipe, ventilated motors, £786 or £709); General Electric Co., £550 12s. or £490 12s. (alternative, totally enclosed motors, £815. 10s. or £727. 10s.); Crompton & Co. (plus 15s. per yard run of cable), £540. 19s. or £940 12s.; British Westinghouse Co., £579 15s. or £525 10s.; British Thomson Houston Co., £551. 7s. or £503 7s.; Siemens Bros. & Co., £545. 10s. or £494 10s.

The Council was recommended to accept the tender of the General Electric Co., at £550. 12s., plus 15s. per yard run of cable, estimated at £33. In their report on the subject the Finance Committee stated that they were informed that when the General Purposes Committee decided to recommend the Council to accept the tender of the General Electric Co. they did so upon its being reported to them that it would be the lowest tender, as it was thought Messrs. Crompton & Co.'s tender did not include the cost of changing the spare armatures. It had since been ascertained that Messrs. Crompton's estimate did include such cost as provided for in the specification; the committee, therefore, recommend the acceptance of Messrs. Crompton & Co.'s tender.

BARNSLEY.—The Council have accepted the following tenders:—Willans & Robinson, turbine £2,590, and condenser £2,150; Dick, Kerr & Co., alternator, £1,980; British Insulated & Helsby Cables, h.t. and l.t. feeders, £2,241. 3s. 3d.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

24,121 RENAULT. Electric illumination systems, more particularly for automobile vehicles. (3/4/14.)

24,231 ARMSTRONG. Receiving system for continuous electric waves. (18/12/13.) Relates to a wireless receiving system in which the receiving circuit is coupled with the detector circuit by a combined electro-static and inductive coupling, so as to facilitate the transfer of the energy of high-frequency oscillations from the wing circuit to the grid circuit.

24,235 GEIPEL. Manufacture of rubber-covered electric conductors.

24,502 BOUSSON. Vapour electric lamps. (Convention date not granted.)

24,657 KERR. Train control apparatus.

[illegible] WHEELER. [illegible]

1915 SPECIFICATIONS.

616 GRAY & BEST. Searchlights.

647 COLE. Electric signalling.

1,090 STERLING TELEPHONE & ELECTRIC CO. & WARD-MILLER. Electrical terminals.

2,014 CURTIS & IGRANIC ELECTRIC CO. Electric control apparatus.

2,[illegible] MIDGLEY & VANDERVEEL. Electric starters for internal-combustion engines.

3,261 LOUISE AUDREY MAURICE (executrix of George Maurice, deceased) & CASH. Electric light fittings.

4,045 LUNDBERG. LUNDBERG & PEGG. Electrical switches.

5,727 ELLISON & ANDERSON. Means for attaching electric cables or conduits to switches and the like.

5,879 STURGE. Combined electric switch and wall plug.

5,889 CABLE ACCESSORIES CO. & REEVES. Electric heating element.

6,093 BEAVER & CLAREMONT. Lead-jointing sleeve for electric joints.

13,051 JOHN. Replaceable electrical safety fuses.

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names in italics are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 18, 1915.

17,736. CREAMER-OSBORNE, HUGHES & HUGHES & SON. Magnetic compasses.

December 20, 1915.

17,752 JENSEN. Indicating or recording the frequency of periodic currents.

17,[illegible] TURNEY & JENSEN. Control of electrical measuring instruments.

17,[illegible] [illegible]. Variable automatic electric power cut-out, device for auxiliary prime-mover machinery.

17,[illegible] [illegible] & WILKINSON. [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] BTH CO. & WILKINSON. [illegible]

17,[illegible] [illegible]

December 23, 1915.

17,[illegible] WILSON, ANDERSON & CRAWFORD. [illegible] (31/12/14 U.S.)*

17,834 WILSON. System of electric welding.*

17,844 B.T.-H. CO. (G.E. Co., U.S.) Starting and lighting sets for automobiles.

17,[illegible] [illegible]

17,[illegible] [illegible]

December 22, 1915.

17,[illegible] WESTINGHOUSE E. & M. CO. (Westinghouse Electric Co., Inc., U.S.) [illegible]*

17,[illegible] [illegible] & KEMP. [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] SIEMENS. [illegible] (18/12/14 Germany.)*

December 23, 1915.

17,[illegible] [illegible]

17,[illegible] [illegible] & HOWARD & BULLOUGH. [illegible] (Addition to 23,336/13. April 20, 1915. Germany.)*

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible] & CO. [illegible]*

17,[illegible] [illegible]

December 24, 1915.

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible]

December 28, 1915.

17,[illegible] [illegible]

17,[illegible] [illegible]

17,[illegible] [illegible] & CO. [illegible] (Addition to and divided application on 16,[illegible]/15. 5/1/14 and 16/1/15 Switzerland.)*

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Poplar (London).—The report of the borough electrical engineer and manager (Mr. J. Horace Bowden) on the working of the Borough Council's electricity undertaking for the half-year to September last contains the following :—

For the second quarter (the September quarter) of the present financial year, the net figure was slightly better than for the first quarter, £2,071 (against £1,286), making a total for the half-year of £3,357. The corresponding figures last year were for the June quarter £871 and September quarter £1,536, total £2,407, therefore the increase to date is £950, of which the September quarter contributed £535. For many years Mr. Bowden has advocated that, given a scientific system of charging, the summer quarters should show a fair proportion of net profit. In former years, and in the case of almost all electrical undertakings, the summer half of the year shows a deficit, which is made up in the winter half by the sale of high-priced units for lighting. Until last year any profit made on the Poplar undertaking in summer quarters was negligible, and in former years a deficit was shown. Had similar coal prices prevailed to those prevailing in the first half of last year the profit would have been increased by £2,835, and as Stepney is not taking a standby supply this year, the net revenue account is depleted by £600. The war has also affected materials other than coal, and pay to dependents of men on active service and war bonus to staff account for £436—total £3,871. Also the revised prices for lighting and domestic supply came into force at the commencement of the half-year, which reduced the average price for private lighting from 2·634d. to 2·3d., equal to a reduction of £522. Unappropriated balance at March 31 last was £10,220, and the amount since earned brings the total to £13,578. Of this £3,500 was allocated to the general rate, and £1,000 granted to the staff under the bonus scheme ; £1,972 has been written off owing to displacement of No. 4 generator set, £1,792 has been expended on buildings, whilst £1,504 has been spent on services, meters, wiring, heating and cooking installations, &c., leaving a net unappropriated balance of £3,811. 0s. 3d. The capital debt at the beginning of the year was at £315,048, which was reduced during the six months to £309,659.

Southwark (London).—At last week's Council meeting the Electric Light Committee reported on the accounts of the electric light undertaking for the year ended March 31, 1915.

The committee regretted that the result of the year's working was a deficit of £6,410. 14s. 11½d. Repayment of loans required £5,526. 6s., interest £4,338. 11s. 6d., war service allowance, £228. 1s. 11½d., and the old stokers which had been scrapped cost £320. 13s. 9½d., total £10,414. The gross profit was only £4,002. 18s. 3½d. The deficit had been included in the estimate for the rates for the current year, and the Finance Committee had been asked to make the necessary transfer of £6,410. 14s. 11½d. to the electricity fund. It was proposed to raise a loan for capital expenditure, including amount required, to March 31, 1916. On March 31 last the capital account was overdrawn by £1,657. 5s. 9¼d., and application has been made to the London County Council for sanction to the expenditure and for a suffi- cient sum to cover the estimated outlay during the current year, estimated at £1,343.

After discussion, the report was referred back for further particulars.

COMPANIES' MEETINGS AND REPORTS.

EAST LONDON RAILWAY.—The report for 1915 states that the number of passengers carried was 8,497,284, against 6,172,121 in 1914. Members of his Majesty's Forces travelling on duty during the period of the war are not included in these figures. At the previously ascertained average rate of 1·27d. for each passenger the traffic should now yield about £45,000 per annum. Owing, however, to largely increased bookings to and from the two New Cross Stations which afford relatively full mileage, the above rate is now probably higher. Warrants for the six months' interest on the 2½ per cent. (Whitechapel Extension), the first 3½ per cent. and the second charge 4 per cent., class A debenture stocks, also for 7s. 6d. per cent. for one year on the second charge 4 per cent. debenture stock, class B, being the same as for the previous year, have been posted.

WESTERN UNION TELEGRAPH CO.—The income for the 12 months ended Dec. 31 last amounted to $52,356,286, while expenses (including maintenance and reserve) were $40,802,317, and interest on bonds $1,335,588, leaving a net income of $10,218,381. The figures for the corresponding period in 1914 showed a net income of $5,371,395.

CITY NOTES.

MEMORANDA (Jan. 19).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 58 15/16 Consols Pay Day, Feb. 2. Stocks and Shares Ticket Days Jan. 26 and Feb. 9. Pay Days Jan. 27 and Feb. 10. Price of silver, 26⅞d

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A dividend of 1 per cent. has been declared on the ordinary stock.

BRITISH INSULATED & HELSBY CABLES (LTD.)—Warrants in payment of the preference dividends will be posted on the 29th inst.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units sold during the four weeks ended Nov. 26, 1915, amounted to 1,709,366, compared with 1,075,864 units in the corresponding four weeks of 1914.

COMPANIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AIRES (LTD.)—A meeting of the holders of the 5 per cent. first mortgage gold bonds will be held at 24 & 28, St. Mary Axe, London, E.C., to consider a scheme of arrangement between the company and such bondholders.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—A dividend of 1¼ per cent. has been declared.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Jan. 18. The greatest care is taken in compiling these figures but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Jan. 18.	Rate per cent Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9 13/32	7 8 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9 1/32	4 15 8	Feb, Aug
10	6%	Do. 6% Cum 2nd Pref.	9 15/16	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar Sep'
5	7%	Do. 7% Pref.	7	0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 19 9	..
St.	4%	Charing Cross West End & City Deb.	83½	4 15 9	..
5	2/3	Do ½% Pref.	3	9 7	..
5	5%	Do Ord.	5 7/8	7 5 0	Aug Feb
5	4½%	Do. City Pref.	2½	8 8 8	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅝	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	11 1/16	5 8 6	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	10	7 0 0	Mar. Sept
10	6%	Do. 6% Pref.	10 1/16	5 19 3	Feb, Aug
St.	4½%	Do. 1st Deb.	90¼	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75½†	5 19 7	July
5	9%	Kensington and Knightsbridge Ord.	6 3/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79½	5 0 8	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 2 3	..
St.	4%	Do. 4% Mort. Debs.	75½	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 15/16	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1	5 16 4	Apl Oct
4	5%	South London E.S Ord	2 1/16	7 8 10	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	6 3/16	5 13 1	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 3/16	7 6 3	Mar Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3¼	6 0 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82⅝	6 0 9	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	76⅛	7 16 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	70⅝	5 14 2	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½†	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	65	6 1 3	May. Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1⅛	3 16 11	Jan, July
St.	4%	Do. 4% Pref.	60⅝	6 12 0	Mar. Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	25⅜	3 18 9	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74⅛	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82¼	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83¼	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	10⅝	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	63½	6 11 5	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109⅓	5 9 7	Jan, July
St	4%	Do. 4% Debs.	69	5 15 11	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan. July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 3/32	..	..
1/0	..	Do. A Ord.	1/16	..	..
St.	6%	Do. 6% Inc. Debs.	106	5 13 2	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Jan. 18.	Rate per cent Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways —*cont.*			
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	83½	7 3 9	Mar, Sept
..	4½%	Do. 4½% Bds.	100	4 10 0	Jan, July
5	..	Yorkshire W. Riding Ord.	¾	..	March
5	6%	Do. Pref.	4½	7 1 2	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2½	5 10 7	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1¼	4 12 10	Mar
100	5%	Do. Prior Lien Debs.	90½	5 10 2	Jan, July
1	6%	Do. 6% Pref.	⅞	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞	7 3 9	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 17 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅞	7 0 7	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	69	5 15 11	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅛	6 12 7	Jan, July
5	2/6	Do. 5% Pref.	4½	5 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3½	6 6 9	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	5⅛	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	62½	6 8 6	Jun, Dec
1	6%	Elec. Construction Ord.	⅛	8 0 0	May
1	7%	Do. 7% Cum. Pref.	¾	7 4 6	Jan, July
St.	4%	Do. 4% Debs	72½†	5 10 4	Jan, July
..	10%	General Electric Ord.	1⅝	9 8 3	July
10	6%	Do. 6% Pref.	9⅞	6 7 2	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 12 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	4 14 9	..
St.	4½%	Do. 4½% Do.	91½	4 18 4	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅞	10 17 8	Feb, Aug
10	5%	Do. Pref.	7⅛	6 7 0	Apl, Oct
100	4%	Do. 4% Debs.	98½	4 1 2	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	3⅝	6 17 2	Mar, July
100	4%	Do. 4½% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 3 3	May, Aug
St.	4%	Do. 1st Debs.	62½	4 16 8	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	
		Telegraphs.			
St.	30/0	Anglo American 6% Pref Ord.	99½†	6 0 9	Fb,My,Aug,N
St.	1½%	Do. Def. Ord. x d. and bonus	21½†	6 19 6	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69	5 15 8	Ja.Ap.Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 7 0	May, Nov
10	10%	Do. 10% Pref.	15⅛	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	6⅛	6 11 11	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½†	5 19 11	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64†	5 9 5	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	81½	4 18 2	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12⅞†	5 11 5	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 4	33	6 13 4	Ja, My, Jly
25	13%	Indo-European	48½	6 13 8	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1¼	4 0 0	July
10	1%	West India & Panama Ord.	11	8 19 9	May, Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 8 9	Mr, Jly,O.Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jan, Dec
..	4½%	Western Union 50 yr. Bds.	94	4 15 9	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	132½	6 [illegible] 6	Ja,Ap,Jn.O
..	5%	Cuban Telephn. Co. 5% Bds.	7⅝	6 13 1	Jan, July
1	7½d.	Monte Video Telephn. Ord.	⅛	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	100⅜	4 9 8	May, Nov
1	10%	*Oriental Telephone Ord.	1⅞	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅞	6 14 9	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	90	5 0 0	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10½	5 14 3	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10½	5 17 1	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	8⅝	5 16 2	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	6⅝	5 17 8	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	120	5 0 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams 5% Debs.	8[illegible]	6 3 11	Jun, Dec
St.	4½%	Do. 4½% Debs	77½	5 15 10	Jan, July
St.	4%	Do. 4% Debs.	7[illegible]	5 11 1	Jan, July
5	5½%	Do. 5½% 1st Pref.	4[illegible]	6 18 4	Jan, July
5	5½%	Do. 5½% 2nd Pref.	[illegible]	7 17 2	Jan, July
100	2%	Brazilian Traction Ord.	5[illegible]	7 16 10	Ft,M,A,.,N
100	$1½	Do. 6% Pref.	91[illegible]	6 11 1	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	[illegible]	[illegible]	May
5	2/6	Do. 5% Cum. Pref.	4[illegible]	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Gen. Debs.	6[illegible]	6 11 [illegible]	..
5	9½%	Calcutta Elec. Tram. Ord.	[illegible]	[illegible]	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	[illegible]	[illegible]	Feb, Aug
5	6%	Madrid Elec. Tramways Cum. Pref.	[illegible]	6 [illegible]	..
100	5%	Manaos Trams 5% Debs.	[illegible]	7 4 11	Jan, July
..	..	Mexico Trams Common St.	[illegible]	[illegible]	Ft,M,A,.,N.
..	5%	Do. 5% Bds.	47	10 12 [illegible]	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	[illegible]	4 [illegible]	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 50 yr. Bds	77[illegible]	6 8 7	Jun, Dec
100	4½%	Toronto Railway Co. 4½% Bds.	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	[illegible]	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	[illegible]	[illegible] 5 3	Jun, Dec
10	6/-	Bombay E. S. & T. 6% Pref.	10[illegible]	5 [illegible]	..
St.	4½%	Do. 4½% Debs.	[illegible]	5 2 [illegible]	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	[illegible]	[illegible]	[illegible]
5	5%	Do. 5% Pref.	[illegible]	5 10 [illegible]	[illegible]
..	7%	Canadian Gen. Elec. Common St.	11[illegible]	[illegible] 1 2	Ja,Apl,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	[illegible]	[illegible] 5 3	[illegible]
St.	5%	Do. 5% Cons. Deb. St.	[illegible]	[illegible] 5 3 4	Apl, Oct
..	..	Mexican Light & Power Ord.	[illegible]	..	[illegible]
..	..	Do. Pref.	3[illegible]	..	[illegible]
..	5%	Do. 5% Bds.	[illegible]	10 16 [illegible]	[illegible]
91½	5%	Shawinigan Water & Power 5% Bds.	[illegible]	4 16 10	Jan, July
..	6%	Do. Cons. Stock	140½	4 [illegible]	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	[illegible]	4 13 [illegible]	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	8[illegible]	5 12 [illegible]	May, Nov
1	..	Victoria Falls & Transvaal P. Co. 6% Pf.	[illegible]	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	92½	5 19 [illegible]	Jan, July

* And 12½% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Jan. 18, the following as the present basis prices of

New Metals.	per lb.		per ton
Solid Drawn Brass Tubes	15½d.	English Lead	£30 10 0
Solid Drawn Copper Tubes	15½d.	Antimony	Nominal.
Brazed Copper Tubes	15½d.		
Brazed Brass Tubes	17½d.	**Old Metals:**	per ton.
Brass Wire	14½d.	Clean Scrap Copper	£32 0 0
Copper Wire	14½d.	Brazlery Copper Scrap	£73 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£60 0 0
Brass Sheets	14½d.	Old Lead	£26 10 0
		Old Zinc	£60 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£125 0 0	Black Pewter	£75 0 0
Spelter	£83 0 0	Gun Metal	£70 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Jan. 18, the following approximate prices of Scrap Metals:—

	per ton.		per ton
Aluminium Cuttings	£125 0 0	Old Lead	£26 0 0
Clean Mixed Brass	£62 0 0	Tea Lead	£24 0 0
Clean Copper	£82 0 0	Old Zinc	£64 0 0
Brazlery Copper	£76 0 0	Hollow Pewter	£115 0 0
Gun Metal	£70 0 0	Shaped Black Pewter	£75 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 12	1,804	+ 244	32	58,601	+ 3,660
Anglo-Argentine	,, 14	50,239	- 1,252	2	101,080	- 3,131
Ashton-under-Lyne	,, 8	484	- 88	41	19,600	+ 1,506
Ayr Corporation	,, 15	244	+ 29	35	13,607	+ 835
Birkenhead Corporation	,, 16	1,408	+ 190	42	57,501	+ 4,857
Birmingham Corporation — Trams	,, 8	15,999	+ 3,600	41	582,490	+ 85,105
Birmingham Corporation — Buses&c.	,, [illegible]	824	+ 169	41	34,267	+ 18,583
Blackburn Corporation	,, 12	1,116	- 135	42	53,117	- 190
Blackpool Corporation	,, 13	785	+ 174	42	70,728	+ 2,136
Blackpool and Fleetwood	,, 15	312	- 53	2	771	- 55
Bolton Corporation	,, 16	2,600	- 118	42	112,699	- 1,073
Bournemouth — Trams	,, 12	1,989	- 295	41	86,808	- 4,401
Bournemouth — Buses	,, 12	[illegible]	- 2	41	942	- 90
Bradford Corporation	,, 8	6,244	- 407	40	263,484	+ 10,429
Brighton Corporation	,, 16	874	+ 32	42§	46,714	+ 573
Bristol Trams — Trams	,, 14	4,671	+ 404	2	9,366	- 57
Bristol Trams — Buses,&c	,, 14	4,918	- 803	2	9,738	+ 589
Burmah E. Trams & Ltg.	,, 15	R3,743	- R3[illegible]	2	R7,356	+ R384
Burnley Corporation	,, 15	1,689	+ 270	15	34,431	+ 2,928
Burton Corporation	,, 16	282	- 1	42	11,976	- 329
Bury Corporation	,, 16	1,274	- 104	42§	56,520	- 72
Calcutta Tramways Co.	,, 15	R70,455	+ R2,942	2	R150,955	+ R8,126
Camborne-Redruth	.. ..	..	..	..	..	..
Cardiff Corporation	,, 8	2,806	- 273	40	109,836	- 2,018
Cork Electric Trams Co.	,, 13	470	+ 43	2	854	- 2
Coventry Corporation	.. ..	..	..	..	..	..
Croydon Corporation	.. ..	..	..	..	..	..
*Derby Corporation	,, 15	1,021	+ 107	41	43,870	+ 1,715
Dover Corporation	,, 8	[illegible]	+ 17	40	12,680	- 2,197
Dublin & Lucan Railway	,, 14	113	- 4	2	228	- 17
Dublin United	,, 14	6,041	- 346	[illegible]	12,212	- 698
Dundee Corporation	,, 12	1,293	+ [illegible]	[illegible]	47,519	+ 2,648
East Ham Council	,, 15	1,303	- 53	41	54,281	+ 5,636
Exeter Corporation	,, 14	335	- 18	41	15,656	+ 829
Glasgow Corporation	,, 15	21,755	+ 2,067	33‡	715,151	+ 52,190
Gossop Trams	,, 15	131	+ 22	3	410	+ [illegible]
Gloucester Corpn.	,, 12	308	- 5	41	13,701	+ 147
Halifax Corpn. — Trams	,, 11	2,065	- 140	41	91,306	+ 780
Halifax Corpn. — Buses	,, 11	[illegible]	- 5	41	[illegible]	- 17
Hastings Elec. Trams Co.	,, 14	773	- 5	2	1,598	- 105
Huddersfield Corpn.	,, 16	2,551	+ 250	41	111,086	+ 15,058
Hull Corporation	,, 15	3,259	+ 195	41	128,335	- 1,751
Ilford District Council	.. ..	..	..	..	..	..
Ilkeston Corporation	,, 12	130	+ 19	41	5,529	- 253
Ipswich Corporation	,, 15	473	+ 91	40	22,787	+ 3,716
Isle of Thanet Co.	,, 15	259	- 20	15*	3,975	- [illegible]
Kilmarnock Corporation	,, 15	198	+ 15	35	5,944	+ 211
Lanarkshire Trams Co.	,, 13	2,068	- 400	2	4,516	- [illegible]
Lancashire United	,, 12	1,593	+ 183	2‡	2,945	+ 167
Leeds Corporation	,, 15	8,893	+ 707	42	373,489	+ 29,032
Leicester Corporation	,, 15	3,173	+ 349	2	7,088	+ 961
Leith Corporation	,, 15	759	+ 118	35	27,977	+ 1,946
Lincoln Corporation	,, 15	136	+ 18	42	5,905	+ [illegible]
Liverpool Corporation	,, [illegible]	14,240	+ 1,391	1	16,393	- 1,175
Llandudno&ColwynBayR.	,, 14	187	- 20	6	1,182	- [illegible]
London County Council	.. ..	..	..	..	..	..
Lowestoft Corporation	,, 15	127	- 43	15	1,990	- 720
Maidstone Corporation	,, 13	195	+ 35	41	9,074	- 368
Manchester Corporation	,, 15	17,579	- [illegible]	40	740,644	+ 28,159
Nelson Corporation	,, 13	182	+ [illegible]	41	8,122	+ 428
Newcastle-on-Tyne Corpn.	,, 15	5,823	[illegible]	41	258,931	..
Newport (Mon.) Corpn.	,, 15	862	+ 108	42	[illegible]	- 1,132
Northampton Corporation	,, 14	[illegible]	+ 117	41*	31,114	+ 5,196
Nottingham Corporation	,, 13	3,747	+ 434	41	[illegible]	+ 11,617
Oldham Corporation	,, 16	2,290	+ [illegible]	43	[illegible]	+ 4,487
Portsmouth Corporation	.. ..	..	..	..	..	..
Preston Corporation	,, 12	1,059	- 153	41**	40,169	+ 2,034
Rawtenstall	.. ..	..	..	..	..	..
Rotherham Corporation	,, 12	1,259	+ 336	41	48,435	+ 6,078
Salford Corporation	,, 17	5,154	+ 413	42‡	[illegible]	+ 9,257
Sheffield Corporation	,, 16	9,667	+ 1,750	41	[illegible]	+ 52,654
Southampton Corpn.	,, 12	1,508	+ [illegible]	41	62,169	+ 7,111
Southend Corporation	,, 12	[illegible]	+ 1	41	33,845	- 7,958
Southport	.. ..	..	..	..	..	..
St'lybridge,Hyde,&c.,Jt. B	.. ..	..	..	..	..	..
Sunderland Corporation	,, 16	1,484	+ 199	42	63,128	+ 1,404
Sunderland District	,, 12	[illegible]	- 88	11	6,251	+ [illegible]
Swindon Corporation	,, 12	187	+ 19	41	8,177	- 744
Tyneside Tram Co.	.. ..	..	..	..	..	..
Wallasey Corporation	,, 15	[illegible]	- 29	41	53,283	- 1,0[illegible]
Walsall Corporation	,, 13	[illegible]	+ 127	3	1,785	+ 214
Walthamstow	.. ..	..	..	..	..	..
Warrington Corporation	.. ..	..	..	..	..	..
West Ham Corporation	,, 13	2,989	- 148	41	127,922	- 10,856
Wigan Corporation	.. ..	..	..	..	..	..
Wolverhampton Corpn.	,, 12	1,152	- 129	15	16,865	+ 1,600
Yorkshire W R Trams	,, 16	[illegible]	- 87	3	5,017	+ 66[illegible]

(a) These amounts are with the corresponding period last year. * Partly electrical. † [illegible] ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days. ¶ Plus 2 days. ** Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES..... 585
Arrangements for the Week . . 588
On Microphones and Microphonic Contacts. By Prof. P. O. Pedersen. Illus. 589
The Losses in Electrical Water-Heaters. By A. Rittershausen. Illustrated 591
The Double Dynamometer Wattmeter. By C. V. Drysdale, D.Sc. Illustrated.—*Concluded* 593
On the Production of High Permeability in Iron. By Prof. Ernest Wilson. Illus. 596
Electrification of the Manchester to Bury Section of the Lancashire & Yorkshire Railway. Illustrated.—*Continued*..... 597
The Principles of Modern Printing Telegraphy. By H. H. Harrison. Illus..... 602
THE LEGAL RECORD OF 1915.. 604
REVIEWS..... 606
The Telephone and Telephone Exchanges: Their Invention and Development [Kingsbury]: Reviewed by W. Aitken.
Examples in Alternating Currents. Vol. I. [Austin].
How to Make Low-Pressure Transformers [Austin].
Directions for Designing, Making and Operating High-Pressure Transformers [Austin].
The Predetermination of the Performance of Dynamo-Electric Machinery.—*Discussion* 607
Commercial Mobilisation. *Discussion* 610
PARLIAMENTARY INTELLIGENCE 611
LEGAL INTELLIGENCE 612
The "Electrician" Commercial and Industrial Section .. 613–620

NOTES.

We Return Thanks.

ON behalf of the family of the late Mr. GEORGE TUCKER, as well as on our own behalf, we return thanks for the many letters of condolence we have received.

The Lancashire & Yorkshire Railway Electrification.

THE electrification of the Manchester to Bury branch of this railway is of more than usual interest because it is the first example in this country of continuous-current working at high pressure. In this case the pressure selected is only 1,200 volts, but it is the outcome of experience with the much higher pressure of 3,500 volts on the line between Bury and Holcombe Brook. Here the results, although nothing has been published upon the subject, appear to have been satisfactory, and, therefore, we may perhaps expect to see an extension of this system in due course. The particular features of interest, however, in the present line are the use of a third rail as distinct from the overhead system, and the use of a special side-running shoe. Owing to the adoption of 1,200 volts it became necessary to have some protection for the third rail. An under-running rail has been adopted on many lines, but the clearance available was insufficient on the Lancashire and Yorkshire Railway for this construction to be used. Mr. J. A. F. ASPINALL, the general manager of the railway, therefore, designed a special side-running shoe, which we illustrate in this week's issue of THE ELECTRICIAN. One difficulty in adopting this form of construction is that the automatic adjustment depends upon a pivoted lever; consequently the wear cannot be so uniform as in the case of the over-running or under-running shoe where a direct downward or upward pressure is obtained. We shall be interested to learn in due course whether this special form of construction shows any disadvantages in maintenance. Minor features of interest are to be found in the precautions adopted in handling the continuous current at the sub-stations and some points of detail in the rolling stock, which we shall describe in our next issue.

Municipal Electricity Supply Finance.

IN non-industrial towns attempts continue to be made by electricity committees to increase the price of current. Many of these attempts are based on unsound argument. At various times in these columns we have directed attention to what we will now call the rottenness of the finances of certain of the municipally-owned electric generating stations. A striking example of how not to run such a station is that of Brighton. In this south-coast town, contrary to the advice of the electrical engineer, the Council has, on various occasions, appropriated large sums from the "profits" of the electricity undertaking for the relief of rates. Moreover, considerable expenditure has been incurred in providing plant for street lighting purposes. Now that there is no street lighting to speak of in Brighton, the remaining consumers are expected to pay, not only the increased cost of the current actually generated, but also the interest, depreciation, sinking fund and managerial charges in connection with a section of the undertaking which represents a large percentage of the total, and which is of no use till such time as street lighting can again be indulged in on an extravagant scale. The endeavour to adopt a rebate tariff beginning with 5½d. per unit is an impudent one, for, at a time like the present, there is no reason why big hotels, places of entertainment and large shops should not bear their fair share of the cost of the undertaking. This fair share per unit is found by dividing the whole of the fixed charges (less street lighting charges) by the number of units sold. The attempt to saddle consumers with *any part* whatsoever of the losses brought about by the absence of street lighting is unjust. We advise consumers of electricity to bring strong pressure to bear in order to get these wrongs redressed, and we compliment the Brighton Corporation on referring back for the second time the question of increased charges. To those who preach economy in council chambers we would say that they should carefully study the methods practised by the gas companies.

Trading with the Enemy.

DURING the last few months public opinion has grown more emphatic in the demand for dealing with enemy firms, or with firms that are of an enemy character, although apparently British, and who are trading to the disadvantage of British firms and of the British Empire. A further Bill has now been passed with the object of dealing with these matters, and we are glad that steps are being taken in this direction. At the same time, it must be admitted that the subject is not one

without difficulty. It largely resolves itself into a question of mutual treatment between ourselves and our enemies. If British firms in enemy countries are being treated in drastic fashion and unfairly, we should at least provide ourselves with the power of retaliation. In any case, however, such power should be used judicially and should be applied with some discretion. There are many companies, for example, who have purchased rights from aliens by means of shares. In cases of this kind a considerable proportion of the shares of the company may be held by enemy aliens. Such companies, however, cannot in any way be considered as enemy companies, and a very great injustice would be done by so doing. On the other hand, it is obviously undesirable that large funds should be accumulated by companies for the benefit of enemy aliens immediately at the end of the war. The Bill meets this position by holding up profits of this kind, which will only be released by an Order in Council when it is found that British firms in enemy countries are receiving proper treatment.

British Patents.

In close connection with the above is the subject of British patents, and the extent to which our present system meets the needs of the case. We are glad to see that Mr. Runciman quite recently, in the House of Commons, expressed the view that our patent system should be overhauled. There is no doubt that at present it is not all that it should be. We think there is much to be said for the modifications suggested at last week's dinner of the British Electrical and Allied Manufacturers' Association by Mr. James Keith. These suggestions include, among other points, a "real" search to ensure novelty and validity, the refusal of a patent unless it be novel or practicable, the abolition of renewal fees, and the extension of the period of a patent from 14 to 17 years. With regard to these suggestions it is, of course, practically impossible for the Patent Office to guarantee a patent against prior publication, but very much more might be done than is done at present to ensure novelty. In comparison with the procedure in the United States and in Germany, our own Patent Office does not show entirely to advantage. It is cheaper initially, but more expensive in the long run. The suggestion, however, that patentees would, on the whole, prefer to pay a heavy fee in one lump sum may be doubted. Another point in our present Act is that referring to compulsory working. This has had the effect of causing many foreign firms to lay down works in this country, and thus to give employment to British labour; but, on the other hand, it has had the disadvantage of introducing large numbers of foreigners who were not altogether desirable. In many ways it might be better to insist upon the working of foreign patents on a royalty basis in this country, with complete disclosure of processes.

Engineering (?)

The current issue of the Post Office Electrical Engineers' Journal contains an illustrated description of a particularly bad piece of engineering, as well as an account of what befell the said engineering nearly two years ago, when it was tried and found wanting. To meet the esthetic tastes of the residents in a certain town it was decided to carry the trunk telephone and telegraph lines on metal poles as far as the borough boundary. All went well till a pantechnicon came into slight collision with one of the poles, when the latter broke off short at the base. This was followed by the similar fracture, in quick succession, of 10 poles. Fortunately this alarming occurrence was not attended by loss of life, and it is to be hoped that the "designers" profited by the experience. The poles were of steel fixed into ornamental cast iron bases, which were sunk into the ground. The steel poles terminated some 2 ft. or 3 ft. above the ground level, and the cast-iron bases were, therefore, heavily stressed. To make matters worse, many of the castings were faulty in so far as the cores had floated in the moulds, thus leaving very little thickness of metal where metal was most needed. Standard tramway practice leaves little to be desired in the way of pole design and fixing, and we suggest to the Post Office authorities that the public highway is not a suitable place for the purpose of ill-conceived and ill-conducted experiments which result in several tons of metal falling on to the highway. Had we, as a department of the State, been in any way connected with such dreadful engineering we should not have sanctioned the publication of the article to which we have referred.

Comparing Load and Water Rate Curves.—The "Electrical World," U.S.A., refers to a case where an obscure water leak was detected by comparing the load curves with feed water curves.

"The Electric Locomotive." *Erratum.*—With reference to Mr. Pierre Weil's letter on "The Electric Locomotive" in our last issue, the drive referred to in his P.S. on p. 574 should read "Kando." instead of "Kands."

Motors Replace Compressed Air.—At Hamilton, Ohio, small power electric motors are, according to the "Electrical World," replacing compressed air for operating the gates of level crossings.

Battery Signalling Bells.—The "Iron and Coal Trades' Review" reports the discussion recently at Manchester by the Association of Mining Electrical Engineers on this subject. It was pointed out, that in a lecture at the Society of Arts, 25 years ago Prof. S. P. Thompson had described several methods of getting rid of sparking. The most satisfactory of the coils tested was the differentially-wound coil, which gave no spark. Most of the speakers referred to the very great importance of bell signalling, the whole work of the colliery depending on it.

Elevator Motor.—According to the "Electrical World," the Westinghouse Co. of East Pittsburgh, Pa., has brought out a motor of the induction type which has two windings. For low speed service (250 revs. per min.) a 24-pole winding is used, and for high-speed work (850 revs. per min.) an eight-pole winding is used. The motor develops a high torque at low speed with a starting current only 50 per cent. above the full-load current. The motor is made in two sizes—viz., 25 H.P. and 35 H.P. ratings.

The Value of the Experimental Fan in the Mining Laboratory. In a Paper read recently before the Manchester Geological and Mining Society, Mr. D. E. Thomas, B.Sc., deals with the testing of mining fans. Tests of a "Sirocco" fan electrically driven gave an efficiency of 81·5 per cent. with 3·4 in. water gauge and a mine opening of 15·9 sq. ft. He compared Rateau's and Murgue's formulæ by means of an experimental fan, and concluded that the value of the "vena contracta" in the latter formula is about 0·70, instead of 0·65. He considers there is still a big field for research in ventilation work.

"Beama Journal."—The current issue of this well-printed quarterly contains a number of interesting articles, amongst which may be mentioned "Protection for National Progress," "The Equilibrium of Society" and "Science and Industry" by Prof. S. P. Thompson. Mr. T. C. Edler contributes an informative article entitled "Electrical Finance and Industrial Banking," and, under the heading "Unfair Handicaps on British Export Trade," Mr. F. Broadbent deals with the questions of export duties, transport, canal and water borne traffic, through rates, ocean freight and rebates. We have difficulty in understanding the *raison d'etre* of the articles "Power Factor Meters" and "Automatic Control Gear," as they appear not only to be somewhat out of place in a non-technical journal, but also to be lacking in originality.

A New Standard Light Source.—Mr. L. A. Jones describes a new light source in the "Abridged Scientific Publications" of the research laboratory of the Eastman Kodak Co., U.S.A. This consists of an acetylene burner giving a long thin cylindrical flame. It is insensitive to air currents, and has a uniform intensity over a considerable length. The results show that such a burner is sufficiently accurate and reliable for all ordinary purposes. The only apparatus necessary to control the intensity is a simple water manometer, whereas with an electric standard some form of potentiometer is usually necessary.

Gas and Hygiene.—A recent article in the American "Gas Age" sums up the results of an investigation as follows: "It can be said that there is no question but that gas lighting stands behind electric lighting in every respect, for the latter causes no vitiation of the air, develops no humidity and moisture and produces little heat." It appears from the results of experiments that the claims for superior ventilating effect of gas does not exist. The tests made were various, one of these being the cooking of sauerkraut in the room, and then observing how long the odour could be detected in the room. There was no difference in the rooms lighted by gas or electricity. Tests for CO_2 showed a higher percentage for gas, and two curves illustrating the decrease of bacteria in the air, when subjected for a definite time to gas or electric lighting, showed little difference.

The Colour of Illuminants.—Mr. L. A. Jones, of the Research Laboratory, Eastman Kodak Co., U.S.A., has a Paper in the "Abridged Scientific Publications" on this question. Usually colour analysis has been made by the trichromatic method, whereas in this Paper Dr. Nutting's monochromatic method is used. Observation showed that no measureable variation occurred in sunlight between 9 a.m. and 3 p.m. Sunlight reflected from a non-selective surface—viz., magnesium carbonate—was used as standard white. The following results were obtained :—

Sunlight	100	per cent. white
Average clear sky	60	,, ,,
Standard candle	13	,, ,,
Pentane lamp	15	,, ,,
Tungsten glow lamp	35	,, ,,
Mercury vapour arc	70	,, ,,
Helium tube	32	,, ,,
Crater of carbon arc	59-67	,, ,,
Acetylene flame (flat)	36	,, ,,

Other interesting data is given, such as the energy radiated per unit area for different surfaces.

Business and Engineering.—An interesting Paper on the above subject was read recently by Mr. F. G. Hatch at a meeting of the Junior Institution of Engineers. The author pointed out that the finished article has to be designed, material must be purchased, processes are required to manufacture, and finally the product has to be sold. He dwelt on the fact that an engineer is, as a rule, a poor business man, and too often fails to realise that all his actions are eventually judged by an £. s. d. standard. He referred to the value of stocks and shares, and as an example quoted the financial position of 38 engineering firms. These firms on the average paid a dividend at the rate of 5·9 per cent. About 14 of these were below this figure, and the author very rightly drew attention to the difference between such cases and gilt-edged securities, and referred to the necessity for industrial concerns paying reasonable dividends to cover depreciation. The author, in urging the importance of the business attitude, pointed out, that, although every business man need not be an engineer, it was of the utmost importance for engineers to be good business men.

Water-Power of Sweden.—Mr. Sven Lübeck read an interesting Paper on the above at the International Engineering Congress recently at San Francisco. Taking the high and low-water seasons into account, he estimates the total turbine horse-power available for utilisation at 6·3 million. As early as 1400 water-power was used in connection with the iron industry, the next great development being the wood pulp industry of 1870. Sweden is rich in lakes, so that the "run off" from the rivers is comparatively uniform, and in addition the lakes are situated on high plateaus, so that their regulating effect is of value for long and important parts of the water course. The cost of storage of an effective horse-power works out at £2. 14s. to £5. 8s. It appears that in 1915 the total turbine horse-power installed, or under construction, was 850,000. This is used as follows :—

Iron industry	28 per cent.
Timber and pulp industry	30 ,,
Textile industry	5 ,,
Electrochemical industry	11 ,,
General power	26 ,,
	100

He considers future progress lies in the electro-chemical and electrolytic industries, and that heating and lighting are of no practical consequence as regards water-power development. After describing several installations, it is pointed out in an appendix that there is an ancient institution called "King's Vein." This applies to the middle third of water courses, and is to protect the community generally. Recently new laws have been proposed, and the Government have claimed a large amount of water-power in the Norrland rivers. Although the Government's demands are usually rejected by the courts, many schemes for utilising water-power are held up for the time being.

The Damping Factor in Highly Damped D'Arsonval Galvanometers.—Mr. Lindley Pyle, writing on the above in the "Physical Review," U.S.A., discusses the equation,

$$K\frac{d^2\theta}{dt^2}+a\frac{d\theta}{dt}-b\theta=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

as follows: K, a and b having the usual significance, then the damping being < critical

$$\theta=\frac{\omega_0}{s}\varepsilon^{-\Delta t}\sin st, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where ω_0=initial angular velocity, when $t=0$ and $\theta=0$, $\Delta=a/2K$ and $s=(b/K-a^2/4K^2)^{\frac{1}{2}}$. Let t_1 represent the time required to reach the first maximum value of θ; then from (2) $\frac{2t_1}{T}=\frac{1}{\pi}\sin^{-1}(1-a^2/4K^2)^{\frac{1}{2}}$, where T represents the damped period. From this it follows that

$$\theta_0=\left(\frac{\theta_1}{\theta_2}\right)^{2t_1/T}\cdot\theta_1,$$

where θ_0 is the undamped throw and θ_1 the first throw. The index $\frac{2t_1}{T}=\frac{1}{2}$ only when a is zero, and decreases with increase in a. By taking values of θ_1/θ_2 the above ratio can be calculated, and a curve for connecting the swings drawn. This is useful in cases where the damping is considerable.

OBITUARY.

R. F. S. Venner.—We regret to have to record the death of Mr. Robert F. S. Venner, electrical engineer, which occurred on Monday last. He was well known in the electrical industry, particularly in connection with meters, electric cooking, electric signs, &c. He was a member of the firm of Messrs. Venner & Co. and a director of the Venner Time Switches (Ltd.) and Venner Signs (Ltd.).

Killed in Action.—The following employees of the County of London Electric Supply Co. (mains department) have been killed in action. They were all of the 9th Battalion (Buffs) East Kent: H. Beazley, T. Hyam and R. Reeves.

PERSONAL.

The following members of the staff of the County of London Electric Supply Co., who are serving with H.M. Forces, have received commissions :—

Mr. H. A. Moncrieff (of the secretarial department of the County of London Co.), who has been serving in the Queen's Westminsters, has obtained a commission as 2nd Lieut. in the 3rd Dorsets. Mr. F. H. Howell (secretarial department), formerly a bombardier in the 7th County

of London (R.F.A.), has obtained a commission in the Royal Field Artillery. Mr. N. F. Gadstone, after service in France, has obtained a commission as 2nd Lieut. in the 4th Essex. Mr. Sydney A. Knight (secretarial department), after service in France, has been gazetted 2nd Lieut. in the North Somerset Yeomanry. Mr. C. E. Scott, of the Putney local office, who served in the 23rd Middlesex Regiment, has been promoted to Regimental Quartermaster Sergeant, and is now a second-class warrant officer. Mr. Alan Leigh, of the mains department, has been granted a commission as temporary 2nd Lieut. of the 14th Service Battalion, East Surrey Regiment.

ROYAL ENGINEERS (T.F.).—The "London Gazette" contains the following announcement :—

London and Tyne Electrical and Mechanical Company : The appointment of the undermentioned officers, previously announced, is cancelled : Capt. (temporary Major) A. E. Levin, Second Lieut. (temporary Captain) Geo. L. L. Russell, Second Lieut. (temporary Captain) Hugh C. C. Tufnell. Second Lieut. (temporary Lieutenant) Fredk. H. Bowers.

APPOINTMENTS VACANT AND FILLED.

The Council of the Indian Institute of Science invite applications for the post of assistant professor of electrical technology. Salary, 625 rupees per mensem, with a house. Further information from Messrs. Jeremiah Lyon & Co., 4, Lombard-court, London, E.C., and applications must be sent to the Director of the Indian Institute of Science, Bangalore, India, by Feb. 15. *See also an advertisement.*

Advertisers require experienced instrument and meter testers, used to three-phase instrument and meter testing for manufacturing works in Manchester district.

Sub-station attendants are wanted for e.h.t. 6,600-volt rotary converters. *See advertisement.*

A firm of switchgear manufacturers advertise for a foreman.

Preston Tramways Committee have promoted Chief Inspector Manning to be chief traffic superintendent, and Mr. H. Alston to be chief traffic clerk.

Mr. H. H. Curtis has been appointed power station superintendent at Lake Coleridge (Tasmania) hydro-electric works.

INSTITUTIONS AND SOCIETIES.

Royal Society.—Last Thursday, the 27th inst., the following Papers, among others, were read : "A Portable Variometer for Magnetic Surveying," by Mr. G. W. Walker, F.R.S. ; "On the Single Line Spectrum of Magnesium and other Metals and their Ionising Potentials," by Prof. J. C. McLennan, F.R.S. ; "Discussion of the Kew Magnetic Data, especially the Diurnal Irregularities of Horizontal Force and Vertical Force from Ordinary Days of the Eleven Years 1890-1900," by Dr. C. Chree, F.R.S.

Royal Society of Arts. *Albert Medal.*—At a meeting of the Council on the 24th inst. the Chairman presented the Society's Albert Medal to Prof. Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S., for his researches in chemistry and physics, and their application to the advancement of arts, manufactures and commerce.

Diesel Engine Users' Association.—At the January meeting of the Diesel Engine Users' Association the subject of the use of tars and tar oils as fuel for Diesel engines was introduced for discussion. The president, Mr. Geoffrey Porter, A.M.I.C.E., referred to the fact that Mr. Charles Day, of Messrs. Marrlees, Bickerton & Day (Ltd.), had carried out tests and researches in connection with this subject, and that he had been specially invited to attend this meeting.

Mr. CHARLES DAY referred to the recent very great increase in the price of fuel oil and to the importance of endeavouring to secure suitable supplies from other sources. Tars and tar oils appeared to provide a suitable alternative to petroleum oils. Such liquid fuel was produced by gas works, coke ovens, blast furnaces, gas producers, and from the low temperature distillation of coal. He dealt at length with the nature of the product from these various sources from the point of view of suitability for use as fuels in Diesel engines, and referred to the fact that such fuels had been successfully used on the Continent. The great difficulties with tar oils had been completely overcome by a simple arrangement, by means of which a small quantity of petroleum oil was injected into the cylinder of the engine slightly in advance of the tar oil. The burning of the petroleum oil raised the temperature in such a manner as to ensure the prompt and satisfactory burning of the tar oil. The largest source of supply of tar oil was from the distillation of gas works tar, this product being obtained after the distillation of crude naptha, light oil and carbolic oil. Referring to the question of a suitable specification for tar oils for use in Diesel engines, Mr. Day mentioned that a very strict stipulation as to calorific value was not necessary, as numerous tests had shown that this is not a very variable quantity. He estimated that the cost of carrying out the necessary alterations to engines manufactured by his firm for adapting them to the use of tar oils, including a new needle valve casing, ignition pump and device for controlling the pump, would be in the neighbourhood of £1 per horse-power. He further estimated that, taking petroleum oil and tar oils at present prices, the cost of this alteration would be paid for in the first year by the saving effected in the cost of fuel oil on an engine working for the average number of hours per annum. As a matter of interest, he mentioned that he had run Diesel engines quite successfully on whale oil.

After a short discussion, the PRESIDENT suggested that, as Mr. Day was present, the members would be very glad if he would let them have some information on the subject of the Crosshead type of Diesel engine which was now being made by Mirrlees, Bickerton & Day (Ltd.).

Mr. DAY referred to its advantages. These were, in the first place, the greatly reduced risk of piston seizing, due to the fact that the piston need not be such a close fit, as the transverse forces due to connecting-rod angularity were taken on the crosshead, and not on the piston. He pointed to the fact that piston seizing in the case of the trunk type of piston was often caused by the distortion of the piston due to irregular sections or to the expansion of the piston pins. There was also reduced risk of piston cracking, and it was possible to give much better support in the crosshead type than in the trunk type to the centre of the piston, which was exposed to the greatest heat and to the maximum stress. To further secure that the piston rod should be kept cool a cover was fitted between the cylinder and the crank chamber, this cover being fitted with a water-cooled gland, which also prevented transmission of heat to the crosshead. A further advantage claimed for the crosshead type of engine was greater economy in lubricating oil. The lubricating oil, not being splashed or thrown on to the cylinder walls, was kept much cooler, and, none of it being lost through the cylinders, a substantial saving resulted. The air on its way to the cylinders was arranged first to go underneath the pistons.

Institute of Chemistry.—The results of the January examinations have now been published :—

Three candidates passed the intermediate examination—viz., H. E. Cox, B.Sc., A. J. Somer and E. E. Wells, B.Sc. Nine candidates passed the final (A.I.C.) examination—viz., in mineral chemistry branch—R. G. Browning, B.Sc. ; in organic chemistry branch—R. Brightman, R. L. Brown, A.R.C.S.I., H. S. Foster and A. Hancock ; in chemistry (and microscopy) of food and drugs, fertilisers and feeding stuffs, soils and water—C. E. Corfield, J. J. Geake, F. A. Pickworth, B.Sc., and Fred Smith.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Jan. 28th (to-day).

PHYSICAL SOCIETY OF LONDON.

5 p.m. Meeting at the Imperial College of Science, Exhibition-road, S.W. Second Guthrie Lecture, by Mr. W. B. Hardy, Sec. R.S., on "Some Problems of Living Matter."

SATURDAY, Jan. 29th.

ASSOCIATION OF MINING ELECTRICAL ENGINEERS.

3:30 p.m. Meeting at University College, Nottingham. Paper on "Unusual Breakdowns in Colliery Electrical Plant," by Mr. Roger Devine ; also "Notes on Experiments with Battery Signalling Bells following the Senghenydd Explosion," by Mr. G. M. Harvey.

TUESDAY, Feb. 1st.

RÖNTGEN SOCIETY.

8:15 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, S.W. Discussion on "The Injurious Effects Produced by X-Rays," to be opened by Dr. Sidney Russ.

THURSDAY, Feb. 3rd.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street, Piccadilly, W. Third lecture on "The Utilisation of Energy from Coal—Industrial Applications of Gaseous Fuels Derived from Coal," by Prof. W. A. Bone, D.Sc., Ph.D.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. CLAY, V.D.

Orders for week commencing 31st January, 1916.

Drills : 6:25 to 7:25 ; 7:25 to 8:25 p.m.

Saturday, 29th January.—Uniform Parade 2:45 p.m.

Monday, 31st January. Sections 1 and 2 Technical ; Sections 3 and 4. Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, 1st February. School of Arms, 6 to 7 p.m.

Thursday, 3rd February.—Shooting for Sections 3 and 4.

Friday, 4th February.—Sections 3 and 4, Technical ; Sections 1 and 2. Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, 5th February.—Adjutants' Instruction Class at 2.30 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 16, Regent street S.W.

Sections for shooting parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Sweet Bros., Ludgate-hill, as soon as possible.

Payment for uniform to be made to the adjutant.

ON MICROPHONES AND MICROPHONIC CONTACTS.*

BY PROF. P. O. PEDERSEN.

Summary.—Part I. contains a description of some simple experiments on microphones showing the great influence of even very minute displacements of the diaphragm on the sensitiveness of a microphone. Some simple means by which a microphone can always be brought in its most sensitive state are described. Part II. contains the results of a long series of tests on microphonic contacts. A theory of the microphonic (carbon) contact is set forth, and several of its consequences are tested.†

Part I.—Some Tests on Microphones.

1. *Some Preliminary Experiments.*—In the primary circuit of an ordinary telephone transmitter with a metal mouthpiece (Fig. 1) is inserted a slide resistance of, say, 200 ohms. A watch is put on the microphone and the resistance adjusted until the ticking is barely heard in a receiver inserted in the secondary circuit. If the mouthpiece is then heated—by means of a Bunsen burner or otherwise—the intensity of the ticking heard in the receiver is greatly increased. This increased sensitiveness of the transmitter not only completely disappears when the mouthpiece is allowed to cool again, but generally, when all heat is lost, the sensitiveness is even less than it was originally. Owing to the heat capacity of the mouthpiece and adjacent parts, it takes several minutes to bring the microphone through the described cycle. If the mouthpiece and front plate are removed, and the front side of the diaphragm thereby exposed, the above experiment may be repeated in a slightly different way—viz., a Bunsen burner placed in front of the diaphragm at a distance of, say, 10 cm. increases the sensitiveness greatly; the increase appears

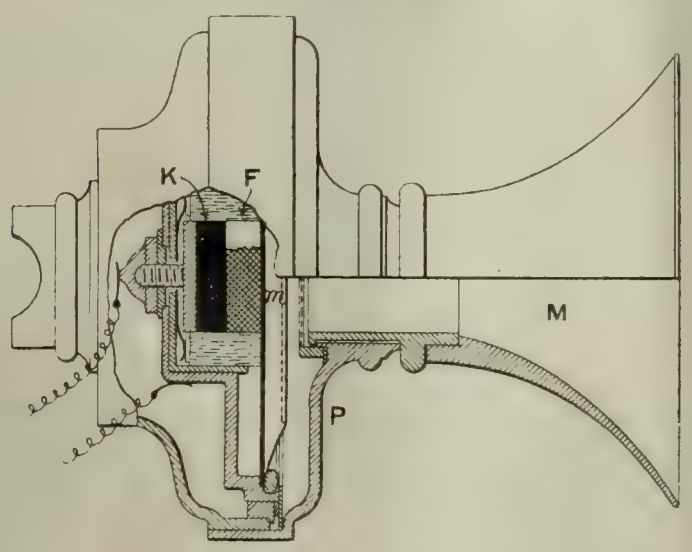


Fig. 1.—Telephone Transmitter used in most of the Experiments. (From the Copenhagen Telephone Co.)

m, carbon diaphragm varnished on front side. F, felt ring. M, mouthpiece. P, front plate.

almost immediately, and is again lost very soon after removing the flame. If the front side of the diaphragm is covered with tinfoil, or if the carbon diaphragm is replaced by one of polished metal, the observed effect is much less pronounced.

These experiments indicate that the increase of sensitiveness is due to the fact that the temperature of the front of the diaphragm is raised above that of the back, the thermal expansion thereby causing the diaphragm to bend forwards (away from the carbon grains). The correctness of this view was proved by the following test: A piece of iron wire 0·5 mm. thick and 10 mm. long was glued to the front of the carbon diaphragm of the microphone, mouthpiece and front plate being removed. By means of a permanent magnet with one of its poles at a distance of 1 mm. or 2 mm. from the iron wire, the diaphragm could be drawn a little forward. The sensitiveness was then increased. As soon as the diaphragm was released the increase in sensitiveness was lost, and generally more than lost.

For further experiments an electromagnet was substituted for the permanent magnet, and the iron wire was replaced by an iron ring as shown in Fig. 2.

2. *Increase of Sensitiveness is always Accompanied by an Increase of Resistance of the Microphone.*—The resistance is most conveniently measured by the ammeter-voltmeter method indicated in Fig. 3. The microphone current was usually between 10 and 40 milliamperes, the ballast resistance R_1 accordingly being between 5,000 and 25,000 ohms. As the resistance of the microphone is only at most a few hundred ohms, the microphone current will be practically independent of the resistance of the microphone, which may be read directly on the millivoltmeter V.

The experiments showed that the resistance and the sensitiveness of the microphone always varied in the same manner. The increase of resistance in the tests mentioned above was generally about 100 to 150 per cent.

3. A long series of experiments was made in order to investigate the *relation between the increase of resistance and the displacement of the diaphragm.* In one series of tests the displacement was measured by optical interference. In another series a known additional air pressure was applied to the capsule and the displacements calculated on the basis of the known elastic properties of the diaphragm. In a third series the back electrode (K in Figs. 1 and 2) was drawn backward by a micrometric device. This has the same effect as a forward displacement of the diaphragm. The result of all measurements was that an outward displacement of either diaphragm or back

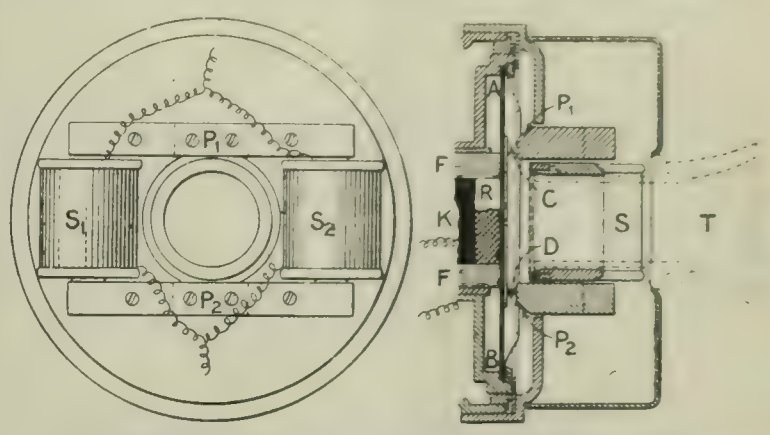


Fig. 2.—Transmitter Provided with an Electromagnet and with an Iron Ring CD Glued to the Diaphragm AB.

S_1 and S_2 are the coils, P_1 and P_2 the pole pieces.

electrode of 1 to 2μ* causes an increase of the resistance of 100 to 200 per cent. or even more. (For further details see the original Paper.)

Another series of experiments may be described in some detail here. The microphone capsule was firmly clamped on a stand with its diaphragm in the normal (vertical) position, and the shellac was removed from the central part of the diaphragm. A metal pin with a rounded end could be pushed against the central point of the diaphragm and moved to and from by a fine micrometric screw. The tests were carried out in this way: The metal pin was pushed against the diaphragm and the whole apparatus shaken until the resistance had attained its normal value of about 100 ohms. The pin was then moved backward very cautiously, and a set of corresponding micrometer and resistance readings noted† until the pin ceased to touch the diaphragm. The results of four sets of measurements are shown in Fig. 4. The curves end at the points where the connection between pin and diaphragm was broken. In curve 1 the original inward displacement was about 7μ, in curve 4 about 51μ. The final resis-

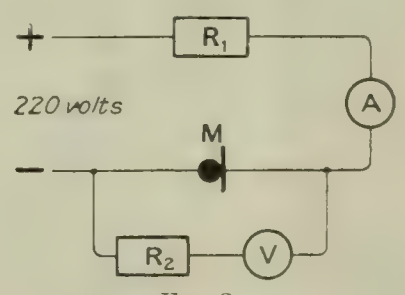


Fig. 3.

. M, microphone. A, milliammeter. V, millivoltmeter. R_1 and R_2 resistances.

tance was between 3·1 times the initial resistance for curve 1 and 6·8 times for curve 4. Experiments proved that the sensitiveness of the microphone also in this case increased with increasing resistance.

4. *Transmitter with Press Button.*—The above-mentioned experiments show that the resistance of a transmitter may equally be increased by a *transitory* inward displacement of the diaphragm as by a permanent outward displacement. An arrangement by which the diaphragm may be given such a transitory displacement without any danger of hurting the diaphragm or other parts of the microphone is shown in Fig. 5. On the flat spring ABA is fastened the press button PB and an insulating pin, P. When the button is pressed P exercises a slight pressure on the diaphragm *m*, and this pressure ceases as soon as the button is released. The result is a great

* Abstract of an article in the Danish journal "Elektroteknikeren."

† All the experiments were carried out in the telephone laboratory of the Royal Technical College in Copenhagen.

* 1μ=0·001 mm.

† The test current used in the resistance measurements was very small.

Table I.

Microphone current, Milliamps.	Resistance. R_1 Ohms.	Resistance. R_2 Ohms.	$R_2 R_1$.	Remarks.
2·5	·128	552	4·31	.....
	160	568	3·55	.....
	128	520	4·07	.....
	116	520	4·49	.....
	128	592	4·64	.....
	120	608	5·06	.....
	128	604	4·72	.....
	128	616	4·83	.....
	144	528	3·67	.....
10·0	125	370	2·96	Mean of 15 tests
15·0	113	295	2·61	,, 9 ,,
20·0	95	245	2·59	,, 7 ,,
30·0	74	182	2·46	,, 8 ,,

increase of the resistance and a corresponding increase of sensitiveness. Table I. shows some of the results obtained with such a transmitter. R_1 is the resistance just after shaking the transmitter, R_2 the resistance when the button has been pressed. It appears that the ratio R_2/R_1 has the greatest value for small currents. The normal current is 20 milliamperes, and for 30 milliamperes the ratio is still about 2·5. *When the transmitter, before pressing the button, is "packed" this ratio is, of course, much greater.*

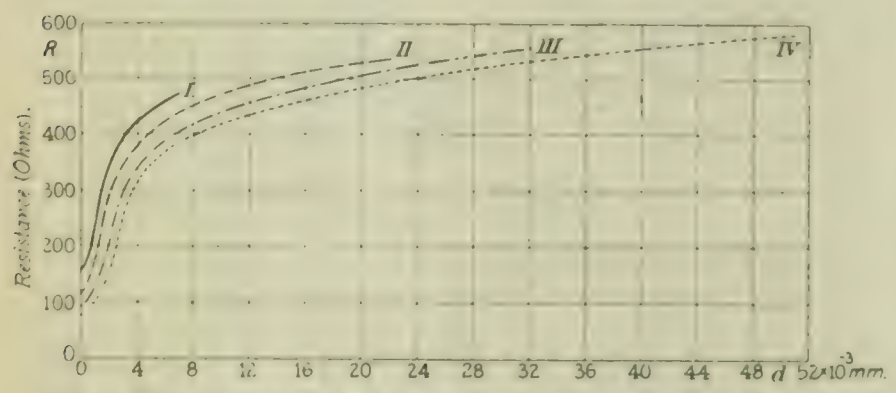


Fig. 4.—Displacement of Diaphragm from its Inmost Position.

The acquired increase of resistance is naturally lost when the transmitter is violently shaken, but it possesses a remarkable stability. The transmitter may be moved about and turned in all directions up to angles of, say, 30 to 40 degrees, and still retain about half of the original increase. The increase of resistance dies gradually away when spoken into the transmitter. When speaking very loud the natural state is reached in a few seconds; under faint speaking it may take several minutes.

5. *Explanation of the Obtained Results.*—A microphone with only one spherical carbon grain (Fig. 6) behaves in the same manner. When cutting away the carbon outside the lines *aa* and *bb* it is possible in this case to investigate the movements of the working parts in a feebly magnifying microscope. If the diaphragm *m* is strongly pushed back, the carbon sphere will be forced up the conical slope of the back electrode E; if the diaphragm is then suddenly released the sphere cannot follow it, but runs down the slope, and with the momentum thus acquired wedges its way between the diaphragm and the back electrode. The pressure between the three parts will then be relatively great and the resistance small. If, on the other hand, the displacement of the diaphragm is only small, and is produced and released gently, the carbon sphere will follow the movements of the diaphragm the whole time, and there will be no "wedging" effect; the pressure will be that corresponding to the weight of the sphere and comparatively small, the resistance rather great. Consequently, ordinary shaking is most liable to give a small resistance, as confirmed by the tests.

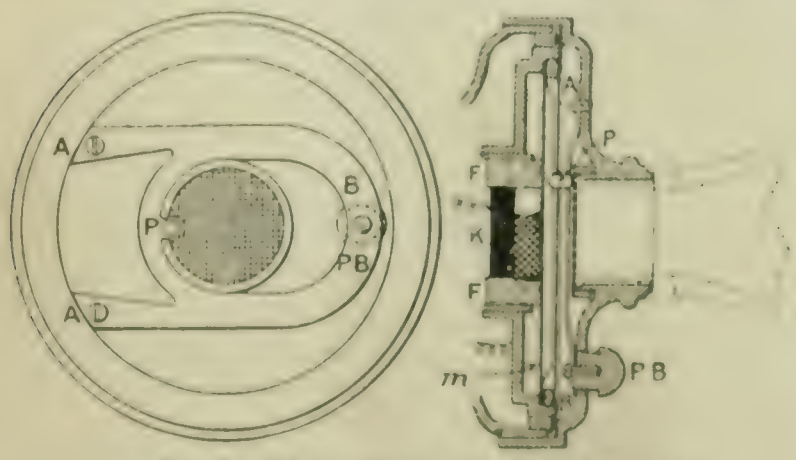


Fig. 5.—Transmitter with Press Button.

The conditions are somewhat similar in the ordinary grain-microphone. By shaking, some of the grains acquire a considerable momentum and some of them will, before they are brought to rest, wedge in between other grains or between the grains and diaphragm, or back electrode, thus increasing the pressure and reducing the resistance. If, on the other hand, the diaphragm is given a small permament outward displacement or a small transitory inward displacement the final result will be a reduced pressure between the grains, and, therefore, an increase of resistance.

6. It appears from the proceeding experiments that *the resistance of the transmitter must be very sensitive to variations in the air pressure in the capsule,* or more correctly, to variations in the difference of air pressure inside and outside the capsule. A rise of pressure in the capsule will give the diaphragm an outward displacement and thereby cause an increase of resistance. This explains satisfactorily the transient increase of resistance observed immediately after the current has been put on. Some measurements were made using the arrangement shown in Fig. 3, and Fig. 7 shows the results of these tests. The explanation is very simple. Just after the current is put on, the temperature in the grain chamber rises rapidly owing to the Joulean effect, $\frac{1}{2}I^2R$, and the rise in temperature is accompanied by a corresponding rise in air pressure in the grain chamber. This increase of pressure gives the diaphragm an outward displacement, and consequently the resistance rises. After some time the temperature in the grain chamber attains a steady value. The higher pressure in the grain chamber will force some of the air to escape through the felt ring, and the pressure in the grain chamber will, therefore, attain its greatest value some time before the steady temperature is reached, and after that time the diffusion through the felt ring will gradually bring the pressure back to its original value. (The outer capsule was provided with holes in order to have the same air pressure on both sides of the diaphragm outside the grain chamber.) This explains satisfactorily the curve *a* for the normal transmitter shown in Fig. 1. In order to test the correctness of the view that the increase of resistance is mainly due to a rise in air pressure in the grain chamber, a hole 5 sq. mm. was cut out at the top of the felt ring. The *b* curve was then obtained, showing the correctness of the view.

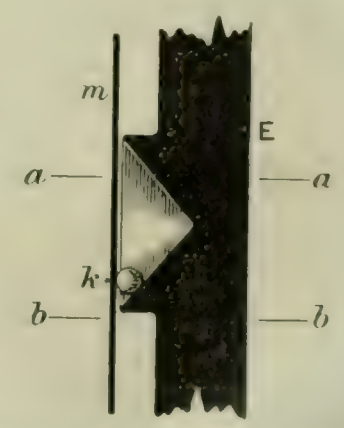


Fig. 6.—Working Parts of a Microphone with only one Spherical Carbon Grain.

Only one point remains to be discussed. As the heat is mainly generated in the contacts between the grains it must take some short time after the closing of the circuit before the air pressure can appreciably alter and still more before the diaphragm can be forced away. This is not clearly set out by Fig. 7, but an oscillographic investigation proved clearly that the tangents to the *a* and *b* curves at the point $t = o$ were horizontal. After a sufficient time the resistance of the current-carrying transmitter will be less than the initial resistance; the reason why will be given later on.*

7. *Relation between the Resistance and the Sensitiveness of a Microphone.*—The preceding experiments show that the resistance and the sensitiveness vary in the same manner and as the resistance is much more easily determined we have up to the present confined ourselves to resistance measurements. In order to judge the impor-

* A. L. Clark has treated the same problem for a solid back transmitter (The Electrician, July 16, 1915). His experiments agree fairly with my own, but his explanation of the phenomenon differs considerably from mine. This may to some extent be due to the different types of transmitters which we have investigated. Still, I think that most of Clark's results may be explained in a satisfactory way from my point of view. His interesting gas experiments are wholly outside the scope of the present investigation.

tance of a certain increase of resistance it is, however, necessary to establish a quantitative relation between resistance and sensitiveness of the transmitter in question. As a first step in this respect it will be necessary to state exactly what is meant by sensitiveness.

If a microphone is acted on by a pure tone of constant instensity and frequency n, the resistance may approximately be put in the form $R=r-r' \cos 2\pi nt=r-r' \cos \omega t$. . . . . (1)
Here r is the mean resistance during the action of the tone, and is generally different from the resistance of the microphone when at rest; r' is the amplitude of the harmonical variations in the resistance caused by the action of the tone. The greater the value of r' the greater is, *cet. par.*, the alternating microphonic current. We, therefore, use r' as a measure of the sensitiveness. In this investigation we are only concerned with the relative sensitiveness—that is, with ratios between the different values of r'.

The strength of the alternating current caused by the harmonic resistance variations is easily found. Let V be the E.M.F., $R_1+r-r' \cos \omega t$ the total resistance, and L the self-inductance of the microphone circuit. If r' is small compared with r, the momentary value of the current may be put in the form

$$i=I_0+I'_m \cos(\omega t+\varphi), \quad . . . . . (2)$$

where $$I_0=\frac{V}{R_1+r}, \quad . . . . . (3)$$

and $$I'_m=\frac{r'I_0}{\sqrt{(R_1+r)^2+\omega^2L^2}}=r'\frac{V}{(R_1+r)\sqrt{(R_1+r)^2+\omega^2L^2}} \quad (4)$$

In cases where r is very small compared with R_1 (4) may be written

$$I'_m=\frac{r'I_0}{\sqrt{R_1^2+\omega^2L^2}}=r'\frac{V}{R_1\sqrt{R_1^2+\omega^2L^2}} \quad . . . . (4')$$

I'_m is the maximum amplitude of the alternating current and according to (4) proportional to the product of r' and I_0. (The microphone acts like an alternating-current generator with a maximum E.M.F. of $(r'I_0)$ and a resistance r.)

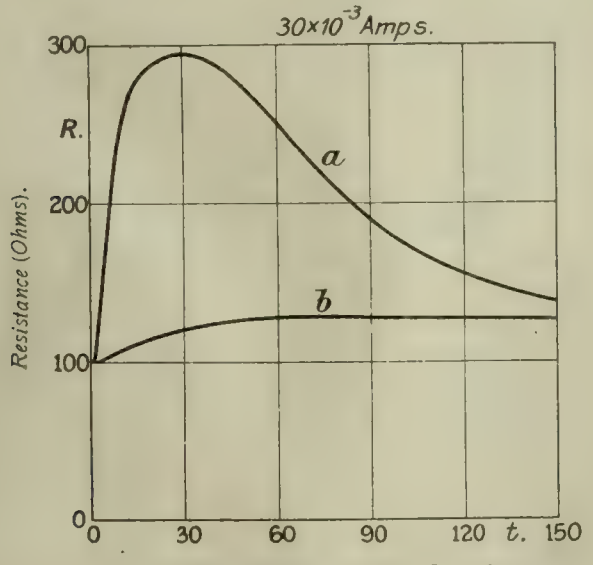


FIG. 7.—VARIATION OF TRANSMITTER RESISTANCE DURING THE TIME AFTER CLOSING OF CIRCUIT.

Curve A.—Normal transmitter (Fig. 1).
Curve C.—Same transmitter with a 5 sq. mm. hole at the top of the felt ring.

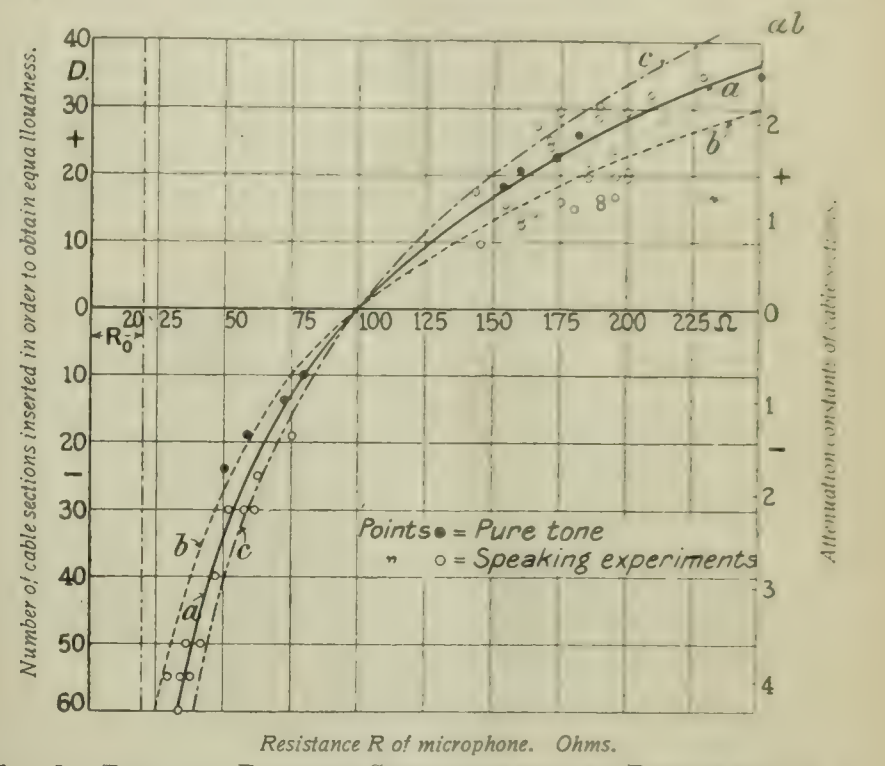
The next step is to determine the empirical relation between r' and the transmitter resistance R. To this end the above-mentioned transmitter with electromagnetic displacement of the diaphragm (Fig. 2) was inserted in a circuit in series with a 110-volt battery, the primary windings of a telephone transformer, and sufficient resistance to keep the microphone current at 20 milliamperes. In series with the secondary windings of the transformer was inserted an artificial cable with 120 equal sections, each one having an attenuation constant of 0·071 (for $2\pi n=5{,}000$). A high resistance receiver could be shunted across the cable between any two sections. The tension at a point not too near the open end of the cable is given by

$$E=E_0 . e^{-0{\cdot}071D},$$

where D is the number of sections between the transformer and the point tested and E_0 the tension at the transformer terminals. As the resistance of the microphone is very small compared with the total resistance of the microphone circuit we may use the approximate formula (4′) and consequently E_0 is proportional to r' but independent of r. As a sound generator I used alternately an Abs. Larsen's microphone hummer and a person speaking evenly. The resistance of the microphone was altered by sending various currents through the electromagnet which governs the displacements of the diaphragm. The microphone resistance was read on a millivoltmeter as usual, and the position of the receiver in the cable was regulated until a certain standard loudness was obtained in the receiver. Now and then the transmitter was shaken in order to bring it to its normal state.

The results of the tests are shown in Fig. 8. The mutual agreement between the different tests is not very good, but the experiments are rather difficult and the inborn intricacies of a microphone so great that considerable errors were to be expected. (The original Paper contains some further particulars concerning these tests.)

The total resistance R of the microphone may be divided into two parts, $R=R_0+R'$, where R_0 is the *inactive* and R′ the *active* resistance (*see* next paragraph). R_0 is that part of the resistance which is independent of the pressure between the working parts—that is, the resistance of leads, electrode, diaphragm, &c. R′ is that part



Resistance R of microphone. Ohms.

FIG. 8.—RELATION BETWEEN SENSITIVENESS AND RESISTANCE OF A TELEPHONE TRANSMITTER FOR CONSTANT CURRENT.

Curve —— corresponds to the sensitiveness formula $\left(\frac{R-20}{80}\right)^{5/2}$.
Curve - - - - to formula $\left(\frac{R-20}{80}\right)^{2}$ Curve — · — · — to formula $\left(\frac{R-20}{80}\right)^{3}$.

of the resistance which varies with the pressure: it is the proper microphonic resistance. With high and increasing pressure the total resistance asymptotically approaches the value of the inactive resistance. It is evident that the sensitiveness must depend principally on R′, and not on R. In Fig. 8 the inactive resistance is fixed at 20 ohms, 100 ohms being the normal total resistance of the transmitter. We shall, however, defer the discussion of the obtained result until later on.

(*To be concluded.*)

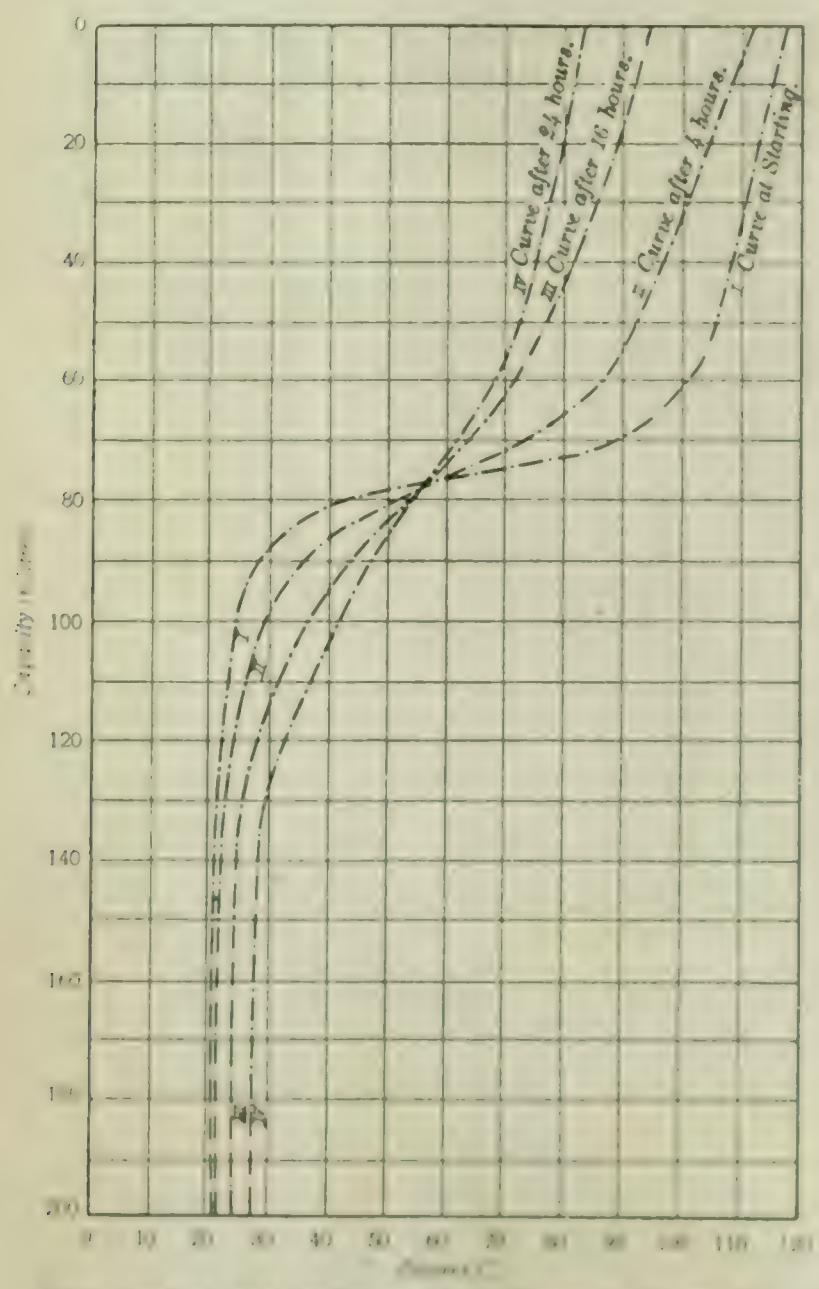
THE LOSSES IN ELECTRICAL WATER-HEATERS.*

BY A. RITTERSHAUSEN.

The losses in electrical apparatus for the heating of water depend on the construction and design, so that it is necessary first to consider these points. The flow of hot water can be shut off in two ways. In the "open" type the valve is on the inflow side, while the outflow is open to the atmosphere. The closed type has a cock or valve on the outflow side; the boiler is then permanently in connection with the inflowing water and is exposed to a certain pressure. The closed apparatus can be heated to a temperature such as 90°C., this being the highest temperature which allows the water to be drawn off without the serious escape of steam. With the closed type there is no loss through the escape of steam, because the apparatus is closed and under pressure. The open type loses much heat because steam passes off at temperatures much below the boiling point. Water expands by 3·5 per cent. between 10°C. and 90°C.; this volume is lost and escapes in the open type, while it presses the cold water backwards in the closed type. Some types have an internal heater, while others have the heating element on the outside, sometimes at the bottom of the vessel and sometimes at the side. With an internal or totally immersed heating element, there is no loss between the heater and the water; all the heat contained in the one passes into the other. This is obviously not the case with an external

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 24, 1915.

heater, but the heating element, if placed at the side, is better than that placed at the bottom (especially if the latter is of the interchangeable type), necessitating metallic connections between the heater and the plates out of which the boiler is constructed. Moreover, much chalky deposit settles out of the water on heating. This falls to the bottom, and makes the action of the heater, if placed at the bottom, more unfavourable. Water drawn off from a boiler of this type is generally cloudy if hot, owing to the continual agitation of the sediment by the inflow of heat through the bottom of the boiler. A very serious loss in any water-heater is that which takes place through the metallic connections between the water-container and the external covering or the air. But all these connections can be avoided except the water-pipes for inflow and outflow of water. The losses due to the inflow pipe can be lessened by having a cold zone at the bottom of the boiler into which the inflow pipe is led. No great depth is necessary for this cold zone, which also has the effect of diminishing the losses through the bottom of the boiler. The outflow pipe must, of course, be connected to the top, where the hot water collects; it causes a serious loss of heat, and its arrangement needs careful consideration. A vertical pipe, going upwards, or a



Showing the rate of Cooling in a Vertical Water Heater.

horizontal pipe for drawing off the hot water is plainly impossible; however such pipes are lagged, there is always a serious loss of heat. The losses are so great that heat accumulators, constructed on these principles, are most inefficient. A simple and ideal solution is to bring the outflow pipe vertically downwards through the heater and to allow it to pass out at the bottom. The loss in a pipe of this kind, if the vessel is well lagged, is very small.

The curves in the accompanying diagram show the results of a test on a boiler with an outflow pipe arranged on this plan. The vessel contained 200 litres, and was of the vertical type, the heater being so arranged that the top part of the vessel, amounting to about one third of the whole, could be heated to 115°C. The heating was continued for several hours, so that it extended to some small extent to the lower layers. A number of thermometers were used to determine the temperature at different levels; the height of the vessel was 1·8 metres. The current was then switched off, and the gradient of temperature through the vessel is shown in curve I. Curves II., III. and IV. show the gradients after the lapse of 4, 16 and 24 hours respectively. From these curves we see that the loss of heat in the upper layers takes place very slowly. Thus in order to get good results the first point is to pay attention to the outflow pipe, which should be brought for some distance vertically downwards through some part of the construction serving to maintain the heat in the apparatus—*e.g.*, through the heated water itself. The next point is to employ the principle that there must always be a supply of hot water and not merely a large supply of lukewarm water. No eddies must be formed inside the apparatus either by the inflow of cold water or by action of the heater itself. This can be done by using suitable baffle plates, regulating the circulation of the water; but it is practically impossible if the heater is arranged at the bottom of the boiler. These baffle plates also allow a simple arrangement for the cold zone at the bottom of the boiler. This cold zone conserves any heat, which tends, as it were, to be displaced towards the bottom. The cold zone, in fact, serves several purposes, but it is impossible, of course, if the heating element is placed beneath the boiler.

This leads us to see that the best plan is to use a "closed" type of boiler and to place the heater inside it. Efficiency is rather a vague term to use of a water-heater. In comparing different types we might speak of the maximum or mean efficiency during a given period of working. The usual sizes contain 100, 200 or 300 litres; their maximum heat-contents vary from 10 to 30 kw.-hours. The conditions under which water is drawn off are very variable, and the losses must be very small. In large installations the internal heater is the only possible solution. The author gives curves showing the rates of cooling for heaters of his design; these curves are approximately straight lines. The lagging is made of silk waste. In an apparatus holding 100 litres the temperature falls from 113°C. to 62°C. in the course of 85 hours; the 200-litre type falls from 104°C. to 72°C. in the same time. Diagrams are given showing the methods of construction. In these particular cases the internal heater is used. It seems to be placed somewhat towards the bottom of the boiler, and to be contained in an inner cylindrical vessel, which reaches nearly to the top of the main vessel; the water is to be drawn off from the top of the main vessel. The cooling in the 200-litre type seems to vary from 0·37°C. per hour at 90°C. to 0·29°C. at 60°C.; in the 100-litre type it varies similarly from 0·68°C. at 90°C. to 0·46°C. per hour at 60°C. The 200-litre type at 90°C. contains heat to the extent of about 16,000 calories; out of these about 74 calories are lost in an hour, amounting to 0·46 per cent. These figures show the state of perfection to which the heat insulation has been brought. The worst case is when the boiler is very hot and no water is drawn off. In such a case 1,780 calories might be lost in 24 hours, a little more than 10 per cent. These figures are believed to be better than any hitherto obtained. In ordinary working the heating generally goes on during the night, and hot water is drawn off during the day; in this case the losses are less; probably 1 kw.-hour would be lost in 24 hours, which is about 5 per cent. It might be a question as to whether a better efficiency could not be obtained by heating the water to 80°C. rather than to 90°C. A little calculation settles the question and something depends on the price at which energy is supplied. But, generally speaking, it will be found that 90°C. is a more suitable temperature than 80°C.

In spite of the fact that the method of internal heating is the best from the point of view of efficiency, it cannot be used in the smaller sizes owing to its greater cost. Curves are given, showing the rates of cooling for the different types, constructed according to drawings, which are also given. Thus a 200-litre boiler, of the kind already described, cools from 90°C. to 86°C. in 12 hours; a 25-litre boiler, with heater at the side, cools from 90°C. to 72°C. in 12 hours, this being of the "closed" type; a 25-litre boiler of the "open" type, with heater at the side, cools from 90°C. to 68°C. in 12 hours; whereas a boiler made by the Therma Company, of Munich, of the "open" type, with heater at the bottom (capacity unstated), cools from 90°C. to 62°C. in 12 hours. The rates of cooling, therefore, vary greatly; thus, at 90°C., the type with side heater cools 1·47°C. per hour if of the "closed" kind, and 2°C. per hour if of the "open" kind; the type with heater at the bottom cools 2·63°C. per hour at 90°C. Thus the "open" type with heater at the bottom gives the worst efficiency. The 200-litre type of the author's construction loses about 5 per cent. of its heat-contents in 12 hours, whereas the type with heater at the bottom might lose 30 or 32 per cent. in the same time. In conclusion, some curves showing the rates of charging with heat, as it were, are given. One line shows the rate at which the temperature should increase on theoretical considerations; the others show what actually takes place in the different types. The curves show that with "open" apparatus and a heater at the bottom, and an input of 10 watts per litre—*i.e.*, 200 watts for a 20-litre apparatus—at least nine hours are needed to heat to 80°C. The larger sizes of electric boiler, having a mean efficiency between 90 and 94 per cent., can compete with other kinds, if energy can

be bought at prices not much exceeding a halfpenny a unit; if the efficiency is lower, the cost of energy must be lower, if there is to be any effective competition, and if the efficiency does not exceed 66 per cent., the price per unit ought not to exceed ½d. per unit. These figures, at any rate, show that central station engineers would do well to encourage the use of boilers, if a high efficiency can be guaranteed.

THE DOUBLE DYNAMOMETER WATTMETER.

BY C. V. DRYSDALE, D.SC.

(*Concluded from p.* 560.)

Summary.—The author refers to wattmeter corrections and to the double wattmeter. He next deals with these instruments for measuring three-phase power, and discusses the errors involved including that of interference between coils. Some examples of their use in testing are then given and a new form of instrument is described.

Three-Phase Testing.—The standard connections for three-phase testing for a three-wire balanced or unbalanced load are shown in Fig. 14, and are equivalent to those shown in Fig. 2. All that is necessary is to see that the reading with each wattmeter separately is positive when the other phase is broken, and that the resistance box and commutator of the two systems are arranged for the same constant. The instrument is particularly convenient for induction motor testing, as no load and short circuit tests can be made by simply altering the current range. A large amount of single and polyphase motor testing has been done in this way, and Figs. 16, 17 and 18 are a typical set of performance curves taken on a 11-B.H.P. 220-volt three-phase induction motor of the Electric Construction Company in the Electrical Engineering Laboratory of the Northampton Institute, using a double wattmeter to measure the electrical input, and the writer's regenerative brake and stroboscopic slip indicator for the mechanical output. Fig. 15 shows the performance on load (*a*) as motor, (*b*) as generator. Fig. 16 (*a*) and (*b*) the no-load, short-circuit and starting torque curves, and Fig. 17 the circle diagrams of the motor at different voltages plotted from the load tests. Although the ammeters and voltmeter had to be changed for the different ranges, the same wattmeter easily covered the whole range, and the negative readings, when the machine was generating, were obtained by simply turning the torsion head in the reverse direction.

Very accurate phase tests in the neighbourhood of unity power factor can be made by connecting a reversing switch to

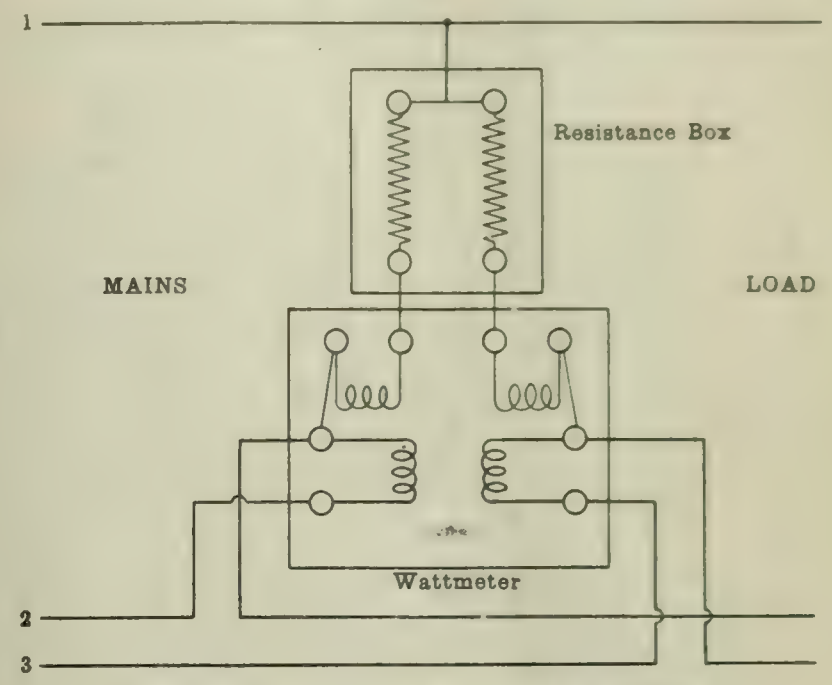


FIG. 14.—ORDINARY THREE-PHASE TESTING.

the terminals of one of the moving coils. Then if w is the normal power reading, and w' the reading with one coil reversed,

$$w = \text{EI}\{\cos(\varphi - 30°) + \cos(\varphi + 30°)\}$$
$$w' = \text{EI}\{\cos(\varphi - 30°) - \cos(\varphi + 30°)\}$$

from which $\tan\varphi = \sqrt{3}\, w'/w$.*

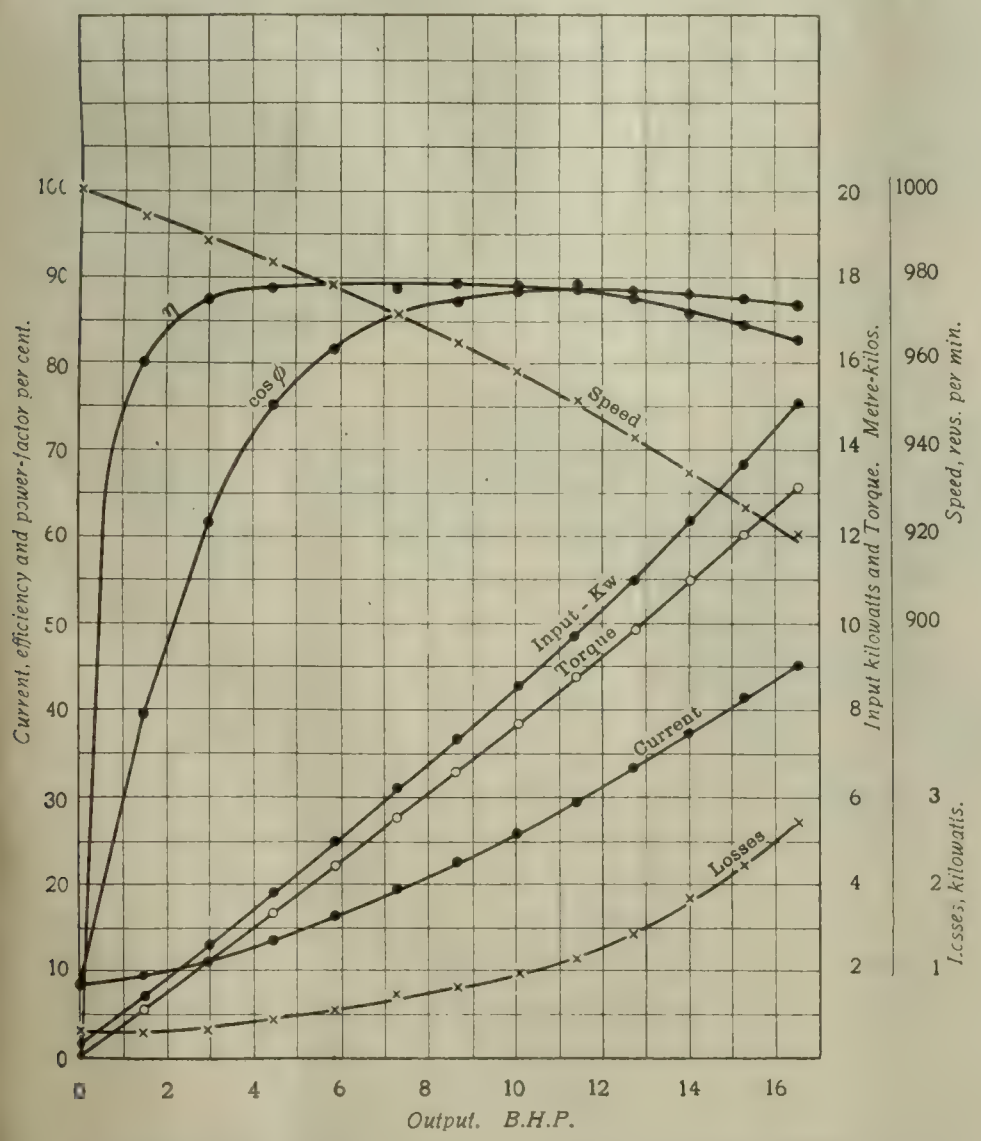


FIG. 15A.—TEST CURVES OF E.C.C. 11 B.H.P. THREE-PHASE MOTOR.

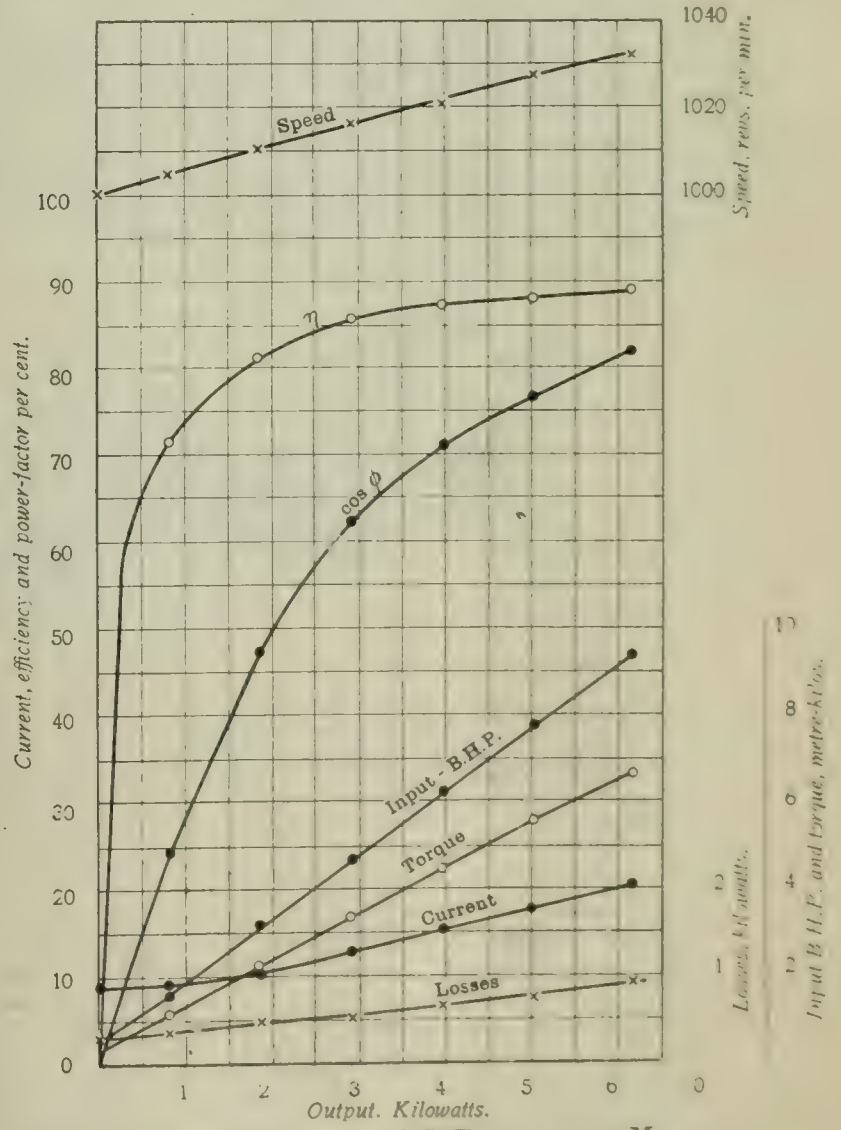


FIG. 15B.—TEST CURVES OF E.C.C. THREE-PHASE MOTOR AS ASYNCHRONOUS GENERATOR.

Fig. 18 gives the connections of the test board which was employed for motor testing at the Northampton Institute. It will be seen that by closing the required switches at the top of

* *See* "The Measurement of Power Factor," THE ELECTRICIAN, Sept. 18, 1908.

the board, either direct current or single-phase, two-phase, or three-phase alternating current can be supplied to the terminals at the bottom of the board, and that the wattmeter gives the total power in every case without any change of contact.

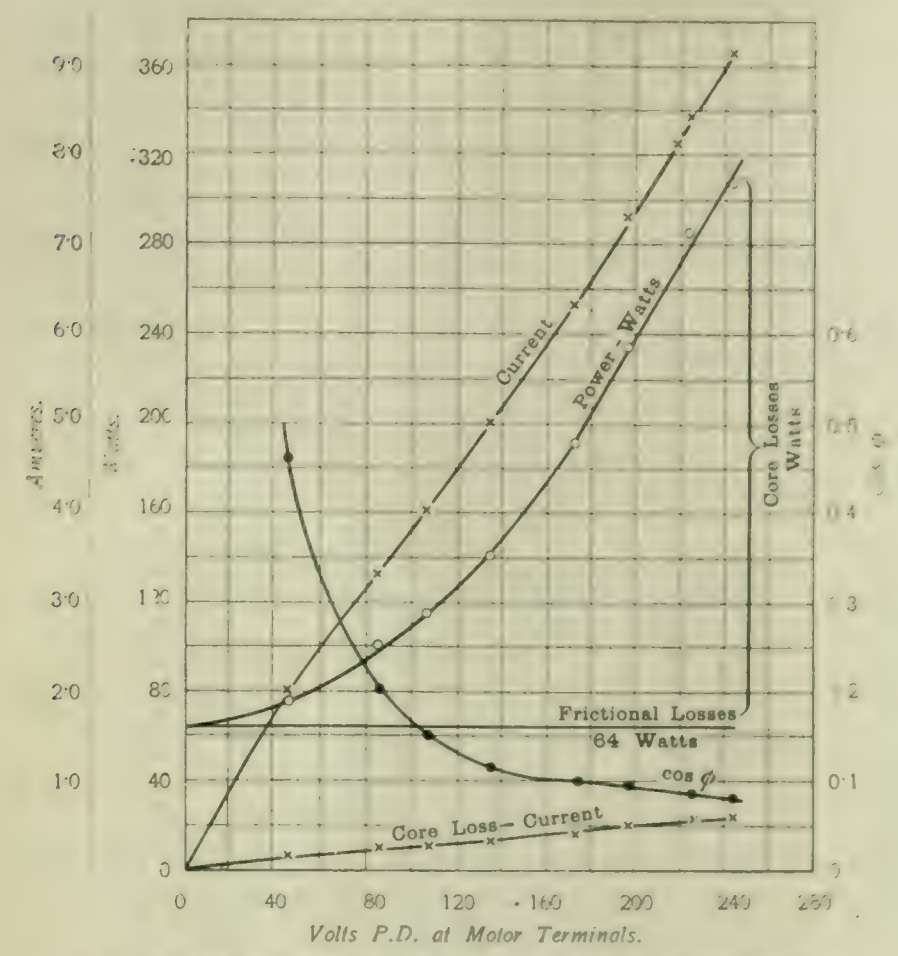


Fig. 16A.—Test Curves of E.C.C. Motor No-load Test.

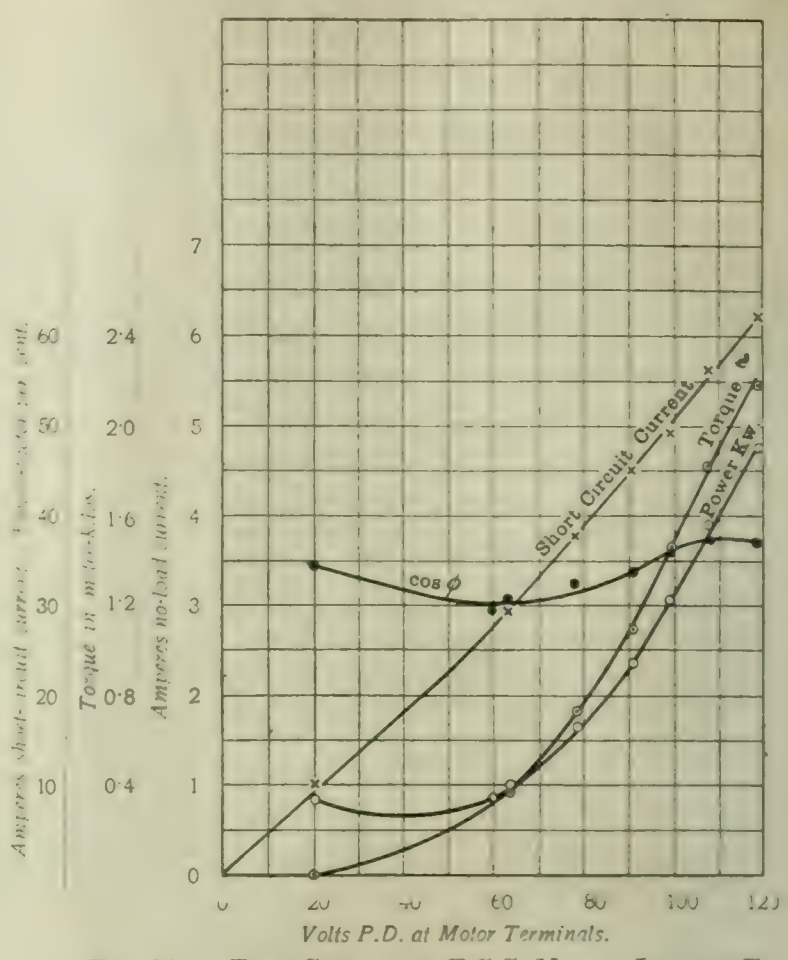


Fig. 16B.—Test Curves of E.C.C. Motor Locked Test.

For continuous current or single phase testing the motor is connected to terminals 1 and 2, and the small wattmeter switch is set to *a*. For three-phase testing, terminals 1, 2 and 3 are used, and for two-phase all four terminals, the wattmeter shunt switch being set to *b*. Ammeters in three of the leads give the currents in all the circuits, while the voltmeter is provided with a change-over switch or receptacle enabling it to be connected between any two mains.

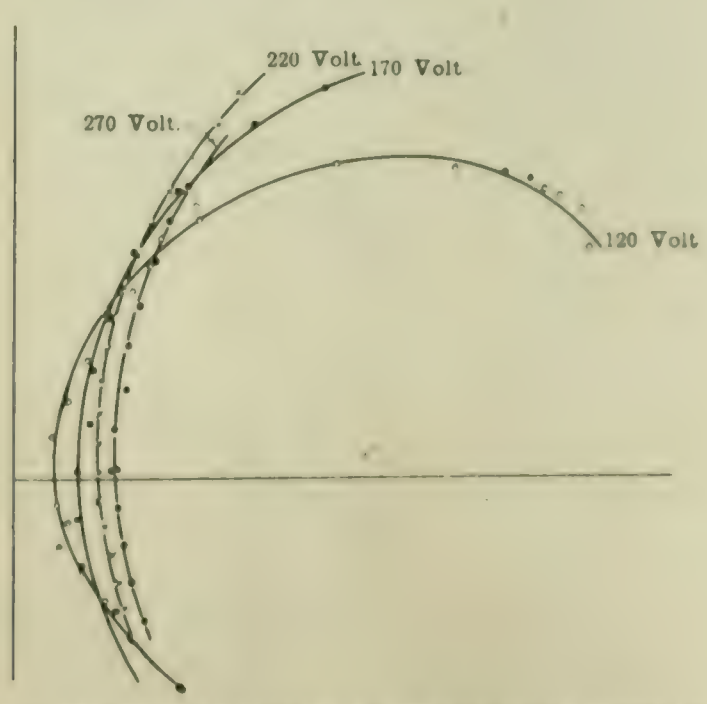


Fig. 17.—Circle Diagrams for Three-phase Motor at Different Voltages.

Alternating current Meter Testing.—One of the most important of routine measurements is the testing of supply meters, and a great deal of effort and expense has been wasted over it. It is certainly time that a definite standard procedure and testing outfit should be devised for what is a necessary adjunct to every supply station, and the writer has given considerable attention to the matter. Only a brief reference can be made to it here, as a separate Paper must be devoted to it. It is of course generally appreciated that the only rational method of testing direct-current, alternating-current or polyphase meters is by "artificial loads," in which the P.D. and current are derived from separate sources, but there are certain precautions which are not always appreciated or observed, and which are advisable if accurate results are to be secured.

As regards the sources of P.D. and current, it has been very

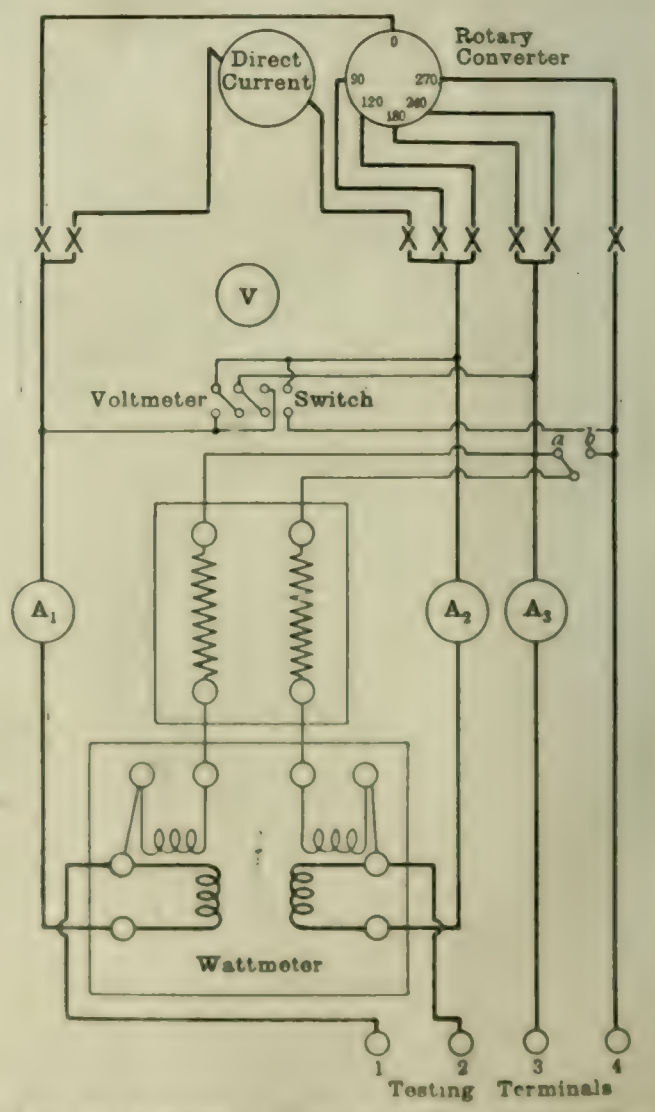


Fig. 18.—Connections of Test Board for Direct Current Single phase or Polyphase Testing.

usual to employ a pair of coupled alternators with a device for altering the relative positions of their armatures. Though this is perfectly correct in principle, the manufacturers of such

machines do not seem as a rule to have properly studied the design of these small machines, and their wave forms are usually extremely bad. Some of the best testing laboratories have been equipped with very costly coupled alternators, which have exceedingly irregular waves.

In arranging a meter testing outfit for the Northampton Institute laboratories some years ago, the writer came to the conclusion that a phase-changing device on the testing table

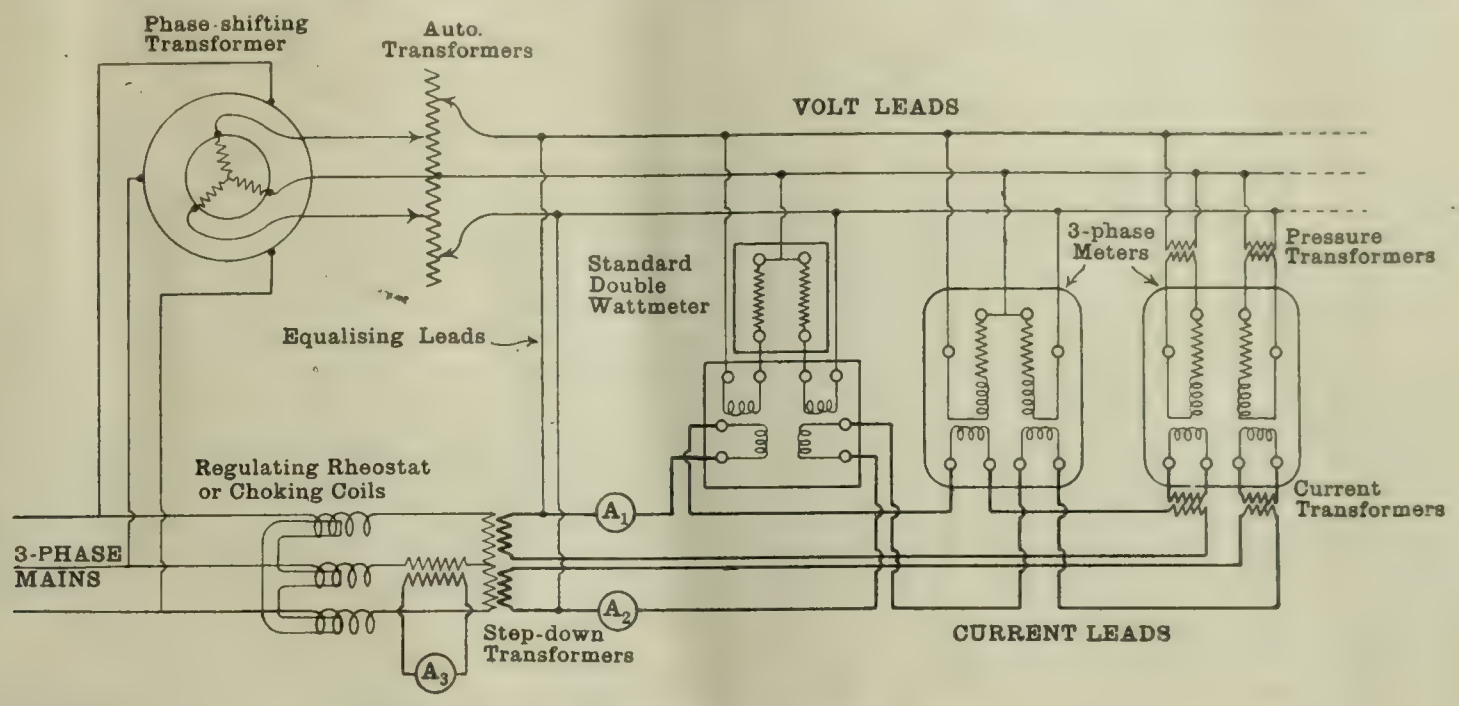


Fig. 19.—Three-phase Meter Testing.

was by far the most convenient and economical arrangement, and devised single phase and polyphase phase-shifting transformers for the purpose.* These have since been considerably improved, in conjunction with the alternate-current potentiometer, so that when fed from supply mains or from a well designed alternator or rotary converter they give a secondary voltage which is constant within a small fraction of 1 per cent. in all positions of the rotor, and a wave form in which no harmonic is greater than 2 per cent. of the fundamental.

Further details and technical data of these transformers will be given later, but the diagram of connections for three-phase meter testing using one of these transformers and the double wattmeter is given here (Fig. 19). A voltmeter with change-over switch to give the R.D. between any pair of the volt leads should also be connected. It will be seen that the meters under test are maintained in identical conditions with those of practical working, both as regards currents and potentials, so that any leakage or electrostatic effects are included under normal conditions.

Astatic Commutator Wattmeter for Heavy Currents.—With the modern increase of output of machines, a demand has arisen for instruments capable of making direct measurements with heavy currents at both low and high voltages. Considerable difficulties present themselves when the design of such instruments is considered, among them being the large sectional area of the conductors, their want of flexibility, the risk of eddy currents and non-uniform current distribution or "skin effect" in them,* the intensity of the magnetic field due to the leads, and the size and difficulty of manipulating the series parallel device. The only good solution of the problem of a heavy current wattmeter so far is that of Dr. E. B. Rosa, of the Washington Bureau of Standards, who has employed the exceedingly neat principle of making the main "coils" in the

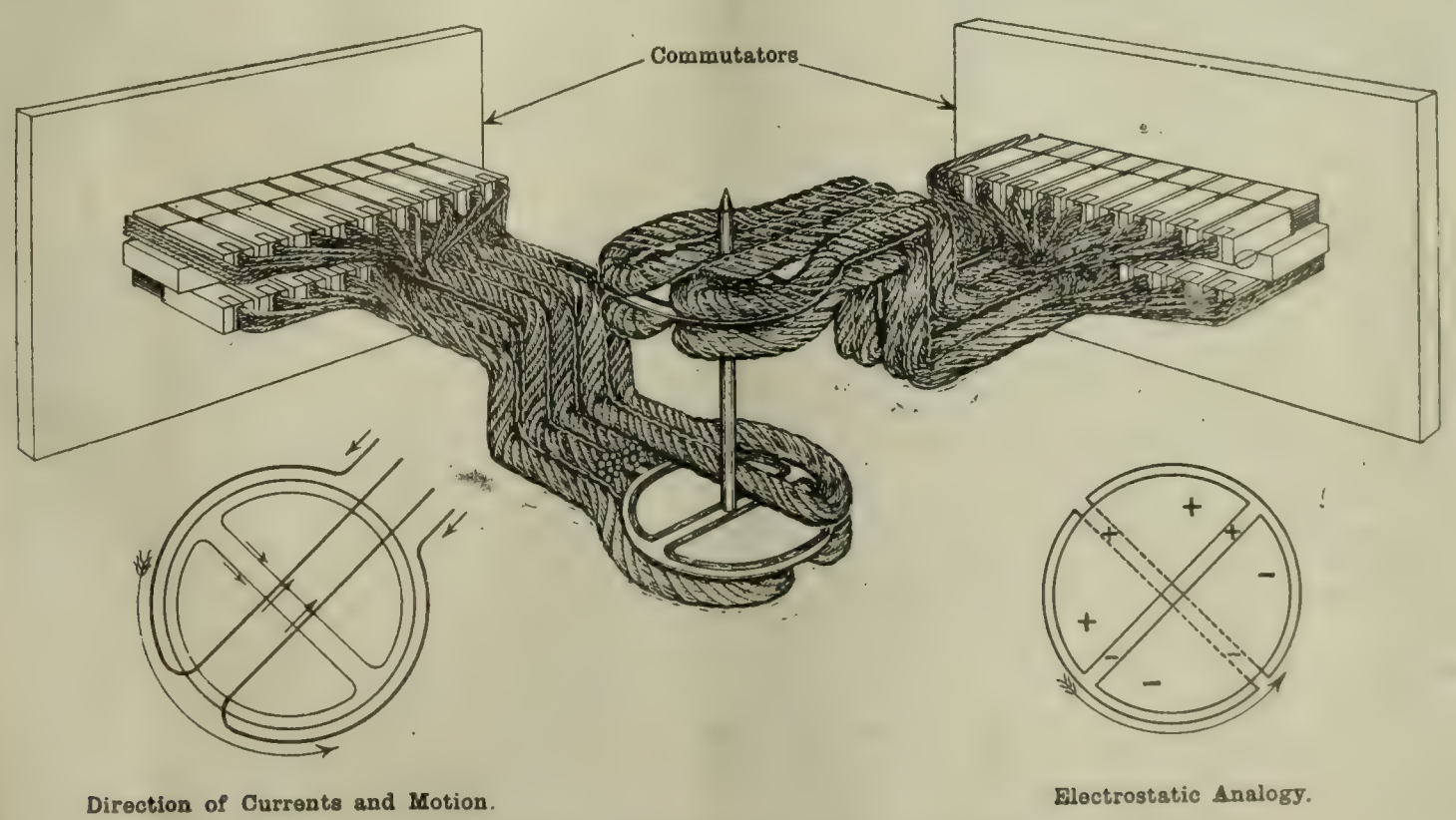


Fig. 20.—Scheme for Heavy Current Wattmeter.

* "The Use of a Phase Shifting Transformer for Wattmeter and Supply Meter Testing," The Electrician, Dec. 11, 1908.

* In one sense it is wrong to speak of eddy currents in a current-carrying conductor, as the combination of the eddies with the main current shows itself in the non-uniform distribution of the latter. It is, however, convenient to consider the question in this way, in analogy with the magnetic fluxes in a generator or transformer.

form of concentric tubes, giving an annular field in the interspace which is independent of the current distribution in the conductors, and which cannot produce eddy currents.

The writer has attacked the problem in another way, and although the apparatus is not yet completed, a brief description of it may be of interest. Starting from the essential principle of a dynamometer instrument—that the torque produced by the fixed on the moving element is proportional to the rate of change of the mutual inductance between them—it was seen that the most simple, compact and easily constructed arrangement was one in which the moving element was in the form of a disc revolving in its own plane with two oppositely wound D-shaped coils, between four stranded main coils also of D-shape, as shown in Fig. 20. The arrangement is the electrodynamic analogue to the quadrant electrometer, or more strictly to its predecessor, the divided ring electrometer. It will be seen that the main coils can be very easily formed, and that they can be fixed to the commutator, and be slid into position without interfering with the moving coils. With the double instrument a strand or two from each main coil can be brought near the other moving coil in order to approximately neutralise the interference of one system on the other.

As regards the commutator, the circular form becomes impracticable for currents over 250 amperes, owing to difficulties with its size and the friction of the 18 brushes which prevent it from being easily turned. The form shown in Fig. 21 has therefore been designed for currents up to 1,000 amperes per phase. The ends of the wattmeter main coils are connected to

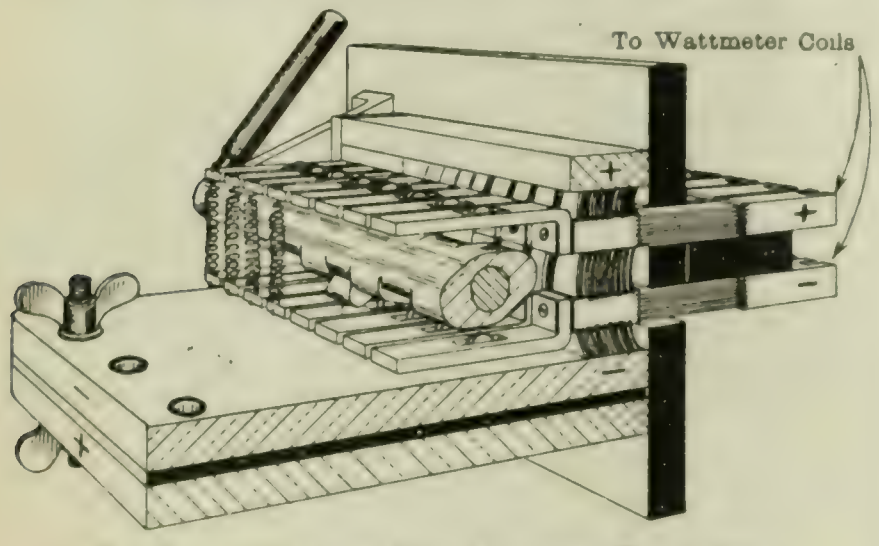


Fig. 21. 1,000-ampere Series-parallel Commutator.

nine pairs of brushes as usual, but instead of these brushes rubbing against cylindrical contacts, they are mounted on flexible supports and pulled into contact by springs, so that all the coils are normally in series. The outside mains are connected to two wide brass plates, one of which has a bridge piece over the other, so that one plate and the bridge piece form two 'bus bars, and the handle actuates a cam which forces the required pairs of brushes apart from each other, and into contact with the positive and negative 'bus bars respectively. For the five-series two-parallel arrangement the cam has simply one projection which separates the two centre brushes; for the two-series five-parallel arrangement the four alternate pairs of brushes are separated; and for the full parallel arrangement all the brushes are separated and pressed into contact with the bars. The brushes are of laminated phosphor bronze, and are so bent that the action of bringing them together or of forcing them into contact with the bars produces a rubbing contact. In this way it is hoped to obtain quite satisfactory results with 100 amperes per contact, or 1,000 amperes total current, and it will be seen that the going and return leads are so arranged that the currents produce very little external magnetic field.

The writer attaches very great importance to a satisfactory commutator device for altering the arrangement of alternating-current testing apparatus of all kinds, and is applying it to ammeters, to calibrating and instrument transformers, to regulating rheostats and choking coils, &c. Those who have had much experience in alternating-current testing well know how annoying it is to be continually getting beyond the range of the instruments and regulating devices, and the ease and accuracy of testing work of all kinds can be greatly enhanced by using the series-parallel commutator, both for the ammeters and wattmeters, and for the regulating devices.

Although this article is somewhat lengthy, it has by no means covered all the uses of the double wattmeter, and many others will be discovered by those employing it. Dr. Nicholson has, for example, used the instrument for testing the power absorption in iron when magnetised by a three-phase rotating field, and to detect the amount of the third harmonic produced by the saturation of the iron.* Another possibility is the actual measurement of the energy liberated in opening circuit breakers on inductive loads. Enough has been said, however, to show that the dynamometer wattmeter can be regarded as a perfectly trustworthy instrument, and the advantages of the double form for polyphase testing need no insisting upon.

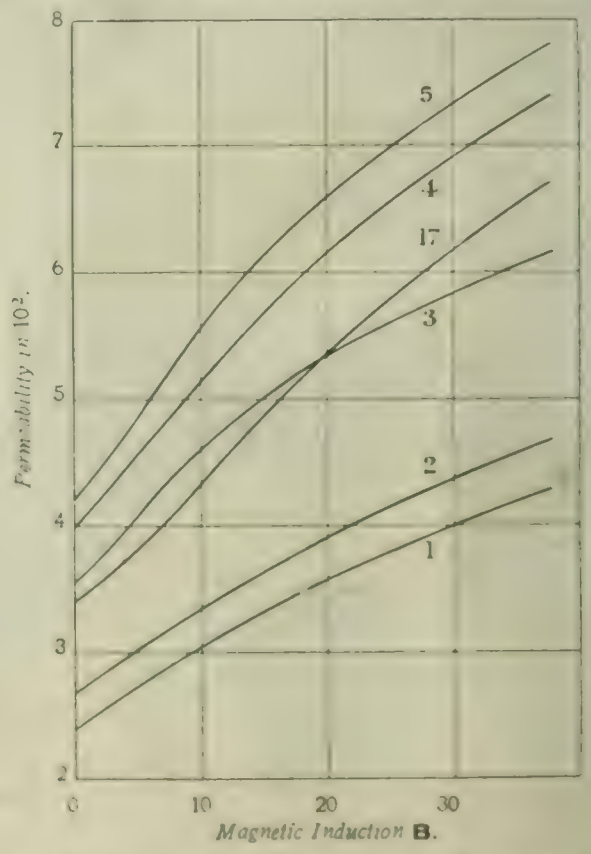
The real difficulties in connection with such instruments are not of an electrical but of a mechanical nature, the chief ones being the difficulty of getting a sufficiently rigid construction without using any appreciable amount of metal, and the variation of the elasticity of the spring with temperature. But with reasonable care an accuracy of one-tenth of 1 per cent. can be obtained at deflections of 200 divisions and over.

The tests on the instrument have all been made in the laboratory of Messrs H. Tinsley & Co., at Eldon Park Works, S. Norwood.

ON THE PRODUCTION OF HIGH PERMEABILITY IN IRON.†

BY PROF. ERNEST WILSON.

By the Method of Magnetic Shielding.‡—The present Paper deals more particularly with the permeability exhibited by a 3 per cent. silicon alloy of iron, known as "Stalloy," over a range of the magnetic induction B from about 0·5 to 100. It is shown that if a ring



consisting of laminæ of the material is placed within a special magnetic shield, and then subjected to a process of careful demagnetisation, the permeability can be largely increased.

Some of the results are given in the figure. Before being placed in the shield the specimen was demagnetised from a maximum force of 0·3 C.G.S. units, and experiment 1, corresponding to curve 1, was made. When in the shield the specimen was demagnetised from a maximum force of 0·59 and experiment 2, corresponding to curve 2,

* "Proc.," I.E.E., Vol. 53, p. 248, 1915.

‡ Abstract of a Paper read at a meeting of the International Engineering Congress, 1915, in San Francisco, Cal., September, 1915.

† "Proceedings" of the Royal Society of London, A., Vol. XC., 1914, p. 179. This Paper is referred to in The Electrician, Vol. LXXIV., 1914, p. 309.

was made. Up to this time it should be noted that the highest force so far applied has been 0·59, and at the close of experiment 2 the specimen was left magnetised as the result of a force 0·0935, and eight days elapsed before further experiments were made. At the end of this time a magnetising force 0·8 C.G.S. units, due to a continuous current, was applied, reversed a few times, and removed.

A force of such magnitude as 0·8, applied to a demagnetised specimen, has, in ordinary magnetic testing, the effect of causing the magnetic induction corresponding to a given smaller force to be lower than it would have been had the iron been in a demagnetised state originally. In the shield the reverse is the case, as is shown by experiment 3, corresponding to curve 3. Curve 4 was obtained after demagnetising from a force 1·2, and curve 5 was obtained after demagnetisation from a force of 2·97. Then followed a number of experiments on the effect of testing the specimen after varying periods of rest in (1) a magnetised condition, and (2) a demagnetised condition. Curve 17 shows the effect of resting in a demagnetised condition for 13 days, and a rest of six weeks gives no further diminution in permeability. Further experiment shows that this high permeability still persists when the specimen is removed from the shield.

The dissipation of energy, due to magnetic hysteresis, corresponding to a given maximum value of the magnetic induction, is considerablv reduced by the above method of treatment.

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE & YORKSHIRE RAILWAY.

(*Continued from p.* 567.)

TRACK.

Though the system adopted is the third or live rail with track return augmented by a fourth rail, considerable departure has been made from previous practice, in that it is a side-running contact, instead of over or under-running. This has been brought about by the fact that 1,200 volts necessitates more adequate protection against shock, and the form of rail adopted is admirably adapted for guarding. This, of course, also applies to the under-running type, but here the objection was the small clearances available.

The live rail and its guarding, also its relative position to the track rails, which is shown in Figs. 27, 28 and 33, is the invention of Mr. J. A. F. Aspinall, the general manager of the railway company. It is very compact, lies close to the running rail, and gives the maximum space for platelayers and other workmen in the six-foot, where the rails are normally fixed. The guarding is of "Jarrah," which has been adopted for its non-combustible qualities, and is arranged as shown in Fig. 32. It is held in position by clips secured by ordinary chair keys, no screws or nails being used.

The section of the rail has been designed so that its centre of gravity is well within the base line. The rail has been supplied by the Shelton Iron, Steel & Coal Co., Ltd., of a special design. The arrangement is such that a projection on the upper portion of the insulator acts in conjunction with the guarding as a key which keeps the rail in position. The insulator itself is kept in position by three small brackets. The rail, however, does not rest directly on the porcelain insulator, but a wooden packing is inserted between to act as a buffer. The normal spacing of the insulators is approximately 12 ft. The live rail is anchored every 100 yds. by a specially designed anchor insulator supplied by Bullers (Ltd.).

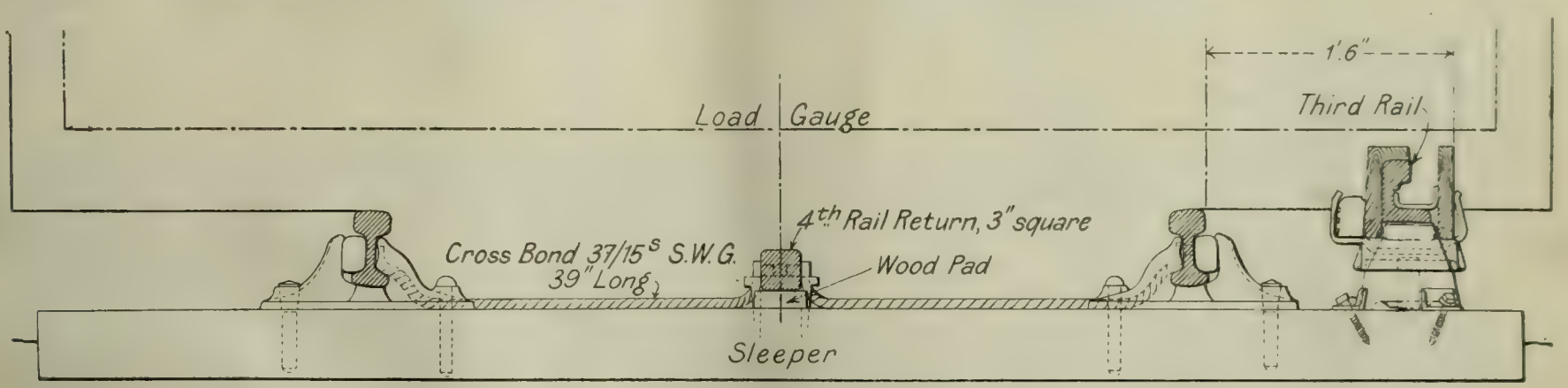


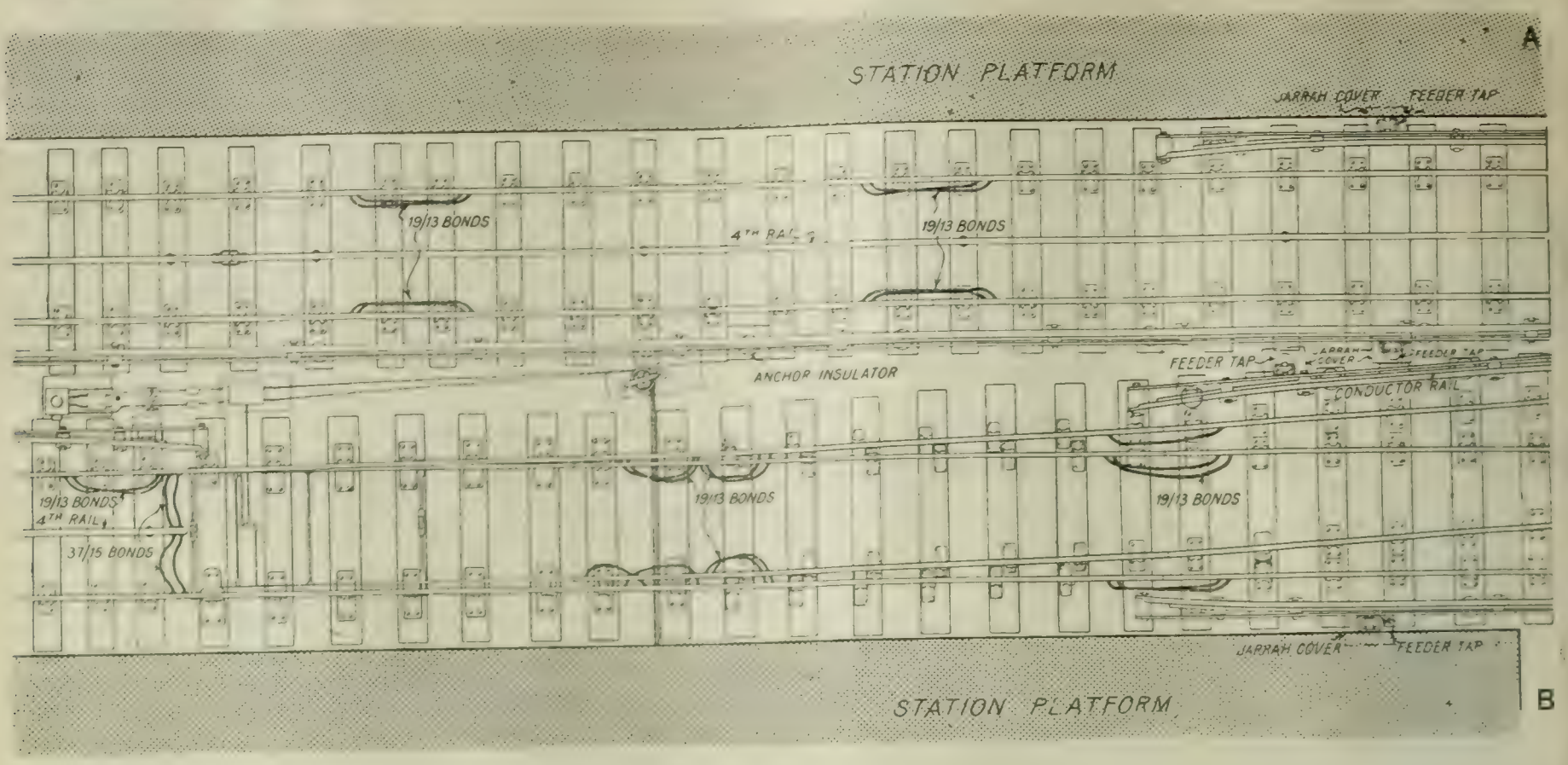
FIG. 27.—CROSS-SECTION OF PERMANENT WAY.

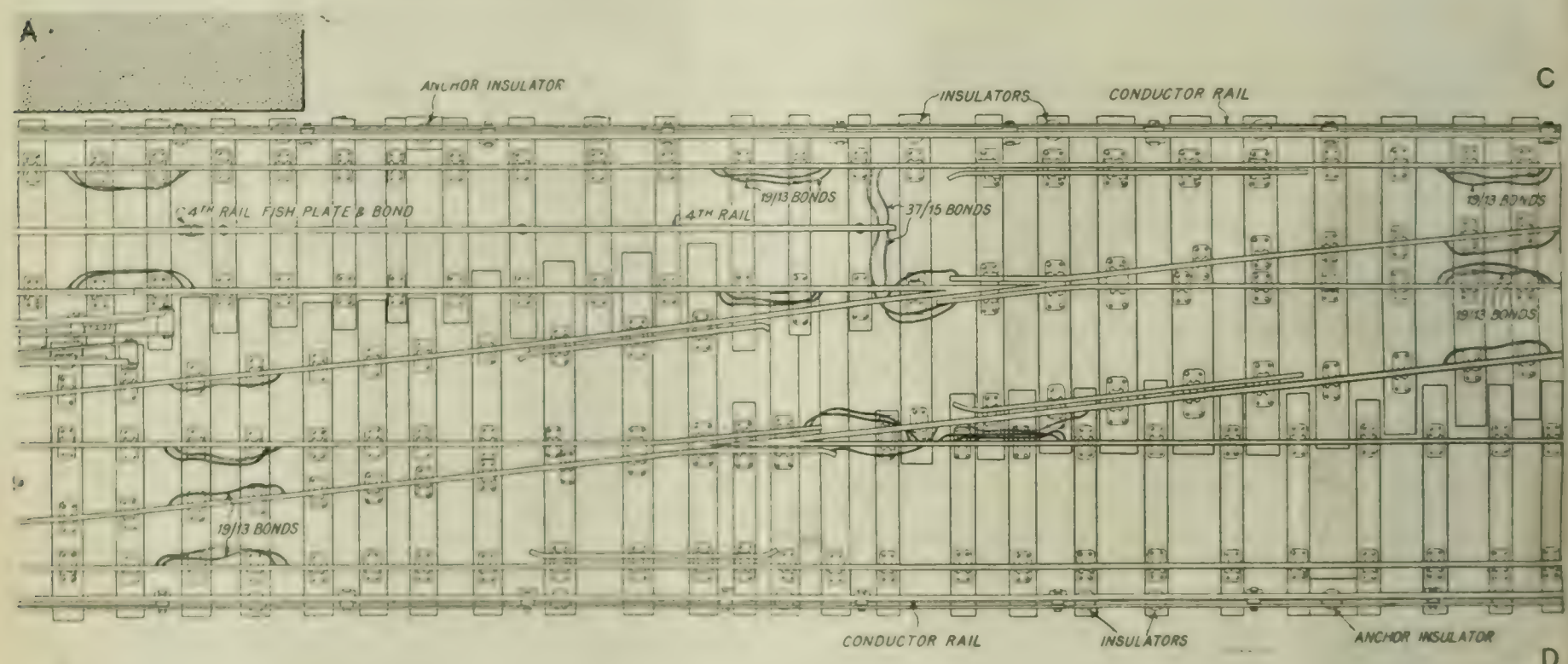


FIG. 28.—VIEW SHOWING LIVE RAIL AND FOURTH RAIL IN RELATION TO THE TRACK.

The live rail insulators are of white porcelain, completely vitrified throughout, and glazed all over, and are 6⅛ in. high. The actual creeping surface is 8 in. from metal to earth. These insulators have been supplied by Doulton & Co. (Ltd.), of London.

The cross-sectional area of the rail is 8·35 sq. in., and weighs 85 lb. per yard. Its resistance ranges between 6·5 and 7·0 times copper of equal area and length. The normal length of each rail is 60 ft.





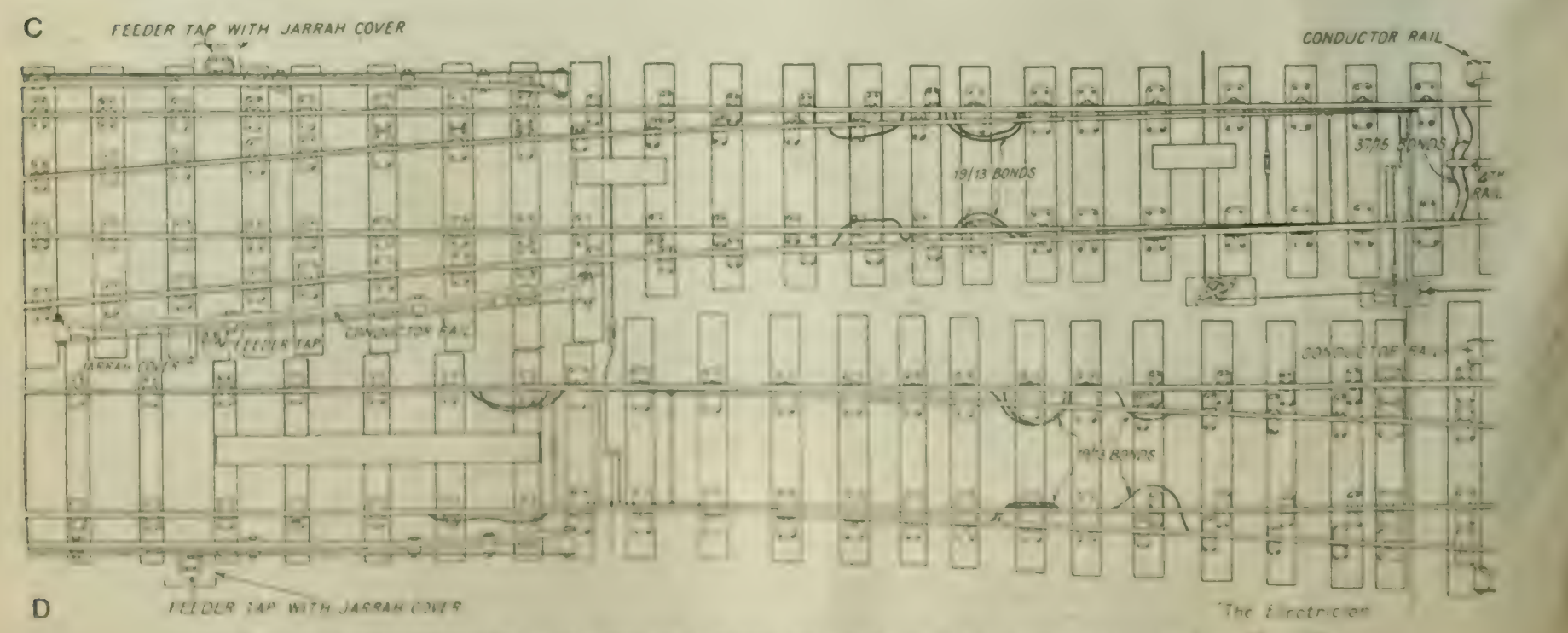


Fig. 29.—Plan of Permanent Way Showing Position of Live Rail and Arrangement of Live Rail Ramps.
(The sections run on continuously, as indicated by the lettering.)

The rails are bonded at each joint with two bonds per joint, each bond having an effective cross-sectional area of 0·4 sq. in. These bonds, which are of the strip-copper flexible type, have been manufactured by the Forest City Electric Services Supply Co., Ltd. The chemical composition of the rail is as follows :—

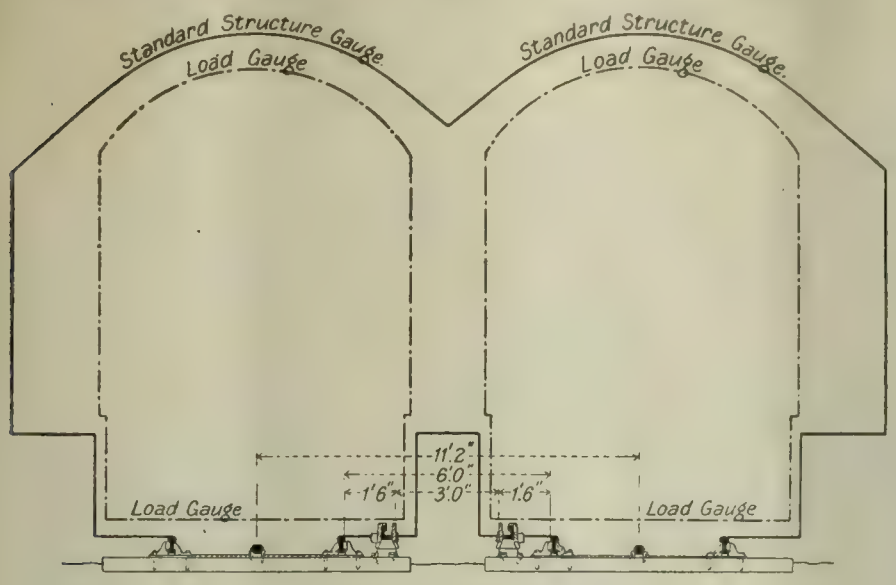


FIG. 30.—CROSS-SECTION OF PERMANENT WAY IN RELATION TO THE STRUCTURE AND LOAD GAUGE.

Carbon	0·08 p.c.	Sulphur	0·026 p.c.
Phosphorus	0·034 ,,	Silicon	0·022 ,,
Manganese	0·22 ,,	Iron	99·618 ,,

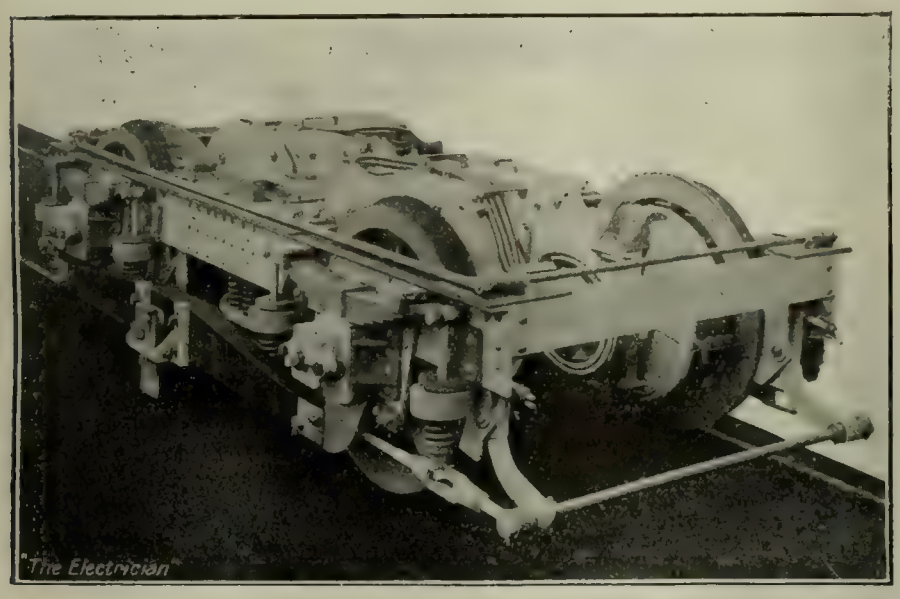


FIG. 31.—VIEW OF MOTOR BOGIE.

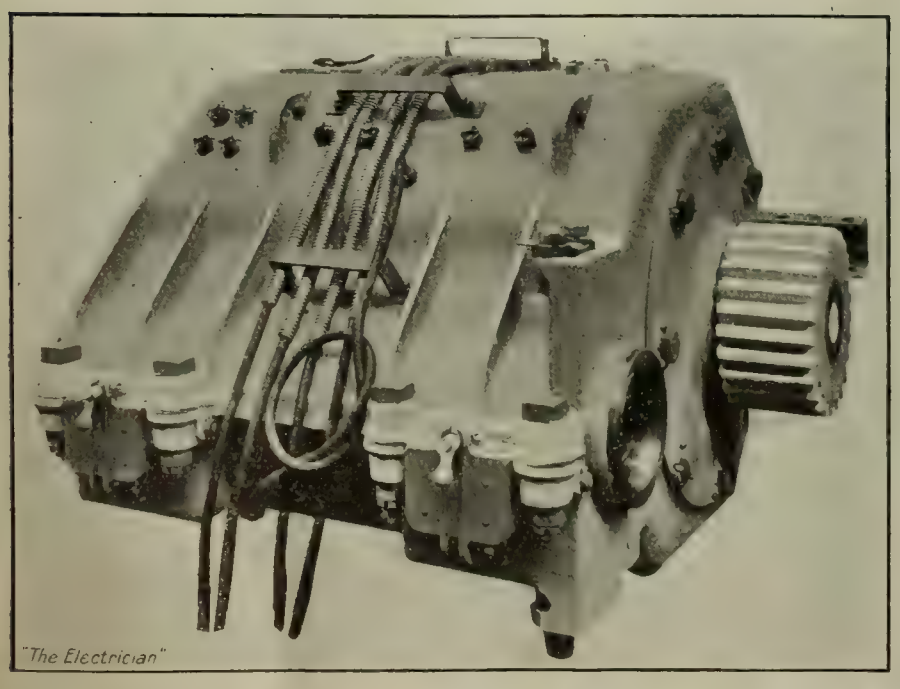


FIG. 32.—VIEW OF 200 H.P. MOTOR.

The cables used for connecting across the gaps were manufactured by W. T. Henley's Telegraph Works Co., and normally two 0·5 sq. in. or a single 1·0 sq. in. cable are used. They are insulated with vulcanised bitumen and run in wooden troughs, which are filled in with bitumen. These troughs are, as far as possible, carried above ground, but in all cases of underground work, " Howard " troughing is used.

The fourth or return rail is of square section with rounded corners, and weighs 88·5 lb. per yard with a cross-sectional area of 8·84 sq. in. The chemical composition and electrical conductivity being the same as the live rail. This section has been adopted on account of the small surface exposed over a given volume of rail, and therefore small maintenance in painting, &c. This rail also is cut in lengths of 60 ft., and is placed between the running rails. It rests on wooden pads 1 in. thick, secured to the sleepers by iron dogs, and is anchored at intervals of 100 yds.

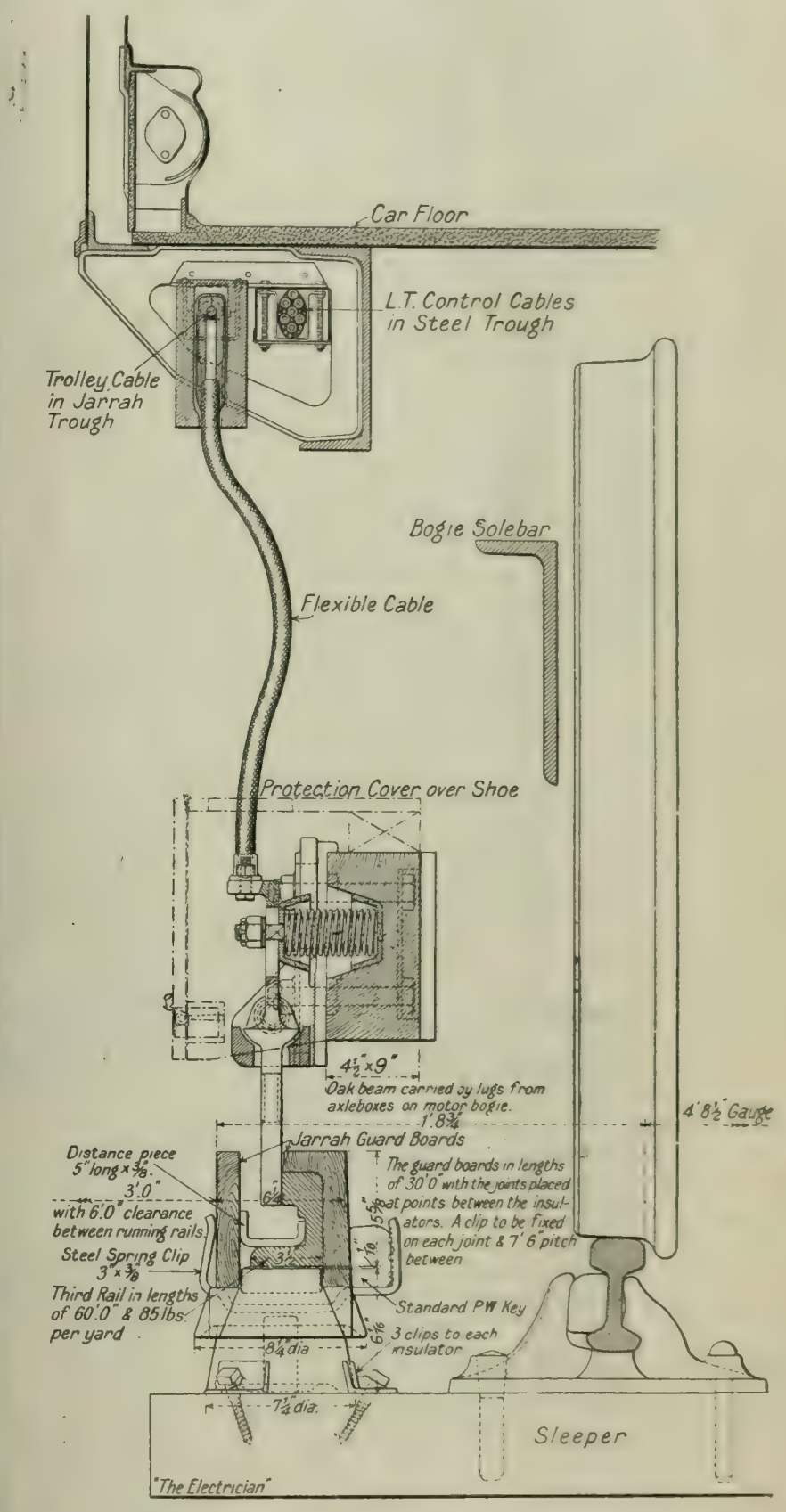


FIG. 33.—CROSS-SECTION THROUGH LIVE RAIL SHOWING CONTACT SHOE AND TROLLEY CONNECTION.

There are two bonds per joint, and the effective cross-sectional area is 0·325 sq. in. per bond. They are also cross-bonded every 100 yds. to the track rails with cable bonds of 37/15 S.W.G. copper, and the track rails are also bonded by cable bonds.

The track is fed from the sub-stations through short feeders, which take the shortest course from the sub-station to the track rails; no supplementary feeders are used. The live rail is divided up into sections, which are connected through section switches placed alongside the live rail, and operated as ordinary hook switches. At all gaps the live rail is ramped towards the running rail, as seen in Fig. 29, so as to receive the shoe which runs on the outside of the rail.

The whole of the erection of the track equipment has been carried out by the railway company.

Shoe.—The general arrangement of the shoe is shown in Fig. 34, and its connection to the trolley cable in Fig. 33. The mounting of the shoe on the bogie is shown in Fig. 31.

through spur gearing, the ratio being 25/59, or 2·36 to 1·0. A view of a bogie is seen in Fig. 31. On each side of the bogie is mounted a shoe beam carrying the collecting shoe. Each motor car is provided with two of these bogies, making a total of four motors, or 800 H.P. per car, the gradients being somewhat severe, as will be gathered from Fig. 36.

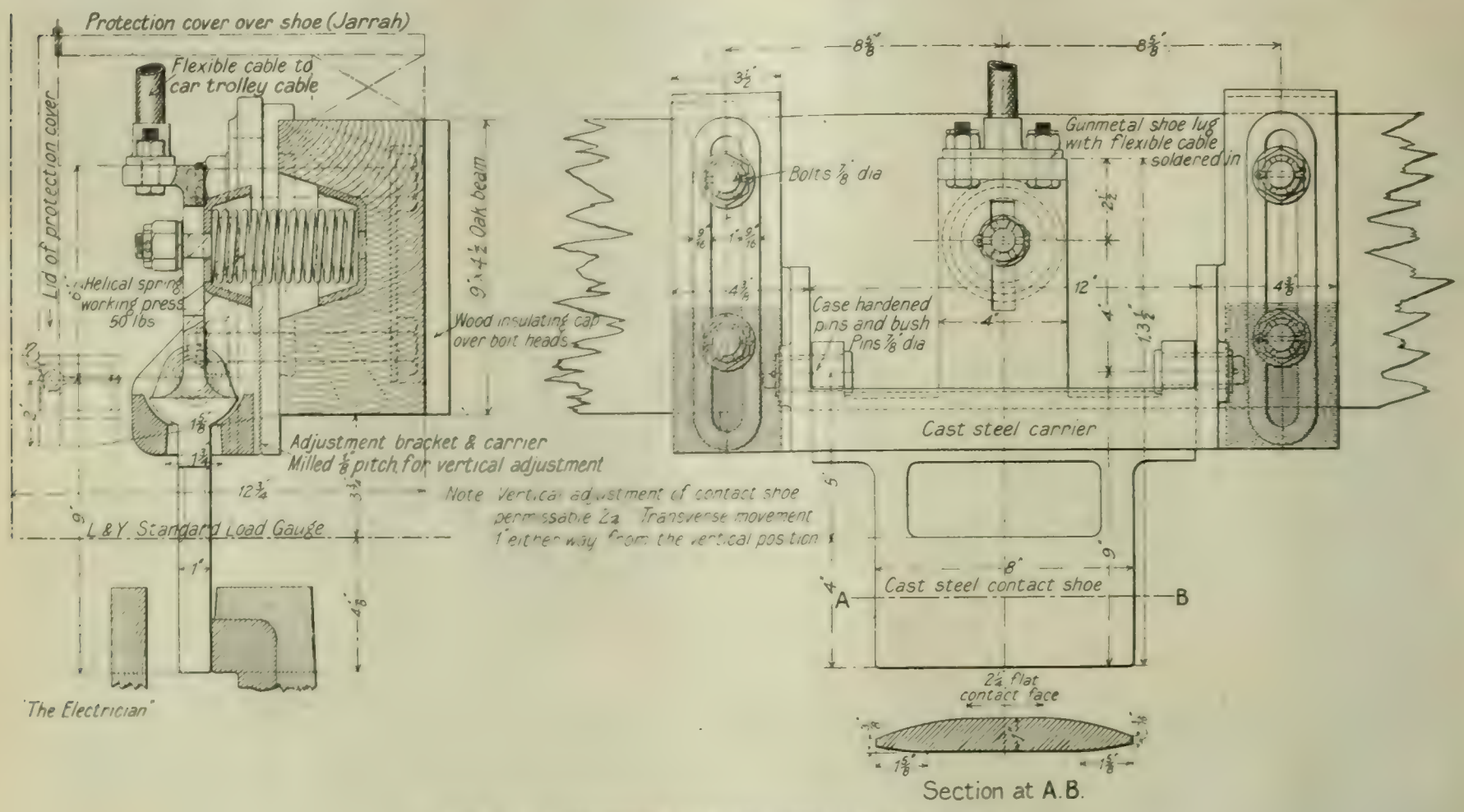


Fig. 34.—Elevation and Side View of Contact Shoe.

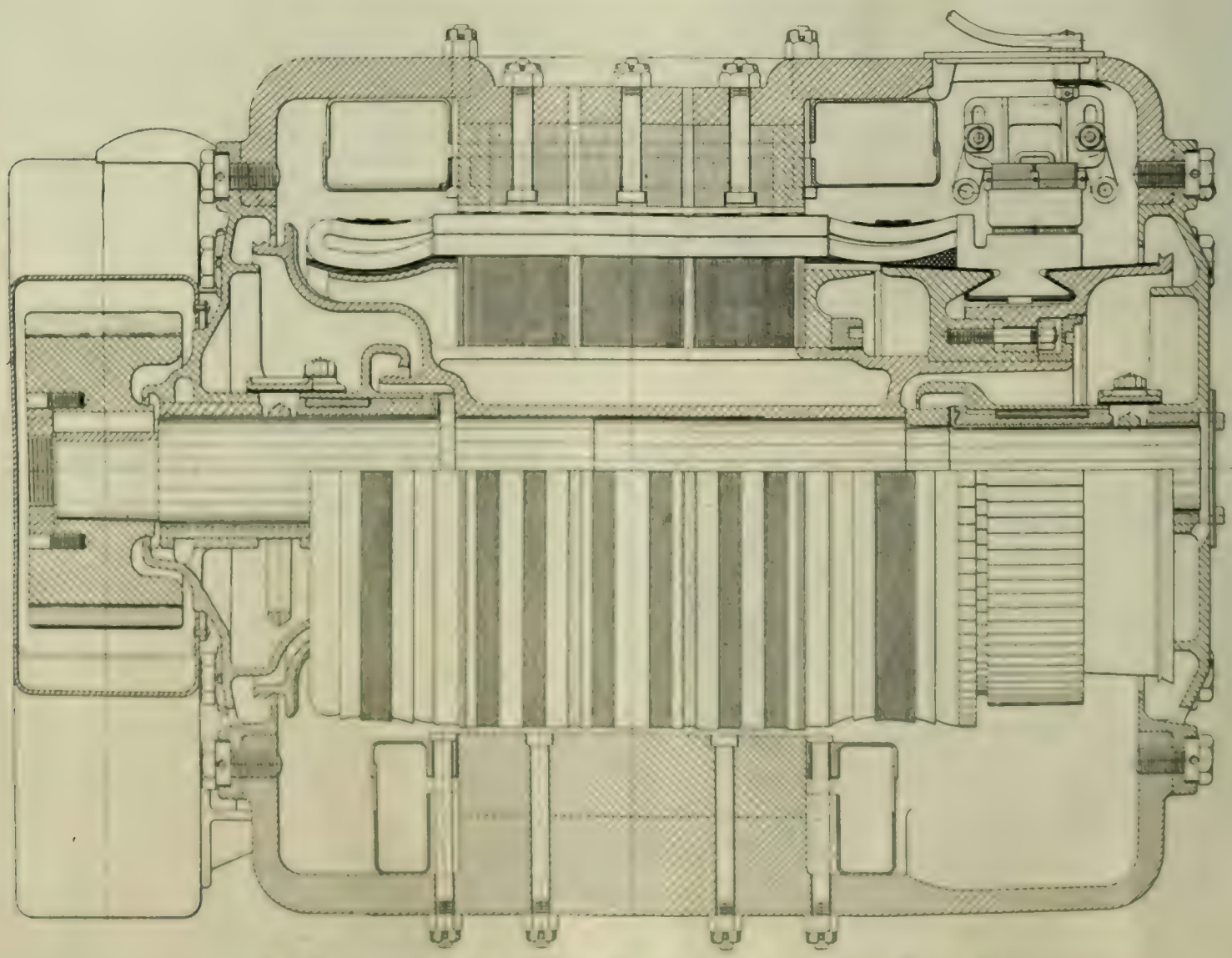


Fig. 35.—Longitudinal Section through 200 H.P. Motor. (Scale 1:9.)

Rolling-stock.

Motor Bogies.—The motor bogies complete, which have been designed and built at the railway company's locomotive works at Horwich, carry two 200 H.P. motors mounted and geared to the axle The wheel-base is 9 ft., and the diameter of the wheels 3 ft. 7 in., the wheels being of standard locomotive pattern. There are two brake-shoes per wheel.

Motors.—The motors (Figs. 32, 35 and 37) are designed for 1,200

volts, series wound, with commutating poles, and are totally enclosed. The field frame is in one piece, of the "box" type, the main poles being arranged vertically and horizontally, this arrangement having been found to give the best space-efficiency in the limited room available. The ventilation of the motors has been carefully considered and provided for.

The armature laminations are carried on a hollow spider, which also carries the commutator. There is a free passage of air through the spider and through the ventilating gaps in the armature, which are continued through the main poles to the outside atmosphere. The armature coils are all insulated with solid mica insulation, and the field coils are enclosed in brass cases to keep them from contact with oil.

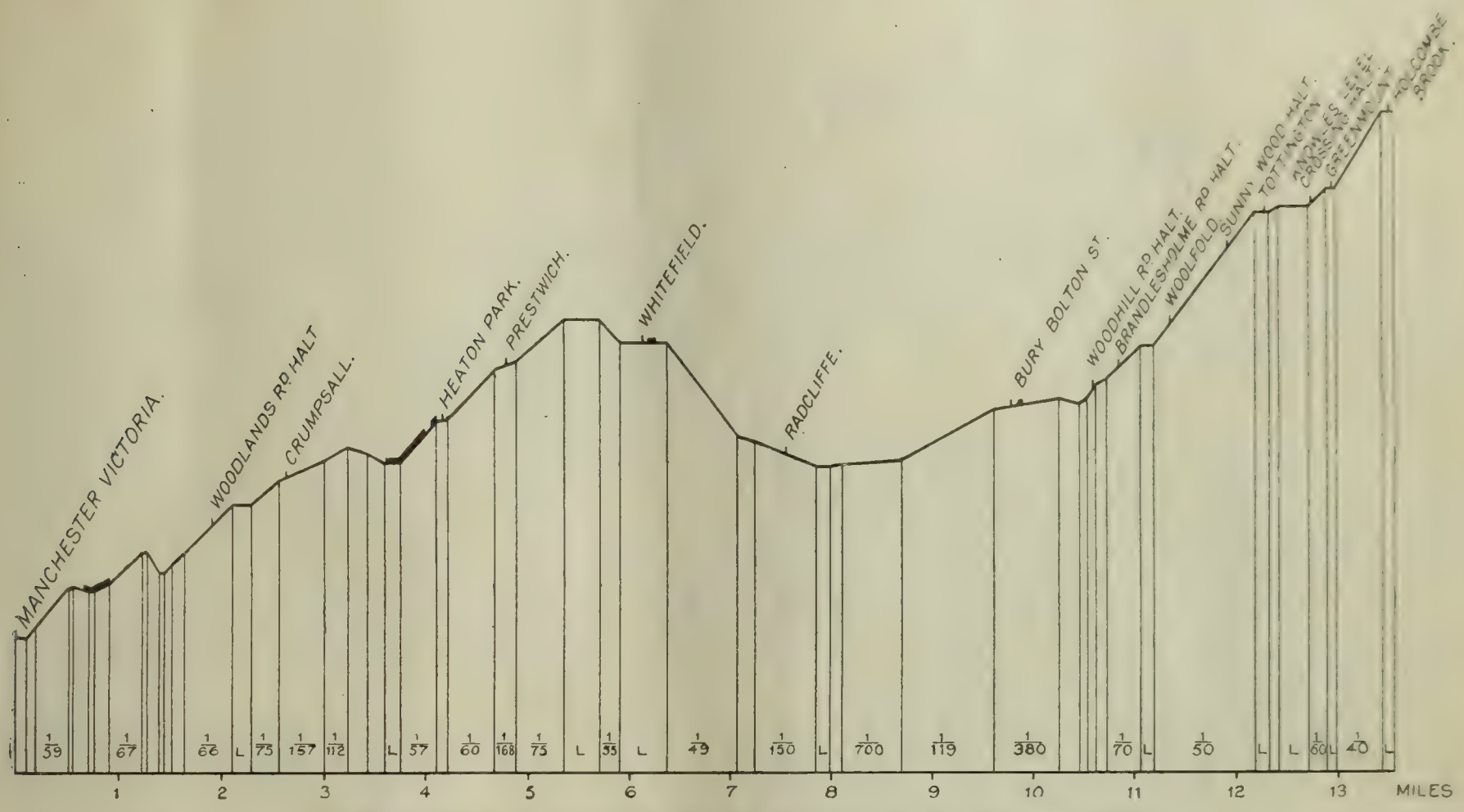


FIG. 36.—DIAGRAM OF GRADIENTS BETWEEN MANCHESTER AND HOLCOMBE BROOK.

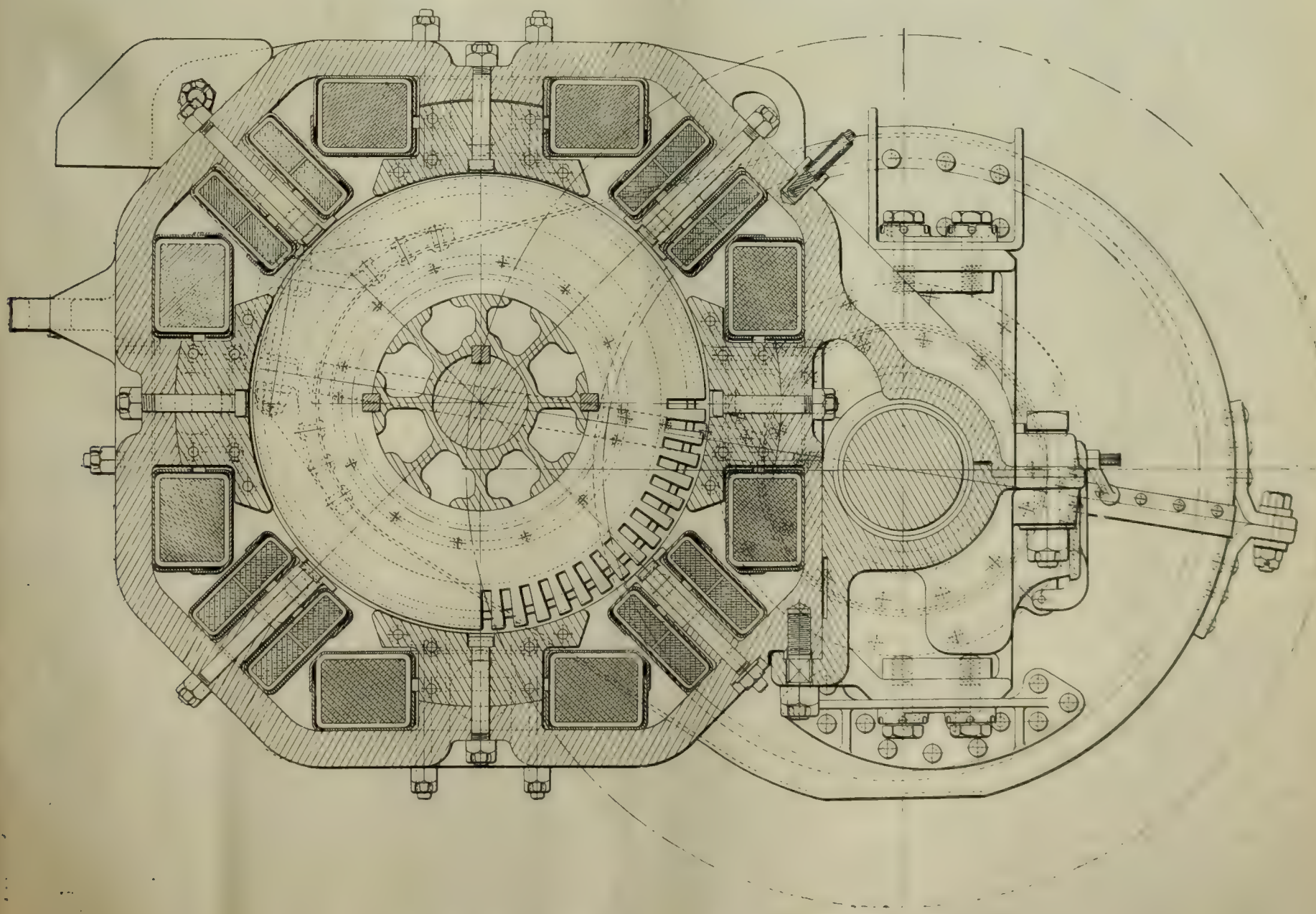


FIG. 37.—CROSS-SECTION THROUGH 200 H.P. MOTOR. (Scale 1:9.)

Ring lubrication is used for the armature shaft, the oil wells being of ample proportions; oil lubrication with pads is adopted for the suspension bearings. The brush gear is carried on a solid steel yoke bolted to the frame, which is insulated with solid mica, and forms a very rigid construction.

Special attention has been given to the machining of the various parts so as to ensure interchangeability.

(To be concluded.)

THE PRINCIPLES OF MODERN PRINTING TELEGRAPHY.*

BY H. H. HARRISON.

Summary.- This Paper is divided into five sections. The first deals with the fundamental principles and leads up to automatic stop and start. After that follows translation of signals, page printing and the principles of letter counting mechanism. The third section deals with low-speed printing telegraphs and chain relay systems. The fourth discusses synchronism, control of phase, leading to synchronism between printer and distributor units. The last part deals with automatic multiple-circuit arrangements, échelon working, repeaters, distribution of signals and quadruple duplex.

The author discusses several elementary telegraph installations, and continues as follows: An elementary printing telegraph can be formed by taking a number of wires equal to the number of characters and connecting to these a similar number of character levers. Each line is connected to earth at the receiving end through electromagnets controlling character key levers of an ordinary typewriter. By adopting both positive and negative signalling impulses the receiving electromagnets may be divided into two groups, if suitably polarised, and the number of wires required, compared with the previous case, is halved.

With any line wire there are three possible variations: positive or negative current flowing or zero current. By taking the three variations possible in one wire and combining them with three similar variations in a second wire nine signals can be formed, and adding the variations of a third wire a total of 27 signals is possible. Actually one of the 27 signals cannot be used, as it consists of a zero unit in each line wire, and this is the normal or non-operative condition, so that generally the number of signals possible is $V^n - 1$, where n = the number of lines available, and V = the number of variations furnished by each wire. For three wires the total number of signals is given by $3^3 - 1 = 26$, which just suffices for the alphabet.

A telegraph on this plan is illustrated in the Paper, in which six keys are connected in three pairs to a similar number of lines. By suitably depressing the keys current permutations are set up. The currents act on three polarised relays at the distant end, the armatures being normally in a neutral or mid-position. A further mechanism is required to translate the complex signal represented by the arrangement of the armatures into the simple signal, the printed character. One method of effecting the translation consists of a series of six electromagnets selectively operated by the receiving relays. Each electromagnet controls a rod carrying bridging contacts or switches, and for any given rearrangement of the rods from their normal position, as indicated, a circuit is completed for the local or printing battery.

It will be seen from the foregoing that the transmission and reception of signals is effected by the displacement of a transmitting lever, which is copied at the receiving end of the line by the displacement of an electromagnetically controlled lever. If we wish to use one line wire only there are three methods of translating such elementary signals into type-printed characters:

1. By the number of signal elements.
2. By the duration of the signal elements.
3. By the moment of their appearance.

The first method assigns one impulse to the letter A, two to the letter B, three to letter C, and 26 to the letter Z. This is the principle on which step-by-step printing telegraphs depend for their action, and is theoretically set out in Fig. 1. The transmitter consists of a barrel B driven by a motor M through a friction drive FD. A number of pins P on the barrel form a helix, and when any one of the keys of the keyboard KB is depressed, its far end rises into the path of the corresponding pin and stops the barrel as long as the key and pin are in contact. The period of the revolution at which this stoppage occurs depends upon the key depressed. At the right hand end of the barrel a crown-wheel commutator is arranged to send alternating currents to line, 14 periods per revolution of the barrel. When the barrel revolves continuously the alternating currents step round the type-wheel at the distant station and a stoppage of the barrel by a character key prolongs the impulse, positive or negative, at that moment going to line, and effects printing in a manner to be described. At the receiving end of the line the alternating currents pass through a polarised relay LR to earth. The armature of this relay alternately closes the circuit of the two escapement magnets EM, which allow the escapement wheel to move round tooth by tooth. This wheel is mounted on a shaft carrying the type-wheel TW, the combination being constrained to rotate by a slipping drive not shown. So long as the barrel continues to revolve the type-wheel follows its movements, keeping in step by the method of control outlined above. In series with both the escapement magnets is a printing magnet PM, which is relatively slow-acting and is unaffected by the stepping impulses. When one of the impulses is prolonged by the momentary stoppage of the transmitter barrel the printing magnet is energised, and forces the paper tape against the type-wheel. This wheel is kept inked by a roller, not shown, and the selected letter is imprinted on the tape.

The second method uses two durations of current, a short impulse and one three times as long, and the various signals are differentiated by combinations of the two elementary signals. The Morse code is an example of this procedure.

The Hughes type printing telegraph is illustrated in the Paper, and the author proceeds: At the transmitting end a contact-brush arm is

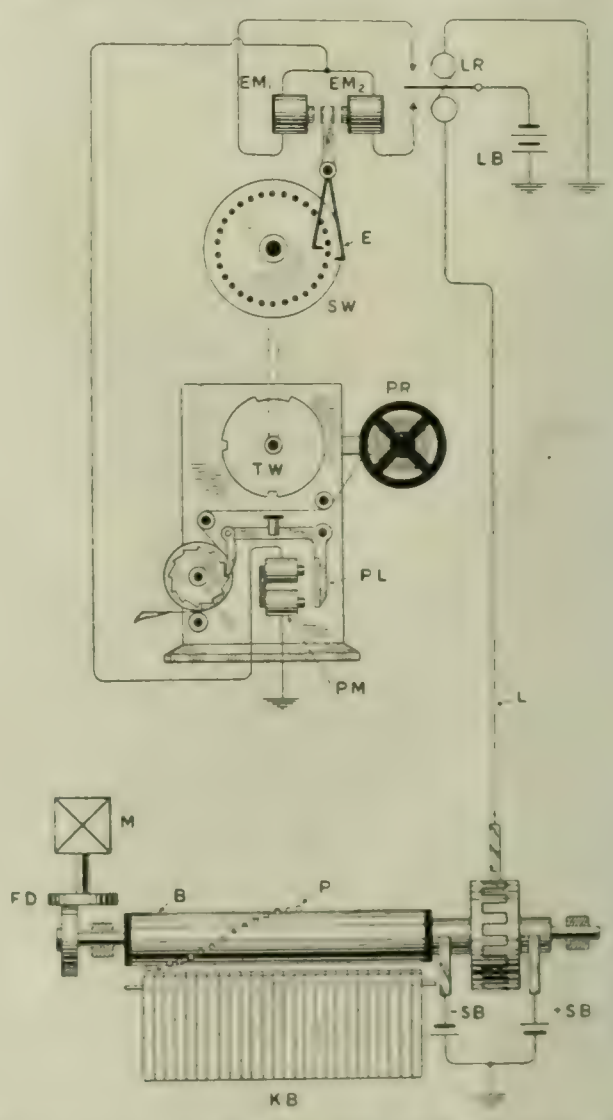


FIG. 1. PRINCIPLE OF THE STEP-BY-STEP TYPE PRINTING TELEGRAPH.

kept in continuous rotation. It makes contact with the solid ring shown and also, in turn, with a number of contacts, each connected to character keys, of which only one is illustrated. Signals pass to line accordingly as keys are depressed or not. The number of segmental contacts is equal to the number of character keys, and the whole transmitting mechanism is simply a device for dividing very precisely the time of a revolution. The significance of a signal depends upon the moment or interval of time in which it occurs during a revolution.

At the receiving end of the line a free-running type-wheel, synchronised with the contact-brush arm, is divided at its circumference into as many type faces as there are transmitting intervals on the collector. Solid on the same shaft as the type-wheel is a feed cam which engages with the paper-feed ratchet mechanism, and feeds the paper tape forward one letter space after printing. In the diagram only one letter per revolution is supposed to be printed, although actually in the Hughes only four letter spaces need intervene between the printing of successive letters. As a signal impulse is received over the line it excites the printing magnet, and the printing hammer forces the paper against the type-wheel, effecting printing of the letter which at that moment is in the printing position.

Both in the Hughes and the step-by-step system the signalling impulses are equal in duration, but the spacing between letters in

* Abstract of Paper read before the Institution of Electrical Engineers on January 13, 1916.

respect to time is variable and depends upon the preceding signal. In both cases signals are differenti ated by time ; a certain period is taken and subdivided into as many parts as the required number of characters, and each interval corresponds to a given letter or character. Highton's telegraph does not depend upon time as a means of differen tiation ; the signals remain space signals at both ends of the wire. A given permutation may be set up indefinitely, and the corresponding type bar, and only that particular bar, will be actuated.

Also, the two systems using time signals have used rotating collectors at the transmitting end by which the signals are impressed on the line, and a revolving type-wheel at the receiving end. The transmitting and receiving organs are dissimilar. If a typewriter is used as a printer then a transmitting collector is used as before, and a similar organ has also to be employed at the receiving end to perform the inverse function, viz., to distribute the incoming signals to the appropriate character key levers. The arrangement is indicated in Fig. 2. Two circular contact discs, D, D_1, are surrounded by segmental contacts connected at the transmitting ends to character keys, and at the receiving end to electromagnets controlling the key levers CKL of the typewriter. Contact-brush arms at both ends rotate synchronously and connect the rings D, D_1 with the segments in turn. Rings D, D_1 are connected together by the line wire. The time taken for a complete revolution, if divided into 26 intervals, only provides for the alphabet, and to print numerals and punctuation, signs further subdivision is necessary. The author next deals with inversion devices for type-wheel or bar printing mechanism, and continues : The saving in line time with the five-unit alphabet, compared with the Hughes and the Morse, is graphically shown in the Paper.

The elementary mechanism by which the signal permutations for the five-unit code may be set up, transmitted, and received, is as follows : Two revolving-contact brush arms, having the same angular velocity and phase, sweep over concentric metal conducting rings, the inner rings being continuous while the outer rings consist of segmental contacts. The brush arms at each end bridge the two

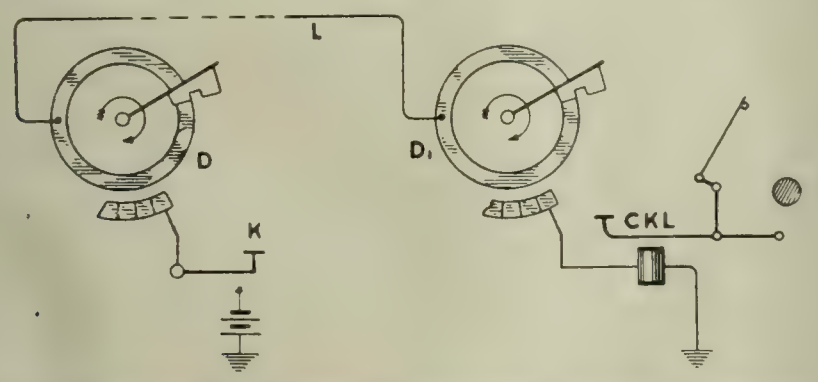


Fig. 2.—Selection of One of a Number of Printing Elements by Means of Time Signals Over a Single Wire.

concentric rings. At the transmitting end, the five signalling keys which normally rest against the upper or negative 'bus bar are joined to five segments on the distributor as shown. If one or any number of these keys are depressed by the operator, they leave this bar and make contact with the positive bar, and as the revolving contact-brush rotates, it collects the current permutation set up at the keyboard and sweeps it into the line. At the receiving end, the signalling impulses actuate a polarised relay, the positive impulses moving its armature to close a local circuit through the distributor to the five setting magnets. If at any moment the contact-brush arms are on corresponding segments, the particular receiving magnet will be actuated accordingly as the corresponding transmitting lever is depressed or not. Thus, by the employment of the intermediate mechanism of distributor and collector, the operator at the transmitting end can select any one of the setting magnets at the receiving end singly or in combination, and this with a single-line wire. This result has been accomplished by the conversion of the space signals at the keyboard into time signals on the line, and their re-conversion into space signals as represented by the displacement of the armatures of the receiving magnets through the distributor at the receiving end of the line.

There is a very necessary condition to be met at the transmitting end of the line, viz., the signal permutations must have been set up before the contact-brush arm commences to sweep over the five transmitting contacts ; and as this arm revolves at from three to five times per second, some indication must be given to the operator when to set up a fresh letter, since it is obviously impossible to ascertain this by watching the revolving arm. It is also necessary that the setting of the keys should persist until the brush arm has swept over the entire five signalling segments.

An early method of accomplishing the two results is shown in Fig. 3, diagram A. Here each of the keys is provided with a locking latch L adapted to be caught by a pivoted rocking-frame RF, which is so constrained by a spring S that it normally tends to lock all the signalling keys. Directly coupled to the shaft carrying the contact-brush arm is a cam C which, during that portion of the revolution through angle β pushes the frame RF to the right, unlocking the keys and allowing the operator to set up a fresh permutation. This period is signalled to him by a hammer fixed on the rocking frame which taps a bell or other suitable device. This illustrates the well-known " cadence " signal of the Baudot printing telegraph, though it may be remarked in passing that it did not originate with Baudot.

The modern arrangement is identical in principle, but different in detail, and is shown in Fig. 3, diagram B. The keyboard is unlocked electrically by contacts closed on the distributor. Such keyboards are termed by Murray " bound," the speed of transmission being fixed by the revolutions per minute of the contact-brush arm. The least stoppage on the part of the operator to sign and time a transmitted message or to decipher a badly written word, reduces the output.

The author next deals with the improvement effected by using individual character keys, and shows how such arrangements save mental strain of the operator, the operation being practically reduced to typewriting. He next refers to mechanical signal storage and continues : There are two ways in which this reservoir may be provided : (*a*) by a revolving drum fitted with pins set from the keyboard ; and (*b*) by the use of a perforated tape. Kinematically the two mechanisms are identical. He then describes a system using a metal disc which is continuously revolving at 3–4 revs. per sec.

The alternative method of signal storage involves two pieces of apparatus : the perforator and the transmitter. An elementary form of perforator due to Baudot is illustrated in the Paper, and the author next discusses the operation of keyboard perforator methods of actuating perforation punches, the Murray automatic start and stop device.

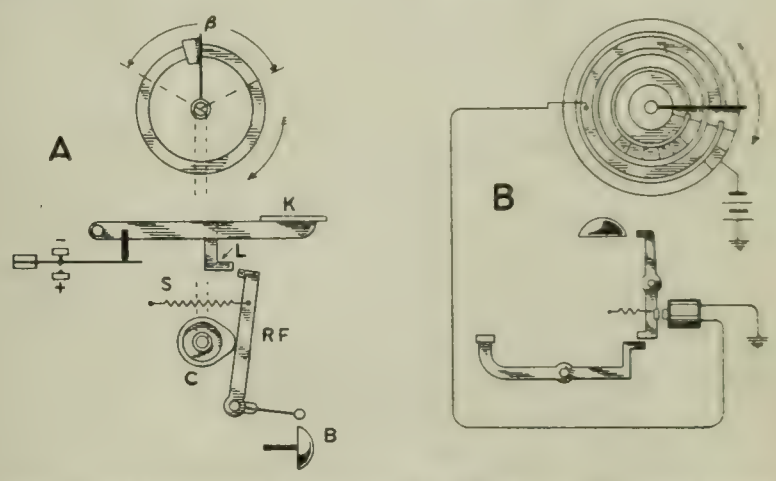


Fig. 3.—Examples of Keyboard Locking and Cadence Signal Devices.

By either of the storage devices described it is possible for the rate of transmission, which is fixed by the number of revolutions of the distributor brushes, to vary from the rate of setting up either the letter pins or the punched holes in the tape. The perforator is usually placed close to the transmitter, and so long as the operator keeps a few letter-signals ahead, there is no risk of the tape being torn. It is customary with modern installations to interpose an automatic device which will stop the transmitter when the number of stored letter-signals on the tape has reached a minimum, usually 10 to 12 letters. The operator is thus relieved from any nervous strain due to anxiety from the transmitter catching up while few letters intervene between the perforating and transmitting points. To make the device completely independent of the operator, automatic starting should also be provided for. The solution of the problem of the completely automatic " stop and start " fulfilling the necessary conditions was first accomplished by Murray. The automatic stop-and-start device is not absolutely necessary, but its omission lowers the efficiency of a high-capacity circuit. Murray's invention in its original form provided only for manual operation of the stop and start, but this is not nearly so satisfactory as the subsequently-developed automatic arrangement. The essential feature of the invention is catching or releasing the armature of the transmitter magnet at the moment when it is attracted. Obviously this can be done electrically as well as mechanically, and several modifications have been devised for electrical operation. An entirely different plan from that evolved by Murray has been proposed, namely, to start the keyboard perforator working automatically so as to produce blank tape whenever the loop of tape gets used up. Unfortunately this device wastes tape and apparently interferes with the free manual operation of the keyboard perforator. Up to the present the Murray arrangement appears to be the most practical plan.

(*To be concluded*)

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THE LEGAL RECORD OF 1915.

The average man looks upon legal proceedings, even the most ordinary step in a civil action, with a certain amount of dread. This feeling is partly due to the increasing prolixity of advocates and greater cost of litigation, and partly to the uncertainty of the result of proceedings. Nevertheless, we have the reputation of being a law-abiding race and of being worshippers of the reign of law. Though our summary of the legal decisions of the year must be necessarily brief, a review of the leading cases and the effect of the more important judgments which concern the electrical industry may not, however, be unprofitable.

The war does not appear to have affected the amount of litigation upon electrical engineering matters, for, from the point of view of the number of cases tried and the scope of the decisions given, the year has been one of more than average importance. Among the patent cases may be mentioned the judgment of Mr. Justice JOYCE in the action brought by the Osram Lamp Works against Pope's Electric Lamp Co. for alleged infringement of patent No. 23,899 of 1904. The hearing occupied 14 days and judgment was reserved. The patent had been judicially considered in the earlier case against the "Z" Electric Lamp Co., but the judge held that the method and processes used by Pope's Company were so different from those particularised in plaintiffs' specification that there was no infringement and he dismissed the action. Plaintiffs appealed and the Court of Appeal first heard the case on the question of infringement, but intimated that the validity of the patent (which had not been decided in the court below) could, if necessary, be argued later. This, however, was unnecessary, for the Court unanimously upheld the judgment of Mr. Justice JOYCE. We understand that there is to be an appeal to the House of Lords against this decision and so we refrain from commenting upon it.

In March, Mr. Justice WARRINGTON heard an interesting petition by the Robin Electric Lamp Co. for a licence to

make, use and sell tungsten wire in accordance with certain inventions covered by the Tungsten Lamp Association. The petition, which was the first case under sec. 24 of the Patents Act of 1907, was opposed by the British Thomson-Houston Co. and Siemens Dynamo Works. After hearing evidence for the petitioners the judge intimated, without calling upon the respondents, that he would reserve his decision and ultimately the petition was dismissed with costs, as it was held that the petitioners had failed to establish their case and to meet the requirements of the Act.

There were a number of applications for the revocation of alien enemy patents or for the grant of licences thereunder. In the majority of these cases licences were granted on the payment of royalties, but in a few instances the patents were annulled. The decisions of the Special Patents Court seem to be based on equitable principles, for the aim is to enable British manufacturers to use alien enemy patents during the war on payment of a royalty, the decision as to the ultimate fate of the patents being reserved for consideration when peace reigns once more. In December, Mr. Justice YOUNGER tried a type of case which does not frequently come up for judicial consideration. Messrs. Vandervell & Co. alleged that Messrs. A. P. Lundberg & Sons had infringed two of their registered designs for electrical switch boxes. After a lengthy hearing, in the course of which the law on this somewhat vexed question was carefully considered, the judge held that there was not sufficient novelty in the plaintiff's design, that he was endeavouring to obtain for a switch box an implied protection to which he was entitled as patentee of a switchboard, and that it would be dangerous to extend the scope of the Designs Act to cover the case. Therefore, the action was dismissed without reference to the other defences set up.

A fair number of commercial contracts came up for review by the Courts, but few of them call for special mention. There were, however, a couple of interesting cases in which the question of the effect of war on contracts was raised. In the first case Mr. Justice BRAY decided, in the action brought by the Zinc Corporation (Ltd.) against Aaron Hirsch & Sohn, that a contract for the supply to a German firm of a large quantity of zinc concentrates from Broken Hill, Australia, was formally dissolved on the declaration of war on August 4, 1914. It appeared that in the agreement between the parties there was a clause which defendants contended merely suspended its operation during the continuance of hostilities. His Lordship, however, held that, apart from that clause, on the principle of the decided cases and as a question of public policy the contract between the parties had been dissolved, for the Courts could not substitute for an agreement made by the parties an agreement minus one of its terms. Plaintiffs appealed from this decision, but the Court of Appeal unanimously dismissed the Appeal with costs. Another interesting point in connection with the effect of war on contracts was raised in an action heard by Mr. Justice SHEARMAN in December. The action was brought for damages for a breach of contract to supply a quantity of G.O.B. virgin spelter to be delivered at plaintiffs' works on or before July 31, 1914, and there was a further contract to deliver 50 tons of the spelter on Aug. 31, 1914. Defendants failed to deliver the whole of the spelter as agreed, and plaintiffs bought other spelter at an increased price and sued for damages. The defence was that plaintiffs had agreed to an extension of time for delivery and that in view of the outbreak of war a clause which exonerated them for delays en route or other contingencies beyond their control was sufficient excuse for the delay. The Judge held that, even assuming war to be in the contemplation of the parties at the time of entering into the contract, defendants failed to satisfy him that the delay in delivery was traceable to the war; he knew of no case where an increase of price owing to unforeseen circumstances excused a vendor from delivery until he could get the goods at a lower price. Judgment was, therefore, given for plaintiffs with costs. This decision may appear inequitable to some, but we consider it to be sound law and in accordance with precedent. The important question of limited liability companies controlled by alien enemies was raised in several actions, but as these companies are now controlled by a public official, and as further legislation is now under consideration by Parliament, the matter is not of the vital importance it was at the outbreak of war. Provided these companies are placed in a position in which they cannot render any aid (direct or indirect) to the enemy, the question of general legislation on this vital subject of the status of these companies might be left over until after the war, when the whole of the circumstances can be calmly considered. Hasty legislation is usually bad legislation and seldom effects its purpose. The capacity of alien enemies to sue has also arisen in many cases, and it has now been judicially recognised that even an alien enemy who is in an internment camp may sue in our Courts and enforce contracts, &c. We consider this to be equitable, so long as an alien enemy is not allowed to aid a country with which we are at war.

Those who have contractual and other relations with local authorities will be glad to learn that the House of Lords delivered a judgment in the case of Myers *v.* Bradford Corporation which places a narrower construction on the Public Authorities Protection Act, 1893, than that hitherto acted upon in the Courts. The point at issue was a small one, but the judgment is very important. Myers ordered from the Corporation a ton of coke which was delivered, but in shooting the coke down the coal-hole the shop window was broken. He sued the Corporation in the County Court, and the jury returned a verdict for £17. 2s., but the County Court Judge held that, as the action had not been begun within six months of the injury complained of (as laid down by sec. 1 of the Public Authorities Protection Act, 1893) the Corporation were protected, and he entered judgment for defendants with costs. The Divisional Court was divided, Mr. Justice BRAY holding that the Corporation were protected by the Act, but Mr. Justice LUSH was of opinion that the section did not apply as the Corporation had entered into contractual obligations towards Myers. The Court of Appeal, however, concurred in Mr. Justice LUSH's view and allowed the appeal. The Corporation appealed to the House of Lords. In delivering judgment the LORD CHANCELLOR dissented from the reasoning of Mr. Justice LUSH. He said that it was not because the act out of which an action arose was within their power that a public authority enjoyed the benefit of the Statute. It was because the act was one which was either an act in the direct execution of a Statute or in the discharge of a public duty, or the exercise of a public authority. He regarded those latter words as meaning a duty owed to all the public alike or an authority exercised impartially with regard to all the public. The act complained of arose because one of the servants of appellants, acting in the course of an errand on which they had power to send him, but on which they were not bound in the execution of any act or in the discharge of any public duty or authority to send him, in breach of his common law duty to his fellow-citizens, caused damage by his personal negligence. An action for such negligence was not within

the class of action contemplated by the Statute. The other Lords concurred and the appeal was dismissed with costs.

Another interesting case arising out of a contract with a local authority occurred in the action Swansea Gas Light Co. *v.* Swansea Rural Council. The agreement was made when the Company was seeking Parliamentary powers and related to the relative areas of electricity and gas supply. In the Court below, the agreement was held to be ultra vires, but the Court of Appeal reversed this decision and entered judgment for the Company. We think both judgments are sound law and common sense. It seems to us preposterous to place local authorities which engage in business in a privileged position merely because they are municipal corporations. Though we are strong advocates of the limitation of actions, we cannot see the justice of saying that a trading corporation cannot be sued when under identical circumstances a private citizen can.

Rating and assessment cases have been more numerous than usual, and in one instance, that of the Brompton & Kensington Electricity Supply Co.'s appeal against the assessment of their undertaking, the weak points of our rating legislation were brought out prominently, and it is obvious that this important question must receive further consideration from our legislators when the war is over.

There were a couple of interesting arbitration cases in connection with the acquisition of the Devonport & District Tramway undertaking and of the Kingstown Provisional Electric Lighting Order. The award in the latter case has led to further legal proceedings, and the whole affair is a bad example of municipal methods and of our private bill procedure. The private promoter of a provisional electric lighting order stands to lose some hundreds of pounds on account of petty municipal jealousy and sordid party strife. Among the telegraph and telephone cases may be mentioned the action by the Postmaster-General against the Grand Junction Canal Co. in which it was held that the word " telegraph " included telephones.

There was a case at Alloa which raised the question whether energy supplied through a motor generator for a bioscope lantern was power or light. In the Sheriff's Court it was held to be power because, as obtained from the Corporation, it was used for driving a motor generator. We do not quarrel with the decision but only with the reason for it. There is no appeal from a decision in the Small Debt Court of Scotland, and so the validity of the judgment, which is generally considered to be unsound, cannot be tested. We understand, however, that the proprietors of the theatre are now paying the higher rate and so this local quarrel may be regarded as closed, but the general principle remains to be decided.

In June the Court of Appeal gave an interesting judgment on the powers of the Light Railway Commissioners. In November, 1913, four urban councils in the West Riding of Yorkshire jointly applied to the Light Railway Commissioners for powers for the construction of light railways. The Commissioners were of opinion the application for the order should be granted, but restrictions were imposed as to certain sections. One section was postponed, and sections 13 and 14 were refused. The promoters appealed to the Board of Trade with regard to the two sections refused, and that Board referred the matter back to the Commissioners. The latter proceeded to rehear the matter, but the railway companies affected refused to take any part in the hearing, and obtained a writ of prohibition to prevent the Commissioners proceeding with the inquiry. Their ground was that there was no appeal, as there had been no refusal of the promoters' application. The prohibition was not upheld by a Divisional Court and the Railway Companies appealed. The Court of Appeal held that the refusal had extended only to part of the application that was before the Commissioners, and under the Act there was no appeal from a restriction imposed on the refusal of a part of a scheme. The granting of a part was the granting of the application within the meaning of the Act, and the section extended only to cases where the application had been refused. Under those circumstances the promoters had no right of appeal, and the appeal was allowed. The rule of prohibition was restored and the appeal allowed.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Telephone and Telephone Exchanges: Their Invention and Development. By J. E. KINGSBURY, M.I.E.E. (London: Longmans, Green & Co.) Pp. x.+558. 12s. 6d. net.

This history of " the inventions and developments in the telephone field " covers 558 pages, divided into 33 chapters, with appendixes and a copious index. The author deals principally with the evolution of the telephone instrument, the exchange or inter-connecting system and the apparatus associated therewith, and, on the outside engineering side, with overhead and underground cables and long-distance work. In connection with these Mr. Kingsbury produces full evidence to prove that, particularly on the engineering side, the entire inception and development has been due to the brains and business enterprise of men of the United States of America, and more especially to the experts of the American Telephone & Telegraph Company and its associated companies. The unprejudiced critic must, however, reluctantly acknowledge this to be the case. Mr. Kingsbury gives credit to the inventors and pioneers of other countries, but they appear so comparatively seldom that at first sight it seems as if this was a history of American enterprise.

The author informs us in his preface that he leaves the word " history " as a title for the use of the author or authors who may produce a more comprehensive treatise, but, in the reviewer's opinion, Mr. Kingsbury has laid the foundations so thoroughly that it must be acknowledged that this is " Volume I." of the books that may go to make up the " comprehensive treatise which the subject deserves." The author has had peculiar facilities granted him for obtaining facts and data for his book, having had access to records of the American companies which would not otherwise be readily accessible. Most interesting are the reports of conferences of the companies' experts, containing the names of the members and their contributions to the subject under consideration. It is to be feared that no such records exist of work done in this country, or it is otherwise obscured.

Just as future authors must borrow from or refer to Mr. Kingsbury's work, so have manufacturers and operating administrations outside America simply built on the foundation work of the Bell Company. Hardly a reference is made to an inventor contributing a fundamental part to the engineering side of the subject who is not an American. Others have modified the design of apparatus, developed other circuits and turned things round, but the American was there first.

The book deals with the pioneer and fundamental work principally, and does not deal with auxiliary parts and circuits which have been more varied and developed by European inventors. Among the pioneers of this country we might have expected to see mention made of Mr. A. R. Bennett's overhouse construction with tubular poles, iron arms, corrugated insulators and silicon-bronze wire, in addition to the mention of his translator. Among European manufacturers, mention might have been made of the originality of design and beauty of manufacture of switchboard material of the Swedish L. M

Ericsson Co., who were the most serious competitors of the American companies prior to the introduction of the common battery system, in addition to the reference to their instrument.

The first third of the book touches on the use of the word "telephone," and describes pre-electric forms. It describes in detail Alexander Graham Bell's researches in connection with the invention of the receiver, and Lord Kelvin's appreciation of the same, and the few hours' priority over Elisha Gray's application for patent; also in an interesting way with the lamp-black transmitter of Edison, the microphone of Prof. Hughes, and the granular carbon transmitter of Hunnings. Reference is made to the work and claims of Reis, points being emphasised by giving patent numbers, dates of conferences and quotations from reports.

The next section of the book describes the evolution of the switchboard and the exchange system, and shows how the telephone developed first along telegraph lines, and describes the exchange system, foreshadowed in a patent by Dumont, of Paris, in 1851, and the use of the telegraph to call for a telephone connection to be set up, in the first Chicago system. The author then takes us through the evolution of the various types of switchboards to the latest forms of the common battery system. He deals also with the commercial side, the forming of companies, and competition, in the U.S.A., the Continent of Europe and in this country.

A section deals with outside construction, but principally with the various forms of cable that lead up to, and include, the dry-core cable. The latter part of the book reviews the evolution of the automatic and semi-automatic systems. It is interesting to note that the idea of working automatically is nearly as old as the inception of exchange working, the first patent being applied for in 1879. Due credit is given to Strowger and the companies that developed his system for originality and tenacity, and for making that system suitable for exchanges of considerable size, and a serious competitor in the hands of the "Independents" against the "Bell" Company. Mention is made of early systems which lead up to the power-driven machine-switching system of the Western Electric Co., of which Mr. R. F. McBerty is the chief inventor. The arguments for and against automatic and semi-automatic systems are also considered.

In long-distance work we are informed of the work done to bring about the extension from the modest estimate of 20 miles by Bell to the 3,400 miles of the New York to San Francisco trunk line, opened January 25, 1915. In this connection the work of Oliver Heaviside, leading up to the work of Pupin with loaded coils (also speech amplifiers) are considered.

The final chapters deal with rates, statistics, economics, relationship to Governments and the like.

The book reviews the whole subject of telephony in general, and, as it is doubtful if there is any other branch of engineering so many sided, the author is to be congratulated on the discrimination he has shown as regards the subject matter he has included. W. AITKEN.

Examples in Alternating Currents. Vol. I. By F. E. AUSTIN. (Hanover, N.H.: F. E. Austin.) Pp. 223.

The object of this book is to assist the college student as well as those who are pursuing correspondence courses, or who are attempting the study of alternating currents by themselves. It has been stated by numerous writers and teachers that a student cannot obtain an adequate understanding of the subject without performing a certain amount of numerical computation. As the result of an extended experience the author has found that the average student requires a certain amount of guidance in the solution of engineering problems. We believe that the earnest student will appreciate the guidance offered in this book. Care has evidently been taken in the selection of the examples, and the author's solutions will be found helpful. A pleasing feature of the book is that calculus methods are introduced and explained. The numerous tables in the volume will materially lessen the arithmetical drudgery and will, at the same time, enable the student to concentrate his attention on the problem.

How to Make Low-Pressure Transformers. By F. E. AUSTIN. (London: E. & F. N. Spon.) Pp. 17. 1s. 8d.

Directions for Designing, Making and Operating High-Pressure Transformers. By F. E. AUSTIN. (London: E. & F. N. Spon.) Pp. 46. 2s. 9d.

In the first of these little books directions are given for the manufacture of a small step-down transformer, of the ring type, to reduce the pressure from 110 volts to about 8 volts as a minimum, for experimental purposes. The secondary pressure may be altered at will by varying the number of turns in the secondary winding, tappings being brought out for the purpose. In the second book directions and data are given for constructing two transformers, one of 3 kw. output, 20,000 volts, and the other of 1 kw. output, 4,000 volts. The reader will have no difficulty in following the author's instructions. In future editions complete working drawings of the several transformers would add materially to the value of the books, and we think that a less ambitious title to the second volume would be no detriment. The attempt to deal with the theory of the subject is entirely out of place in practical books such as the ones under review.

THE PREDETERMINATION OF THE PERFORMANCE OF DYNAMO ELECTRIC MACHINERY.

The following is a report of the discussion on Prof. Miles Walker's Paper at the Manchester meeting of the Institution of Electrical Engineers on the 11th inst. An abstract of this Paper appeared in our issues of the 14th and 21st inst.:—

Mr. L. H. A. CARR said the treatment of design could be divided into two portions, the academic or general side, which was comprehensive of many makes of machines, and the specific side, which embodied the application of constants and data for any given line of machines. The division only took place in the more variable quantities, leakage, temperature rise, &c., and not in the fundamental formulæ of magneto-electric phenomena. The present Paper gave formulæ of fairly general application, and indicated the limits between which designers were likely to find constants. Regarding leakage, however, the author's method seemed rather complicated, containing as it did four quantities. The determination by numerous tests of the constants necessary to correct these formulæ for a large range of sizes of machines was almost hopeless, as the four variables might change independently. A simplified general equation was required to enable the individual designer to determine fairly easily the constants for a line of machines. The speaker had found it possible in practice to calculate leakage by means of a formula containing only two terms, the first being proportional to the core lengths (a different constant being used accordingly as the rotor slots were more or less than the stator slots), the second giving the end leakage. This method worked well in practice, and the determination of the two constants for any given line of motors was fairly simple. The author's formulæ for end leakage, with constant ampere wires per inch, gave the leakage increasing roughly as the square of the pole pitch. In the speaker's experience this was too high, and the pole pitch raised to the power 1·5 was probably high enough. The author's suggestion to separate the core and end leakage by comparing tests of stators of different lengths seemed difficult to determine accurately on account of the small difference. Better results would probably be obtained by comparing machines of the same core length, but differing in pole pitch. The speaker disagreed with the author regarding the large difference in the end leakage between concentric and barrel windings. Instead of a difference of 1·4 to 2·45 (Table II., barrel-wound rotor in each case), which represented a ratio of 4 to 7, the ratio 6 to 7 seemed much nearer the truth. The core loss curves in the Paper called for some criticism. It was not stated whether they applied to continuous or alternating current machines, but it was inferred that they held good for both classes. Some years ago the speaker had carried out a series of experiments on core losses, and it was found that for a given periodicity and flux density the core loss in a continuous-current machine was about double that in an alternating-current machine, and this fact was borne out by other authorities. The author gave 0·05 watt per cubic centimetre, with $B=10\,000$ at 50 cycles, whilst other authorities gave figures ranging from 0·05 to 0·07 for alternating-current machines. In the case of continuous-current machines the author gave 0·02, against the following figures from other writers: Hobart, 0·035; Alexander Gray, 0·037; Schukkermann, 0·052; Whittaker, 0·052; Cramp, 0·061. The latter figure certainly seemed high, and 0·04 was a good estimate. Regarding the "tailing off" at the upper end of the curves, the speaker had observed this effect in asynchronous machines with cylindrical rotors. It did not occur, however, in continuous-current machines even with extremely high apparent tooth densities, the curves taking, in fact, an increased upward tendency. This phenomenon was observed in machines with armature conductors of small round wires, so that eddy currents were negligible. The probable explanation was that, due to the high tooth saturation the shape of the flux space curve under the pole

tip altered, the flux widening out to a more square-shouldered form, with a consequent quicker change from a high positive value of B to a high negative value of B, and hence a higher eddy current loss in the iron. This again leads to the doubtful reliability of the author's curves for continuous-current machines. Was the scale of flux density the real or apparent value? The method of calculating the difference in temperature between copper and iron was not included in the appendix, as stated, but this would be found in the author's recent book on dynamo-electric machinery, p. 221. The equation for watts dissipated from cylindrical surface in the appendix seemed much too high for an induction motor. This type of formula gave good results for direct-current machines with relatively large air spaces between the salient poles, but with an induction motor with small air-gap the figures seemed much too optimistic. Referring to the calculation sheet given in the Paper for an asynchronous motor, the temperature rise of the stator inner face seemed to have been taken at about 30°C. allowing presumably the 10°C. difference between copper and iron mentioned in the Paper. This heat represented by 4,270 watts had to be dissipated somewhere, and since it was unreasonable to expect it to be transmitted to the rotor the only other place was the air in the air-gap. The quantity of air required to carry off this heat could be calculated as follows: The speaker then calculated that the weight of air per second would be 0·475 lb. and the velocity through the air-gap 88·5 ft. per second. The pressure required is given by the standard formula :—

$$\text{Inches water-gauge} \left(\frac{V}{483}\right)^2 \cdot \frac{4 \times \text{perimeter} \times \text{length of path}}{\text{area}} \cdot \left(\frac{V}{66}\right)^2.$$

and substituting the values this gives 620 in. of water, (V = feet per second). Making all possible allowances—viz., 30°C. rise (reducing the head to four-ninths its value), assuming the air blown in at both ends and out through the ventilating ducts (reducing the head another quarter), there was still 68 in. head required, which was absurd for a self-ventilated machine. These figures would entirely disprove the possibility of getting enough air through a narrow induction motor air-gap, in order to dissipate the quantity of heat mentioned. Regarding the heat dissipated from the ventilating ducts, it was of interest to know how the figure of 2,000 watts was arrived at and the air velocity in the ducts. Also with regard to the heat dissipated from the back of the stator core, in the majority of the box-type frames in use the air driven out by the revolving rotor passed over the back of the stator laminations. Under such circumstances surely the heat dissipated would increase with the peripheral velocity of the machine, so that a formula of the type $(1+nV)$ would be expected to apply. The speaker agreed that the machine considered should not get unduly hot, but the method of calculating the watts dissipated left something to be desired.

Mr. Julius Frith said it was disappointing that two such interesting points as the commutation limit in direct-current machines and the regulation limit in alternators had been left out of the Paper. It was noted also that the two classes into which methods of design naturally fell referred to flux loading. The current loading was surely quite as important, also the ratio of flux loading to current loading. The method of taking the maximum induction in the air-space and multiplying it by the maximum possible area of the air-space in order to get a fictitious large flux was not inviting, and the stated advantage that it did not necessitate working out the number of teeth carrying the flux from one pole to the armature seemed rather a complicated way of overcoming a difficulty. The speaker referred to the increased ohmic resistance due to the current being forced outwards in the slot conductors, and with regard to vector diagrams said: The use of flux diagrams was much better than diagrams showing voltage which had no real existence. The same reasoning applied to the treatment of commutating poles. The four curves showing iron losses at different frequencies could, with sufficient accuracy, be combined into one curve by plotting watts per cubic centimetre against the product of induction and frequency. The author might advantageously have dealt with the maximum difference between iron losses in revolving and alternating fields, and this matter was deserving of serious research.

Mr. Juhlin said that from personal experience he could testify the ease with which a designer could lay out machines and get a clear grasp of the factors involved, using the method outlined by Prof. Walker. The method might show disadvantages with men of short experience, but after using it for some time it was exceedingly quick. Regarding the calculation of induction motor leakage, the splitting up of the leakage into several different parts would be a disadvantage if several types of machines were continually being designed, but manufacturing firms generally laid out machines on certain constant lines, and it was quite feasible to draw curves for different parts of the leakage, either zig-zag or end leakage, with advantage. Some reference to the belt leakage in induction motors, which in some cases was of considerable importance, would have been welcomed. A Paper by Prof. Adams before the Electrical Congress at St. Louis in 1904, and a Paper before the Mechanical Institute in 1905, would be found useful references in connection with this subject. There was an apparent contradiction in the author's Paper on the question of iron losses. Prof. Walker had stated that it was hardly worth while to calculate the iron losses or to attempt to calculate them very accurately. It seemed, however, that without some fairly accurate idea of the iron losses it was impossible to deal with one of the main headings, namely temperature rise. The speaker went further, and said it was necessary, or at least desirable, to allocate the loss to different parts of the magnetic circuit. The speaker referred to the losses in turbo-alternators as varying with the third or fourth power of the density, and thought the curves shown on p. 572 were too low. Were the curves intended for alternating current or direct current machines? In direct-current machines the loss would be greater than calculated from the curves. The eddy current losses increased very rapidly with the working of the iron. For example, in turbo-alternators there was a big mass of unworked iron, whereas in induction motors with a large number of slots the worked surface was considerable and the losses consequently high. The same remarks applied to direct-current machines. Tests made by the speaker in order to determine the magnitude of these extra eddy current losses in the machined parts of a transformer gave results which were by no means negligible. The temperature rise formula given in the Paper gave very good results for direct-current armatures, using a constant between 300 and 350.

Mr. R. E. Grime said that a special sheet for each type of machine would be preferable, and three such sheets would fulfil most purposes. The author had practically limited the Paper to methods of calculation as distinct from methods of design, but in practice the two features were inevitably bound together, and it was difficult to separate them entirely. The author had given prime importance to what might be described as "frame constants"—*i.e.*, the idealised total magnetic flux crossing the air-gap $A_q B$, and the total ampere-turns $I_a Z_a$. The speaker entered a plea for the utility of the *specific* magnetic and electrical loadings, especially in preliminary calculations. The specific magnetic loading was the average air-gap induction round the whole machine. Denoting this by B_{av}, it equalled $2p\varphi \div 2\pi rl$. The specific electric loading equalled $I_a Z_a \div$ circumference, and was often denoted by q. These two quantities had the great advantage that for a given type of machine they remained sufficiently constant over a wide range of frame sizes. After some experience with these constants, a designer could usually estimate what values to aim at, and make the constants the basis of the first tentative design. The output coefficient given by the D^2l formula on design sheets always appeared rather a blind way of estimating what use was being made of available space and material. This coefficient was inversely proportional to the product $B_{av} \times q$. For example, in a continuous-current machine, after allowing for internal resistance drop, the D^2l formula might be written

$$\frac{KW}{R.P.M.} = D^2l \times B_{av} \times q \times \frac{\pi^2}{6} \times 10^{-12}.$$

This expression, which was quite familiar, merely brought out the fact that whereas the ordinary output coefficient was often used to indicate that it was possible to put a given output into certain dimensions, if this coefficient was replaced by the two quantities B_{av} and q, the designer would see at once how it was possible to get it into those dimensions. It was obvious that the air-gap induction B might be used instead of the average value at the discretion of the designer, as the author's field form coefficient K_f was simply the ratio of these two quantities—*i.e.*, $B_{av} = K_f B$. As an example, in induction motors possessing a large number of poles, considerations of power factor often limited the magnetising current to, say, 35 or 40 per cent. of the full-load current. This percentage was directly controlled by the specific magnetic to the specific electric loading as follows :—

$$\frac{I_m}{I_a} = 1{\cdot}85 \frac{B}{q} \times \frac{g_{eff.}}{\tau},$$

where I_m/I_a = ratio of magnetising to full-load current,
B = maximum air-gap induction,
q = specific electric loading $IaZa/2\pi rl$,
τ = pole-pitch in centimetres,
$g_{eff.}$ = air-gap length in centimetres, corrected for slot opening and with an additional allowance for iron.

This simple relation was often of great service in the preliminary stages of design. Regarding temperature rises, the product of $q\Delta$ of specific electric loading by current density in armature copper often gave a very close idea of the temperature rise of standard machines. Obviously this product did not take into account all the factors governing temperature rise, but it was something more than an empirical rule, as it was proportional to the copper loss per square centimetre of air-gap area, and also, in the case of a barrel winding, per square centimetre of end connection cooling surface. Thus, for a given continuous-current frame of practically constant flux a curve could be plotted showing the relation between the permissible value of the product of $q\Delta$ and the peripheral speed. There would be no great advantage in this were it not for the fact that over quite a wide range of frame sizes this curve remained practically the same. In a line of standard machines of one type, therefore, such a curve, when once determined, gave instantly a fairly close indication of the current density to be employed in connection with any proposed value of the specific current loading. Regarding the iron loss curves, the speaker said that in completed machines the observed total iron loss was usually considerably higher than that indicated by the curves. This was particularly the case in continuous-current machines, even with laminated poles and rooted slots. In induction motors and alternators, with the flux densities usually employed the losses generally increased approximately as the square of the total flux while in continuous-current machines the index was usually 2·5 to 2·8, or even higher, at very high tooth inductions. The author had mentioned one reason for this, but for the present the difficulties in the way of forming a reliable estimate of the extra losses were so great, especially in view of the large differences produced by small shop variations, that the allowance for them must remain mainly empirical. The question of stray losses dependent upon the load, whilst a very important one, had been very little discussed in this country, and the author had confined his Paper to the calculation of the eddy current losses in the conductors embedded in the slots. The following note on stray losses in direct current machines might form a

starting point for further discussion and investigation. The stray losses which were dependent upon the load were mainly accounted for by (*a*) eddy current losses in the conductors embedded in the slots, and (*b*) additional iron loss due to distortion of field form by armature reaction. There were a number of other and more elusive losses, but in normal machines at normal loads these would be comparatively small. The effective increase in resistance of embedded conductors carrying sinusoidal currents were well known from the investigations of Messrs. A. B. Field and M. B. Field. No figures were easily available in this country, however, for the corresponding losses in the armature conductors of continuous-current machines. Owing to the almost rectangular shape of the current wave form in the latter case, the effective increase in resistance was considerably greater than when the same conductor carried a sinusoidal alternating current. The curves shown in the accompanying figure might, therefore, be used as a step towards increased accuracy. The curve AC gave the mean coefficient of increase in resistance for the top and bottom conductors of an ordinary barrel winding carrying a sinusoidal current. The curve DC showed the corresponding effect in a normal continuous-current winding. The effective resistance depended somewhat upon the width of the commutating zone, being higher when narrow brushes were employed. Within the usual limits of practice, however, the difference was not comparatively great, and the curve given was, therefore, based on the assumption that the effective total width of the commutating zone was one-tenth of the pole-pitch. The

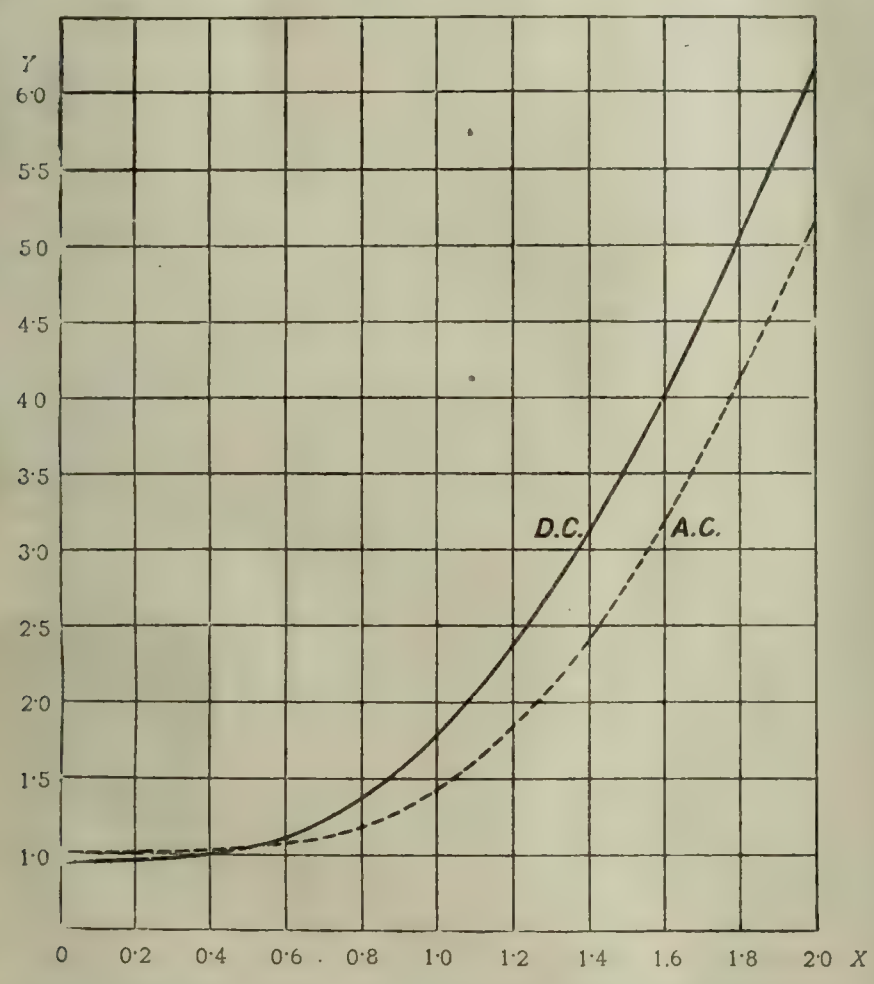


FIG. A.—EFFECTIVE INCREASE OF RESISTANCE OF EMBEDDED PORTION OF STANDARD TWO-LAYER BARREL WINDING DUE TO LEAKAGE FIELD ACROSS SLOT.

Y=Coefficient of increase of resistance (mean of top and bottom conductors).

$$X = 0{\cdot}14 \times \text{depth of conductor in cms.} \times \sqrt{\frac{\text{frequency} \times \text{width of conductors total}}{\text{width of slot}}}$$
for copper at 60°C.

A.C. Curve is the mean of Field's curves for first and second conductors carrying sinusoidal alternating current.

D.C. Curve is based on straight line commutation with total width of commutation zone equal to one-tenth the pole pitch.

calculation was made after the manner suggested by M. B. Field ("Idle Currents," "Journal" I.E.E., Vol. XXXVII., p. 83). The eddy current losses in an actual machine were dependent upon the nature of the commutation. Straight line commutation was assumed, so that the current wave form was a trapezium, and it was also assumed that all the conductors in one slot were commutated simultaneously. The end connections were not appreciably affected by eddy current of the nature under consideration, and as it was usually necessary to make the armature conductor of uniform section throughout (except occasionally in turbo-generators) it would be found that there was seldom much to be gained in total copper loss by making the top conductor smaller than the bottom one. For simplicity, therefore, the curves showed only the mean increase in top and bottom conductors, assuming these to be identical in size. The stray iron losses on load were not so amenable to calculation owing to the unsymmetrical and awkward shape of the field form. It was possible, however, by ignoring the field form altogether and simply considering the maximum induction under the trailing pole tip (of a generator) to arrive quickly at a result which was at least of the right order of magnitude. The method of procedure was then to calculate the actual maximum air-gap induction at the pole-tip due to the combined main and armature magnetising forces available at this point and read off directly from the no-load iron loss curve, the total iron loss corresponding to this air-gap induction. In spite of the crudeness of the method it had given fairly good results even for machines running with very weak main fields, such as boosters and variable speed motors. As an example of the accuracy to be expected, the following table summarised the results of tests and calculations on two 900 kw. 230-volt 150 revs. per min. continuous-current generators, which were coupled together and tested by the Hopkinson parallel method. The results were somewhat on the safe side at half-load, but on full-load there was some stray loss still unaccounted for :—

Approximate load on generating machine.	Full.	¾.	½.
Total armature losses in two machines calculated in ordinary way from measured resistances and observed no-load losses	Kw. 122·4	Kw. 88	Kw. 63·1
Actual total losses from Hopkinson test	153·3	105·7	71·7
Difference equals actual stray load losses	30·9	17·7	8·6
Additional eddy current copper losses from figure above	8·1	4·3	1·9
Additional iron losses calculated as outlined above	20·2	15·9	9·8
Losses still unaccounted for in two machines	+2·6	+1·8	−3·1

Mr. R. TOWNEND said that after 10 years' experience of Prof. Walker's method for calculating the magnetic quantities of machines, he preferred it to the methods generally adopted by other designers. The constant K_e might seem rather complicated and difficult to obtain, but after a little use it was quite simple, and once obtained for a given frame it was practically constant irrespective of the number of slots per pole. For example, with a sinusoidal field on a three-phase machine K_e=0·389 for an infinite number of slots per pole, 0·39 for nine slots per pole, 0·395 for six slots per pole, and 0·41 for three slots per pole. Six slots per pole was generally the lowest figure employed. K_e for a two-phase machine could be obtained by multiplying the constant for a three-phase machine by $\sqrt{2}/\sqrt{3}$. The great advantage of using the constant was that it conveyed so much meaning in one figure, and showed at a glance whether the best results were being obtained from any particular design of frame. Regarding the adoption of one calculation sheet for all machines, this was not desirable. For example, if a designer had been working on alternator design for some time and suddenly turned to direct-current machines, it was quite easy to overlook the fact that in one case a certain portion of the tooth depth had to be added to the armature diameter, and in the other a certain portion had to be subtracted. A separate type of design sheet would certainly tend to prevent mistakes of this kind; in fact, sheets having different colours would be preferable.

Mr. W. E. M. AYRES said the calculation of the magnetising current given by the author was useful and quick for the air-gap, but the methods of Dr. Kloss or Dr. Smith, to which the author referred for the remainder of the circuit, were rather involved. The speaker had found it very useful in practice, particularly in the calculation of the magnetising current for induction motors, to plot curves for the magnetising current in terms of the air-gap plotted against flux densities for different parts of the magnetic circuit. Regarding the curves for iron losses which, presumably, were for alternating-current machinery, the speaker had not found the actual losses tapering off so much at high densities. It often happened in certain types of induction motors with open slots in the stator that iron losses calculated from these curves would be considerably in error owing to additional losses which were due to the open slots. Infinitely thin iron sheets perfectly insulated would not allow eddy currents to be set up in the rotor teeth due to pulsations set up by the open slots, but actual punchings were appreciably thick and frequently burred in the working. The use of the same curves for losses in teeth and core was frequently insufficiently accurate owing to the fact that the core was usually substantial unworked iron, while round the slot was considerably worked iron. A large number of induction motors had a small core section compared with the large space taken up by the slots, and it was necessary in order to obtain sufficient accuracy for practical work in some cases to use quite a different factor for the losses in teeth and losses in core. The estimation of the heating of machines, particularly induction motors, was a very complicated matter. A rotor with considerable losses, which did not ventilate well, could conveniently transfer heat to the stator by the air brushing through the gap at higher speed. Cases had been observed where a reduction of rotor losses had resulted in cooler stator iron, although the stator iron losses had increased. The heating of the stator could be considerably modified by taking the heat away from the end connections in an efficient manner. Mr. Grime had mentioned that the heating of the end connections could easily be proportioned by taking the product of the current density in the windings by the ampere wires per unit length. This product was a comparative measure of the heating per unit area of the stator connections quite irrespective of the length of the connections. These two figures divided by a function of the rotor speed gave the heating of the end connections very satisfactorily. The speaker also agreed with Mr. Grime in taking the ampere wires per inch length as the values were easily remembered and machines could be compared. Taking the ampere wires per unit length of periphery as the current loading and air-gap flux density per unit area as the magnetic loading for any machine, the product of these values multiplied by D^2L was a measure of the output, and a glance at such figures was sufficient to indicate to an experienced person how the machine was loaded.

Mr. VICKERS asked for figures showing the end connection leakage in

two-phase motors, also the effect of the chorded winding on the short-circuit current. The figures for barrel windings in Table II. seemed to be reversed, also the method of estimating the slot heat seemed hardly correct.

Prof. WALKER, in a brief reply, said he did not agree with Mr. Carr's suggestion regarding the correct method of calculating the leakage of induction motors. The calculation should be made as simple as possible, but the designer should have before him the principal factors which determined the amount of leakage. If the slots were made deeper there must necessarily be more leakage, and it was not sufficient to say, "Well, we standardise our machine, and get so much from it as it stands, and the leakage is a certain amount." The main factors should be taken into account, so that the effect could be seen when the design was improved. In connection with end leakage it was to be remembered that a small piece representing the length of the overhang had to be added to the pole-pitch, and this made a substantial difference between the author's method and that proposed by Mr. Carr. In a number of cases worked out by the author the end leakage was quite twice as great in the concentric as in the barrel winding. Regarding the iron loss curves, which had been subjected to considerable criticism, these curves were intended to represent the legitimate iron losses. Reasons were given in the Paper, although perhaps not very fully, why some of the so-called iron losses were actually higher in practice, but the author did not consider it right to accept these additional losses as something inevitable, and put them into the curves for general application. The correct procedure was to give curves for the legitimate iron losses, and if there was additional loss, say, due to eddy currents in conductors occurring when the teeth became saturated, a separate small formula should be employed to take care of it. The author was quite assured that the legitimate iron losses would follow a curve as given in the Paper. The eddy current losses in the iron would only vary as the square of B. The effect of hysteresis at 50 cycles and normal densities was greater than the eddy current losses, and this gave the curve a curious inflection. The subject of hysteresis losses due to a true rotating flux had been investigated both by Prof. F. G. Baily and Dr. Beatty, and it had been shown that the hysteresis losses above B = 22,000 became practically zero. In dynamo machines, however, the flux was as a rule an alternating one, not a true rotating flux, and the hysteresis loss became almost constant above B = 22,000. In connection with the cooling of induction motors the method of applying the formula was shown in the calculation of the performance of a three-phase generator. It would be seen that before applying the formula it was necessary to obtain some idea of the temperature of the air in the air gap, and with this correction the result would be fairly true. If the air in the gap was hotter than the iron then heat would pass from the air to the iron. Thus, it was possible for the stator to pass some of its heat to the rotor and *vice versa*. Referring to Mr. Grime's valuable contribution in connection with the specific loading constant, the author's formula permitted of the introduction of this constant. The vector diagram referred to in the Paper was not a time diagram, but a space vector diagram, the vectors pointing to the centre of the phase band which carried the maximum volts or amperes, as the case might be. In reference to Mr. Frith's comment, the reactance voltage had no existence, but it was very convenient to express it as a voltage when the saturation curve was plotted in volts. Regarding the curve for estimating zig zag leakage, the leakage figures were taken from Goldschmidt's Paper, using slightly different gap constants according to the size of slots. The American Papers referred to by Mr. Juhlin were certainly very valuable in regard to leakage problems. The author agreed that the teeth and core losses should be separated, and the individual curves plotted. The importance of the iron losses was enormously great, and the temperature rise of a machine could not be estimated without a fair knowledge of these losses. It was not intended to imply what Mr. Juhlin understood regarding the exclusion of the iron losses, but, however carefully calculations were made the results would probably not be very accurate. Regarding the design sheets, for some reasons it was probably better to adopt separate sheets, but it was well to have one general method of design, and to emphasise this, the author had employed the same design sheet in both cases.

COMMERCIAL MOBILISATION.

A dinner was held by the British Electrical & Allied Manufacturers' Association on Thursday evening the 20th inst., when a discussion was held on Commercial Mobilisation. The was opened by Mr. Henry Thornton, general manager of the Great Eastern Railway. Although the dinner was "informal" it was a great deal more formal than its predecessors and in some respects, we think, this was a disadvantage, as the discussion was not so free. The chair was taken by Mr. F. R. Davenport, the Chairman of the B.E.A.M.A. and a number of well known men were present, including Mr. S. Z. de Ferranti, Mr. C. H. Merz, Sir George Ridgeway, Mr. Jean Colson, Mr. F. Dudley Docker, Mr. H. Gordon Selfridge, Mr. T. W. Allsop, Mr. James Keith and Mr. F. W. Wolf.

DISCUSSION.

Mr. F. R. DAVENPORT, in opening the proceedings, remarked that they were quite prepared to put a properly organised body for the reconstruction of our trade position.

Mr. H. THORNTON said it was a sign of healthy optimism that we should be discussing what we were going to do with Germany at the conclusion of the war. It had been remarked that we should have great difficulty in raising capital after the war, but in considering this point we must look at our assets. These were our excellent credit, an enormous mercantile marine, the fact that a large proportion of our population were skilled in trades, and lastly, our indomitable courage. In his opinion, therefore, there was no question of our being insolvent. The time for talking had now passed and it was time for action. In this connection it might be useful to observe what was being done in the United States, where, in order to take advantage of the position, it was realised that it was insufficient to rely upon the Government or upon any one section of the community. It was necessary to appeal to the patriotism of the whole population, not merely to a combination of banks. A large combination, the American International Corporation, had, therefore, been formed in order to secure foreign trade. He, the speaker, gave this as an illustration of one way in which the problem might be approached, but not necessarily the only way. He was afraid that in this country a number of efforts were being made which might eventually dissipate themselves with but little result, and in order to avoid this it was necessary to have combination on a large scale. In his opinion a knowledge of foreign languages was necessary, and among other things the support of bankers and a good consular service. Lastly, there must be the active and sympathetic support of the Press. Probably the American International Corporation could not be copied over here, but there might well be a committee to bring together all interests, particularly the banking interests, with someone at the head in whom everyone would have confidence.

Mr. C. H. MERZ thought that any beginning must be on the right lines. In the past, manufacturers had suffered from excessive competition and the purchaser consequently had suffered also. In the case of the smaller tenders the number of quotations was excessive, and there was difficulty in doing justice to them. It would be better if the B.E.A.M.A. could prevent more than a certain number of its members manufacturing in any one line. If trade was to be successful abroad it must first be successful at home. Owing to Government action in the past, electricity undertakings at home had not been successful and thus the necessary experience had not been gained for success abroad.

Mr. H. GORDON SELFRIDGE remarked that after the war the commercial men would have to fight Germany commercially as earnestly as the men in the trenches were figthing to-day. There was no use depending upon Government. Business men must carry on irrespective of Government lawyers; old ideas must be scrapped and new ideas taken up. Never was there such an opportunity before this war, but in order to take advantage of it we must be prepared to take up new ideas. Conservatism was a good thing, but when it became mere mental laziness it was very harmful.

Mr. C. COLTON (British Westinghouse) wished to see the industry of this country in such a condition that it could compete against any country, and with this object in view he thought that representatives of labour should be included in the organisation suggested by Mr. Thornton. If advantage were not taken of the present opportunity it would mean commercial ruin.

Mr. S. Z. DE FERRANTI thought that the B.E.A.M.A. was acting on the right lines. As to capturing foreign trade, the first thing necessary was to ensure the home market. There should be a number of rich British manufacturers instead of many poor ones. So far it had been a case of severe competition, and patronage had been obtained only when prices were very low. It was necessary for manufacturers to have plenty of money, firstly for development work, because what was satisfactory to-day would be comparatively useless to-morrow; and, secondly, for the development of the world's markets. It was impossible to get these markets without spending money upon them. We must see that we did not work with too severe a handicap after the war, so that we might be prosperous at home. We were very fond as a nation of taking up sport and taking half measures. Thus we started with self-imposed handicaps and felt that to work on even terms would be too easy. The electrical industry came into existence under peculiar conditions, namely, under the creed of municipalisation. Politicians had used electricity as a toy; otherwise it would have grown into another textile industry of this country, but it was not the only industry that had suffered. In 1837 steam 'buses ran from Hyde Park to the Bank, but this new industry was killed. Had it been otherwise, this country would have reaped an enormous benefit from the automobile industry. We must not ignore what the Germanic powers would do after the war, and knowing their methods it would be folly not to treat them accordingly. Where there were several methods of treatment the proper course was to utilise them all so as to avoid risks. He would like to see the Allied Empires exclude everything German. It was useless to do things by halves. If the Germanic powers were not allowed to recover commercially then they could not regain the position of first class powers. His views would probably not be acceptable generally, and for that reason he felt it was necessary to organise most thoroughly.

Mr. F. W. WOLF said it was altogether a wrong idea that Germany was defeated commercially. If such an idea were put forward it would merely lull us into a foolish sense of security. In Germany, Government cooperation with business was an essential feature. In fact, the German Government were getters of business. Germany was now throbbing with efforts to get to work again after the war.

Mr. JAMES KEITH (Keith & Blackman), in some communicated remarks, referred to Mr. Runciman's statement in the House of Commons that our patent system and copyright laws should be overhauled. He thought we ought to see that this pledge was maintained, and he would

suggest that the following amongst other provisions should be embodied in the new Act :—

1. A real search to ensure novelty and validity before any application for patent be even entertained.
2. No patent to be granted unless it be novel or practicable.
3. The total abolition of all renewal fees (as in U.S.A.).
4. The extension of the period of the patent from 14 to 17 years (as in U.S.A.).
5. Some form of Government protection to the bona fide inventor.
6. A special court and experienced judge solely for patent cases.
7. Some reasonable limit to the right of appeal in patent litigation.

In framing any new Act, inventors, engineers and business men of the first rank should be consulted. With the appointment of a Minister of Industry and the passing of a suitable Patent Act, Great Britain would be brought into something like line with the United States, which country would undoubtedly be our future principal competitor in the world's trade.

PARLIAMENTARY INTELLIGENCE.

TRADING WITH THE ENEMY (AMENDMENT) (No. 2) BILL.

In the House of Commons on Friday last this Bill was read a second time.

In moving the second reading Sir GEO. CAVE said it was intended particularly to deal with registered companies having a large number of enemy shareholders. Those companies could already be dealt with under existing Acts by the appointment of inspectors, or supervisors, or controllers, and the profits which might accrue to enemy shareholders could not be remitted abroad, but were paid to the custodian of enemy property. It still remained a fact, however, that those companies might continue to carry on their business in this country in time of war. In that way the goodwill of companies which belonged wholly or mainly to enemies was maintained, and it might even be increased in consequence of certain war profits. In the second place, the profits continued to accumulate in this country to the credit of the enemy shareholders, and in that way a fund was being set aside which might possibly be of great use to the enemies of this country in the economic struggle which must follow at the end of the war. By an increase of goodwill, and accumulation of funds here in the name of the custodian, a certain amount of credit accrued to the enemy, which might even during the war be used to the detriment of this country, and the benefit of its enemies. In the matter of British ships the position was most extraordinary. A British ship could not be held in the name of an alien, but two aliens, or indeed two enemy aliens, might, by the simple process of registering themselves as a limited company, become a British entity, and the owners of a British ship. So that if before the war two German subjects registered themselves as a private company under the title of Hans & Fritz (Ltd.), that company might well be the owners of a British ship, and to-day nothing could be done to deprive them of that ownership. They might even take a share in supplying our demands during the war, and by this means might actually be forging weapons which might be used against this country during and after the war. In the opinion of the Government such a state of things ought not to be allowed to go on. What he had said about companies applied in a less degree to individuals living here under licence and to firms which might have shareholders who were enemies. It seemed to the Government that the best way of dealing with the matter was to entrust a Government department with power by administrative order to deal with it in a summary way. The proper department was the Board of Trade, which would no doubt make proper inquiries and listen to all proper representations. Subject to that, the proposal in the Bill was to give to the Board of Trade special powers which were set forth in Clause 1. The effect of that was that where the Board of Trade were satisfied that a business carried on in the United Kingdom was, by reason of enemy nationality or the enemy association of those who carried it on, wholly or mainly for the benefit of subjects of an enemy State, then the Board should, if it thought it expedient, make an order either prohibiting the carrying on of that business during the war, or directing the business to be wound up. It was clear that it would not be wise to pass the Bill in a form which would make it imperative that every one of those businesses should be closed down. It was necessary to give some discretion to the Board of Trade. In many cases it might happen that a business was carried on for the national benefit. In the distribution of the assets of a company which was to be wound up it was provided that preference should be given to British and friendly creditors over those who were enemy creditors. If a company had assets in an enemy country, presumably they would be first applied to paying creditors in that country, and in distributing the assets here credit should be given to British shareholders and creditors in that respect. There were other cases to be considered. For instance, there were cases where a minority of shareholders, or perhaps only a few shareholders, were enemies. In such cases the company suffered in public estimation, and the British shareholders often desired if they could by fair means to rid their companies of those enemy shareholders. Enemy shares and other property belonging to enemies in this country ought to be kept in safety until they found how British property in enemy countries was being dealt with. Sir Geo. Cave cited an instance of a British subject who had been interned and whose business was taken over by a controller appointed by the German Government. The controller told the British subject that there was no intention of allowing him to resume business in Germany after the war. Though the Government could not take all statements regarding the treatment of British interests in Germany as established, there was reason to believe that British property there was not being fairly treated, or even kept safe, so that it might be restored to its owners after the war. There was no desire in this country to confiscate enemy property, but he thought it was desirable that the hand of the State should be placed upon enemy property, and that it should be kept safe, and held here until we saw what happened. Then when the question arose of the treatment of the property of our subjects abroad we could secure them fair treatment ; or, if we failed, we could compensate them out of enemy property here. The proposal was that the Board of Trade should have power to vest in custodians any property, real or personal, belonging to, held by, or managed for, enemies, and that the custodians should be at liberty to sell with the property. Shares of a company held by a custodian might be sold to the company. Clause 4 made it possible to grant a patent, in which the enemy was interested, to the custodian of enemy property. At present applications for patents on behalf of enemies could not be sealed or granted. The custodian might grant licenses to deal with these patents in the proper way. Clause 5 dealt with the position of enemy companies immediately after the war. They could not make remittances to enemies abroad during the war, but when peace was declared this restriction would cease, and the result might be that remittances would be sent abroad before there was time to investigate and consider the treatment of British property in enemy countries. The clause would secure that there should be an interval during which the whole position of property here and abroad could be considered, dealt with and adjusted before this general release of property could take place. There would be an Order in Council releasing such property as soon as matters had been assured. Clause 9 gave special powers in relation to companies registered in this country who were carrying on enemy business abroad. The Board of Trade might apply to the Court to wind up such companies. He was sorry to say such cases had occurred. The Government was satisfied that the proposals of the Bill were expedient during the war and the period after the war, and that they would be beneficial to this country.

In the course of the debate several members expressed their views.

Mr. BUTCHER, K.C., said the Bill marked a great advance. He knew of enemy firms in this country who had decided, because they could not send their profits to Germany, that they should make no profits during the war, but, by a system of undercutting, should extend their business to the permanent detriment of British firms.

Sir H. DALZIEL was disappointed that the Bill did not declare the legal status of enemy companies and he asked the Solicitor-General to consider whether a clause should not be introduced to prohibit German companies suing British subjects. Another thing that would strengthen the Bill was that the Board of Trade should be compelled to tell the public who the 600 German firms were that were controlled by the Government. His only doubt about the success of the Bill was the fact that the Board of Trade were to be given so much discretion.

Sir G. CROYDON MARKS urged that all business connected with the granting of patents to alien enemies should be stopped. Hundreds of pounds were being sent every week from this country to Germany for the purpose of maintaining patents. Our manufacturers had many lessons to learn, and one was the need for specialisation in connection with the articles they produced.

Sir J. WALTON said our object ought to be to prevent the economic rehabilitation of Germany after the war. It should be our desire to lessen our trading relations with our enemies and to increase in every possible way our trading relations with our Allies.

Mr. DENNISS submitted that the only way the Bill would be properly administered was to relieve the Board of Trade of a large amount of the work which at present weighed down that department. The Bill would add enormously to the labours of the Board of Trade. Therefore, there should be established a Ministry of Industry and Commerce, which would relieve the Board of Trade of half its labours, and enable it to undertake the gigantic task of carrying out the new powers under the Bill.

Mr. PRETYMAN, speaking on behalf of the Board of Trade, said the Bill must be administered by that department in a firm, and at the same time a just, spirit. He was prepared to give an undertaking that it would not be a dead letter so far as the Board of Trade was concerned. They were prepared to keep the direction of policy and proceedings in the hands of departmental officials thoroughly competent to deal with those points, and to strengthen them with outside help. He could not say it would be a pleasant duty to administer a Bill of that character, but it was a duty from which the Board of Trade would not shrink. He was sure the House did not desire that the Bill should be carried out in any spirit of persecution, nor merely as a means to take sides in trade rivalry. What had to be done was to get rid of the German element in our trade as far as possible. With reference to patents, the apparent meaning of Clause 4 of the Bill was to enable the enemy to obtain patents, but the real object was to enable British manufacturers to use such patents. There were many German inventions, some of them of great importance, for which preliminary protection had been taken out in this country, but the patent had not been completed. Under present circumstances those patents could not be licensed for use by British manufacturers. The object of the Clause was to complete such patents, not for the benefit of the German owners, but in order to place them at the disposal of British manufacturers. The question of contracts was a difficult and complicated one. It might be possible in Committee, however, to deal with the question so far as it was concerned with matters in the Bill, and the Government would be open to consider the point. One principle which must be observed was that they must not, in their anxiety to remove enemy trade from this country, take any action that would injure British industry more than it injured the enemy. He could not undertake to publish a list of the names of all enemy firms in this country. Where were they

to stop? In the case of cosmopolitan firms with both British and German shareholders, it was difficult to say how far the Board of Trade would be justified in transferring their administrative responsibility to the public and in holding up to odium firms which did not deserve it. It was better to deal with the firms under the Bill. The Board of Trade were bound to report to the House at frequent intervals exactly what they had done and to furnish lists of the firms dealt with under the Bill.

The Bill was then read a second time.

The Committee stage was taken and completed on Tuesday.

On the motion of Mr. PRETYMAN, it was agreed to insert a provision that the Board of Trade should from time to time prepare and lay before Parliament lists of the persons, firms and companies as to whom orders had been made under clause 1, together with short particulars of such orders. Mr. Pretyman also promised that they should be published in the "London Gazette." It would be undesirable to publish the names of firms already under control, or the names of those dealt with under clause 3 (which related to the vesting of enemy property in the custodian).

On the motion of the SOLICITOR-GENERAL, additions were made to the clause providing that where a British subject or the subject of an Allied State was detained in enemy territory against his will he should not be treated for the purposes of the section as being in enemy territory; and that an order made under the section should continue in force, notwithstanding the close of the war, until determined by order of the Board.

After the remaining clauses had been agreed to, the SOLICITOR-GENERAL moved a new clause imposing on enemy subjects in the kingdom the duty of making returns of their stocks or other securities, if required to do so by the custodian, and the clause was added to the Bill.

Mr. MORTON proposed a clause providing for the determination or suspension of contracts made with enemies.

The SOLICITOR-GENERAL said the question had always been a very thorny one, and it was a little dangerous to take general powers to cancel contracts made before the war. He thought, however, they might deal with contracts which were against the public interest. Therefore he would suggest, instead of the clause proposed, a clause in the following terms: "Where it appears to the Board of Trade that a contract entered into before or during the war with an enemy or enemy subject, or with a person, firm or company in respect of whose business an order shall be made under sec. 1 of this Act, is injurious to the public interest, the Board of Trade may, by order, cancel or determine such contract either unconditionally or on such conditions as the Board may think fit."

Mr. MORTON withdrew his clause, and the words suggested by the Solicitor-General were added to the Bill.

The Bill was then reported with amendments and read a third time.

LEGAL INTELLIGENCE.

Alien Enemy Patents.

In the Patents Court recently Bi-Metals (Ltd.) applied for a licence to use the trade-mark "Tinol" over a solder which could be applied with a brush and which was manufactured under two German patents the Board of Trade had given them the right to use. The first was 13,557 of 1903, registered by J. Callman and R. Bormann, and related to a method for intimately associating finely powdered soft solder, such as tin or tin alloy with a paste, with a deoxidising agent like zinc chloride or ammonium chloride or both, and a thickening body such as cellulose which burns easily and leaves no trace. The second patent (17,624 of 1904) was granted to M. Leisel (Cologne) and R. Kupper (Bonn, Endenich), related to a substitute for soldering with resin and tin. In addition to the aqueous solution of ammonium chloride or chloride of zinc, or the double chloride for soft solder, it used borax, water-glass or glass powder, for hard soldering and met the three requirements of (1) a soldering metal in a fine state of division, (2) a flux which did not leave behind an oxide residue to impair the joint, and (3) a neutral liquid organic substance which does not evaporate until the soldering metal had melted. The soldering flux chloride or borax was mixed with glycerine and the metallic powder or finely comminuted metal. It was stated that various metals—bismuth, tin, lead, zinc, antimony, brass, copper, nickel, aluminium, iron, bronze, cobalt or silver had all been used with that soldering paste.

For applicants, Mr. ISSKIP, K.C., said that in October, 1914, they were the English agents for a German corporation, and the Board of Trade had granted Bi Metals (Ltd.) the right to manufacture under the patents on payment of a royalty of 10 per cent. on the gross selling price. From the Patents Court had come the suggestion that they should take the trade marks as well, and they were now applying for them. As selling agents for the Kuppers Metallwerke (G.m.b.H.) of Bonn, applicants had the option to purchase the patent right. That option had expired before the war, and they had then entered into negotiations to renew it.

Mr. PERCY GOOD, a director of applicant company, stated that they wanted the trade mark rights solely for the article to which the design applied. They had had one complaint as to the efficiency of the method since the war broke out. That was due to the fact that for the purposes of munitions all the pure glycerine being required, Bi Metals (Ltd.) attempted to manufacture with crude glycerine and found that did not answer. Apart from the small quantity made then they had never had any difficulty. They communicated with the authorities and got leave to obtain all the glycerine they required pure. They continued to receive repeat orders from engineering and other firms who used the composition in all directions. They supplied a convenient lamp with horizontal flame, and the paste always made a firm job.

The Controller of Patents (Mr. TEMPLE FRANKS) said he had no desire to encourage the application for trade-marks for use in connection with preparations to which they had not previously applied. Very few applications for trade-marks on that account had been granted. That, however, appeared to be a genuine manufacture in this country of an ingenious invention about which there could be no mistake. He should report to the Board of Trade favourably upon the case.

Wynstanley v. Macartney, McElroy & Co. (Ltd.)

Mr. Justice Scrutton recently delivered judgment in this action in which the plaintiff (May Octavia Wynstanley) claimed damages from defendant company for alleged wrongful dismissal from her position as secretary of the company and a declaration that she was still secretary and director of the company. The defence was a denial of any wrongful dismissal, or that plaintiff was properly a director of the company, and they counterclaimed for the return of moneys alleged to be the property of the company, and for the transfer of shares which defendants said plaintiff held as nominee of the company. The hearing of the case took place in the last sittings, and occupied several days.

In giving judgment his Lordship reviewed the facts of the case at some length. He said the case involved charges of forgery and other misconduct upon which he should have been glad to have had the assistance of a jury. Complications arose from the fact that after the death of Mr. Macartney, the elder, his affairs were managed partly by plaintiff, who had learned what little business she knew from the dead man, whose own business methods were original and peculiar. When he died in 1913 two of his sons were appointed directors when aged 16 and 13 respectively. Speaking generally, his Lordship was unable to accept either plaintiff's or the boys' oral evidence unless it were corroborated. Plaintiff made suggestions against other people which were without foundation, and Frank Macartney, the elder son, who had been guilty of gross misconduct as a director, showed great feeling against plaintiff. Wilfred, the younger son, was equally impetuous in attacking plaintiff. After careful consideration, he was satisfied that deceased's signature to plaintiff's share certificate was genuine. It followed that the two boys were wrong when, acting under advice, they decided to treat plaintiff as no longer a director. He was satisfied that the company had ample ground for dismissing plaintiff from her position as secretary, because the loan to herself of £800 constituted gross misfeasance and breach of duty. Plaintiff was also wrong in taking £90 for director's fees in the Malta Tramways Co. (defendants' subsidiary company) and £48 for back dividends out of the company's funds. Plaintiff's claim for damages for wrongful dismissal as secretary failed, but she was entitled to a declaration that she was a holder of 50 ordinary £10 shares in defendant company, and an injunction to restrain the company from dealing with the shares except according to law. She was awarded £100 damages for wrongful removal from her post as director, but he declined to grant an injunction on that point, partly because he did not think it in the public or shareholders' interest that the Court should assist her in retaining office as a director—a post for which she was unfitted. On the counter-claim, his Lordship found plaintiff guilty of misfeasance, and gave judgment for defendants for three sums of £800, £90 and £48, with interest at 5 per cent. Defendants failed on a claim for £35 and £192. He expressed his opinion of the witnesses by giving neither party any costs. He regretted that some part of the burden of litigation would fall on the unfortunate shareholders. He hoped some means would be found of transferring part of it to the present directors.

Napier Kimber (Ltd.) v. Davis & Smith.

On Friday last, at Marylebone (London) County Court plaintiffs sued Messrs. Davis & Smith, trading as the Essex Battery Mfg. Co., of Ilford, for £25 paid for defective workmanship.

Mr. LEONI, who appeared for plaintiffs, stated that his clients had entrusted a number of batteries to defendants to be refilled, and had paid for such as had been returned to them. A large proportion failed to come up to the standard, and it was for these that they claimed the refund.

Mr. ARTHUR KIMBER, of the plaintiff firm, gave evidence to the effect that of 1,500 batteries sent to defendants to be refilled only 976 had been returned, and of these 411 were actually faulty. Those refills were guaranteed for six months, and in three weeks they were useless. When he went over to ask for the refills to be delivered he found the works closed and defendants gone.

His HONOUR: And your money with them. You can have judgment for the amount claimed, with costs, for what it may be worth.

Cecil Hodges & Co. v. Ellis & Ward.

In the City of London Court last week Plaintiff sought to recover £95. 18s. 6d. for an electric light installation at Bristol. There was no dispute about the delivery of the goods, but defendants said they were entitled to set off £26. 11s. 9d., and they counter-claimed for £24. 10s. 8d., because certain goods were not supplied that ought to have been supplied, or work which ought to have been done had not been done. They also pleaded that the ivorine labels ordered had not been delivered. The Deputy Judge found for plaintiffs for £69. 6s. 9d. on the claim, without costs, and for defendants for £24. 10s. 8d. on the counter-claim, with costs, because of the expense to which they had been put.

Re Consolidated Diesel Engineers Manufacturers (Ltd.)—An application for the appointment of a liquidator of the company, in addition to Sir William Peat, was recently refused by Mr. Justice Astbury.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	613	**Electric Vehicle Progress Supplement—No. 24.**	
Imports and Exports of Electrical Manufactures	614	Dangers of the Streets—The Craze for Speed	1*
Educational Notes	614	Performance of Petrol and Electric Vehicles in Similar Service. Illustrated	2*
Business Notices	614	Economy on Short Hauls	3*
Bankruptcies, Liquidations, &c.	614	No Electric Knackers	4*
Electricity Supply	614	The Popular Electric Stevedore	4*
Lighting and Power Notes	616	G.V. Electrics Progress	4*
Traction Notes	616	Elwell-Parker Railway and Industrial Battery Trucks. Illustrated	6*
Telegraph and Telephone Notes	616		
Empire Notes	616		
The Round Table	113	Foreign Notes	617
Photographic Lamps	114	Miscellaneous Notes	617
Willans-Oddie Steam Pump. Illustrated	114	Tenders Invited	617
Fume Removal in Doping Rooms. Illustrated	116	Tenders Received & Accepted	618
Tungsten Targets for X-Ray Tubes. Illustrated	117	Companies' Meetings and Reports	618
Mazda Lamp Progress. Illustrated	118	New Companies, &c.	619
		City Notes	619
		Electrical Companies' Share List	619

COMMERCIAL TOPICS.

London Electricity Supply Loans. During the year 1914-15 the London County Council sanctioned 24 loans for electricity supply extensions, representing an aggregate of £212,673, compared with 26 loans and £291,672 in 1913-14 and 19 loans and £238,163 in 1912-13. It would appear from these figures that the past year's expenditure on municipal electric supply undertakings in the London area was not much below the average for the past five years. As very few lighting consumers are being connected the demand for power must have been larger than usual.

* * * *

Private versus Municipal Enterprise. At the meeting of the Brighton Council last week, during the discussion of the new tariff proposals of the Electricity Department, a question was asked as to how much the Council proposed to pay the local gas company who are "suffering from reduced public lighting," to quote our contemporary, the "Journal of Gas Lighting." Our contemporary further states that "The question was lost in space. Private enterprise had to fight its own battles; municipal enterprise is nursed at the expense of the general ratepayers' pockets." This statement needs some slight correction. May we remind our contemporary (though in the main correct) that private enterprise does not run the risk of the confiscation of its profits for the relief of rates as do so many municipal undertakings.

* * * *

Trade after the War. In a report recently issued by the London Chamber of Commerce, the following recommendations (inter alia) are made:—

1. That any measures which may be considered in connection with trade during and after the war should provide (*a*) For preferential reciprocal trading relations between all parts of the British Empire; (*b*) for reciprocal trading relations between the British Empire and the Allied countries; (*c*) for the favourable treatment of neutral countries; and (*d*) for regulating, by tariffs and otherwise, trade relations with all enemy countries, so as to render impossible a return to pre-war conditions and for stimulating home manufactures.
2. That steps be taken to prevent dumping of enemy goods into British markets after the war.
3. Discriminatory taxes on the tonnage of all enemy ships using British ports.
4. State encouragement of production and use of raw materials and manufactured goods within the Empire under such legislative conditions as will prevent their being controlled by, or on behalf of, subjects of enemy countries.
5. The appointment of a Minister of Commerce.

The Efficient Use of Electric Battery Trucks. The commercial motor vehicle user is attracted by power methods of transport for a variety of reasons. One of these is the advertisement which his business obtains from quick-moving motor vans of smart appearance on the streets. Another reason is the saving of a certain amount of time in the delivery of goods upon given routes. The power vehicle user who comes into this new field for the first time has previously been an extensive user of horses. The methods of handling the goods will at the time of the introduction of a few motor wagons be based upon the horse régime. In these circumstances he may be surprised to find that the motor wagon gives disappointing results. If he attaches the whole blame to the power vehicle, he will do that mechanism a grave injustice. This line of argument applies particularly to the electric battery vehicle, which at the present time is being sold in twos and threes to certain industrial concerns whose business depends upon efficient transport. If petrol vehicles have not previously been employed and the electric comes on the scene as the first power machine, it stands the risk of working under the serious handicap that no attempt is made to adjust the methods of the packing floor and the delivery department to the new order of things which a power vehicle quite naturally inaugurates. This important fact is elaborated in a short article we give from "Electric Vehicle Progress." It is hardly to be expected that haulage contractors, carting firms, large warehouses and similar establishments can make a complete change from the conditions which have previously obtained so long with horse haulage. The difficulty of making a change is, if anything, accentuated by the fact that during the period of transition from horse to power haulage a mixed service is being given. Those who may be disposed to judge the electric vehicle harshly require to take this vital factor into consideration. It is worthy of note that the battery vehicle, and in particular the small industrial baggage truck, are responsible for the introduction of quite new devices in the handling of goods. One of the most important of these is the detachable body and the warehouse and yard tractor, with its string of trailers; mention may also be made of the nest bodies under which a battery driven truck may be run and the load raised from the floor and immediately transported to its destination.

* * * *

Tube and Omnibus Facilities. The agreement providing facilities for through passenger traffic between the City and South London, the Central London, the London Electric and Metropolitan District Railway Companies, and the London General Omnibus Company, was approved by the shareholders at respective meetings of the companies last week. The new arrangement will enable the companies to introduce greatly increased travelling arrangements, including a comprehensive system of through or interchange tickets.

* * * *

Power Plant in the Thames. Public interest at the present time is unfortunately not likely to be distracted from the conduct of the war. It cannot, therefore, be hoped that attention can at once be given to the momentous problems involved in the economical supply of electrical energy to Greater London. The published reports of Messrs. Merz & McLellan and of Dr. H. F. Parshall have already shown that enormous economies can be effected by the re-grouping of the existing power supply undertakings and the modernising of the generating plant. In an interesting letter to "Engineering" Mr. F. W. Dean of Boston, Mass., makes the suggestion for a project, "To place several express power stations in the middle of the Thames. Between the Waterloo and Blackfriars Bridges the Thames has a width of about 850 ft. Here there might be formed a narrow island, say, 100 ft. wide on which a long power station could be placed." Mr. Dean thinks that the waterway could be utilised for handling coal and ashes and would also furnish an abundance of condensing water. He suggests further that "Such plants could be placed at intervals in the river, could be extended, and if of a suitable design would be as beautiful as most other buildings, and when viewed from one side of the river would be as sightly as the other side in many places." Mr. Dean is evidently familiar with British institutions, for he concludes his letter thus, "Difficulty in carrying out this

scheme would only be encountered with the Thames Conservancy Board, but perhaps in time it could be overcome in view of its manifest advantages." Here we, with perhaps closer knowledge than Mr. Dean has of home affairs, are inclined to dissent. Apart from any opposition which the Thames Conservancy Board would undoubtedly offer, there are several serious engineering difficulties which would probably prove insuperable. The existing electric supply authorities would also strongly oppose it. The publication of Mr. Dean's letter by our contemporary is none the less a matter of great public interest. Apart from the scheme proposed by Mr. Dean, the problem of London power supply requires to be kept constantly in view, and we make this statement quite apart from the conditions arising out of the war. The modernisation of the production and distribution of electrical energy in the Greater London area is a great public work and one to which we are hopeful that both our financial and engineering resources will be applied in the near future.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 17, 1916, *to* Jan. 22, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (See also note at foot of Exports.)

IMPORTS.

LONDON.—*U.S.A.:* Elec. machinery, £2,358; carbon candles, £64; elec. lamps, £2,173; telephone material, £58; wire and cable, £24; lamp parts, £120; unenumerated, £3,882. *Holland:* Elec. lamps, £1,089—21 pkgs.; lamp parts, £21; unenumerated, unenumerated, £169. *Canada:* Unenumerated, £20.

DENMARK.—Elec. machinery, £45.

EXPORTS.

£248. *Adelaide:* Wire and cable, £38; unenumerated, £495. *Perth:* Unenumerated, enumerated, £150. *Lyttelton:* Elec. machinery, unenumerated, £52. *New Plymouth* £10. *Newcastle:* Elec. machinery, £116. *Townsville:* Unenumerated, £75. Unenumerated, £1,438.

£1,590. *Cape Town:* *Beira:* Elec. machinery, £124; wire *Mejillones:* Wire and cable, £ £51.

Unenumerated, £138.

£362; telegraph material, £60; unenumerated, £375.

MALTA.—

cable, £36; unenume £120.

ITALY.—*Genoa:* Elec. £167; unenumerated, £149.

FOREIGN GOODS (duty paid and free).

IN TRANSIT.

Canada: Elec. lamps, etc., £786 £1,544. *Natal:* Elec. lamps.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL NOTES.

University of London, University College.—Owing to circumstances arising out of the war, Mr. Sidney Scott's course on "Electrical Production of Nitrates for Explosives," announced to begin on January 26th, will not be held.

University of Liverpool.—The Lent term began on Jan. 11. The special matriculation examination of the entrance examination must be passed to secure admission to the courses of instruction in the Faculty of Engineering. Prospectuses and full particulars of the courses in electrical, civil, mechanical and marine engineering, design and drawing, mathematics, physics and inorganic chemistry may be obtained from the registrar, Mr. Edward Carey. There are well-equipped laboratories, and facilities for practical and research work are available.

BUSINESS NOTICES.

Works Extension.—Willesden Council has approved plans of an additional building to be erected at the British Thomson-Houston Co.'s factory in Neasden-lane.

Patent Exploitation.—The proprietor of patent No. 4,228/1909, for "Improvements in electric cut-outs," desires to make arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents, 28, Southampton-buildings, London, W.C.

Agency Wanted.—A Danish firm advertise for the sole agency for electrical novelties.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of the Automatic Electric Block Signalling Co. (Ltd.) will be held at 10, Victoria-street, London, S.W., on Feb. 9. Claims to the liquidator, Mr. A. Colls, 12, Victoria-street, S.W., by March 7.

A meeting of creditors of the Hele-Shaw Patent Clutch Co. (Ltd.) (in vol. liq.) will be held at Hartford Works, Oldham, on Jan. 31.

Geo. Edward Bonner, electrical agent, Ashcroft, 105, Fox-lane, Palmers Green, Middlesex, has been adjudicated bankrupt.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bacup.—The Council have received sanction to a loan of £300 for extending the supply mains to a new factory.

Bath.—The Electricity Committee have decided to extend the supply mains to the War Hospital at a cost of £170.

Bermondsey (London).—As the loans for meters, mains and services have been overspent to the extent of £1,610, the Borough Council is recommended to apply to the L.C.C. for sanction to borrow this sum, and to advance a further loan of £3,000 for future extensions.

St. Pancras (London).—Some correspondence has passed between the Finance Committee of the Borough Council and the London County Council as to sanctions for loans and expenditure on extensions of mains and generating plant, &c.

In the County Council's communication it is stated that they will only be able to approve expenditure out of loans under these heads which complies with the Treasury requirements.

The Finance Committee, acting upon a report from the Electricity Committee, have decided to inform the L.C.C. that the committee have had under consideration the question of extending feeding mains in the northern and Prince of Wales road district, at an estimated cost of £4,526, owing to the large increase of power for factories.

The L.C.C. have now agreed that the Borough Council's application for sanction to a loan of £13,000 in respect of the King's-road electricity station extension should be proceeded with.

The Electricity Committee has received a petition from the station mains staff for 15 per cent. increase in their wages in lieu of the present war bonus. The men's complaint is that they consider the incidence of the war bonus is unfair in its operation, as it excludes all higher grade men whose wages are above 35s. per week from receiving any benefit. The committee is of opinion that the time has arrived for the Council to reconsider the question of the war bonus, and recommends accordingly.

The borough electrical engineer (Mr. S. W. Baynes) suggests the closing for the period of the war of the showroom in Camden-road, which will effect a saving of £138 a year. He also proposes to extend the conversion of the existing arc lamps (250), and so enable them to be used for incandescent lighting, which will also save £270. In view of existing circumstances, Mr. Baynes states that he is in a position to amend the estimates so far as they affect generation, repairs, maintenance and distribution, which will reduce expenditure by £2,305.

Swindon.—The Council have authorised an extension of the electric supply mains to Broome Manor, at an estimated cost of £275. Half the cost will be borne by the owner of Broome Manor and the other half by the electricity department. The minimum amount of current to be taken will be of the value of £20 a year.

Torquay.—The L.G. Board have authorised an extension of the plant at the electricity generating station.

West Ham.—The Finance Committee recommend the Corporation to apply to the L.G. Board for a consent order authorising the raising of the unexpended balance of £2,000 of the loan of £17,500 granted in January, 1914.

GENERAL.

Abertillery.—The manager of the Urban Council's electricity works (Mr. Dan Lloyd) has resigned.

Bedford.—The Corporation have entered into a contract with Messrs. W. H. Allen, Son & Co. for the supply of the whole of the electrical energy required by the firm.

At the last meeting of the Council the chairman of the Electricity Committee (Ald. Kilpin) submitted a report to the effect that Messrs. Allen had notified their intention to put down a further 250 kw. motor generator so as to enable them at all times to take the whole of their supply from the municipal undertaking. At present it was necessary now to run their own plant as well, owing to considerable increase in the number of machines recently put down. The existing mains would be large enough to take the increased demand provided a synchronous motor generator were installed, and Messrs. Allen had agreed to do that. It would only be necessary for the Council to provide the necessary additional meters and switchgear at a cost of £130, and this was agreed to.

Bexhill.—The chairman of the Electric Light Committee (Commander Loane) has taken up a naval appointment, and the membership of the Committee has been reduced by three, each absentee being on National Service. The quorum of the Committee has had to be reduced to three.

Brighton.—The report of the Lighting Committee, recommending an increase in the charge for electric current, a revision of the tariff system, &c., was discussed at some length at the meeting of the Council last week.

The chairman of the committee (Councillor LINTOTT) said the recommendation was briefly a proposal to adopt a flat rate of 5½d. per unit. For some considerable time they had been suffering from a multiplicity and complication of tariffs, and now they had a splendid opportunity of doing away with them. He dealt with the specific recommendations (set out in our last issue), and said it might seem rather hard on small consumers, but the matter was fully considered by the committee. It was not proposed to make any alteration in the power rate, which was a paying department; last time an alteration was made they increased the power charges by ¼d. and the 10 per cent. discount was abolished.

Councillor TINDALL referred to the recommendation that £2,000 should be paid from the rates to the electricity undertaking on account of the capital loss the undertaking had been put to owing to the street lighting not being maintained. He read a letter from the electrical engineer (Mr. J. Christie), stating that roughly some £40,000 of capital, irrespective of that provided by the district fund account, was locked up in plant solely reserved for street lighting purposes, and the amount of loss on account of interest and sinking fund charges in respect of that capital could not be less than approximately £2,000 per annum. There were whole streets through which mains had been laid for street lighting in which there was not a single private consumer. In regard to the revision of the tariff he said that if the prices could be raised all round an extra farthing a unit would be sufficient to pay the increased price of coal, but it was impossible on some items to levy it. Eighty per cent. of the small consumers would get no rebate, and of the remaining 20 per cent. about 10 per cent. got no appreciable benefit from the rebates. The scheme did for the first time put the whole of the consumers on some sort of a scale.

Ald. WELLMAN failed to see why there should be a difference between one class of consumer and another. He regarded a difference of 35 per cent. between the ordinaty and the big consumer as almost an immoral transaction. Unless they could bring up a scale of rebates which would be fairer to the parties, it would be better to charge a fair price all round and make no rebates at all. He moved an amendment to refer the matter back to the committee.

Councillor BLACK, who seconded, agreed that the scheme was a great improvement on the present one. It was not in the interests of the town that smaller users should be discouraged from using electric light, and large users encouraged by that tremendous difference between 5½d. and 3½d. per unit. It was a very unfair handicap to the small shopkeeper that his competitor should be able to get lighting, provided by the town and backed by the ratepayers, at a lower price. He was glad to see the final departure from the maximum demand system.

Councillor LEWIS said that, although an improvement on their last report, the present report was disappointing. He did not think the engineer had budgeted for a sufficient loss on the year, and he objected to the abolition of the maximum and minimum rate, that being in his opinion absolutely the fairest way of supplying electricity. The flat rate to large consumers should not be so low; the committee should encourage small consumers. He objected to a number of shops or hotels pooling their supply, and if they charged large consumers a flat rate of 6d. he was perfectly certain they would not lose a single customer. As to bearing the charges, Brighton was never more prosperous than now. The charges were not high enough for the big consumers, and they should aim not only to ensure no loss on the undertaking, but to provide a reserve.

Councillor CAMPBELL thought the system which was gaining ground was that of one fixed charge with rebates on quantities, and that was what the committee were adopting. He should like to see the system of discounts extended, but it was obviously not practical at present. He did not think they could get a fairer tariff than the engineer had drawn up.

Councillor HARDY complained that when the Council last raised the minimum charge on the maximum demand system the customers suffered an injustice because they had already paid for three months on the higher scale, and thought they were about to reap the benefit of the lower one. He protested against such a thing being done again while their six months' contract was running.

Councillor LINTOTT gave an undertaking that no alteration [illegible] effect during the six months.

Ald. CARDEN said the 5½d. flat rate was absolutely impossible. They would ruin the business altogether to attempt to impose such a rate all round. They had 6,500 customers, built up during 20 years, and people had come in on a certain understanding, getting current at a very low rate. But these very low rates would not now pertain. There would now be no 1d. units, no 2d. units, and no 3d. units, and the minimum price would be 3½d. per unit. Thus, the big customers, in fact, would have their bills very largely and substantially raised. No one was going to get a reduction; they were all going to be raised. Now, to tell the man who was paying 1d. and 2d. for units, after having a certain number of units, that he was to pay 5½d. all round, was absolutely impossible. It would so increase their bills they could not afford to pay. They could not drastically say they were going to increase the Grand Hotel bill by three times, and say they must pay £1,200 instead of £400. It would drive them to put down their own plant at the first opportunity. The beauty of the system proposed was that they wanted a 5½d. tariff so that immediately after the war they would reduce it to 5d. He disagreed with the view that a low maximum would mean a great increase in the number of small consumers. The difficulty in the way of that was that small property was not wired; and he did not consider that either landlord or tenant would do that to any extent.

Councillor LINTOTT, in reply, said the revised tariff would come into operation in the March quarter, with the exception of the maximum demand, which would apply in July. He hoped the Council would not go back on the scheme; it would serve no useful purpose to do so.

The exception was carried, and ultimately Councillor Lintott agreed to take the recommendation back.

Burton.—The chairman of the Gas and Electricity Committee (Ald. Lowe) announced at the last meeting of the Council that there would be shortly a revision of the electricity supply charges, both for lighting and power, owing to the increasing cost of coal. It was anticipated that by March of the present year the augmented cost would be £2,000.

Chippenham.—The Council have urged the local electric lighting company to carry out their respective contracts in the recently added portions of the borough.

Chislehurst.—The Foots Cray Electricity Co. proposes to make a quarterly charge of 1s. per meter as from Jan. 1.

Hitherto no meter rent has been charged, and the innovation has been adopted in order to avoid an increase in the price of current, and the Urban Council have decided to take no action in the matter.

Coal Supplies.—At the last meeting of Glasgow Corporation considerable discussion arose upon a recommendation by the Special Committee on Prices of Coal to Small Consumers that the Corporation petition the Government to exercise full control over the production and supply of coal during the war.

The question was discussed at a previous meeting of the Corporation, when Mr. Bruce Murray moved as an amendment that the recommendation be disapproved.

Bailie HUTCHISON seconded the amendment and said the Government had plenty to do at present with the war on their hands without having to look after that matter. The Government had already given consideration to the question, and had fixed a maximum price of coal.

Mr. JUBB argued that the Government's management of the telephones was not such as to encourage a hope of their being able to provide coal at a cheaper rate than private enterprise.

Mr. DOLLAN, convener of the Special Committee, said the people in Glasgow were paying 1s. 7d. per cwt. for coal which could be had for 1s. prior to the war. That was 7s. 8d. per ton more than the 4s. increase on the 1913 prices allowed by the Government. The Committee had had members of the coal trade b fore them who had stated that unless the Government exercised fuller control over the coal supply there would be an absolute coal famine in Glasgow at the end of this month. It was said that coalowners were actually shipping coal, so urgently needed for Glasgow, to neutral countries because they got higher prices there.

On a division the recommendation in favour of Government control was carried by 39 votes to 37.

Hammersmith (London).—In order to maintain the stock of coal the Electricity Committee has accepted the offer of Cory Bros. to supply 90 tons per week of Hacknall high hazel coal, at 21s. 6d. per ton, during the period ending June 30 next.

The special committee appointed to consider the amount to be allowed to the Council by the electricity undertaking from the ordinary charge for public lighting in consequence of the lighting restrictions recommends the deduction of £2,500 from such charges for the year ending March 31 next, and that an allowance at the same rates per annum be made subsequent to that date, until otherwise ordered.

Interest on Municipal Loans.—At Tuesday's meeting of the L.C.C. the Finance Committee reported having decided that until further order the rate of interest to be charged by the Council for loans to local authorities shall be 5 per cent. Amongst the first loans to be made at the new rate of interest is one of £2,618 to Battersea Borough Council for electric supply mains.

Sheffield.—On Friday an inquiry was held into the application of

the Corporation for authority to transfer from the Tramways to the Electric Light department the Kelham Island power station.

The TOWN CLERK (Mr. W. E. Hart) submitted particulars of the proposed transfer, and pointed out that the capital expenditure incurred and transferred from the liability of one department to the other amounted to £331,460.

The LORD MAYOR said that it was desirable that the supply of electric current should be under one management, for greater efficiency and economy and for the welfare of the city.

Mr. A. R. FEARNLEY, general manager of the Tramways Department, said new records were continually being made in regard to the number of passengers on the tramcars, and the previous Wednesday provided a record for a week-day.

Wigan.—On Friday evening last there was another breakdown of electricity supply, and most of the streets were in darkness.

On Friday all the tramcar services to Ashton-in-Makerfield, Standish and Hindley were stopped. It was announced that the electric supply might not be maintained, and at half-past eight there was a total failure, resulting in the performances at theatres and picture-houses being interrupted. The great increase in the local demand for power and lighting has practically outgrown the capacity of the station, and additional plant cannot be readily obtained.

At a special meeting of the General Purposes Committee on Saturday, the chairman (Ald. J. T. Grimshaw) made a statement on the position. He said they had suffered very much on account of the war, and had not received the new boilers they had expected. The Committee were trying to make arrangements for the supply of current from the South Lancashire tramway generating station at Howe Bridge, 3 miles from the Hindley boundary. The tramway service would be stopped until Wednesday, and there was no guarantee that light would be possible that night. A deputation would wait upon the South Lancashire Company's directors at once. The loss to the town in tramway revenue alone would not be less than £1,000, and the power and lighting revenue would also be affected.

LIGHTING & POWER NOTES.

Aldershot.—The Council have adopted a recommendation to make an increase of 10 per cent. on all lighting accounts as from March 31 next.

The charges for power and heating have also been revised as from the same date: Up to 250 units per quarter the charge will be 2d. per unit, up to 500 units 1·9d., 750 units 1·8d., 1,000 units 1·7d., 2,000 units 1·6d., and up to 5,000 units 1·5d. per unit. Above 5,000 units the charge is to be fixed by agreement. During the war, and until such time as prices of coal, &c., become normal, these charges are subject to 20 per cent. increase.

Electric Cooking.—London County Council have decided to continue for another year the electric cooking stove installed as an experiment at the Maxly-road domestic economy centre, Woolwich.

Electric Lighting of Trains.—At the Board of Trade inquiry into the recent Jarrow railway accident the acting chief mechanical engineer of the North Eastern Railway Co. (Mr. C. A. Stamer) was asked whether the company had gone into the question of strengthening the ends of the gas cylinders. In reply, he said the matter had been considered, but they thought no advantage would be gained from such a strengthening. The question of using non-inflammable wood in the construction of carriages had been considered, but owing to the war there had not been time to go further into the matter. They had experimented also with steel carriages. During the last three years all the passenger-carrying vehicles they had built had been fitted with electric light.

Rugby.—The Council have made arrangements for the supply of electrical energy for power to the Rugby Sparking Plug Co.

TRACTION NOTES.

Colwyn Bay.—Recently Llandudno & Colwyn Bay Electric Railway (Ltd.) proposed to run double-deck tramcars on the Colwyn Bay section of their system, but the Urban Council opposed, and asked the Board of Trade to withhold its consent to the company's application.

The Board have now informed the Council that it sees no reason to alter its view that the double decked cars might be allowed to run.

The Council are still opposed to the proposal, and the matter has been referred to a special committee with a view to a local enquiry being held by the Board.

Halifax Tramways.—The Board of Trade have extended for one year from Aug. 18, 1916, the time limited by the Halifax Corporation Act, 1911, for the completion of construction of various tramways authorised by the said Act.

London County Council.—At Tuesday's meeting it was stated that the temporary war grant to certain members of the staff of the tramways department (*i.e.*, those to whom the conciliation boards' scheme did not apply) in order to meet the increased cost of living was estimated at £3,700 for the year 1915-16.

L. & S.W. Railway Electric Service.—The difficulty in connection with the electric train service on the Waterloo to Kingston, Richmond and Shepperton lines of the L. & S.W. Railway Co., which was to have been inaugurated on Dec. 5, has been overcome, and it is officially announced that the service will begin on Sunday, Jan. 30. The first train from Kingston to Waterloo will start at 6.45 a.m., and on week-days at 4.21 a.m.

Metropolitan District Railway.—The Board of Trade have extended for one year from Aug. 15, 1916, the time limited by the Metropolitan District Railway Act, 1913, for the exercise of the powers for compulsory purchase of lands and easements in Fulham, Whitechapel and Stepney authorised by the said Act.

Swansea Light Railways.—The Board of Trade have extended for one year from Feb. 28, 1916, the time limited by the Swansea Corporation Light Railways (Extensions) Order, 1914, for the compulsory purchase of lands for extensions of Railways Nos. 1 and 3.

West Ham.—The Tramways Committee recommends the approval of plans for the erection of temporary offices and store accommodation at the Greengate-street depot.

It is proposed to increase the salary of the works superintendent (Mr. T. C. Winfield) from £250 to £275 per annum.

TELEGRAPH & TELEPHONE NOTES.

Week-End Messages.—The Pacific Cable Board announce that during the suspension of week-end messages between the United Kingdom and Australasia (owing to interruptions on the Atlantic cable systems) messages will be accepted for transmission by post to Montreal and telegraphed from thence to destination at the rate for week-end messages from Montreal to Australasia.

It is stated that telegrams sent by this service will probably reach their destination in about 12 to 16 days, the period depending on the mail service between this country and Montreal. Telegrams for this service may be posted to the Pacific Cable Board, Queen Anne's Chambers, London, S.W., together with remittance covering cost at following rates:

To Australia, 20 words, minimum charge 11s. 8d., each additional word 7d.; to New Zealand, Norfolk Island and Suva (Fiji), 20 words, minimum charge 10s., each additional word 6d. Messages must be prefixed P.W.T., which is counted and charged for as one word. These telegrams may also be handed in or posted to any of the offices of the Western Union Telegraph nCable System. An arrangement is already in fôrce in Australia and New Zealand for the acceptance of week-end messages to be telegraphed to Montreal, and posted thence to their destination in the United Kingdom.

Telegraph Codes.—It is announced that the Rubber edition of Broomhall's Imperial Combination Code has been added to the list of codes authorised for use in foreign telegrams.

The code is not at present available for use in telegrams to the Argentine Republic, Brazil, Paraguay, Uruguay and the Republic of Honduras, but otherwise it can be used under the same conditions as those applicable to the seven codes already in use.

EMPIRE NOTES.

Australasia.—The "Australian Mining Standard" says the Prahran-Malvern (Victoria) Tramway Trust is seeking an increase in its borrowing powers by £50,000, making its limit £725,000. A Bill authorising the construction of a new line has been introduced.

The receipts of the Port Melbourne Municipal Electric Light and Power department for the year ended Sept. 30 were £4,514, and expenditure was £3,762 (including £2,403 paid to Melbourne Council for current) From the year's profit of £752 has to be deducted the debit of previous year (£239), leaving a profit of £513 for the first two years' working.

The city electrical engineer of Melbourne, Mr. H. R. Harper, has reported adversely on Councillor Atkins's scheme for installing electric lighting in city premises on extended terms of payment running to 30 months. The greatest objection, says Mr. Harper, would be the large number of bad debts that the Council would be liable to incur. Moreover, he does not consider that the scheme would be availed of to an extent to justify its adoption, as he thinks landlords would not be willing to bear the expense of installation without recouping themselves by raising the tenants' rent. Practically the only class of property in regard to which he would recommend the scheme would be cases where the owner is also sub-tenant.

FOREIGN NOTES.

Ecuador.—The "Registro Oficial" publishes a decree providing for the raising of funds for the installation of electric lighting and water supply systems in the town of Tulcán. The electric lighting undertaking is to be given preference should the sum available not be sufficient to permit of both schemes being entered upon.

Hydro-electric Power in Brazil.—At the recent meeting of the Rio de Janeiro Flour Mills and Granaries (Ltd.), the chairman (Mr. R. Foster) referred to their electric power installation, and said that, as coal was now costing about 80s. a ton delivered in Brazil, it was difficult to realise what they would have done without the electrical plant for the working of the flour and cotton mills.

He would, however, like to inform them that they need have no fears of any trouble or interruption on that account, as they had a long contract for electric current with the Rio de Janeiro Tramway, Light & Power Co. at a satisfactory rate.

Morocco.—The British Consul at Fez reports that the following are likely to meet with a sale in his district on a small scale :—

Columns, brackets, lamp pillars, general constructional ironwork electric light columns and brackets, section pillars, castings for electrical engineers, enamelled iron signs. Sending catalogues in any language but Arabic would not be of much use. A list of Fez traders can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

The Cherifian "Bulletin Officiel" contains a decree, dated Nov. 6, 1915, authorising the commencement of, and the expenditure of certain sums upon public works in the French Zone in Morocco. In some cases these works have already been completed, whilst others are in course of construction or contracted for. Out of the total sum of 98,111,424 frs. to be expended on these works, 6,591,880 frs. are for subventions to municipalities of various towns for public works, 3,693,467 frs. for telegraph and telephone services, 1,938,782 frs. for public offices, &c., and 500,000 frs. for the preparatory surveys and plans of the Tangier–Fez and other railways.

Russia.—A consular report on the Odessa district for 1914 says the work of constructing the electric tramways at Nicolaieff was continued throughout the year and the two principal lines were opened towards the end of the year.

Imports into Nicolaieff included machines and parts valued at 855,000 roubles, and electrical and physical apparatus 35,000 roubles.

A report from Berdiansk says there are openings there for the sale of British electric lighting plant and spare parts, steel tools, &c.

It is stated that the appearance and standard of comfort of the town of Kharkoff are improving. Amongst the utilities available are electric tramways and electric lighting. The Vice-Consul at Kharkoff urges that British goods should be pushed forward there. A few British engineering firms have sent illustrated catalogues with Russian text, but this is not yet the rule.

A report from Rostov-on-Don says 20 new electric tramcars were purchased by the local tramway company from Belgium in the spring. They were found too heavy for the existing tramlines, and 10 of the cars are laid up in the depot through accidents and cannot be repaired there.

In regard to Openings for British trade, the report says the way to procure big results is to step entirely into the shoes of the German and Austro-Hungarian trader and continue working on his conditions and terms. The Russian importer will buy in the market where he can get the easiest terms. German traders have had long enough experience of this to have thoroughly estimated, tested and discounted the risks of giving credit, while British merchants do not need to question whether the risks of such enterprise are commensurate with the chances of increased sales, as results are in front of them. When export conditions are normal, travellers must be sent out with representative samples. Correspondence should be in French, failing Russian.

A fairly important trade in certain articles has been carried on by German firms through the post. The parcels are delivered to the consignee against payment of the sale of the goods, which sum is remitted by the Post Office for payment to the order of the goods. If this convention existed between the United Kingdom and Russia, as it has existed between Germany and Russia, a not unimportant trade, mostly business could be effected in certain articles.

Credit terms vary somewhat in the different trades but broadly are 90 days, credit with 5 per cent. discount for cash, or six months' credit net.

Spain.—The "Madrid Gazette" publishes a list of articles which may be required by Spanish Government departments, and to the supply of which foreign competition will be permitted during 1916.

Amongst these are bitumen, crude petroleum, coal for naval purposes, specified kinds of manufactured steel and wire, steel rails exceeding 30 kilogs. per metre, tubes and cables, tin, nickel, aluminium, platinum, bronze and copper goods, steam turbines, gas engines exceeding 300 H.P., steam boilers, tools, metal testing machines, machines connected with quarrying, &c., weighing machines, electrical laboratory apparatus, electrical measuring instruments, telegraph and telephone appliances, electric searchlights, submarine cables, electric lighting accessories and arc lamps, electric generating machines, gas lighting apparatus for railway carriages, fire extinguishing and life saving appliances, munitions of war, arsenal machinery, aeroplanes, scientific instruments, ventilating apparatus, lighthouse accessories and chemical products, &c.

MISCELLANEOUS NOTES.

Closing of Museums.—It is officially announced that the Government have decided to close the following museums :—

British Museum (except reading room), Natural History Museum, Science Museum (except to students), Geological Museum, Bethnal Green Museum, Tate Gallery, National Portrait Gallery, Wallace Collection and London Museum.

The National Gallery and the Victoria and Albert Museum will remain open. A saving of £50,000 a year is anticipated.

Inquests.—An inquest was held last week at Southall on Fredk. Browning, an employee at some works at Hayes.

It appeared that Browning was taking a 20-ft. iron shaft out of a lift when one end came into contact with an uncovered electric switch and he received a severe shock. After a fortnight's illness the man died.

A doctor stated that death was due to syncope caused by electric shock, and the jury returned a verdict to this effect.

At Kirkcaldy recently Sheriff Armour-Hannay and a jury held an inquiry into the death of Alex. Martin, apprentice electrician, who was instantaneously killed on Dec. 11 by coming into contact with the live electric apparatus in the motor haulage room of No. 2 Pit, Leven Colliery.

The evidence showed that deceased had come into contact with a switchboard panel and had received a shock from electric current at 3,000 volts. It was stated that there was no lock on the door of the panel. In addition to the formal verdict a rider was added recommending that more stringent precautions and regulations should be adopted in regard to apprentice electricians working in a mine, and that H.M. Inspector should be invited to consider along with the pit manager whether some device should not be adopted for protecting such apparatus.

Wills.—The late Henry Cornelius Donovan, M.I.E.E., whose estate has been valued at £17,223 gross, left £100 to the Benevolent Fund of the Institution of Electrical Engineers.

The late Sir Arthur W. Rücker left estate valued at £40,465, with £34,414 net personalty.

TENDERS INVITED.

Tramway Stores.

The Tramways Committee of MANCHESTER Corporation invite tenders for the supply of General Stores, including Motor and Controller parts, Resistances, Armature and Field Coils, Trolley Poles and Bases, Lightning Arresters, Lamps, Car Switches, Bells, Cells, Telephones, Carbon Brushes and Carbons, Overhead Equipment Material, Trolley Wheels, &c., Cable, Wire, Timber, Lubricants, Oils, Paints, &c., Glass, Rubber and Leather Goods, Tools, Iron and Steel, Car Axles and Tyres, Castings, Fuel, Cement, Sand, &c. Schedules, &c., from the General Manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by 10 a.m. Tuesday, Feb. 15. *See also an advertisement.*

Wiring, Fittings, &c.

ST. MARY, ISLINGTON (London). Guardians require tenders for Alterations to Wiring, Supply of s.p. Motors, &c. Tenders by 4 p.m. Feb. 17 to the Clerk, St. John's-road, London, N.

SWANSEA Education Committee require tenders by noon Feb. 7 for the Electric Lighting of Brynmill Infant School. Specifications from the Clerk, 9, Grove-place, Swansea.

Tenders are required for 150 kw. Installation (including Lighting and Motors) for the Dunfermline Co-operative Society, Randolph-street, Dunfermline. Specifications from Secretary.

Turbo-Alternator.

LEIGH (Lancs.) Council require tenders for a 2,000 kw. Turbo-Alternator, Surface Condenser, &c. Tenders by noon Feb. 18.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmasters-General.

Electrical and Tramway Stores.

PEMBROKE (co. Dublin) Urban Council require tenders by noon Feb. 7 for 12 months' supply of Electrical Goods, Oils and Colours, &c. Specification, &c., may be obtained at the Town Hall, Ballsbridge, co. Dublin.

BERMONDSEY (London) Guardians require tenders by 6 p.m. Feb. 10 for one year's supply of Electric Lamps, Oils, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

MIDDLESBROUGH Corporation require tenders by first post Feb. 7 for 12 months' supply of Electric Lamps, Bolts and Nuts, Oils, Paints, &c. Specifications from Borough Engineer.

WIGAN Tramways Committee require tenders by Feb. 5 for one year's supply of Overhead Line Material, Tramcar Accessories, Steel Tyres, Axles, &c., Iron and Steel Castings, Oils and Grease, &c. Specifications, &c., from the General Manager.

The BIRMINGHAM TAME AND REA DRAINAGE BOARD require tenders by Feb. 8 for one year's supply of Electrical Stores. Specification, &c., from the Board's offices, Tyburn, Birmingham.

HALIFAX Corporation require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their electricity department, including Lighting Fittings and Electrical Accessories (Lamps, Switches, Tapes, &c.), v.r. Cables and Phosphor Bronze Wire, e.h.t. 6,600-volt Cable, l.t. Lead-covered and Armoured Cable, Meters, &c. Forms of tender from Foundry-street, Halifax.

HALIFAX Corporation also require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their Tramways Department, including Lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor Bronze Wire, Trolley and Overhead Line Materials, Oils, Paints, &c. Forms of tender from Tramways Engineer, Skircoat-road, Halifax.

The MIDLAND RAILWAY CO. NORTHERN COUNTIES COMMITTEE (IRELAND) require tenders by Feb. 4 for six or 12 months' supply of Electric Lamps, Carbons, Rubber and Asbestos Goods, Oils, Paints, Varnishes, &c. Forms of tender from the Stores Superintendent, York-road Station, Belfast.

Tramway Trucks.

MELBOURNE, BRUNSWICK and COBURG (Victoria) Tramways Trust invite tenders by Feb. 18 for Six Radial-type Trucks (contract No. 28). Specifications from the office of the Melbourne, Brunswick and Coburg Tramways Trust, Coburg, Victoria.

Hydro-Electric Generator.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Distribution Boxes and Fuses.

Tenders are required for the supply of Fuse Distribution Boxes and Fuses (contract No. 26,111) for the VICTORIAN STATE RAILWAYS. Specifications from Messrs. John Coates & Co. (Ltd.), 115, Victoria-street, London, S.W. Tenders to the Agent-General for Victoria, Melbourne-place, Strand, London, W.C., by 11 a.m. Feb. 2.

TENDERS RECEIVED AND ACCEPTED.

WALTHAMSTOW.—The tender of W. T. Henley's Telegraph Works Co. has been accepted by the Council for the supply of l.t. cables.

ST. PANCRAS (LONDON).—The following tenders have been received by the Electricity Committee for work at King's-road generating station extension :—

For concrete coal bunkers and lift wall four tenders were received, and the lowest, that of W. King & Son (at £2,764) is recommended for acceptance. The amount of the highest tender was £3,476.

For steel construction work there were tenders varying from £7,615. 10s. to £8,527, and the lowest (that of E. C. & J. Keay) is recommended for acceptance.

Three firms tendered for the coal and ash handling plant, the lowest and most satisfactory being sent in by W. Strachan & Henshaw, at £3,660, and is recommended for acceptance.

Government Contracts.—The following tenders were accepted by the British Government Departments during December :—

War Office.—British Insulated & Helsby Cables, Hooper's Telegraph & India Rubber Works, Johnson & Phillips, Liverpool Electric Cable Co., Midland Electric Wire Co., Siemens Bros. & Co., and Western Electric Co., cable and wire, &c.; Mann, Egerton & Co., electric lighting at R.F.C. Camp, Thetford; Ellis & Ward, ditto, New Hut Hospital, Dublin; Grindlestone & Co., ditto, Houghton Regis Camp; Grindlay, Ross & Co., ditto, Hutted Camps, Duddingston and Dreghorn, Eastfield and Westfield; Siemens Bros. & Co., electric cells; Kartret Engineering Co., distribution boards, switches and fuses; Fyfe, Wilson & Co. & Parsons Motor Co., electric lighting sets; Austin Motor Co., generating sets and parts; British Thomson-Houston Co., switchgear for transformers.

Post Office.—Automatic Telephone Mfg. Co., additional automatic equipment Leeds Exchange; Bullers (Ltd.) and Leys Malleable Castings Co., g.i. brackets; J. Bourne & Son, Bullers (Ltd.) and Taylor, Tunnicliffe & Co., insulators; John Ellis and Taylor & Co., poles; R. Johnson & Nephew, g.i. wire; Eyre Smelting Co., battery zincs.

Office of Works.—W. O. Rope & Co., electric wiring, Admiralty.

Meter Contracts.—Chamberlain & Hookham (Ltd.) have received the contract from Bath Corporation for direct-current meters for the ensuing year, and they have also obtained a similar contract for Taunton, subject to the approval of the Council.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

EAST LONDON RAILWAY.—Lord Claud Hamilton, who presided at the meeting on Tuesday, explained that the non-receipt of the report was due to the fact that the company was one of those under Government control, which prevented its traffic returns being settled by the Clearing House. He attributed the large increase in traffic to the electrification of the line, which was now entirely completed. He was glad to say that although in the first place there were some objections by the leading companies to the electrification, it had been fully justified. The change to electric traction had been delayed to enable the two bits at Wapping, which were considered an essential part of the scheme, to be finished. In 1912 they carried 4,224,050 passengers, and now they were carrying 8,497,284, which was more than double the number carried before the adoption of electric traction. It might be said that the war may have had something to do with that increase owing to munition workers and other people using the line in large proportion than in normal times, but too much importance need not be attached to that suggestion. He believed it to be rather due to the facilties they had given, especially for through booking on the Metropolitan and District Railway, which had really brought about the great increase, and that they might safely presume that the increase would go on, and not recede, when the war came to an end. The average rate of 1·27d. per passenger yielded £15,080 per annum, added to which were the receipts from goods and livestock, bringing the total to £93,000. It was the first time since 1904 that he could speak in a fairly optimistic sense, and he believed they had turned the corner and would go on steadily improving. He felt really optimistic about the future.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS CO. (LTD.).—Sir Herbert S. Leon, who presided at the meeting last week, said that their receipts were £6,976 more than in the previous year, but working expenses were £8,474 up. The percentage of expenses to receipts was 44·25, against 43·22, and on a mileage basis the working expenses were 4·88d. per car-mile, against 4·37d. Income per car-mile had risen from 10·001d. in 1914 to 11·34d. The tramway revenue had grown steadily from £38,051 in 1905 to £81,080. To what extent the increase in ex-

penses was likely to be permanent he could not say. A large number of their men had enlisted, and the result of their places being filled by inexperienced men had been that many hundreds of pounds in compensation claims had risen through accidents which probably would not have occurred if the experienced men had remained in charge. They were employing with very good results, and in spite of some prejudice against it, about 30 women as car conductors. Owing to the War it was impossible to get the labour and material, and work in connection with the electric supply undertaking had had to be deferred.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

ATKINSON, LLOYD & CO. (LTD.) (142,724).—Reg. Jan. 15, capital £500 in £1 shares, to carry on the business of electrical engineers, manufacturers, agents and contractors. Private company. First directors are J. E. Atkinson, S. Lloyd and R. F. Peacock.

T. E. BLADON & SON. (LTD.) (142,782.)—Reg. Jan. 20, capital £5,000 in £1 shares (2,000 7½ cumulative preference), to carry on the business of brassfounders, stampers, piercers, motor accessory makers, electrical engineers, &c., and to adopt an agreement with T. E. Bladon and W. E. Bladon. Private company. First directors are T. E. Bladon and W. E. Bladon (both permanent governing and joint managing directors, subject to holding 500 shares each).

GENERAL ENGINEERING CO. (KING'S CROSS) (LTD.) (142,760.)—Reg. Jan. 19, capital £1,000 in £1 shares, to take over the business carried on as the General Engineering Co. and/or A. V. Bond, to carry on the business of scientific and experimental engineers, model and tool makers, electricians, electrical, hydraulic and gas engineers, &c. Private company. First directors are A. V. Bond and H. C. H. Braun. Reg. office, 97, Caledonian-road, King's Cross, N.

H. E. JACKSON (LTD.) (142,778.)—Reg. Jan. 20, capital £2,500 in £1 shares, to take over the engineering business carried on at Leicester as H. E. Jackson & Co., to carry on the business of ironfounders, mechanical and electrical engineers, electricians, suppliers of electricity, &c., and to adopt an agreement with H. E. Jackson, E. H. Kirk and C. H. Kirk. Private company. First directors are H. E. Jackson (managing), E. H. Kirk and C. H. Kirk (all permanent).

PARSONS & HODGES (LTD.) (142,731).—Reg. Jan. 15, capital £3,000 in £1 shares, to take over the business of an electrical, mechanical and general engineer and contractor carried on by A. J. Hodges, and the similar business carried on by A. E. Mason, as receiver for the debenture holders of Brown & Parsons (1913) (Ltd.) Private company. Reg. office: 63, The Parade, Leamington, Warwick.

RELIANCE LUBRICATING OIL CO. (LTD.) (142,742.)—Reg. Jan. 17, capital £6,000 in £1 shares, to carry on the business of manufacturers, refiners and preparers of an dealers in petroleum, naphtha and all kinds of lubricating and other oils and oleaginous substances, importers, exporters, contractors, seed crushers, &c. Private company. First directors are A. Holt (governing), A. W. Holt, W. N. Holt and H. Holt. Secretary, J. R. Kennedy. Reg. office, 19 and 20, Water-lane, E.C.

SANDERS & FORSTER (LTD.) (142,743.)—Reg. Jan. 17, capital £5,000 in £1 shares, to carry on the business of ironfounders, mechanical, electrical and general engineers, builders of locomotives, motor cars, railway wagons, tramcars, &c., and to adopt agreements with J. T. Sanders and R. Forster. Private company. First directors are J. T. Sanders (permanent chairman, subject to holding £500 shares) and R. Forster. Reg. office, Royal Works, 27, Union-road, Rotherhithe.

MORTGAGES AND CHARGES.

AMAZON TELEGRAPH CO. (LTD.)—Capital at Nov. 30, 1915, £250,000 in £10 shares. All shares taken up. £250,000 paid. Mortgages and charges, £272,900.

ELECTRO FLEX STEEL CO. (LTD.)—Issue on Dec. 30, 1915, of £4,000 debentures, part of a series of which particulars have already been filed.

ENFIELD ELECTRIC CABLE MFG. CO. (LTD.)—Mortgage on certain freehold land at Brimsdown, Enfield, with factory and other buildings, &c., thereon, dated Dec. 31, 1915, to secure all moneys due or to become due from the company to London County and Westminster Bank, not exceeding £10,000.

RECEIVERSHIP.

"CEDES" ELECTRIC TRACTION (LTD.)—Notice of appointment of J. W. Barratt, 19s, Coleman-street, E.C., as receiver or manager, by order of Court, dated Jan. 14, 1916, has been filed.

CITY NOTES.

MEMORANDA (Jan. 26).—**Bank rate 5 per cent. (since Aug. 8, 1914). Consols 59. Consols Pay Day, Feb. 2. Stocks and Shares Ticket Day, Feb. 9. Pay Day, Feb. 10. Price of silver, 27 1/16d.**

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—Mr. Cecil George Stanesby, F.C.I.S., has been appointed secretary of this company in succession to Mr. Edward Wilmot Seale, who has retired after 26 years' service.

GERMAN ELECTRICAL COMPANIES.—It is announced that Siemens & Halske A.G., of Berlin, has declared a dividend of 12 per cent. for the year ended July 31 last, compared with 10 per cent. for the previous year.

The Siemens Schuckert Werke G.m.b.H. has also declared a dividend of 10 per cent., against 7½ per cent. for the previous year. The report states that much material was supplied for military and marine purposes, and that these demands made up for the falling off in peace requirements. The gross profit of the Siemens & Halske Co. was 17,083,720 marks, against 13,222,009 marks in the previous year, and the gross profit of the Siemens-Schuckert Werke Co. was 27,988,988 marks, against 21,274,418 marks.

MONTREAL LIGHT, HEAT & POWER CO.—A quarterly dividend of 2½ per cent. has been paid on the capital stock.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors recommend a balance dividend on the 7 per cent. preference shares for the half-year ended Dec. 31, 1915, of 3s. 6d. per share, and 4s. 6d. per share on the ordinary shares, making, with the interim dividend paid thereon, a total distribution of 8 per cent. for the year.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—Sir Philip Watts, K.C.B., has been elected to a seat on the board of this company.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—A dividend at the rate of 8 per cent. per annum (less tax) has been declared on the ordinary shares for the half-year ended Dec. 31 (making 7 per cent. for the year, against 9 per cent. for 1914). The dividend is payable on March 1.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Jan. 25. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Jan. 25.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅝	7 5 5	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9⅜	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7 1/16	4 19 1	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs...	83½†	4 15 9	Jan, July
5	2/3	Do. 4½% Pref.	3 15/16	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	2⅝	8 8 8	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	10⅞	5 10 4	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9⅞	7 1 9	Mar. Sept
10	6%	Do. 6% Pref.	10 1/16	5 19 8	Feb, Aug
St.	4½%	Do. 1st Deb.	90½	4 19 8	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs...	75†	6 0 0	July
5	9%	Kensington and Knightsbridge Ord. ..	6 7/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79	5 1 3	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 1/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 3/16	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs ..	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
..	6%	North Metropolitan E. P. Supp. 6% Pref	1 3/16	5 16 4	Apl. Oct
4	5%	South London E.S. Ord	2¼	7 5 5	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7⅜	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	5⅜	5 19 2	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations..	1 3/16	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3½	6 0 0	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82⅝	6 0 10	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	76½	7 16 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord. ..	69	5 15 11	..
St.	4%	Do. do. Assented Def. Ord. ..	68	5 17 5	..
St.	4½%	Do. 4½% Pref.	99½†	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	65	6 1 3	May. Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	5%	London Electric Ry. Ord.	1⅛	3 16 11	Jan, July
St.	4%	Do. 4% Pref.	60½	6 13 1	Mar. Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan. July
St.	1%	Metropolitan Ry. Con. Ord.	25½	3 19 2	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	80½†	4 4 6	Jan. July
St.	3½%	Do. 3½% Debs.	83½†	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15⅞	..	Feb, Aug
St	4%	Do. 4% Prior Lien	92	4 7 0	May. Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	103⅜	5 10 4	Jan. July
St	4%	Do. 4% Debs.	70⅜	5 13 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	70⅜	5 13 4	Jan, July
St.	4%	Do. 4% Guar. Stock	67½	5 18 10	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1⅛	..	..
1/0	..	Do. A Ord.	5/16	..	..
St.	6%	Do. 6% Inc. Debs.	106	5 13 2	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Jan. 25.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	83	7 4 3	Mar, Sept
..	4½%	Do. 4½% Bds.	100½	4 9 3	Jan, July
5	..	Yorkshire W. Riding Ord.	⅞	..	March
5	6%	Do. Pref.	4½	7 1 2	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅞	5 1 10	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 14 1	Mar
100	5%	Do. Prior Lien Debs.	90½	5 10 2	Jan, July
1	6%	Do. 6% Pref.	¾	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞	7 3 9	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 17 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅝	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅜	6 19 2	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	67½	5 19 6	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅞	6 12 7	Jan, July
5	2/6	Do. 5% Pref.	4¼	5 1 3	Feb, Aug
St.	4½%	Do. 4½% Deb.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3⅜	6 8 0	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	1⅝	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	1½	..	Feb, Aug
St.	4%	Do. 4% Deb.	57½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	1	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	71†	5 12 8	Jan, July
..	10%	General Electric Ord.	10⅛	9 7 2	July
10	6%	Do. 6% Pref.	9½	6 6 4	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 9 6	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4¼	4 14 9	..
St.	4½%	Do. 4½% Db.	91½	4 18 4	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅞	10 17 8	Feb, Aug
10	5%	Do. Pref.	7⅜	6 7 0	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 6	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	30½	6 12 5	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82½	4 16 8	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	99½†	6 0 2	Fb,My,Aug.N
St.	1½%	Do. Def. Ord. x d. and bonus	21⅛†	6 17 6	Fb,My,Aug.N
St.	4%	Commercial Cable 4% Debs.	69½	5 15 6	Ja.Ap,Jly.O
10	5%	Cuba Submarine Ord.	7⅛	6 15 7	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7½	6 13 4	..
10	4%	Direct United States	5⅝	6 14 9	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½†	5 19 11	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½†	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	79	5 1 3	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12½†	5 9 6	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 4	33½	6 13 4	Ja, My, Jly
25	13%	Indo-European	48½	6 13 8	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅝	5 6 8	April
1	7%	Do. 7% Pref.	1½	3 18 7	July
10	1%	West India & Panama Ord.	1⅛	9 2 10	May, Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 8 9	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	79	5 1 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	94	4 15 9	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	132½	6 0 6	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	7⅞	6 13 1	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅝	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101	4 9 0	May, Nov
1	10%	*Oriental Telephone Ord.	1⅜	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	6¼	6 12 8	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	87½	5 2 10	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10½	5 14 3	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10½	5 17 1	Sp,Dc,Mr,Jn
100	5%	Mackay Companies Common	80½	6 4 7	Ja, Apl,Jly,O
..	4%	Do. $100 Pref.	67½	5 18 0	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	122½	4 18 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	81	6 5 0	Jun, Dec
St.	4½%	Do. 4½% Debs	77½	5 11 10	Jan, July
St.	4%	Do. 4% Debs.	71½	5 13 5	Jan, July
5	5½%	Do. 5½% 1st Pref.	4⅜	6 11 4	Jan, July
5	5½%	Do. 5½% 2nd Pref.	5⅛	5 9 0	Jan, July
100	2%	Brazilian Traction Ord.	52½	7 11 9	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	89½	6 14 1	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6¾	6 3 1	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64½	6 12 4	..
5	9½%	Calcutta Elec. Trams. Ord.	7⅝	7 19 8	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	90†	5 11 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4½	6 13 4	..
100	5%	Metropolitan Trams 5% Debs.	67	7 9 1	Jan, July
..	..	Mexico Trams Common St.	42	..	Fb,M,Aug,N.
..	5%	Do. 5% Bds.	48	10 17 5	Mar, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94½	4 15 6	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 50 yr. Bds	70½	7 11 3	Jun, Dec
100	4½%	Toronto Railway Co 4½% Bds.	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5⅞	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	98	5 5 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	13⅛	5 19 3	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	4⅞	9 8 10	May, Nov
5	5%	Do. 5% Pref.	4⅜	5 11 11	May, Nov
..	7%	Canadian Gen. Elec. Common St.	110½	6 6 0	Ja,Ap,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs.	94	5 6 3	June, Dec
St.	5%	Do. 5% Gen. Deb. St.	90½	5 3 4	Apl, Oct
..	..	Montreal Light & Power Ord.	178	..	Ja,Ap,Jly,O
..	..	Do. Pref.	31	..	May, Nov
..	5%	Do. 5% Bds.	101½	10 13 1	Jan, July
$1½	5%	Shawinigan Water & Power 5% Bds.	103½	4 17 6	Jan, July
..	6%	Do. Cum. Stock	126½	4 7 11	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb. St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	89½	5 12 0	May, Nov
1	..	Victoria Falls & Transvaal P. Co. 6% Pf	1⅜	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	97½	5 18 8	Jan, July

* Ad 13s. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Jan. 26, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	15½d.
Solid Drawn Copper Tubes	16½d.
Brazed Copper Tubes	16½d.
Brazed Brass Tubes	17½d.
Brass Wire	14½d.
Copper Wire	14½d.
Rolled Brass	14½d.
Rolled Copper	15½d.

	per ton.
Copper Sheets	£129 0 0
Spelter	£91 0 0
English Lead	£31 17 6
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£86 0 0
Brazier Copper Scrap	£74 0 0
Clean Scrap Brass	£63 0 0
Old Lead	£27 0 0
Old Zinc	£60 0 0
Hollow Pewter	£115 0 0
Black Pewter	£75 0 0
Gun Metal	£70 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Jan. 25, the following approximate prices of Scrap Metals:—

	per ton.
Clean Mixed Brass	£62 0 0
Clean Copper	£84 0 0
Brazier Copper	£78 0 0
Gun Metal	£74 0 0
Old Lead	£27 0 0
Tea Lead	£25 0 0
Old Zinc	£66 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 19	1,677	+ 177	33	60,278	+ 3,837
Anglo-Argentine	,, 21	47,515	— 2,308	3	148,595	— 5,439
Ashton-under-Lyne	,, 22	467	+ 73	43	20,512	+ 1,631
Ayr Corporation	,, 22	257	+ 46	36	13,865	+ 881
Birkenhead Corporation	,, 23	1,414	+ 226	43	58,915	+ 5,093
Birmingham Corporation — Trams	,, 15	15,564	+ 3,375	42	598,055	+ 88,480
Birmingham Corporation — Buses &c	,, 15	790	+ 136	42	35,058	+ 18,720
Blackburn Corporation	,, 19	1,076	— 64	43	54,193	— 125
Blackpool Corporation	,, 20	697	+ 126	43	71,424	+ 2,255
Blackpool and Fleetwood	,, 22	291	+ 25	3	1,062	+ 80
Bolton Corporation	,, 23	2,665	+ 280	43	115,363	— 794
Bournemouth — Trams	,, 19	1,873	— 171	42	88,681	+ 4,571
Bournemouth — Buses	,, 19	8	— 1	42	950	— 88
Bradford Corporation	,, 15	6,184	+ 163	41	269,668	+ 10,592
Brighton Corporation	,, 23	896	+ 118	43§	47,610	+ 691
Bristol Trams — Trams	,, 21	4,609	+ 592	3	13,976	+ 535
Bristol Trams — Buses &c	,, 21	4,775	+ 1,205	3	14,513	+ 1,793
Burmah E. Trams & Ltg	,, 22	R3,475	— R29	3	..	+ R7,163
Burnley Corporation	,, 22	1,569	+ 163	16	36,000	+ 3,091
Burton Corporation	,, 23	286	+ 28	43	12,261	— 309
Bury Corporation	,, 23	1,278	+ 136	43§	57,799	+ 124
Calcutta Tramways Co.	,, 22	R68,070	+ R6,978	3	..	+ R15,104
Camborne-Redruth	,, 15	149	+ 29	2	298	+ 53
Cardiff Corporation	,, 22	2,737	+ 344	42	115,305	+ 1,428
Cork Electric Trams Co.	,, 20	462	+ 40	3	1,346	+ 39
Coventry Corporation	.. ..	..	..	..	..	..
Croydon Corporation	.. ..	..	..	..	..	..
*Derby Corporation	,, 22	1,060	+ 159	42	44,931	+ 1,875
Dover Corporation	,, 22	259	+ 24	42	13,204	+ 2,238
Dublin & Lucan Railway	,, 21	112	+ 1	3	340	+ 16
Dublin United	.. ..	..	..	..	..	..
Dundee Corporation	,, 19	1,304	+ 126	36§	48,824	+ 2,775
East Ham Council	,, 22	1,294	+ 90	42	555.75	+ 5,726
Exeter Corporation	,, 21	338	+ 43	42	16,004	+ 872
Glasgow Corporation	,, 22	21,744	+ 1,775	34‡	736,896	+ 53,976
Glossop Trams	,, 22	132	+ 29	4	543	+ 109
Gloucester Corpn	,, 19	305	+ 12	42	14,006	+ 159
Halifax Corpn. — Trams	,, 18	1,961	+ 30	42	93,267	+ 811
Halifax Corpn. — Buses	,, 18	44	..	42	2,050	— 17
Hastings Elec. Trams Co	,, 21	701	..	3	2,299	+ 105
Huddersfield Corpn	,, 22	2,620	+ 283	42	113,706	+ 15,342
Hull Corporation	,, 22	3,219	+ 256	42	131,555	— 1,492
Ilford District Council	,, 15	635	+ 50	41	26,985	+ 3,044
Ilkeston Corporation	,, 19	129	+ 18	42	5,659	+ 271
Ipswich Corporation	,, 22	482	+ 115	41	23,269	+ 3,833
Isle of Thanet Co.	,, 22	241	+ 4	16¶	4,216	— 982
Kilmarnock Corporation	,, 22	157	+ 15	36	6,101	+ 226
Lancashire Trams Co.	,, 20	2,076	— 362	3	6,592	+ 850
Lancashire United	,, 19	1,596	+ 105	3‡	4,548	+ 260
Leeds Corporation	,, 22	8,875	+ 950	43	382,368	+ 29,922
Leicester Corporation	,, 22	3,234	+ 458	3	10,323	+ 1,413
Leith Corporation	,, 22	752	+ 125	36	27,829	+ 2,072
Lincoln Corporation	,, 22	142	+ 23	43	6,047	+ 709
Liverpool Corporation	,, 15	13,672	+ 1,261	2	30,065	+ 2,437
Llandudno&Colwyn Bay R.	,, 21	195	+ 27	7	1,377	+ 80
London County Council	.. ..	..	..	..	..	..
Lowestoft Corporation	,, 22	129	— 14	16	2,120	— 734
Maidstone Corporation	,, 20	177	+ 23	42	9,251	+ 341
Manchester Corporation	,, 22	17,900	+ 1,353	42	760,549	+ 26,516
Neath Corporation	,, 22	201	+ 56	42¶	8,323	+ 481
Newcastle-on-Tyne Corpn	,, 22	5,868	..	43	264,800	..
Newport (Mon.) Corpn.	.. ..	..	..	..	..	..
Northampton Corporation	,, 21	701	+ 161	42¶	30,815	+ 5,356
Nottingham Corporation	,, 20	3,735	+ 439	42	157,878	+ 12,059
Oldham Corporation	,, 23	2,309	+ 324	44	99,934	+ 4,810
Portsmouth Corporation	,, 15	2,239	+ 80	42	103,811	..
Preston Corporation	,, 19	1,004	+ 120	42••	41,173	+ 2,159
Reading	,, 22	1,659	+ 216	..	72,595	+ 3,584
Rotherham Corporation	,, 19	1,272	+ 330	42	49,708	+ 6,407
Salford Corporation	,, 24	5,222	+ 639	43‡	222,690	+ 9,720
Sheffield Corporation	,, 23	9,687	+ 1920	42	392,784	+ 54,546
Southampton Corpn.	,, 19	1,441	+ 254	42	68,611	+ 7,374
Southend Corporation	,, 19	591	— 25	42	34,436	7,983
Southport	.. ..	..	..	..	..	..
Stalybridge, Hyde &c., Jt. B	.. ..	..	..	..	..	..
Stockport Corporation	,, 23	1,470	+ 168	43	64,598	+ 1,571
Sunderland District	,, 19	343	+ 59	12	6,795	+ 578
Swansea Corporation	,, 19	164	+ 22	42	8,361	+ 766
Todmorden	.. 12	497	+ 4	2	864	+ 64
Walsall Corporation	,, 22	1,163	+ 132	42¶	54,446	+ 1,147
Wednesbury Corporation	,, 22	811	+ 161	4	2,600	+ 375
Wallasey	,, 22	774	+ 93	43	38,088	+ 3,664
Warrington Corporation	,, 20	496	+ 65	42	19,586	+ 1,159
West Ham Corporation	,, 20	2,987	+ 227	42	130,909	+ 11,085
Wigan Corporation	.. ..	..	..	..	..	..
Wolverhampton Corporation	,, 19	1,143	+ 117	16	18,008	+ 1,717
Yorkshire West Riding	,, 23	1,[illegible]	+ 243	4	6,613	+ 912

† Three weeks. ‡ Four weeks. § Five weeks. ¶ Plus 3 days. • Partly electrical. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES..... 621
Arrangements for the Week.. 624
On Microphones and Microphonic Contacts. By Prof. P. O. Pedersen. Illustrated. *Concluded* 625
Artificial Insulating Materials. Illustrated 627
Electrification of the Manchester to Bury Section of the Lancashire & Yorkshire Railway. Illustrated.—*Concluded*..... 629
The Manufacture of Drawn Tungsten Wire 633
The Principles of Modern Printing Telegraphy. By H. H. Harrison. Illustrated. *Continued* 634
Coal-Cutting Machinery in 1914 637
A MYTH AND A MORAL..... 638
REVIEWS..... 639
A Treatise on Light [Houstoun]: Reviewed by W. H. Bilson.
Experimental Harmonic Motion [Searle].
REVIEWS—*Continued.*
Elementary Lessons in Electricity and Magnetism [Thompson].
Means for Producing a Sparkless Break of an Inductive Circuit. By T. F. Wall, D.Sc., D.Eng. Illustrated. 640
The Magnetic Testing of Bars of Straight or Curved Form. By Albert Campbell, B.A., and D. W. Dye, B.Sc. Illus. 642
CORRESPONDENCE..... 644
The Institution of Electrical Engineers (W. Perren Maycock).
New Generating Station of the Philadelphia Electric Co. Illustrated 645
The Flow of Electricity Through Dielectrics. By S. W. Richardson, M.A., D.Sc. Illustrated 646
B.E.A.M.A. Annual Meeting.. 646
Parliamentary Record for 1915 647
LEGAL INTELLIGENCE 647
The "Electrician" Commercial and Industrial Section .. 649-656

NOTES.

Engineers, Cranks and Business.

IN the age in which we live it is customary to gauge a man's business ability by his bank balance. Applying this test to many of our engineers and inventors they would be judged by their fellow-men to be deficient in business capacity. We prefer to think that our great engineers and inventors are men of such lofty ideals that they despise the "get-rich-quick" policy, a policy which is pursued more at the present day than probably at any other time in our history. Those who are led to believe that they will get something for nothing by investing money in an invention based on crooked philosophy find it difficult afterwards to recognise pure gold at a glance. Lack of opportunity thus accounts for the failure of some of our great men to attain eminence in business. We have just come across a Paper entitled "Business and Engineering," which was read by Mr. F. G. HEDGE at a recent meeting of the Junior Institution of Engineers. In this Paper illustrations are given with the object of showing that the engineer does not excel in business. The author cites the case of WATT and the sun-and-planet motion, and asks why WATT took the trouble to devise such a complicated piece of mechanism when the crank was available. Until we read the Paper we thought that every student of engineering knew why WATT invented the sun-and-planet motion. In his "Manual of the Steam Engine" THURSTON states that about 1782 WATT invented the crank and flywheel, but as the former had been patented by WASBOROUGH—who is supposed to have obtained a knowledge of it from men employed by WATT—the latter patented several other methods and temporarily adopted the sun-and-planet motion. It matters little to the community whether men like WATT STEPHENSON, FARADAY and KELVIN are good business men or not, as long as their talents are recognised and rewarded by those who pride themselves on their business ability.

Artificial Insulating Materials.

IT is sometimes not realised what a wealth of insulating materials has sprung up during the last few years, and some people are apt to think that they still have to depend practically upon porcelain, mica, ebonite and fibre alone. This is now very far from the case. Not only have various materials been produced which can be machined into the desired shapes, but a whole class of materials has sprung up, known by the name of plastics, which by means of heat and pressure can be moulded readily into any desired form. Thus the cost of manufacturing complicated pieces of apparatus, provided they are required in sufficient quantities, has been very materially reduced. By combining various fillers with suitable binders the properties of the material may be varied over a wide range. Thus high dielectric strength is obtained by using mica, and fire-resisting qualities by using asbestos. One difficulty, however, that is often experienced, is due to the softening of the material under heat, which, although useful in the process of moulding, is very undesirable when the material is employed under certain conditions. From this point of view an advance has been made by the use of synthetic resins, which owe their formation to the application of heat, and therefore do not soften upon a second application of the same temperature. Although much of this insulating material during the last few years has found its way from Germany, many of our own manufacturers are well alive to the situation. It is with a wish to inform our readers what is being done in this direction that we publish an article on another page dealing with many of these materials.

A Time for Linking-Up.

AT the present time when the amount of spare plant in electricity works is far from what is desired, it is obviously a time for linking-up of power stations so as to make the most of our resources. This point of view has evidently been forced upon the Electricity Committee of Wigan after their recent breakdown, with the result that a temporary supply is now to be taken from the South Lancashire Tramways Co. We are glad to see that a move has been made in this direction. In the past there has been too much independence of working between one concern and another, largely with a view to the glorification of individual concerns rather than for the benefit of electricity supply as a whole. In the Midlands we feel sure that very much more might be done in the way of interlinking than hitherto, and we trust that the present opportunity will be seized for this purpose.

Legislation in 1915.

In another column we give a brief record of the Parliamentary session which ended last week. During the lifetime of the present Government we have had several long sessions, but the recent session, which commenced in November, 1914, and terminated on the 27th ult., breaks the record for length. Though many public Acts were passed, the great majority of the measures were temporary expedients necessitated by the needs of the empire in the present crisis and for the prosecution of the war. For instance, there were four Acts dealing with the vexed question of trading with the enemy, three Finance Acts, two measures relating to munitions of war, and two to defence of the realm, while Bills were passed for increasing the postal and telegraph rates, restricting exports, limiting the price of coal, &c. When peace reigns once more most of these Acts will not be required, or will be replaced by legislation of a permanent character. This statement, however, will not apply to the Finance Acts, for much of the new, and perhaps additional, taxation will be required for many years to come. Of the financial proposals of the Chancellor of the Exchequer those relating to the increase of the postal and telegraph rates aroused most opposition, and considerable modifications, including the dropping of the proposal to abolish the half-penny postal rate, had to be made by the Government. The excess profits tax also aroused so e opposition by tramway and electric supply companies. Many of these companies are liable to be purchased by local authorities on inequitable terms, and as for many years after their incorporation they paid little or nothing by way of dividend; it was considered that the 6 per cent. maximum profit to be allowed was too low, more particularly as the profits were to be estimated on the usual basis adopted for income tax assessments. However, some changes were made in the Finance (No. 3) Bill in the Committee stage, and as companies have a right of appeal to the Board of Referees set up by the Treasury, it is probable that questions arising out of the excess profits tax will be dealt with in a reasonable manner. The increase in the telegraph and telephone charges has led to some agitation in commercial and industrial circles, but it is probable that this question will be reconsidered as soon as the war has been brought to a successful termination.

The number of private Acts was not up to the average of recent years, though many electric supply and tramway authorities secured useful powers for extensions and for carrying on their undertakings. Plymouth Corporation were authorised to apply the surplus profits of their electric supply undertaking to the improvement and extension of the works. This power is not novel so far as private Acts are concerned, but it was included for the first time in some provisional electric lighting orders of the past session, including the extension order of Tunbridge Wells Corporation. The authority is desired by many local authorities, for it enables them to form what is termed a working capital fund. Plymouth Corporation had a strenuous fight in both Houses of Parliament over the "wiring" clauses in their Act, which ultimately took the form of the standard clause in the Model Bill. Southampton Corporation also had a very stiff contest over the inclusion of the Northumberland clause in their provisional order for the extension of their area of supply to the Parish of Bitterne. The Board of Trade refused the application of the local gas company to insert the clause, and a House of Commons Select Committee confirmed this decision; but the gas company found the House of Lords Committee more sympathetic, and the clause was inserted in the order, its operation being however confined to the Bitterne area. It is questionable whether the insertion of the clause in its present form is justified under any circumstances, but in the case of an old-established, financially sound undertaking like the Southampton electricity works its inclusion is a most retrograde step, likely to militate against the development of electric power supply. Doncaster, Lincoln, Halifax and South Shields Corporations succeeded in getting powers which should prove useful in developing their electric supply and tramway departments. Four gas companies obtained electrical powers and the Spennymoor and Tudhoe Gas Co. has been authorised to deal in (inter alia) dynamos. The Board of Trade objected to this power being given, but the company pleaded that its customers like it to be able to supply complete electric lighting plants, gas engines, dynamos, &c., and so the Select Committee passed the clause.

We regret that, owing to the war and to the desire to abandon all measures of a controversial nature at present, the two interesting Bills relating to the London electric power problem were of necessity dropped. Fate has been singularly unkind to the promoters of the many London electric power schemes, and we have begun to doubt whether electric supply in the metropolitan area will ever be placed on a satisfactory basis. In the meantime many of the existing supply undertakings are being linked-up, and by this means some of the Borough Councils hope to postpone indefinitely, if not to defeat, the proposals of the London County Council. The rejection of the Yorkshire Electric Power Bill by a Select Committee of the House of Lords caused keen regret in electrical circles. The Company desired to have power to supply electrical energy for lighting as well as power in certain portions of their area of supply. From the 63 districts scheduled there was no opposition, and the Councils of 43 of them gave active support; but the promoters apparently forgot that the sacred principle of purchase by local authorities was enshrined in the Electric Lighting Acts of 1882 and 1888, and a vigilant official of the Board of Trade discovered this omission from the Bill (though it appears the question was dealt with in the Company's Act of 1901). Anyhow, the absence of the purchase clause proved fatal, for this portion of the Bill was at once rejected by the Committee, and as the Company had lost the essence of their measure the entire Bill was abandoned. There can be little doubt that few of the Councils of the rural and urban areas affected by the scheme could run electric supply undertakings without recourse to the rates, and the purchase clause is, therefore, quite inapplicable to them. We should have thought that the Board of Trade officials would have remembered the disastrous effect of the Electric Lighting Act of 1882 upon the electrical industry of this country, and that they would have recollected that a pedantic adherence to obsolete statutory forms would be bad for electrical engineering and for the whole country. Government departments and civil servants move slowly, however; red tape and excessive formalism still reign supreme in some departments, and especially in that department which is supposed to be particularly interested in the maintenance of our trade and commerce.

Organisation of Scientific Research.—Prof. J. A. Fleming, F.R.S., will deliver a lecture on the above at the Royal Society of Arts on the 9th inst. at 4.30 p.m. We understand that, instead of negative criticism, a constructive policy will be set forth. We trust there will be a good attendance and that a valuable discussion on this important subject will result.

Water-power Development.—Entitled "Status of Water-power Development," Mr. H. W. Buck read a Paper at the Pan-American Scientific Congress, Washington (U.S.A.), at the end of December. The author dealt with the economic advantages of utilising maximum stream flow with auxiliary steam stations to compensate for water deficiency.

Petrol Electric Sets.—The "General Electric Review" refers to auxiliary sets of 5 kw. These are for use on board ship for either lighting or wireless telegraphy. They may also be used inter-connected for either of the above purposes.

Cables at the Golden Gate.—The "Electrical World" recently referred to the fact that two 11,000-volt submarine power cables have been laid across the Golden Gate at San Francisco. Power is transmitted at high pressure from the Cordelia sub-station and stepped down to 11,000 volts on the north side of the Gate before transmission under water to the city sub-stations.

Electric Sprinklers.—The "Electrical World" refers to the City of Lynn, Mass., where the electric sprinklers used during the summer act as dust carts in the winter. These sprinklers carried a 1,200-gallon tank, 13 ft. 10 in. long by 4 ft. 6 in. diameter. They were converted to ash carts by removing the tanks. Each truck is considered equivalent to three double and two single teams for sprinkling and dust cart service respectively.

Mollier Diagram.—Mr. H. A. Cozzens, jun., writing recently in the "Electrical World," states that frequently the figures for the thermal efficiency of steam turbines differ although the machines are of similar design and rating. He considers this is due to different methods being used for evaluating their thermal performance, and he suggests the use of a modified Mollier diagram, which enables the efficiency to be rapidly found in each case.

New York Discards the Arc Lamp.—According to the "Electrical World," all arc lamps in New York City are to be replaced by gas-filled tungsten lamps having a range of 100 c.p. to 400 watts. The total cost of lighting is about £604,508 per annum, and the change will effect a saving of £2. 10s. per lamp per annum. Careful tests have proved that, in addition to avoidance of flicker and glare, the gas-filled lamps have greater penetrating power in foggy and stormy weather.

Cast Iron.—Mr. E. L. Rhead gave an interesting Paper recently before the Manchester Association of Engineers on the above. It was pointed out that the temperature for pouring the metal depended on a variety of factors, amongst which may be mentioned the nature of the metal, size of casting, shrinkage, contraction and the time taken to pour the metal. It appears, therefore, that every casting has a certain temperature at which coarse graphite will not separate, causing weakness.

Shaft Winding.—In a lecture recently at Glasgow on "Electrical Shaft Winding," Prof. D. Burns pointed out that the work of a winding engine depended on (1) the output to be raised per day, (2) depth of shaft, (3) inertia and acceleration stresses to be overcome. The fact of having to dispose of the residue of the coal washer must, and probably would, exert a powerful influence on the cost of steam raising. It appears now that colliery owners need have no hesitation in adopting electrical machinery when suitable conditions existed for its application.

Recent Developments in Telephony.—A Paper on the above was read last week by Mr. G. C. Marris, B.Sc., at a meeting of the Liverpool Engineering Society. The author dealt with transmission, central battery and automatic telephone systems—comparing the population per telephone, the figures for some countries are: U.S.A., 11; Denmark, 24; British Isles, 65; France, 150; and for towns, Los Angeles, 4·1; New York, 11·3; London, 32·5; and Liverpool, 35. In North America there are 8,693,000 telephones, compared with Europe's 3,133,000.

Horizontal and Vertical Magnetic Force.—Dr. C. Chree, F.R.S., in a Paper read recently before the Royal Society on the "Discussion of Kew Magnetic Data, especially the Diurnal Irregularities of Horizontal Force and Vertical Force from Ordinary Days of the Eleven Years 1890-1900." The changes in the regular variation throughout the year are detailed, and inequalities are expressed by Fourier series. There is also an investigation of the annual inequality. The relation of diurnal inequality to sunspot frequency is considered, and the constants in Wolff's formula determined. The daily range is also considered, including the frequency of occurrence of ranges of different size.

Portland Cement.—In a Paper on the above, read before the Institution of Engineers and Shipbuilders in Glasgow recently, Mr. B. J. Day suggests using the waste slag heaps to make cement. This forms a large industry in Germany at present, the product being the well-known "Eisen" Portland cement. He points out that, although it is not quite so good as Portland cement, it requires less fuel consumption per ton. This kind of cement is generally quicker in setting than ordinary cement, but this property can be controlled by the addition of gypsum, plaster of paris, or by hydration.

Beit Scholarships for Scientific Research.—From a note in the current "Journal" of the Institution of Electrical Engineers it appears that the third election of Fellows will take place on or about July 15, 1916. The Fellowships, of which not more than three will be awarded at this election, will be tenable at the Imperial College of Science and Technology, South Kensington, and will each be of the annual value of £150. The tenure of a Fellowship is for one year, but it may be extended by the trustees for a further period not exceeding one year. Candidates must be under 25 years of age on the date of election. Applications will be received up to April 15, 1916, and must be made out on special forms which, together with any other particulars in respect of the Fellowships, may be obtained, by letter only, addressed to the Director, Imperial College of Science and Technology, South Kensington, London, S.W.

The New Crystallography.—The "Yorkshire Post" recently gave an account of a lecture on the above by Prof. W. H. Bragg, D.Sc., F.R.S., at the Leeds Philosophical Society. The X-ray spectrometer made at Leeds University is based on the assumption that the atoms in crystals are arranged in planes at regular distances from one another. It therefore resembles a very finely ruled diffraction grating. Using a ray from rhodium having a wave-length of 0·614 Angstrom units, the angle at which this ray is reflected from a face of a crystal may be observed for the different faces. Then, knowing the number of atoms in the crystal per cubic centimetre from its density, the arrangement of the atoms within the crystal can be determined. For the diamond, for instance, the carbon atoms are arranged so that each atom is at the centre of a regular tetrahedron, at the points of which are its nearest neighbouring atoms.

Organisation of Science.—A Re-organisation Committee (of 107, Piccadilly, London, W.), has been formed by the signatories given below, who have issued a manifesto calling attention to the neglect of science in this country. Not only are our legislators ignorant of science, but the same defect runs through our Civil Service departments and schools. They urge a drastic reform in the examinations for public service, and electors should see to it that candidates for Parliament are pledged to aid this by legislation as much as possible. The following are the signatories:—

Sir Thomas Clifford Allbutt, M.D., F.R.S.
H. Edward Armstrong, D.Sc., F.R.S.
Earl of Berkeley, F.R.S.
Rowland Biffen, F.R.S.
Gilbert Charles Bourne, F.R.S.
Louis Brennan, C.B.
Sir William Crookes, O.M., D.Sc.
James Cossar Ewart, M.D., F.R.S.
John Ambrose Fleming, M.A., F.R.S.
Arthur George Green, F.R.S.
John Walter Gregory, F.R.S.
Ernest H. Griffiths, M.A., F.R.S.
Sydney John Hickson, D.Sc., F.R.S.
Leonard Erskine Hill, M.B., F.R.S.
James Peter Hill, D.Sc., F.R.S.
Sir Edwin Ray Lankester, M.A., F.R.S., K.C.B.
P. Chalmers Mitchell, D.Sc., F.R.S.
Sir Henry Morris, Bt., F.R.S.
Sir William Osler, M.D., F.R.S.
Hon. Sir Charles A. Parsons, D.Sc., F.R.S., K.C.B.
Karl Pearson, M.A., F.R.S.
W. H. Perkin, M.Sc., F.R.S.
John Perry, M.E., D.Sc., F.R.S.
James Charles Philip, D.Sc.
Edward Bagnall Poulton, M.A., D.Sc., F.R.S.
Sir William Ramsay, K.C.B., F.R.S.
Lord Rayleigh, P.C., D.Sc., O.M., late P.R.S.
Major Sir Ronald Ross, K.C.B., F.R.S.
Arthur E. Shipley, D.Sc., F.R.S.
Ernest Henry Starling, F.R.S.
John Arthur Thomson, D.Sc., LL.D.
Sir Edward Thorpe, C.B., F.R.S.
Sir Wm. Aug. Tilden, D.Sc., F.R.S.
Herbert Hall Turner, D.Sc., F.R.S.
Sir John Williams, Bt., M.D., D.Sc., G.C.V.O.
Thomas Barlow Wood, M.A., D.Sc.

OBITUARY.

CHARLES FREDK. MITCHELL.—The death is announced of Mr. Chas. Frederick Mitchell, headmaster of the technical day school of the Regent-street Polytechnic for 25 years. Deceased was 56 years of age.

F. J. JONES.—The death took place recently of Mr. Frederick James Jones, electrical engineer and contractor, of Chester. Deceased was head of the firm of F. J. Jones & Sons.

KILLED IN ACTION.—Lieut. John McLaren Thornton, R.E., who was killed in Flanders on Jan. 20, was born in 1889. He was educated at St. Paul's School and the Central Technical College, taking his engineering B.Sc. in 1910. He was apprenticed to and later became a junior member of the staff of Messrs. Siemens Bros. Dynamo Works. In 1913 he joined the London Scottish and went to France with the 1st battalion in September, 1914, and was wounded at Messines. He obtained his commission in the Royal Engineers in December, 1914, and returned to France in September, 1915.

Second Lieut. O. P. Gwynne, who was recently killed in the Tigris operations, spent five years at Messrs. Vickers as engineering pupil, and sailed to Ceylon as resident engineer on the Dunsinane tea plantation. When war broke out he joined the Ceylon Planters' Rifle Corps and went to Egypt. He was given a commission in the 92nd Punjabis, and was sent with the relief force to the Persian Gulf.

PERSONAL.

On March 4 the marriage will take place (very quietly at Herne Hill, London) of Mr. Henry Cobden Turner, of the British Westinghouse Co., Trafford Park (son of Mr. Wilberforce Turner) and Elizabeth Anderson (Bessie), daughter of Mr. William Noble, assistant engineer-in-chief of the G.P.O., of Herne Hill, London, S.E.

ROYAL ENGINEERS (T.F.).—The following appointments and changes have been made :—

Tyne Electrical Engineers : Wm. W. Wilson and Pte. John B. Murray (from Artists' Rifles Officers' Training Corps) to be second lieutenants (on probation). Second Lieut. N. G. Hollebone has relinquished his commission on account of ill-health.

APPOINTMENTS VACANT AND FILLED.

Bispham-with-Norbreck Council require an assistant electrical engineer. Applications to the clerk to the Council, Mr. J. W. Tickle, Council Offices, Bispham. *See also an advertisement.*

A leading firm of electric accumulator makers require an estimating clerk for their London office. *See an advertisement.*

A large electrical firm in the Midlands advertise for a testhouse assistant.

The Woking Electric Supply Co. advertise for a shift engineer used to single phase.

The Council of the Indian Institute of Science invite applications for the post of assistant professor of electrical technology. Salary, 625 rupees per mensem, with a house. Further information from Messrs. Jeremiah Lyon & Co., 4, Lombard-court, London, E.C., and applications must be sent to the Director of the Indian Institute of Science, Bangalore, India, by Feb. 15.

Advertisers require experienced instrument and meter testers, used to three-phase instrument and meter testing for manufacturing works in Manchester district.

Mr. F. Mawdesley, assistant engineer at Plumstead electricity works of Woolwich Borough Council, has been promoted acting charge engineer.

Mr. E. W. Dunton has been appointed electrical engineer to the Anglo-Saxon Petroleum Co. at Sarawak.

INSTITUTIONS AND SOCIETIES.

Royal Institution.—On Thursday the 27th ult., Prof. W. A. Bone, D.Sc., F.R.S., delivered an interesting lecture on "Fuel Economy from a National Standpoint." The lecturer referred to the fact that the coal supplies of China were probably under estimated, and also dealt with the necessity for economy after the war in Great Britain. It was pointed out that the greatest coal producers, viz., the United States, Germany and Great Britain, were increasing their annual outputs at about 6 per cent., 4 per cent. and 2 per cent. respectively. The world's demand in 1913 was 1,250 million tons and was increasing at the rate of 5 per cent. per annum approximately. With regard to Great Britain our exports of coal had increased twentyfold in the last 60 years and its value was now fourfold of what it then was. This export was a necessity in order to preserve our naval supremacy. In Great Britain the consumption of coal per head of population had increased in the ratio of 4·25 to 3·75 during the last 50 years. Assuming that our output of coal increased at 2 per cent. compound interest per annum, our available coal supplies at 4,000 ft. depth would last 580 years. This question, however, was rather one of price, which, during the period 1897-1910, had risen by 37 per cent. Dealing with the 6·5 millions annually burnt in beehive ovens, the lecturer thought this should be stopped, since it involved an annual waste of £2,500,000 in bye-products. Modern regenerative ovens were illustrated, and the processes of distillation at high and low temperatures were sketched. Referring to the 38 million tons annually burnt in the domestic fireplace, it was unlikely people would use gas largely, since they could obtain about five times as much heat from coal for the same expenditure. Apart from this, on account of cleanliness, gas fires would be used in flats and occasional rooms. A fireplace designed by Prof. Vernon Harcourt for burning coke was illustrated, and the fuel cost per day of 14 hours, was 3·66d., the coke costing £1 per ton.

ARRANGEMENTS FOR THE WEEK.

MONDAY, Feb. 7th.

WESTERN SECTION INSTITUTION OF ELECTRICAL ENGINEERS.

5:30 p.m. At South Wales Institute of Engineers, Park-place, Cardiff. Paper on "The Testing of Underground Cables with Continuous Current," by Mr. O. L. Record.

TUESDAY, Feb. 8th.

INSTITUTION OF CIVIL ENGINEERS.

5:30 p.m. Meeting at the Institution, Great George-street, S.W. Paper, "Notes on the Working of a Rack Railway," by Mr. W. T. Lucy.

SCOTTISH SECTION INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at Princes-street Station Hotel, Edinburgh. Paper on "The Principles of Modern Printing Telegraphy," by Mr. H. H. Harrison.

MANCHESTER SECTION INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at the Engineers' Club, 17, Albert-square. Paper on "The Testing of Underground Cables with Continuous Current," by Mr. O. L. Record.

WEDNESDAY, Feb. 9th.

ROYAL SOCIETY OF ARTS.

4:30 p.m. Meeting at Society of Arts, Adelphi-street, W.C. Paper by Prof. J. A. Fleming, D.Sc., F.R.S., on "The Organisation of Scientific Research."

YORKSHIRE SECTION INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at the Philosophical Hall, Leeds. Paper on "The Testing of Underground Cables with Continuous Current," by Mr. O. L. Record.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

8 p.m. Meeting at St. Bride Institute, Bride-lane, E.C. Paper on "Multiple Effect System of Refrigeration," by Mr. Wilfred Stokes.

THURSDAY, Feb. 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment, W.C. Paper on "The Testing of Underground Cables with Continuous Current," by Mr. O. L. Record.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Commanding Officer, Lieut.-Col. C. B. Clay, V.D.

Orders for week commencing February 7, 1916 :—

Drills : 6:25 p.m. to 7:25 p.m. ; 7:25 p.m. to 8:25 p.m.

Sunday, February 6th.—Trench Work Train, 9:33, Cannon-street.

Monday, February 7th.—Sections 1 and 2, Technical : Sections 3 and 4, Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, February 8th.—School of Arms, 6 p.m. to 7 p.m.

Thursday, February 10th.—Shooting for Sections 1 and 2 and Signalling Class.

Friday, February 11th.—Sections 3 and 4, Technical : Sections 1 and 2 Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, February 12th.—Uniform Parade, 2:45 p.m.

Sunday, February 13th.—Signalling Section. For particulars see Notice Board.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 16, Regency street, S.W.

Sections for Shooting Parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Sennit Bros., Leicester-hill, as soon as possible.

Payment for uniforms to be made to the Adjutant.

ON MICROPHONES AND MICROPHONIC CONTACTS.*

BY PROF. P. O. PEDERSEN.

(*Concluded from p.* 591.)

Summary.—Part I. contains a description of some simple experiments on microphones showing the great influence of even very minute displacements of the diaphragm on the sensitiveness of a microphone. Some simple means by which a microphone can always be brought in its most sensitive state are described. Part II. contains the results of a long series of tests on microphonic contacts. A theory of the microphonic (carbon) contact is set forth, and several of its consequences are tested.†

Part II.—A Preliminary Theory of Microphonic Carbon Contacts.

8. *Introduction.*—The total resistance R between two carbon pieces consists of three parts—

$$R = R_0 + R_1 + R_2.$$

R_0 is the *inactive resistance*, which is, within practical limits, independent of the pressure between the pieces. R_1 is the proper *contact resistance*—that is, the resistance due to the intervening layer. R_2 is the *spreading resistance* from the area of the contact to the bulk of the pieces. The two last ones taken together form the *active resistance* $R' = R_1 + R_2$. In the following investigations we are only concerned with the active resistance, and the inactive resis ances have been deducted from all experimental data.

The theory here tentatively put forward rests on the following hypotheses :—

(*a*) *The product of contact resistance* R_1 *and contact area a is independent of the contact pressure* P, providing the current I through the contact is small.

(*b*) The contact resistance depends on the current in the following way :—

$$R_1 = \frac{\sigma}{a} - \frac{\beta R_1 I^2}{P^{\frac{2}{3}}},$$

where σ is the specific contact resistance for small currents and β is a constant.

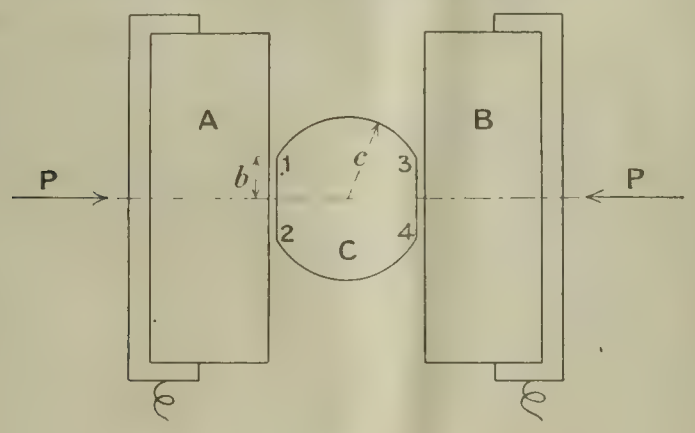


Fig. 9.

In order to simplify the calculations we restrict our investigations to the case shown in Fig. 9—viz., a carbon sphere, with radius *c* cm., slightly pressed between two carbon plates. The radii of the circular contact areas are denoted by *b*.

The carbon used was hard homogeneous microphone carbon, which had a resistivity $\rho = 0{\cdot}0091$ ohms/cm.^{3} and a Young's modulus, E, estimated to $250 \cdot 10^6 g/\text{cm.}^2$.

9. *The Spreading Resistance* R_2.—The resistance from the contact area 12 through the sphere to 34 (*see* Fig. 9) is given by‡

$$\frac{\rho}{2b} - \frac{\rho}{2\pi c} \cdot \log \frac{b}{2c},$$

provided *b* is very small compared with *c*. The spreading resistance from 12 to A or from 34 to B is $\rho/4b$. The total spreading resistance between A and B is, therefore,

$$R_2 = \frac{\rho}{b} - \frac{\rho}{2\pi c} \cdot \log \frac{b}{2c}.$$

As *b* is small compared with *c*, we have approximately

$$R_2 = \rho/b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

10. *The Relation between Contact Resistance and Pressure.*—According to our hypotheses we have

$$R_1 = \frac{\sigma}{a} - \frac{\beta R_1 I^2}{P^{\frac{2}{3}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For the present we shall only consider such cases in which the current is so small that the last term in (7) can be neglected. We may call the corresponding resistance R_1^0 and have

$$R_1^0 = \frac{\sigma}{a} = \frac{\sigma}{\pi b^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

According to a well-known formula of H. Hertz,* *b* and *a* are given by

$$b = 1{\cdot}11\left(\frac{Pc}{E}\right)^{\frac{1}{3}} \text{ and } a = 3{\cdot}87\left(\frac{Pc}{E}\right)^{\frac{2}{3}} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

$$\therefore R_1^0 = \frac{\sigma}{3{\cdot}87}\left(\frac{E}{Pc}\right)^{\frac{2}{3}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Hence

$$R^{01} = R_1^0 + R_2 = 2\frac{\sigma}{a} + \frac{\rho}{b} = \frac{\sigma}{1{\cdot}94}\left(\frac{E}{Pc}\right)^{\frac{2}{3}} + \frac{\rho}{1{\cdot}11}\left(\frac{E}{Pc}\right)^{\frac{1}{3}} \quad . \quad . \quad (11)$$

This equation gives, for small currents, the relation sought between active resistance and pressure.

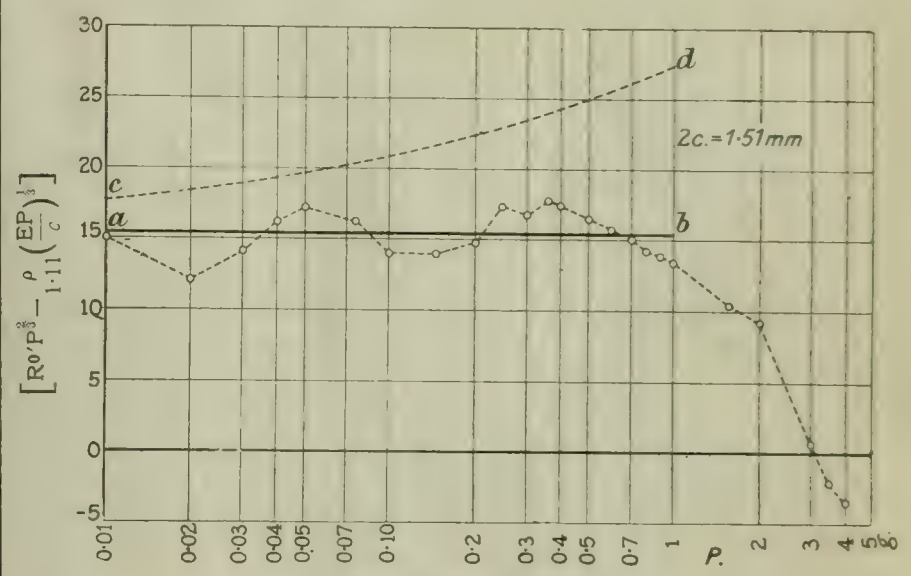


Fig. 10.—Carbon Sphere 1·51 mm. in diameter.

In order to test the validity of (11) it is more convenient to write this equation in the following form :—

$$R^{01} \cdot P^{\frac{2}{3}} - \frac{\rho}{1{\cdot}11} \cdot \left(\frac{EP}{c}\right)^{\frac{1}{3}} = \frac{\sigma}{1{\cdot}94} \cdot \left(\frac{E}{c}\right)^{\frac{2}{3}} \quad . \quad . \quad . \quad . \quad (12)$$

In (12) the right-hand side is independent of the pressure P. If our theory is valid, the left-hand side will also be independent of P. In order to test this, a long series of experiments was made, using

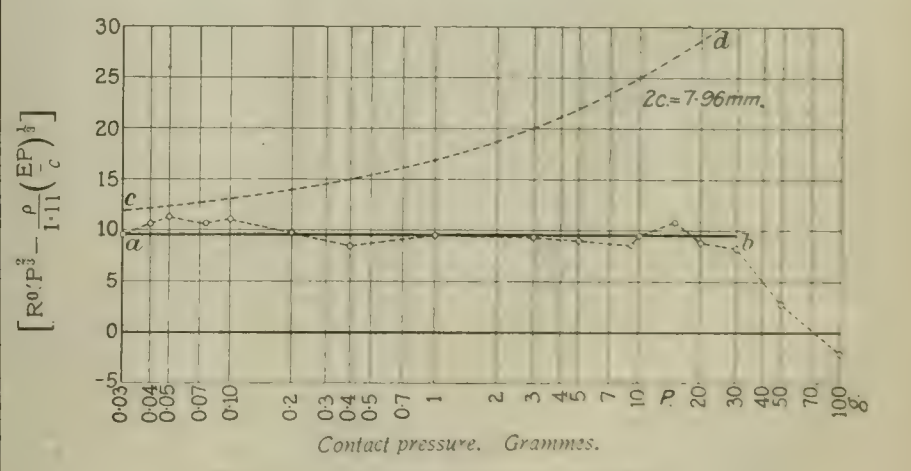


Fig. 11.—Carbon Sphere 7·96 mm.

carbon spheres of diameters from 0·5 mm. to 10 mm. In each series a set of corresponding values of P and R_{01} were measured and the left-hand side of (12) was calculated. The values obtained for two series of tests are shown in Figs. 10 and 11 by small circles connected by a broken line. The results are fairly constant up to a certain pressure, P_b, corresponding to the points marked *b* in the figures. For higher pressures the left-hand side of (12) falls off rapidly. The mean value of the left-hand side up to this point *b* is shown by a thick line, *ab*.

* Abstract of an article in the Danish journal "Elektroteknikeren."

† All the experiments were carried out in the telephone laboratory of the Royal Technical College in Copenhagen.

‡ Riemann-Weber, "Die Partiellen Differentialgleichungen der Mathematischen Physik," I., p. 482, 1910.

* H. Hertz, "Gesammelte Werke," I., p. 175; A. E. H. Love, "Math. Theory of Elasticity," 2nd Ed., p. 192; "Hütte," 20th Ed., I., p. 409.

In Table II. are to be found a few of the values obtained.

Table II.

Diameter of sphere. $2c$.	P_b.	S.	f_0.	σ.
0·047 cm.	0·080 g.	811 kg./cm.^{2}	82·0	$3{\cdot}30\times10^{-5}$ ohm/cm.^{2}
0·151 ,,	1·00 ,,	865 ,,	15·3	$1{\cdot}34\times10^{-5}$,,
0·797 ,,	30·0 ,,	893 ,,	9·7	$2{\cdot}54\times10^{-5}$,,

If the maximum stress S, corresponding to the pressure P_b, is calculated, the value of S thus found is always about 800 to 900 kg./cm.^{2}. The carbon can hardly be expected to stand any greater stress.

It therefore appears *that equation* (12) *holds good*, within the limit of experimental error, *for all pressures up to the breaking point of the carbon*.

Table II. also contains the mean value f_0 of the left-hand side of (12) up to the point *b*, and the corresponding value of σ calculated from (12); σ varies considerably from case to case, but its magnitude is of an order of a hundred-thousandth of an ohm per square centimetre. The variations in σ are, no doubt, mainly due to slighter impurities on the surface of the carbon. Even minute impurities may raise the value of σ a thousand times or more.

In Fig. 10 and 11 the dotted lines *cd* indicate the value of

$$g - f_0 = \frac{\rho}{1{\cdot}11}\left(\frac{EP}{c}\right)^{\frac{1}{3}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

For any definite value of P the ratio $(g-f_0)/f_0$ is equal to the ratio R_2'/R_1^0. It appears that for small values of P—that is, for all microphonic pressures—*the contact resistance is far greater than the spreading resistance.*

11. *Relation between Resistance and Size of Grains.*—From equation (11) it appears that the active resistance of the contacts shown in Fig. 9 only depends on P . *c*—that is, on the product of the pressure nd the radius of the sphere. We have investigated the validity of

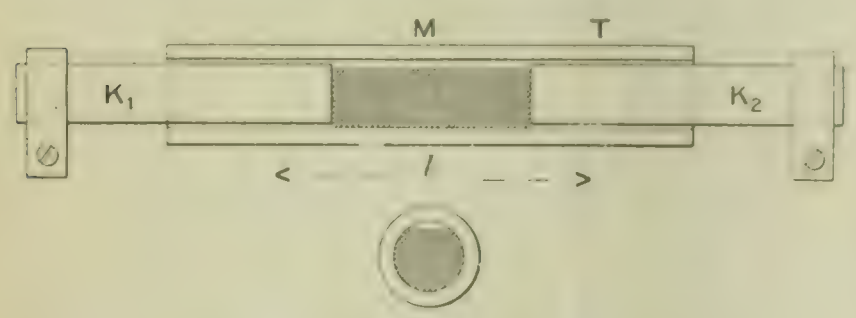


FIG. 12.

T... K1 and K2 ... R ...

(11) for variations of P. We may, theoretically, do the same for variations of *c*. But a great practical difficulty is here met with in the form of the above-mentioned uncertainty in the value of σ. In order to eliminate this uncertainty it would be necessary to carry out a very great number of tests and find the mean values of the results obtained. This difficulty is overcome by measuring the volume resistance of a mass of grains containing a great number of these. If the grains of different sizes are made of the same sort of carbon it is to be expected that the deviations from the normal value of σ will mutually compensate each other, and the measured resistance, therefore, will only depend on the size of the grains in the manner required by our theory, provided this theory is right. The grains were placed in the apparatus shown in Fig. 12. The hole in the glass tube had a cross section of 1·02 sq. cm. The distance between the carbon ends K_1 and K_2 was always chosen so great that the grains did not fill the whole cross-section of the tube, but only about 1·00 cm.^{2}. The resistance was measured as indicated in Fig. 3, and the test current was small. Before every measurement the apparatus was gently shaken. For every length *l*, corresponding to a total volume of grains of *l* cm.^{3}, a number of measurements were made and the mean formed. The greatest deviations seldom exceeded 5 per cent.

Such measurements were made with grains consisting of carbon spheres of diameters $2c$ = 1·53, 1·00 and 0·47 mm. respectively. The results are shown in Fig. 13. R is the resistance corresponding to the length *l*. The relation between R_l and *l* can approximately be represented by the three straight lines. The resistivity ρ' of the grain mass is given by $\rho' = (R_1 - R_0)/4$. The results are summarised in Table III.

The relation between ρ' and $2c$ as required by our theory is easily found if we neglect the spreading resistance and only consider the contact resistances. The number of contacts in parallel are proportional to $1/c^2$, of contacts in series to $1/c$. The pressure on each one of the contacts is proportional to c^2, the resistance, therefore, to $1/c^2$. The resistance ρ' per cubic centimetre is, therefore, proportional to $c^2 \cdot c^{-1} \cdot c^{-2} = c^{-1}$. The result is that the product $2c \cdot \rho^0$ shall be constant. The experimental agreement is fairly good.

Table III.

$2c$.	ρ^0.	$2c \cdot \rho^0$.	R_0.
1·53 mm.	20 ohms	30·6	26 ohms
1·00 ,,	29 ,,	29·0	20 ,,
0·47 ,,	76 ,,	35·7	27 ,,

The resistance $R(l=0)$ is the resistance between the grains and the flat ends of the carbon electrodes. It is easily proved that this resistance, according to our theory, should be independent of *c*. This consequence is also approximately satisfied.

A number of tests were also made with ordinary sharp-edged grains of different sizes. The grains were made from the same sort of carbon, and were sorted by means of sieves with circular holes of different sizes. In Table IV., containing the results of these experiments, $2c$ denotes the diameter of the holes which the grains were just able to pass.

Table IV.

$2c$	2·3	2·1	1·9	1·7	1·5	1·3	1·1 mm.
ρ^0	380	410	560	582	685	734	824 ohms.
$\rho^0 \cdot 2c$	874	860	1,060	990	1,030	954	906 ,,
$\rho^0 \cdot (2c)^{\frac{1}{2}}$	502	525	694	694	781	801	849 ,,

In applying the theory to this case the question is: What are the radii of curvature at the points of contact? If these radii are independent of the size, it is easily found that, according to our theory, the product $\rho' \cdot (2c)^{\frac{1}{2}}$ should be constant. Table IV. shows that there is a systematical deviation from this law. If, on the other hand, the radii of curvature are proportional to the size of the grains, the theory demands that $(\rho' \cdot 2c)$ shall be constant, as in the case of spherical grains. Table IV shows that $(\rho^0 \cdot 2c)$ is fairly constant. There is some reason to believe that the edges of the big grains really are somewhat more rounded than on the small ones. The edges cannot be mathematically sharp, they must be more or less rounded and the forces tending to do this are greater for big grains than for small ones.

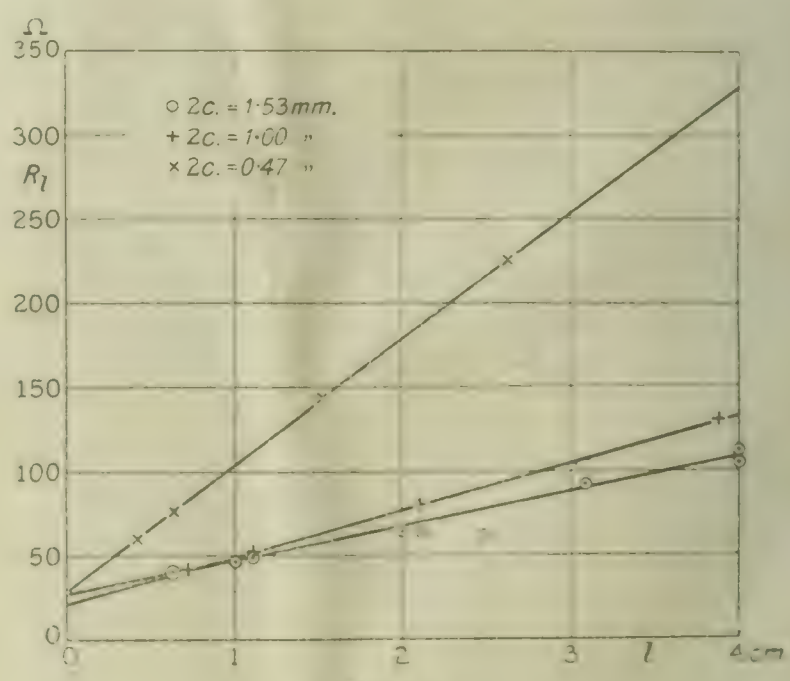


FIG. 13.

Another observation bearing on this point is the following: If some of these grains are put in a box and violently shaken for one to two minutes their ρ' is reduced by 30 per cent. or more.

12. *Relation between Resistance and Strength of Current.* It is a well-known fact that the contact resistance decreases when the current rises. A part of this reduction of resistance takes place immediately after the increase of current, while the remainder only dies away gradually. The last part, which is mainly due to the heating effect of the current, has no greater microphonic interest, as the variation is too slow. We shall, therefore, only consider the first instantaneous effect.

According to our hypotheses, the relation between contact resistance and current is given by

$$R_1 = \frac{a}{\sqrt{P}} = \frac{aR_1 I}{P} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

or, solved with regard to R_1,

$$R_1 = \frac{\sigma/a}{1+\beta I^2 P^{-\frac{3}{2}}} = \frac{\sigma P^{2/3}}{3{\cdot}87\,.\,c^2(P^{\frac{2}{3}}+\beta I^2)} \quad \text{or} \quad \frac{C}{P^{\frac{2}{3}}+\beta I^2}. \qquad (15)$$

R_1 is the initial value of the resistance just after the current has been switched on. Equation (15) may also be used to determine the variation of R_1 for sufficiently rapid variations of the I current about a mean value, I., even if the constant value of R_1 corresponding to the constant current I, is not given by (15).

According to (14), the initial reduction of the resistance due to the current is proportional to the power lost per unit area of contact.

The validity of (15) was investigated in the following way: For a given pressure the resistance $R_1^0+R_2$ was first measured by means of a very small current, the stronger current was then put on and the resistance R_1+R_2 measured at once. The sphere was then turned, or a new sphere inserted, the pressure again put on and a new measurement taken in the same way. The results of three sets of tests on 1·51 mm. spheres are shown in Fig. 14. The values of R_1 may vary considerably (*see* 10), but the experimental values have all been reduced to an initial resistance of 100 ohms, and the curves shown in Fig. 14 are the result of a geometrical interpolation between the experimental results.

In order to compare the experimental data with equation (14) it is necessary to obtain the values of R_1^0 alone, and therefore to deduct R_2 from the experimental values shown in Fig. 14. R_2 can be calculated from the known constants of the carbon, and the values obtained are inserted in Table V. This table also contains the values assigned to β in the three cases. These values of β have been inserted in the formula (15), and the resistance calculated from this

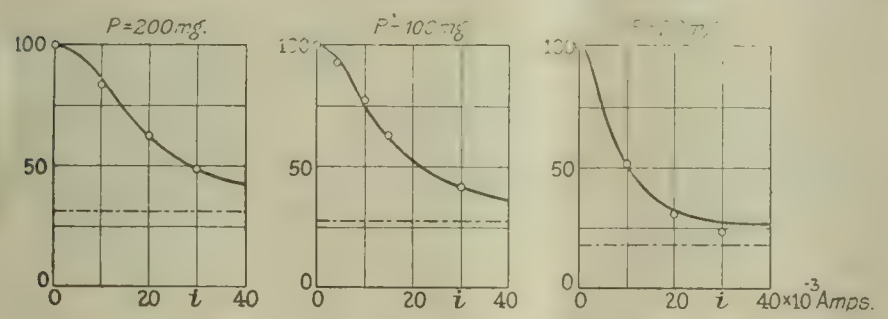


Fig. 14.—Relation Between Initial Resistance and Current for 1·51 mm. Sphere.

formula for various currents. The results are marked by small circles in Fig. 14. The agreement between the theoretical and the experimental values is very good. For a complete transmitter similar curves were obtained.

Table V.

P.	R_2.	β.
0·200 g.	31 ohms.	$1{\cdot}08\times10^3$
0·100 „	27 „	$1{\cdot}01\times10^3$
0·020 „	17 „	$1{\cdot}05\times10^3$

13. *The Microphonic Sensitiveness* is proportional to the ratio of a small increment in pressure to the corresponding decrement in resistance. In accordance with (7), we denote the sensitiveness by r', and supposing the spreading resistance may be neglected compared with the contact resistance, it appears from (15) that

$$r' = -\frac{dR_1}{dP} = \frac{2}{3}\cdot\frac{C}{P^{\frac{5}{3}}(P^{\frac{2}{3}}+\beta I^2)^2} = \frac{2}{3}\cdot\frac{R_1^2}{C P^{\frac{5}{3}}} = \frac{2}{3}\cdot\frac{R_1^2}{C\sqrt{\frac{C}{R_1}-\beta I^2}}. \qquad (16)$$

For small currents this formula reduces to

$$r' = \frac{2}{3}\cdot\frac{R_1^{\frac{5}{2}}}{C^{\frac{3}{2}}} = \text{Constant}\,.\,R_1^{\frac{5}{2}}. \qquad (17)$$

In order to compare this result with the experiments described in (7), and which have been included in Fig. 8, we have drawn three curves in this figure corresponding to the exponents 3, 5/2 and 2 respectively in formula (17). There is no doubt that the exponent 5/2 gives the best, and a fairly good, representation of the experimental data.

14. The investigation has, within the experimental limits, supported the theory advanced—that is, it has proved the constancy of σ and β within the said limits; but it has not given any indication as to the nature of these constants. It appears to me that the next step to be taken in order to elucidate the intricate and very interesting question of microphonic action must be an investigation of the physical nature and behaviour of σ and β.

ARTIFICIAL INSULATING MATERIALS.

During recent years a great deal of work has been done on the subject of insulating materials, not merely upon such materials as mica, porcelain, indiarubber, gutta percha, &c., which may be regarded as more or less natural products, but in the production of plastic compounds, which may be moulded under heat and pressure, and various forms of built up insulation. It is obvious that if machining operations can be reduced by moulding, a very marked cheapening results when the articles are required in any great quantity. The important point is to obtain a material which will not only mould satisfactorily, but will have the required properties from the electrical point of view.

Such materials may be classed under four general headings:—

1. The first class embraces materials which are good insulators at ordinary temperatures, but which are not necessarily suitable for higher temperatures. This class includes ebonite and many of the newer materials, depending to some extent upon bituminous bodies which soften somewhat readily.

2. The second class includes materials which would be used in electrical machinery generally, and which, therefore, are subject to temperatures up to, say, 80°C. Here it is important that the material should not soften, otherwise its mechanical properties become very poor, and it is also necessary that the dielectric strength should be maintained.

3. Going a step further we came to that class of insulation which may be described as fireproof, in that it will stand considerable heat, and may, therefore, be usefully employed in switchgear.

4. Lastly, we have material capable of standing high temperatures, such as that given by the arc, and which depend, largely upon asbestos as a constituent.

Apart from moulded materials we have also insulation of a built-up character depending upon impregnated paper formed into sheets of the Pertinax variety.

Of all the insulating materials which we have at our disposal mica shows the greatest dielectric strength, and consequently from this point of view built-up insulation made of mica splittings stands ahead of all others. On the other hand, when we come to mechanical strength, mica compounds necessarily give place to materials such as Bakelite and other compounds of this character.

In addition to heat resisting qualities, it is often important that insulating materials should withstand the action of acids and oils; this is particularly the case with material used in oil-cooled transformers, and to a less degree in many electrical machines. Further, it is often essential that absorption of moisture should be very small. From this point of view ebonite is an excellent insulator, and it has the advantage that it will take a good finish; on the other hand, it easily softens with heat. Here it is that moulded insulation depending upon synthetic resins, such as Bakelite, is at an advantage for the reason that these resins require considerable heat for their formation, and consequently unaffected by temperatures at which shellac softens. As a "filler" in such material, wood meal, paper, asbestos meal and other substances are used, depending upon the character of insulation required. Whereas wood meal is excellent from the point of view of a good surface finish, asbestos gives a material which is preferable for high temperatures, though inferior in surface.

In what follows we give an account of the various materials now obtainable in this country, the information for this purpose being kindly supplied by the various makers.

Callender's Cable & Construction Co. manufacture insulating material, which is sold under the registered name of Kalanite. This is composed of various ingredients giving different grades according to the use to which the insulation is to be put. It possesses considerable insulating properties, strength and adaptability, and is moisture proof. It is also tough and will withstand rough usage. Consequently, it is suitable for a wide range of applications. Three grades are manufactured known as "A," "C" and "E." The "A" grade is supplied in the form of sheet or rod and is suitable for turning, drilling, screwing, tapping, machining and working in a lathe and in a similar manner to vulcanite and ebonite; it will take an excellent polish. The "C" grade is used for making moulded articles, such as bushes, terminal blocks, overhead insulators, bobbins, &c. The "E" grade is fire-resisting and is employed for arc shields, switch boxes, dividing fillets for switchboards, &c. There is also a special grade which is used for moulding battery boxes.

Messrs. Carson & Evans manufacture material, which is known by the trade name of Carvanite, to meet the demand for a cheap material where very high insulation is not essential. It can be moulded, turned, drilled, screwed, or sawn, and from the testimonials that have been received it appears to be an excellent insu-

lating material. A large stock is carried, and we understand that the material has proved very satisfactory to the users.

The firm of Arthur Cort & Co. are concerned more particularly with vulcanised fibre and ebonite, and are identified with the well-known insulating material known as Chatterton's Compound. Before the war this material was largely imported from Germany. Messrs. Cort & Co. are now manufacturing six stock qualities, so that all needs can be easily supplied.

The material manufactured by the Ebonestos Mfg. Co. is made, as the name implies, from ebonised asbestos; that is, asbestos fibres which are impregnated and coated with a compound of various gums in such a manner that they will not absorb moisture. The material is moulded under heat and under considerable pressure. It retains its shape after being removed from the moulds and since there is practically no shrinkage great accuracy can be obtained. Thus threaded holes or tapped brass pieces can be readily moulded in the articles. The material can be made in a variety of colours, but black is more generally used for electrical work. There are also a number of grades which may be classified as follows:—

A. Bright natural finish, hard and short grained, but low softening point.
B. Smooth dull black finish, hard and short grained, softening point 212°F.
C. Tough fibrous material, which usually relies upon a varnish finish: softening point 170°–180°F.
D. Coarse, fibrous material (fireproof).

The insulating properties of the first three classes are high and do not vary very much from one another. We understand that a test

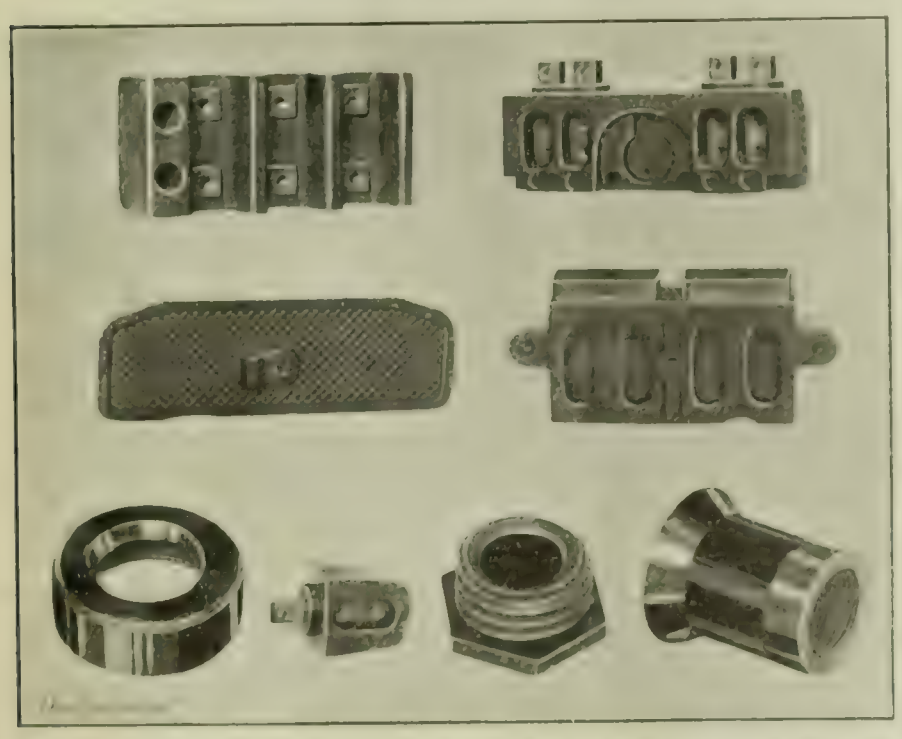


Fig. 1.—Examples of Moulded Articles by the Ebonestos Mfg. Co.

of Class A, carried out at Faraday House, showed a resistance of 50,000,000 megohms per centimetre cube after the material had been immersed in brine for 48 hours. The fireproof material under Class D absorbs from 0·1 to 0·5 per cent. of moisture. Fig. 1 illustrates some of the special forms manufactured by this Company. [illegible] The Company is the oldest [illegible] established in [illegible] business.

Messrs. Ermoid (Ltd.), of Stroud, who are the proprietors of Syrolit, manufacture from the solids of milk a material bearing the trade name of Ermoid. Its general properties, as regards appearance and working, are nearer to horn than to any other natural product. It is made in the form of sheets and rods, the sheets being 16 in. by 20 in., and ranging up to 12 mm. in thickness. The rods are about 40 in. in length, and vary from 6 mm. to 25 mm. Being made in various colours, such as black, blonde, white, green, mauve, and also with a striated appearance, this material is very suitable for a variety of work. In some of the plain colours it is also made in the form of tubes. With regard to insulating properties, these appear to be quite satisfactory so long as the material is not in very damp situations. Any firm accustomed to the working of Gabalith, the German equivalent to Ermoid, will find no difficulty in working Ermoid, as it can be readily sawn, drilled, &c. Polishing is readily effected on the mop or by rotation in barrels along with Ermoid shavings and pumice stone or polishing chalk.

The India Rubber, Gutta Percha & Telegraph Works Co., Ltd. (the Silvertown Co.), have been identified for the past 40 years with ebonite. With their long practical experience and up-to-date machinery they are able to supply everything that is required in this particular line. We cannot deal here with all the ebonite articles manufactured by this company, but as an example we may mention containers, separators and accumulators, telephone receiver cases, ear pieces and other telephone accessories, switch handles, telegraph insulators, tramway insulators, insulating parts for magnetos, material for wireless telegraphy, and tubes for induction coils, as used for electric railways and wireless telegraphy. With regard to the last item, every tube is thoroughly tested before it leaves the works. Other articles that may be mentioned are acid cocks, unions and pumps for chemical works, and keys and spanners with ebonite insulation. It may be mentioned that the ebonite used by the National Physical Laboratory for conducting their exhaustive tests on which the Admiralty specification is based was supplied by the Silvertown Company.

The Improved Solidite Co. are successors of the Solidite Co., a firm which was concerned with the making of composition top corks

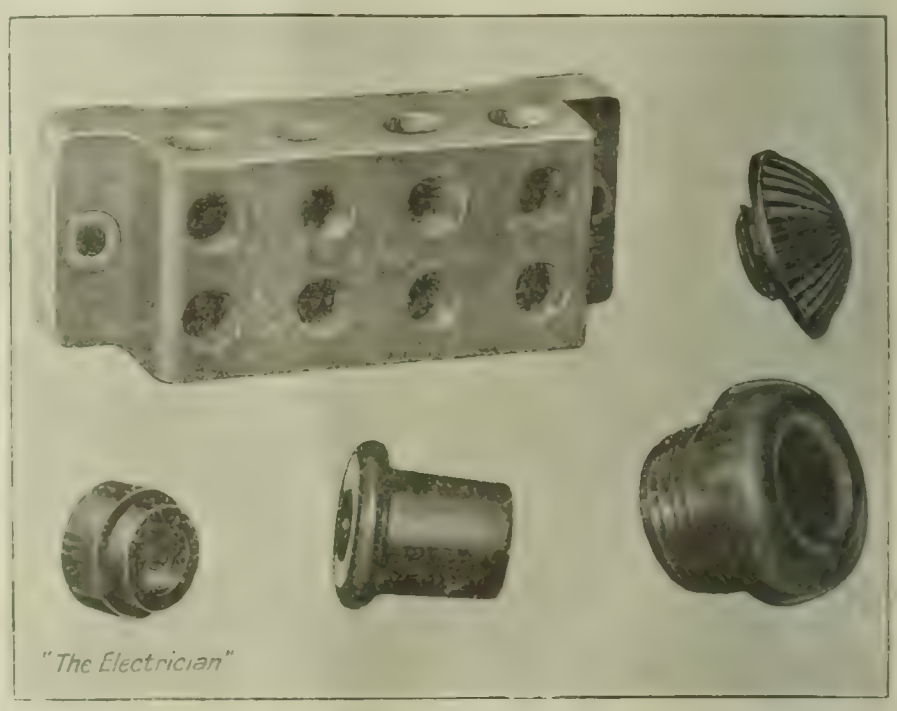


Fig. 2.—Examples of Moulded Insulation by the Improved Solidite Co.

Since the war the Company has laid down plant for making moulded insulated articles such as handles, bushes, hand wheels, &c. We understand that Solidite has passed exacting tests at the National Physical Laboratory, which tests have shown that it is quite suitable for electrical work. The only difficulty experienced by the Company at the present moment is in obtaining moulds for executing the orders, but this difficulty is being gradually surmounted. Fig. 2 gives an idea of the character of work undertaken by this Company.

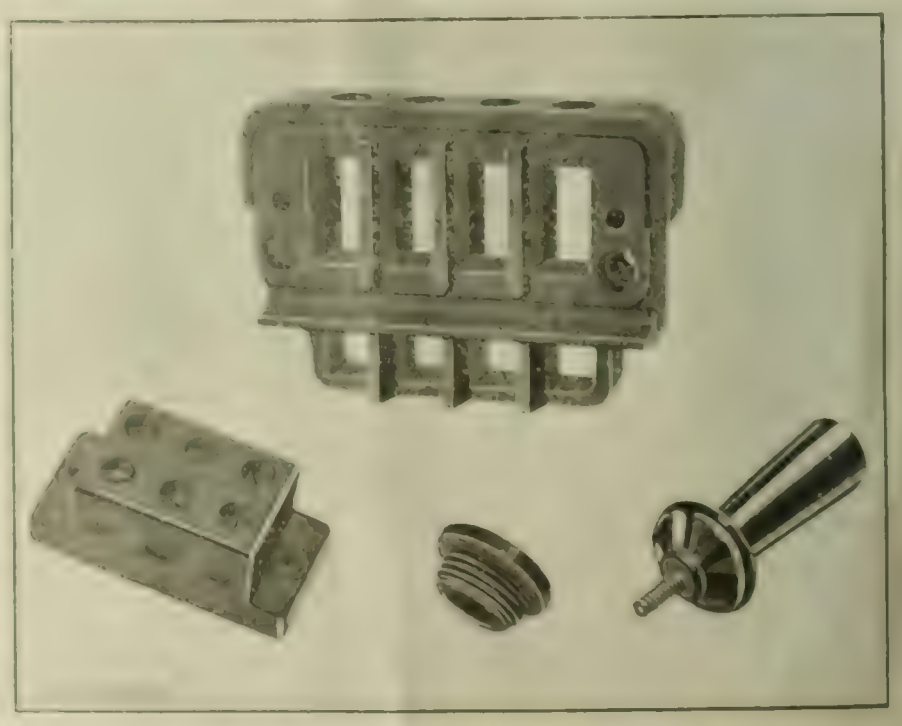


Fig. 3.—Examples of Moulded Litholite.

Litholite (Ltd.) have been in existence for a number of years, being pioneers in the manufacture of moulded insulators in this country. They are very well known in this line of work, and have

been able to take advantage of the present position to obtain some of the trade which was previously carried on by German firms. Fig. 3 illustrates some of the articles made by this firm.

The MICANITE & INSULATORS Co. have for many years been associated with the production of what is known as Micanite, consisting of mica splittings held together by a special varnish. Since the outbreak of war the output of the Company in this direction has been increased and has been extended to the manufacture of "mica folium," which is made of mica splittings pasted on varnished paper rolls. Before the war this class of insulation was obtained wholly from the Continent and largely from Germany, but as the Company had already begun to put down plant for its manufacture they are now able to fulfil all the requirements of the market.

The chief development of the Company, however, since the outbreak of war has been the manufacture of materials which were formerly sold under the German trade name of Pertinax, the Swiss trade names of Micarta, Bakelite, &c., and their own trade name of Paxolin. These trade names, however, all represent the same insulating material, which consists of sheet and tubes, having as a basis paper impregnated with synthetic resins.

"Paxolin High Grade" is supplied in the form of sheets of any thickness and in tubes of any diameter and in various specially shaped forms. Special insulated paper is impregnated with varnish from synthetic resins, and thus a sufficient thickness is built together or rolled by special machines to give the required thickness. Such insulation is impervious to oil and is largely used for transformers and oil-immersed switchgear. Its insulating properties are good and it is capable of withstanding temperatures up to 250°F. without deterioration. The material has great mechanical strength, and can be machined by ordinary methods to form coil bobbins or other specially shaped insulators. Paxolin is now being used in place of fibre, porcelain and other insulating materials, and for electrical instruments it is becoming a serious competitor of ebonite. Special Admiralty quality is made in accordance with an Admiralty specification; this is impervious to moisture and has higher insulating properties than the standard grade.

The very special properties of synthetic varnishes have enabled great improvements to be made in paper insulation, and it is also interesting to note that such varnishes can be applied, to a limited extent, to the manufacture of micanite. The insulating properties of synthetic varnish are equally as good as those of mica; the nature of the varnish is such that, after continuous heating at low or high temperatures, the varnish changes its state and sets hard, so that no further heating will affect it. As mica will also withstand high temperatures it will be evident that a grade of micanite can be obtained perfectly able to withstand much higher temperatures than the limit generally allowed for micanite insulation. The Micanite & Insulators Co. have developed and are now manufacturing several grades of this special micanite which has enabled micanite insulation to be successfully used under temperature conditions which would destroy ordinary grades of micanite. In the case of heating units, asbestos insulation is largely used because of its high heat resistance properties, although its electrical properties are poor; but with mica insulation the electrical properties are maintained at high temperatures. For slot insulation the material is specially suitable, and in view of the safe temperature limits for insulating materials as given in the recent British standardisation rules for electrical machinery it would appear probable that when this insulation is more generally used these limits will be considerably extended.

Synthetic varnish is not affected by weak acids, nor is mica, so that a further important application will suggest itself. The winding of motors which are operating in atmospheres highly charged with acid fumes are generally protected with coatings of excellent

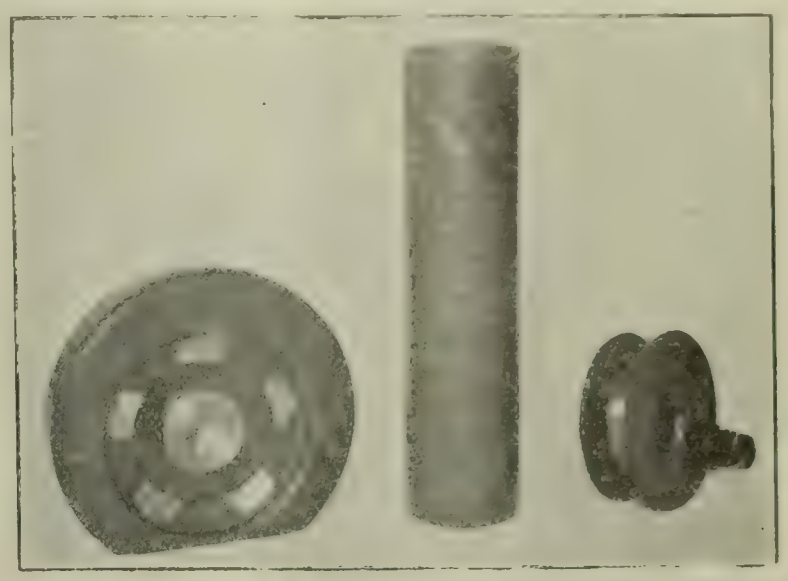


FIG. 4.—MOULDED ARTICLES AND A PAXOLIN TUBE BY THE MICANITE & INSULATORS CO.

acid-resisting varnishes, but if an insulating material, such as this special micanite, which in itself is not affected by acids, can be used on the windings, then the insulation and reliability of the machine must be improved.

Prior to the war practically all magneto distributors were obtained from Germany and when such supplies were cut off a serious shortage occurred. The Company, therefore, commenced to manufacture distributors and slip-rings in moulded Bakelite and these have proved satisfactory as compared with Stabelite, the German product formerly used. Two of these are seen in Fig. 3 along with a Paxolin tube. We understand that the Micanite & Insulators Co. never really suffered from German competition as regards quality, but suffered greatly before the war owing to continual cutting of prices.

(To be concluded.)

ELECTRIFICATION OF THE MANCHESTER TO BURY SECTION OF THE LANCASHIRE & YORKSHIRE RAILWAY.

(Concluded from p. 602.)

ELECTRICAL EQUIPMENT FOR CARS.

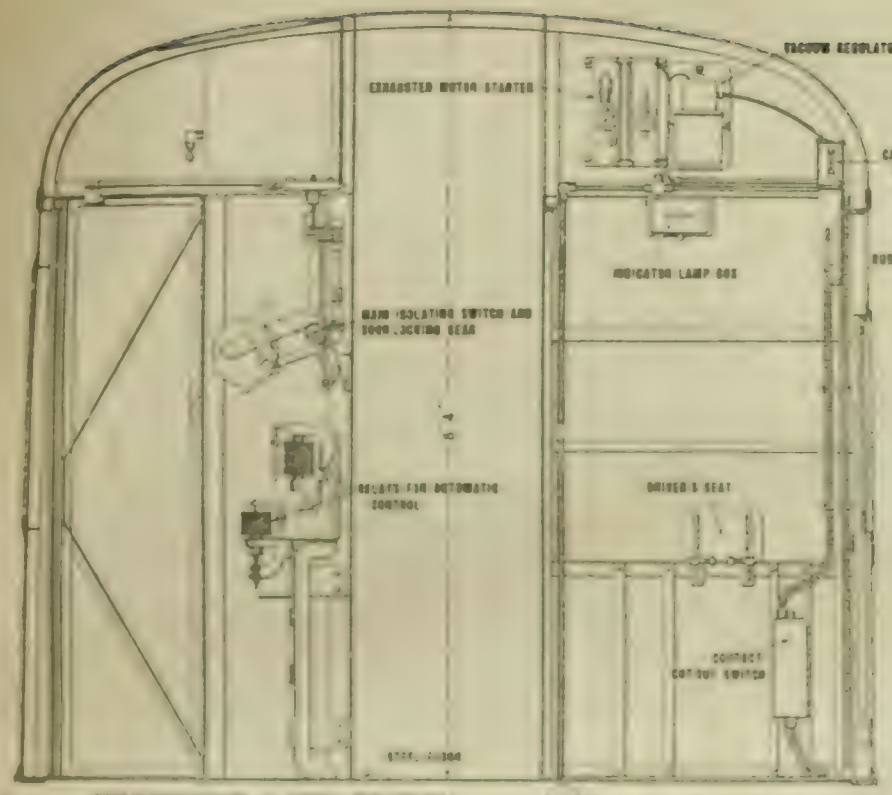
The control equipment on the cars is on the multiple unit system, and is arranged to be operated on the automatic principle—that is, instead of the motorman notching up in the usual way by hand, he puts his controller into the "Full series" or "Full parallel" position, the various intermediate steps being performed automatically. It can also be operated by hand, by simply moving the reversing lever to a certain position. The control equipment on each car is capable of controlling the four 200 H.P. traction motors, with a line voltage of 1,200, to give "Series parallel" and "Parallel" combinations of the motors.

The whole of the equipment is operated by 100 volts direct current, which is transformed from the line voltage (1,200) by means of a a rotary transformer mounted under the car. All the 1,200-volt equipment is housed in a special high-tension chamber, the door of which is interlocked so that the isolating switch connecting the control leads to the shoes must be opened before entrance can be effected. The arrangement of the motorman's compartment and the high-tension compartment is shown in Fig. 38.

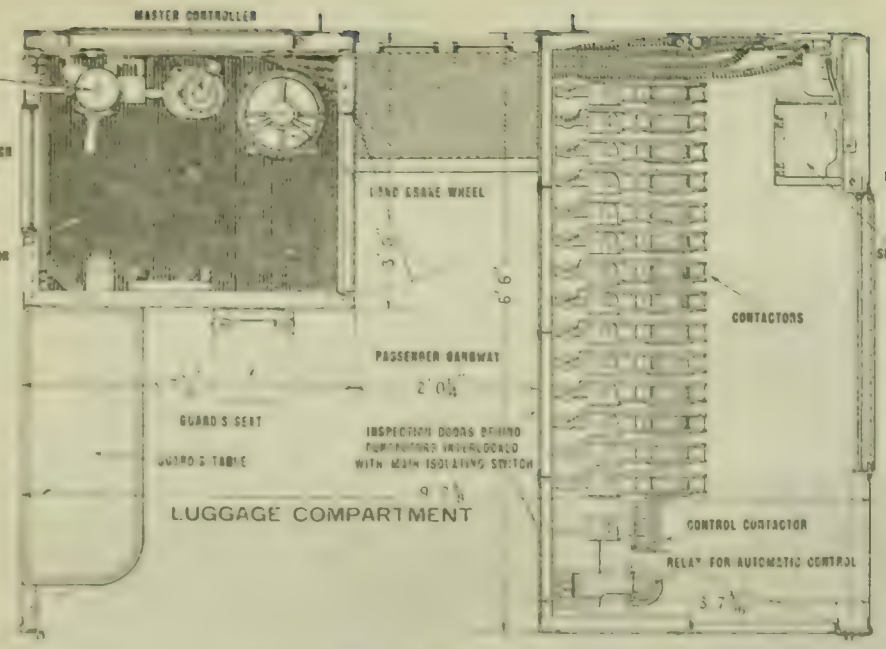
All the contactors, the reverser and the motor cut-out are mounted on the inner wall of the high-tension compartment, opposite the window, and above these are mounted the isolating switch, main fuse, main circuit-breaker; and in an auxiliary high-tension chamber is the starting gear for the rotary transformer with its isolating switch. The high-tension wiring is carried in flexible steel tubing.

The motorman's compartment contains a brake valve fitted with an emergency handle which on release applies the brake instantly, and also trips the control circuit, thereby opening all the contactors; a master controller and a hand brake, together with the switches for lighting and the necessary switches and fuses for the control and brake. Also it contains the automatic controller and regulator for the vacuum pump. The arrangement shown is the same at each end of the motorcar, with the exception of the brake pump controller and regulator.

The reverser handle on the master controller has four positions, reading from right to left, "Reverse," "Off," "Ahead automatic control" and "Ahead manual control." It will be noticed that one of the positions is "Ahead manual control." This is used in case of emergency due to failure of the "Automatic control." Normally this is a stop which is sealed, and which prevents the reverser handle being placed in the manual position. There are four "Series" points on the controller, three "Intermediate" and three "Parallel," with an additional two positions by which the field of the motors is shunted when higher speed is required for express traffic.

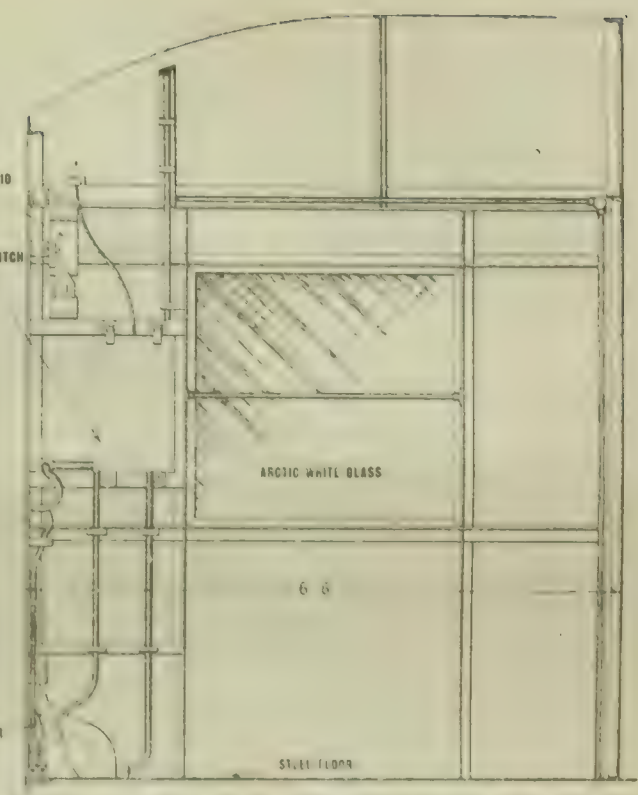


MOTORMAN'S & HIGH TENSION COMPARTMENTS. BACK ELEVATION

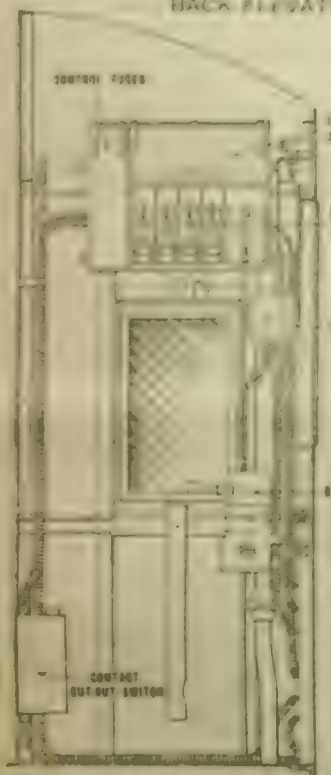


LUGGAGE COMPARTMENT

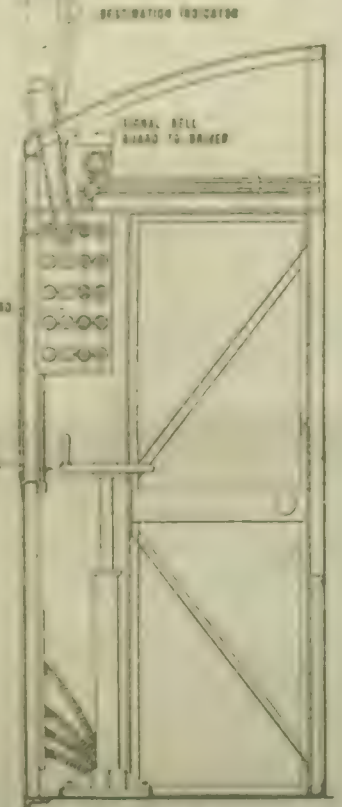
PLAN OF MOTORMAN'S & HIGH TENSION COMPARTMENTS.



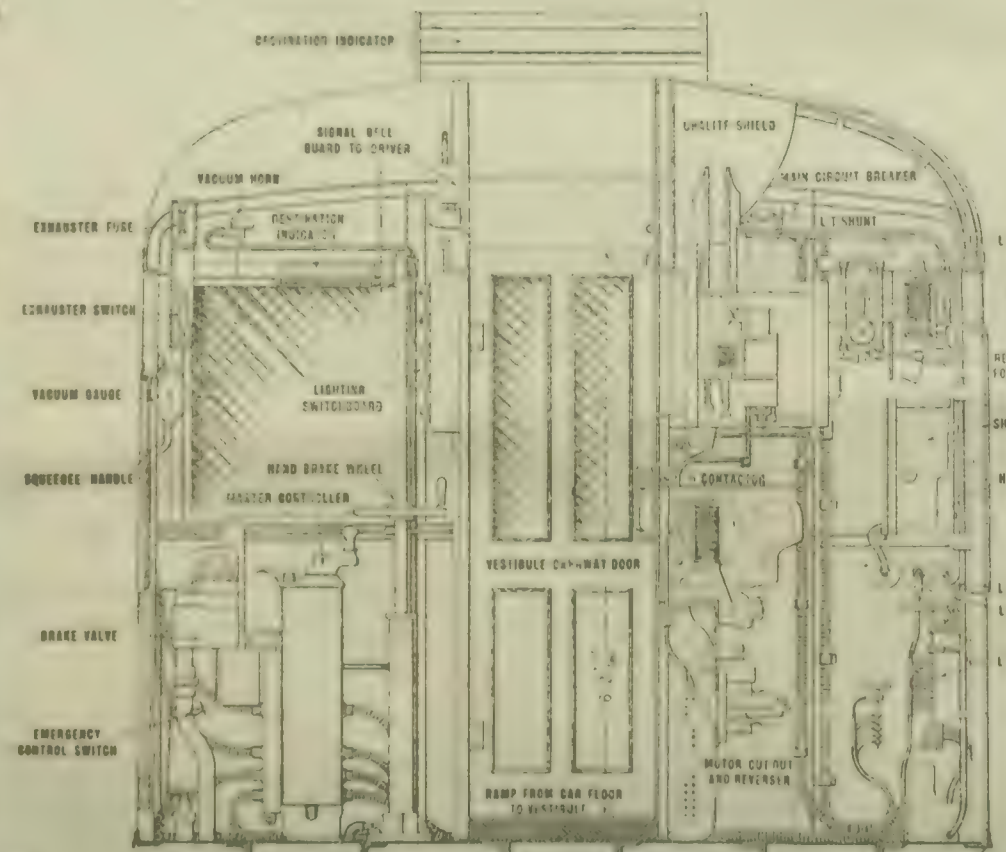
HIGH TENSION COMPARTMENT BODY SIDE ELEVATION.



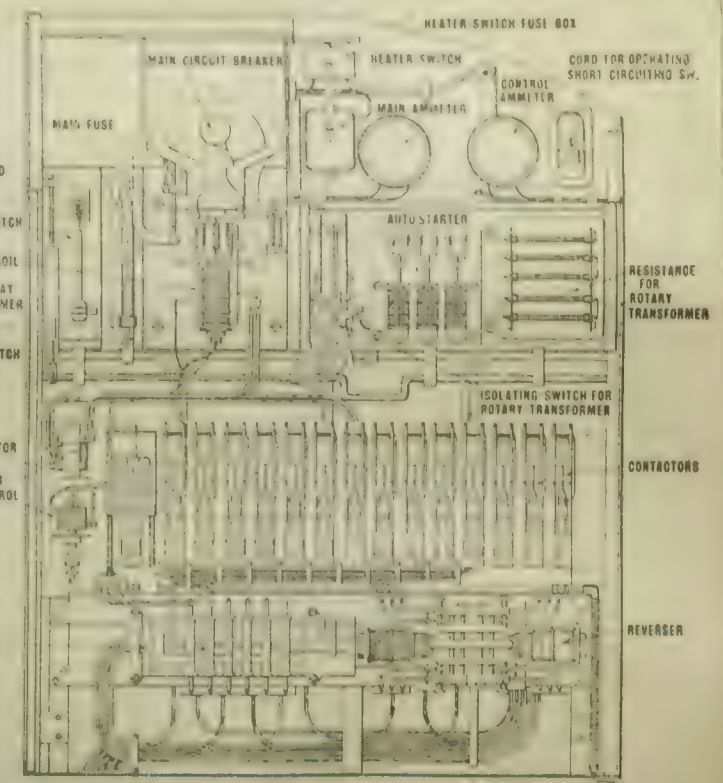
MOTORMAN'S COMPARTMENT BODY SIDE ELEVATION.



MOTORMAN'S COMPARTMENT. PARTITION SIDE ELEVATION



MOTORMAN'S & HIGH TENSION COMPARTMENTS FRONT ELEVATION.



HIGH TENSION COMPARTMENT. PARTITION SIDE ELEVATION

FIG. 38.—INTERIOR VIEWS OF MOTORMAN'S AND HIGH-TENSION COMPARTMENTS.

All the cables, with the exception of the trolley cable are carried in sheet steel troughs; the trough for the trolley cable is made of "Jarrah."

Each equipment consists of 14 contactors which are of the "Hammer" type with a rolling action, and are fitted with special soapstone dished arc-horns for receiving the arcs.

The control equipment has been supplied by Dick, Kerr & Co.

Brake.—The brake is the standard automatic vacuum brake, so

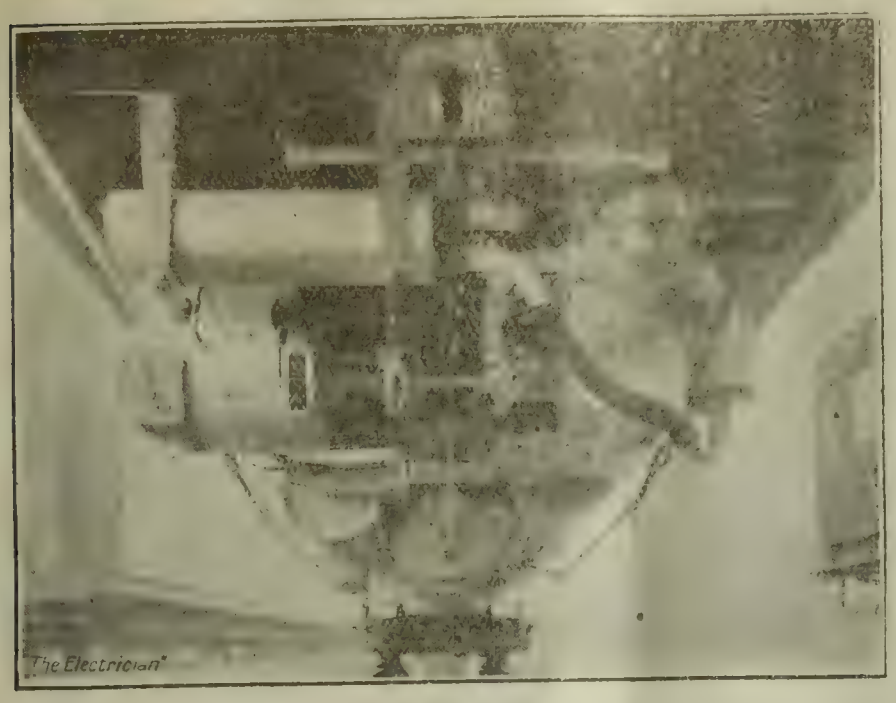


FIG. 39.—PHOTOGRAPH OF THE UNDERSIDE OF MOTOR-CAR.

that if necessary ordinary steam trailers cars can be coupled to them, the brake still being effective. The vacuum is produced by means of a twin cylinder exhauster, driven through gearing by a Mather & Platt 5 H.P. 100-volt motor. This arrangement is shown in Fig. 39, which also shows the brake cylinders and the resistances. In arranging the apparatus underneath the car every consideration has been given to accessibility for purposes of maintenance and inspection.

The heating is operated off the 1,200-volt circuit, and the lighting, pump motor and control off the 100-volt circuit.

The trolley cables, of which there are two, one on each side of the car, are continuous throughout the trains, connections being made through couplers. This figure also shows the multiple couplers for the control and the coupler for the bell and brake exhauster control.

ROLLING STOCK.

The electric trains for this service have been built at the company's carriage and wagon works at Newton Heath, and consist of either two, three, four or five bogie cars, according to the requirements of traffic, but the standard train will have five cars, the front, centre and rear vehicles being third-class motor-cars, and the intermediate vehicles first and third-class trailer cars. A feature of the design is that the driving compartment for the accommodation of the driver is at each end of all cars, which enables the trains to be made up to any accommmodation required with the minimum of shunting operations, time being of the utmost importance on an electric service.



FIG. 41.—INTERIOR PHOTOGRAPH OF FIRST-CLASS TRAILER CAR.

Fig. 40 shows a five-car train; Fig. 42 the underframe, and Fig. 43 the general arrangement of a motor-car, Fig. 44 is an outside view.

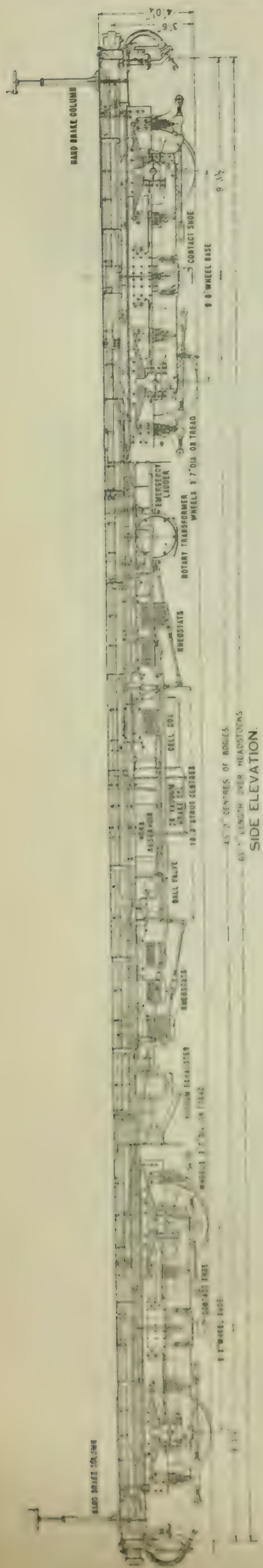
The most interesting feature, from a public point of view, is that timber has been entirely superseded by metal in the construction of these cars, the vehicles being therefore entirely fireproof. The framework is of steel, the panelling of the sides and roof is made up of aluminium sheets, the interior work being finished with mouldings of drawn steel and aluminium sections. The net rod brackets, air

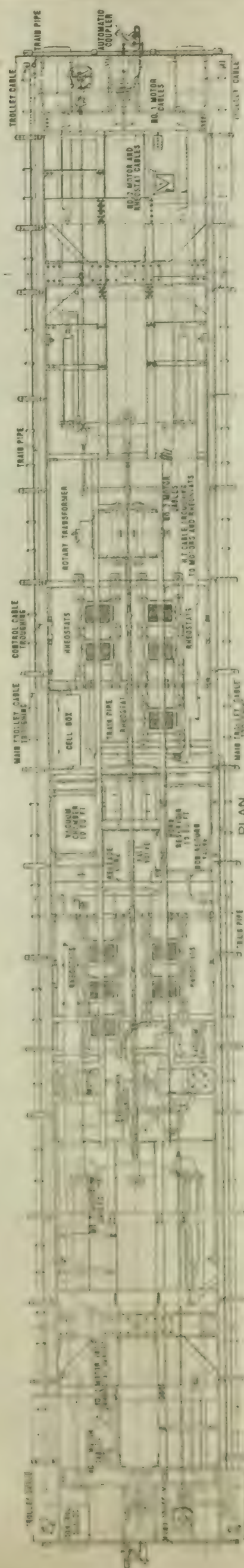


FIG. 40.—PHOTOGRAPH OF FIVE-CAR TRAIN.

extractors and electrical fittings, together with all inside furniture of the cars being in polished aluminium. The doors are of steel.

The all-metal car has largely been introduced in America, and to some extent in this country, but hitherto the term has been somewhat of a misnomer, as timber has been largely used for windows, seats, packings and other fittings; it is, therefore, a point of some importance that the new cars which will run on the Manchester and Bury electric line will no doubt be the first passenger cars in either country, and





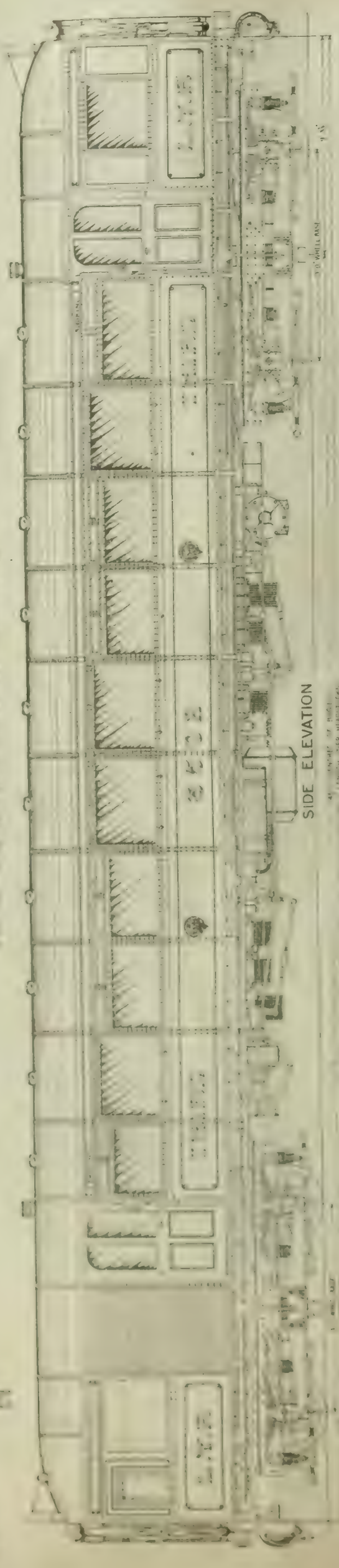


FIG. 42.—DRAWING OF MOTOR-COACH UNDERFRAME.

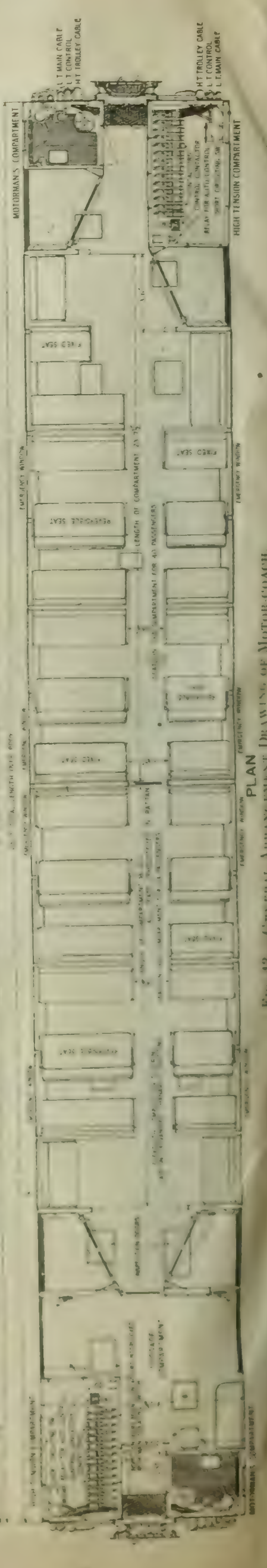


FIG. 43.—GENERAL ARRANGEMENT DRAWING OF MOTOR-COACH.

probably in the world, in which metal has superseded wood entirely in the construction of railway vehicles.

The following are particulars of the motor and trailer cars :—

Total length of five-car train	overall	326 ft. 3 in.
Seating accommodation of five-car train (72 first-class and 317 third-class)	total	389 passengers
Length over body		63 ft. 7 in.
Length over couplers		65 ft. 3 in.
Height from rail to top of roof		12 ft. 4½ in.
Centre to centre of bogies		45 ft.
Wheel base of motor-car bogies		9 ft.
Wheel base of trailer-car bogies		10 ft.
Total weight of five-car train		220 tons
Weight of motor-car		54 tons
Weight of trailer car		29 tons.

The vehicles have been designed with a slight taper on the sides of the bodies, and with elliptical roofs, the cars having large side lights and fan lights. The flooring has been built up of "Keystone" or "Chanarch" galvanised sheets, which are riveted to the steel underframe, and on these sheets is laid "Flexolith" or "Decolite" composition.

The cars are entered at the extreme ends of each vehicle, through vestibules, and gangways are provided throughout the trains, so that passengers can pass from one car to another to secure a seat. A feature of note is that the usual step-board used on most British trains is dispensed with, and passengers will be able to enter the vehicles direct from the station platform without making the usual intermediate step, which will be a decided advantage in quickening the ingress and egress of passengers at the stations.

Each car is divided into two main passenger compartments with a central aisle, fixed and reversible seats being arranged alternately on either side ; the first-class seats being upholstered in tapestry, as seen in Fig. 41, and the third-class in rattan ; the former cars have the floors carpeted.

Other interior fittings of importance are the arrangement of electric lighting and heating, the former of which gives an excellent distribution of light, and the latter, arranged in ducts along each side of the car at the floor level, ensures comfort in the coldest weather. Electric fans are also fitted, and by means of a two-way switch they can supply fresh air from the outside, or extract foul air from the inside of the car. Sanitary strap-hangers for rush periods are provided in the third-class cars, which are secured to the roof by aluminium brackets.



FIG. 44.—PHOTOGRAPH OF MOTOR-COACH.

THE MANUFACTURE OF DRAWN TUNGSTEN WIRE.*

Just and Hanamann, of Vienna, made the first successful tungsten lamps by a substitution process ; a carbon filament was heated in the vapour of an oxy-halogen compound of tungsten in the presence of hydrogen ; thus the tungsten was substituted for the carbon. Another process was a squirting one ; tungsten in the form of a fine powder was mixed with a binding substance, such as gum arabic, sugar, or the like, and then pressed through dies as in the making of artificial silk. But these processes only gave a filament with poor mechanical properties, and it may be of interest to notice some of the more important patents in connection with the methods of drawing tungsten wires, which have since become of great importance.

According to the Siemens & Halske German patent No. 194,682, tungsten is put in a tube of ductile metal, such as copper, iron or nickel ; it is then heated to a bright red heat, and rolled or drawn. In this way it can be made into a ribbon or sheet or wire of the thinnest description. The foreign metal can be removed chemically or by electrical volatilisation. But further experiments showed that the containing tube was really unnecessary. German patent No. 233,885 stated that the auxiliary metal could be added in the form of a powder, and the best thing was found to be a colloidal plastic mass of combinations of tungsten compounds. Such a mixture was formed into a rod and then heated till it sintered. A rod of this kind, 20 cm. or 30 cm. long and 1 mm. or 2 mm. in diameter, was heated gradually by an electric process in a tube, and exposed to the reducing action of a current of hydrogen. At 1,400°C., the rod has a fairly uniform structure, consisting, say, of nickel and tungsten. It is then heated above this temperature, and it is found that an alloy, containing 90 per cent. tungsten and 10 per cent. nickel, has good ductile properties. A material which contains from 7 to 20 per cent. of nickel and from 93 to 80 per cent. tungsten can be drawn out into the finest wires. The nickel is then volatilised in a vacuum at a suitable temperature.

The A.E.G. patent No. 269,498 is entirely concerned with the transformation of a crystalline into a fibrous structure. Tungsten powder is used, which is obtained by the reduction of the trioxide by hydrogen or carbon. By the application of great pressure, the powder is squirted into rods, which have just enough cohesion to hold together. The moulds into which they are pressed are polished on the inside, and smeared with a mixture of turpentine and boiled linseed oil, in order to facilitate the removal of the rods. The rods, which are 20 cm. long and 10 mm. square, are heated in iron tubes in a gas oven. This heating continues for two hours at 1,200°C., and hydrogen is passed through to prevent oxidation. The lubricating oil distils off, the residual carbon is removed by the hydrogen, the rods contract and become much stronger. They are then put in a flask, filled with hydrogen, and an alternating current of 1,400 amperes is passed through them for 10 minutes. This produces sintering at a white heat ; the rods become hard and are brittle at ordinary temperatures. The object of the invention is the rolling, drawing, or hammering of the wires, which treatment alters the molecular structure and makes the metal ductile at ordinary tem-

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 37, 1915.

peratures. The work begins with rolling and hammering; the wire is drawn while still hot. The hammering is similar to the process used in making needles. Four thousand blows are given by the hammers in a minute; the rod, which was 10 mm. square in section, is thus reduced to one of 1·5 mm., and the tungsten is rendered ductile. It then shows a conchoidal fracture and a fibrous structure.

It is now necessary to consider the actual drawing process, whereas up to the present we have only described what may be called the preliminary processes needed to obtain a ductile material. The tip of the wire must first be pointed, in order to introduce it into the die; this is done by the mechanical method of filing or grinding, but it is not at all easy, as a conical tip must be obtained. We therefore proceed to some chemical and electrolytic methods of obtaining a pointed tip. By the Pintsch process, German patent No. 251,836, the tip is heated in a Bunsen flame till oxidation sets in; when the oxide is rubbed off, the diameter is found to be reduced. If the flame is gradually passed over the tip outwards, a larger film of oxide is formed at the tip than at the other parts, and a conical tip is obtained. This heating can be done electrically in the middle of the wire, so that one obtains two pointed tips if the wire is broken at the point of maximum oxidation. The Westinghouse Co., Patent No. 275,656, uses the tip as kathode in an electrolytic bath; a high current-density is used, producing great heating, and the submerged tip takes the conical form. The process seems to depend on a kathodic volatilisation. In this way a tungsten wire with a diameter of 0·03 mm. gets a sharp tip in two to five seconds in a bath of dilute sulphuric acid, if the current density is about 25 to 30 amperes per square millimetre.

The tungsten wires are very hard and wear away the holes in the dies, thus altering the diameter of the drawn wire. Seeing that dies with very small holes are correspondingly expensive, it is very necessary to take precautions to prevent this wear, and various lubricants are, therefore, used. Ordinary fats are no use at the high pressures that obtain. The A.E.G., according to Patent No. 262,078, uses finely divided graphite, suspended in water or oil; such lubricants are known in the trade under the names of "Aqua-dag" or "Oil-dag." An addition of 10 per cent. of ammonium sulphide to the aqueous suspension is recommended. The lubricant ought to have the consistency of a thin ointment, through which the wire is drawn; it is a good plan to draw the wire through a lump of cotton wool, containing an excess of the lubricant. Before passing through the lubricant, the wire passes through a gas flame and is heated to a red heat, this in its turn heats the lubricant and burns it into the wire, covering it with a bright black durable coating in such a way that it can be passed through several successive dies without any further addition of lubricant. This plan adds foreign substances to the surface of the wire, and thus has disadvantages. The A.E.G., therefore, in Patent No. 262,928, uses tungsten compounds in suspension, which decompose at a red heat, and leave metallic tungsten on the wire. The sulphide of tungsten (WS_2) is recommended as being obtainable in the form of a smooth powder, or of crystals resembling graphite. The Phillips Co., of Eindhoven, adopt a very different plan; they cool an ordinary lubricant by means of liquid air or ether, and pass the wire through it. The viscosity of the cooled lubricant is said to be such that it adheres to the wire during its passage through the dies.

After the rod has passed through the hammering or rolling machinery, and has been reduced from a diameter of 10 mm. to one of 0·9 mm., it is then drawn through the dies. According to the A.E.G. Patent No. 269,498, the thicker wires can be drawn through one of the high speed steels, which can stand a red heat without injury; still diamond dies are much to be preferred. The mouths of the dies on the side on which the wire enters must be well rounded. The drawing process is much simplified if the wire is drawn hot; therefore the dies are heated by gas or electric means, and the wire is also heated. The drawing temperature ought to be from 600° C. to 650° C. for diameters between 0·65 mm. and 0·45 mm., 500° C. for diameters down to 0·25 mm., and below this 400° C. The dies must be very finely graded. In reducing from a diameter of 0·65 mm. to one of 0·35 mm., the successive dies decrease by 0·0125 mm. Between 0·35 mm. and 0·1 mm., they decrease by 0·006 mm., between 0·1 mm. and 0·075 mm. by 0·003 mm., from 0·075 mm. to 0·375 mm. by 0·0025 mm., from 0·0375 mm. to 0·025 mm., and less by 0·00125 mm. A drawn tungsten wire, 0·18 mm. in diameter, can be twisted round the finger at ordinary temperatures without breaking; as the drawing process continues, it becomes more and more ductile, till with a diameter of 0·1 mm. it can be drawn through the dies at ordinary temperatures. Tungsten wire, obtained in this way, breaks down under a tension of 420 kg. to 460 kg. per square millimetre, it is elastic, non magnetic, and not easily affected chemically.

With fine wires of diameters less than 0·02 mm., the mechanical difficulties of the drawing process are great; it is also difficult to get the dies made of very exact sizes. Burgstaller and Schwarzkopf, in Patent No. 278,415, propose electrochemical methods for further reduction of size, and for cleaning the wire from adhering lubricant. They propose the use of several baths, in which the wire is successively oxidised and reduced. Thus the wire, running on insulators, passes through a bath of dilute alkali, and then through another containing dilute sulphuric acid. In the first, there is an iron electrode, and in the second one of platinum. If the iron and platinum electrodes are used as terminals, the wire acts as a connection between the two baths; the wire is, therefore, a kathode in the one bath and an anode in the other. In both baths the water is decomposed into oxygen and hydrogen. In the alkali bath the wire is oxidised, and in the acid bath a reducing process takes place. This results when the iron electrode in the first bath is used as the kathode, and the platinum electrode in the second bath is the anode. The oxidation and deoxidation is continued till the desired result is obtained.

A few words may be said about the peculiar behaviour of drawn tungsten lamps on alternating current. Under the influence of this kind of current, tungsten wires undergo a very undesirable change in their molecular structure, just as tantalum filaments do. There are displacements of the various molecules, which take place sideways with regard to the axis of the wire, so that the different portions of the wire seem to be cut off into lengths, which adhere only at their tips. This change of structure may be caused by the vibrations due to the passage of the alternate current, and cause an early breakage of the filament. The Auer Co., in the Patents Nos. 261,130 and 271,730, note this peculiarity and make the following suggestions. They say that if the wire has a phosphorus content of 0·02 per cent., this characteristic change of structure does not take place, the ductility of the wire being the same as usual, so long as this percentage is not overstepped. A second proposal is to add lime or some calcium combination to the filament. Thus, to a mixture containing 8 per cent. nickel oxide, and 92 per cent. tungsten, a small amount of some solution of a calcium salt is added. When dry the mixture is reduced with hydrogen, and rods are then made and sintered together. When the auxiliary metal, *i.e.*, nickel, has been volatilised, there remains a certain amount of calcium in the tungsten filament. This is said to give a wire which is insensitive to the action of alternating current.

THE PRINCIPLES OF MODERN PRINTING TELEGRAPHY *

BY H. H. HARRISON.

(*Continued from page* 603.)

Summary.—This Paper is divided into five sections. The first deals with the fundamental principles and leads up to automatic stop and start. After that follows translation of signals, page printing and the principles of letter counting mechanism. The third section deals with low-speed printing telegraphs and chain relay systems. The fourth discusses synchronism, control of phase, leading to synchronism between printer and distributor units. The last part deals with automatic multiple-circuit arrangements, échelon working, repeaters, distribution of signals and quadruple duplex.

The next part of the subject requiring attention relates to the principles involved in the design of the mechanism required to translate the current permutations into printed characters at the receiving end of the line. The signals in the line, being time signals, are transient in their effect on the receiving electromagnets, and, as the latter are set successively, it is necessary to arrange that the act of translation be suspended until the whole setting cycle is passed through. This condition will be met if the setting magnets are arranged to trip some trigger device, electrical or mechanical. In general, there are three cycles to be considered: (1) the setting cycle; (2) the printing cycle; and (3) the resetting cycle; and they occur in the order given. The author proceeds to discuss the mechanism used, beginning with the early Baudot transmitter, flying print of Hughes, paper feeds and page up devices, and letter counting mechanism.

A number of printing telegraphs operated manually with distributors worked step by step from the signals have been proposed from time to time by McCaskey, Kirk Himrod and others, but the single-channel low-speed printer using the Baudot alphabet has not been applied until comparatively recent times. C. L. Buckingham was early in the field with the system depicted in the Paper. The distributor is driven step by step by the electromagnetic escapement controlled by the line signals. The stepping impulses, which are alternately positive and negative, would invariably actuate the

* Abstract of Paper read before the Institution of Electrical Engineers on January 13, 1916.

setting magnets, if it were not for a special arrangement designed to prevent this. The line relay alternately closes the circuit of battery through the escapement magnets. In series with the relay is a slow-acting relay, which is unaffected by the stepping impulses, but will act if any of these are prolonged. When energised, this relay closes the circuit of battery through the distributor to the setting magnets. Selection is thus accomplished accordingly as the first five impulses of a letter signal are prolonged or not. The sixth impulse effects printing.

The transmitter consists of a metal drum continuously rotated by a motor not shown. Two earthed transmitter batteries are connected to fingers, and these make contact with the drum through holes in a perforated tape. The impulses are long or short accordingly as the holes in the tape each side of the feed holes are opposite to each other or displaced. All letters have the same number of impulses, but different time values, depending upon the number of magnets to be set. The Buckingham system underwent several departures from the simple system shown in the Paper, and has long since disappeared from practical work, but it is noteworthy as showing that a step-by-step distributor can be worked at speeds ranging from 80 to 100 words per minute.

The author describes the step-by-step printing telegraphs of distributors being produced in a local circuit. What has been said for the starting impulse applies to the remaining five signal impulses, and no zero currents occur in the line, while if any pauses occur in transmission, protective negative line current flows all the time.

At the receiving end the polarised line relay controls two non-polarised relays NPR_1 and NPR_2. During the time that no transmission is taking place and negative line current is flowing, NPR_1 is operated, but it does not start distributors C and D as the circuit of the escapement magnet is broken at the point X. When the positive starting impulse arrives, NPR_2 is operated and its second armature A_2 closes the circuit of battery LB_3 to distributor C, conductor 22, and the escapement magnet to earth. Distributors C and D move through 2/24ths of the circle in two steps, as explained in connection with A and B. After the starting impulse, the setting cycle commences, and the escapement is worked locally by either of the two local relays and battery LB_1 through distributor D.

Provided the ratchet mechanisms have about the same period, the one will drive the other perfectly and any change in current from positive to negative in the line will act to control them. Should they get out of step, a pause of less than a second will automatically restore unison, since for any but the normal position a negative current to line will operate the escapement.

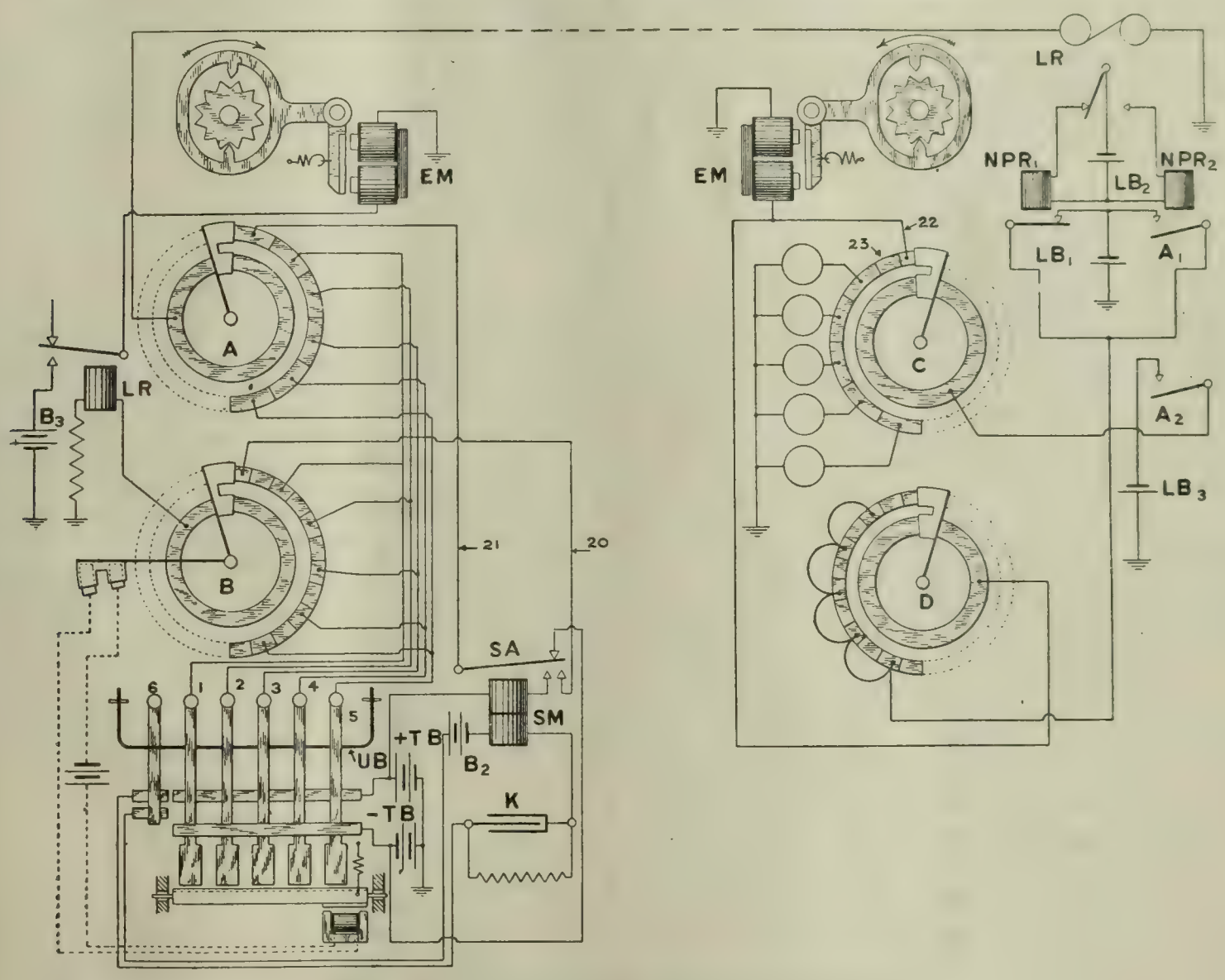


FIG. 4.—STEP-BY-STEP PRINTING TELEGRAPH (HARRISON).

McCaskey & Pierart and continues: The arrangement of the Harrison printing telegraph, Fig. 4, due to the author, removes the necessity for the zero unit in step-by-step printing systems using the five-unit code. The transmitter is arranged on the same lines as those previously described, and a starting impulse and trigger circuit is provided. Negative current normally passes from the battery TB through the armature SA of the starting magnet SM. This current will not operate the distant distributor, which remains at rest until the line current is reversed. When a signal permutation is set up at the transmitter SA is attracted and locked by current from the positive transmitter battery passing through one winding of SM where it divides, part going through conductor 21 and distributor A to line, the remainder going through distributor B to the leak-relay LR. This relay closes the circuit from battery B_3 through the escapement magnet, and both the distributors A and B move through 1/24th of the circular path. The circuit of LR is now broken at distributor B and this releases, breaking the circuit of the escapement magnet EM, when both distributors move through another 1/24th of a revolution. It is to be noted that current has been on the line the whole time, the disconnection necessary for stepping round the

This printer can be operated by a standard five-unit perforated tape, and can be arranged to furnish a similar tape if required.

Before leaving this part of the subject one other device requires mentioning. In single-channel printers since the setting cycle must precede the printing cycle, a pause is necessary between letters while the printing is effected. This leads to waste of line time and the keyboard has to be locked. The loss of line time is not serious, but the bound keyboard is a grave disadvantage. To reduce the lost line time to a minimum and to approximate to a free keyboard, the printing is effected as rapidly as possible, which involves heavy wear and tear. By employing two groups of setting magnets, one group being set while the other is effecting printing, the printing and setting cycles completely overlap and no waste of line time occurs, while ample time can be allowed for printing and the keyboard is free. Signal storage between the keyboard and the transmitter is also of advantage. Kirk Himrod was the first inventor to apply this principle to single-channel sets. A description is then given of the arrangement due to Kirk Himrod. All modern high-capacity printing-telegraph systems depend for their operation on the satisfactory maintenance of identical speed and phase between two rotat-

ing mechanisms at each end of the line, and there are two broad aspects into which the subject may be divided, viz.: (1) Means for obtaining uniform angular velocity of the rotary device. (2) Automatic methods of securing and maintaining a definite phase relationship between the rotating means at each end of the line.

The synchronism may also be considered as (*a*) main, and (*b*) local. Under the first sub-heading falls the synchronism between two distributors with an intervening line wire; while the second refers to the synchronism between a distributor and its local printing units, all on the same table or adjacent to one another.

It is a comparatively easy matter to secure synchronism between two rotating bodies fixed on the same instrument table, but when these are controlled through a line wire which will be subject to interruptions and the constants of which may vary from hour to hour, disturbances are bound to arise. On the other hand, the work of driving distributor brushes is constant, except for non-periodic effects such as failure of lubrication or dust in bearings. With a printer unit, however, the necessity for printing, paper feeding, and change of case, will throw extra work on the printer motor and render this liable to get out of step with its controlling distributor.

To secure the necessary identity of angular velocity, the first thing to be done is to adopt a motor either having a periodic characteristic or provided with some form of governor, rendering it isochronous. This by itself is not sufficient. Taking a brush speed of 4 revs. per min., the contact arm of a distributor revolves 14,000 times as fast as the minute hand of a clock, so that an extremely small difference in

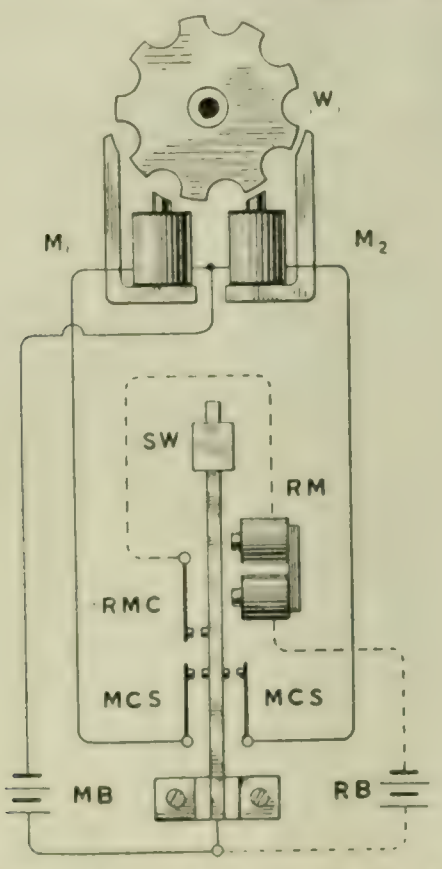


Fig. 5.—Phonic-wheel Motor Controlled by Vibrating Reed.

the going rate of two distributors would accumulate very rapidly if means were not provided for intermittently correcting the shift of phase before this becomes serious.

Should the two towns between which communication is desired have alternating-current supplies of standard frequency, then, by using two-pole synchronous motors and gearing down, identical speeds and phase could be maintained. This points to distribution of standard-frequency alternating current over a network of special wires to centres at which distributors are to be equipped, a suggestion which has actually been made by Crehore; but the capital cost of such a scheme would render it prohibitive, while the periods of zero current would be dangerous. It would be better to use two earthed batteries oppositely connected to line through a two-part commutator. In any case, other and more convenient measures are available.

Until comparatively recently, independent weight motors were employed for both distributor and printer unit-drives, but such motors are fast disappearing and need not be considered. Shunt-wound electrical motors worked off the power mains are now generally used. Provided with a flywheel of suitable energy-storing capacity such an arrangement forms a very steady drive, though not in itself sufficiently precise for time dividing of the required accuracy.

A flywheel cannot alone give any periodic characteristic to a revolving system to which it may be attached. It acts only to keep variation of angular velocity within certain limits. When the accelerating tendency is removed and the angular velocity approaches the normal, the surplus energy stored in the flywheel is given up, retarding the return to normal speed. Thus instead of a quick variation from normal speed and an equally quick return, there is a smaller variation spread over a longer time. This swinging out of phase and back is slow and can be kept down to a very small amount just as much as the flywheel capacity of the system is increased. If, however, we have a flywheel with a large moment of inertia, it takes a long time to bring the whole system up to speed; rather a serious matter in the event of a temporary stoppage, as the whole printing system is in a state of enforced rest, and delay to traffic accumulates.

Phase oscillation may be checked considerably by viscous damping devices. The author then discusses various damping devices and methods of motor speed control.

The most satisfactory method of obtaining a motor with a time characteristic is to use the so-called "Phonic Wheel" of Rayleigh and La Cour. This motor, which is really a reversed inductor alternator used as a synchronous motor, consists (Fig. 5) of a toothed iron wheel W, and rotation is secured by the alternate action of two

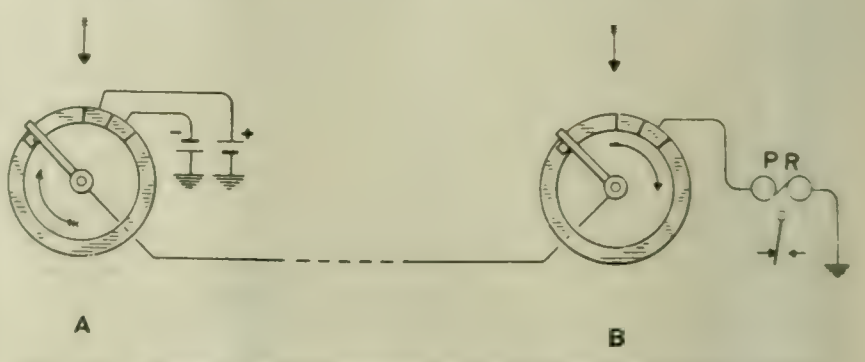


Fig. 6.—Method of Transmitting and Receiving Correcting Impulses.

magnets M_1 and M_2 energised by the battery MB through two contacts MCS on a vibrating reed. The reed is tuned to a definite frequency by means of a sliding weight SW, and is kept in vibration by a separate battery RB, the circuit of which is closed through a driving magnet RM and the contact RMC. It is important that this circuit should be distinct from the motor-magnet circuit of the wheel, otherwise reactions are set up interfering with the free vibration of the reed, and the speed is consequently very variable.

After discussing the Baudot isochronous governor the author continues: The next part of this section of the subject relates to methods by which the rotating mechanisms are kept in step with one another, a line wire intervening. As explained before, it is not possible to get two motors to run absolutely in step indefinitely, and therefore one motor is the "standard clock" of the system, the other being the secondary or controlled clock. The latter is arranged to run either faster or slower than the standard clock so that it gains or loses $\frac{3}{4}$ deg. to $1\frac{1}{4}$ deg. per revolution, the exact figure depending upon circumstances. Referring to Fig. 6, A is the master or correcting

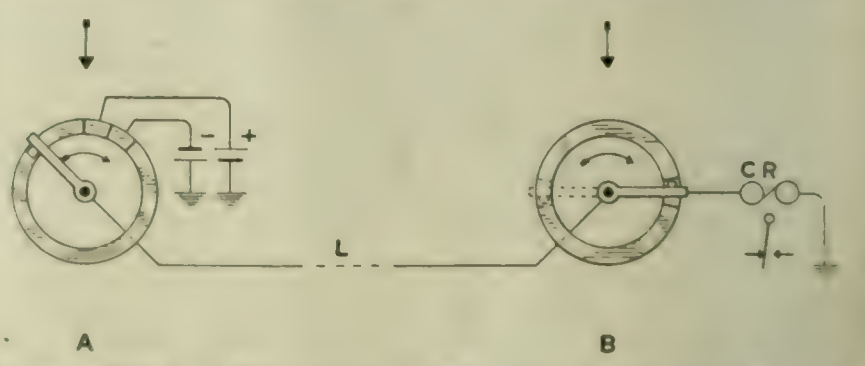


Fig. 7.—Effect of Orientation of Receiving Correcting Segment.

distributor, and B the controlled or corrected distributor. Each distributor possesses a pair of correcting contacts, a transmitting pair at A connected to two earthed batteries, and the receiving pair at B, of which one is left disconnected and one earthed through a polarised relay PR.

If both distributor contact-brush arms arrive at 12 o'clock simultaneously, the positive transmitting battery at A will find no circuit at B, since the 12 o'clock segment there is disconnected. During their passage over the second segments of each pair, a negative current passes from the battery over the line and through PR, which remains in the position shown, viz., with its armature on the left-hand contact. After one or two revolutions the distributor at B will have gained on A to such an extent that it will pass over its active receiving segment while A is passing over its 12 o'clock segment connected to the positive battery. The polarised relay PR will now move its armature on to its right-hand contact, and correction will be effected

in some suitable manner so that the two brush arms start the next revolution in phase.

In Fig. 7 the effect of shifting the active correcting segment at station B is shown. If this contact is moved to 3 o'clock, the brush arm will ultimately "come in" at this point, and the two arms will be 90 deg. out of phase, B leading. If the contact is shifted counter-clockwise to 9 o'clock, B will come in 90 deg. out of phase, lagging. Both of these positions would result in the wrong letter being printed, and it is evident that the position of the receiving correcting segment is critical.

He next deals with methods of "finding the letter," Murray's one-segment correction, "step back" correcting mechanism, and arrangement between printing and distributor units.

The author discusses interference between incoming and outgoing signals, double échelon and multiplex repeater working and then proceeds as follows: It is evident that for very long lines re-transmission by relays with a minimum number of repeating points would seriously reduce the speed; the French Administration have therefore introduced an apparatus for repeating purposes which they call a re-transmitter, whereby the signals are repeated onward in as perfect a form as that in which they left the originating transmitter. Fig. 8 represents in principle this device. Sectors 1 and 3 of the distributor at the repeating station are used, 1 for incoming signals from the transmitting, and 3 for outgoing signals to the distant receiving station, respectively. During the passage of the contact-brush arm over segments 1 to 5 of sector 1, five setting magnets SM

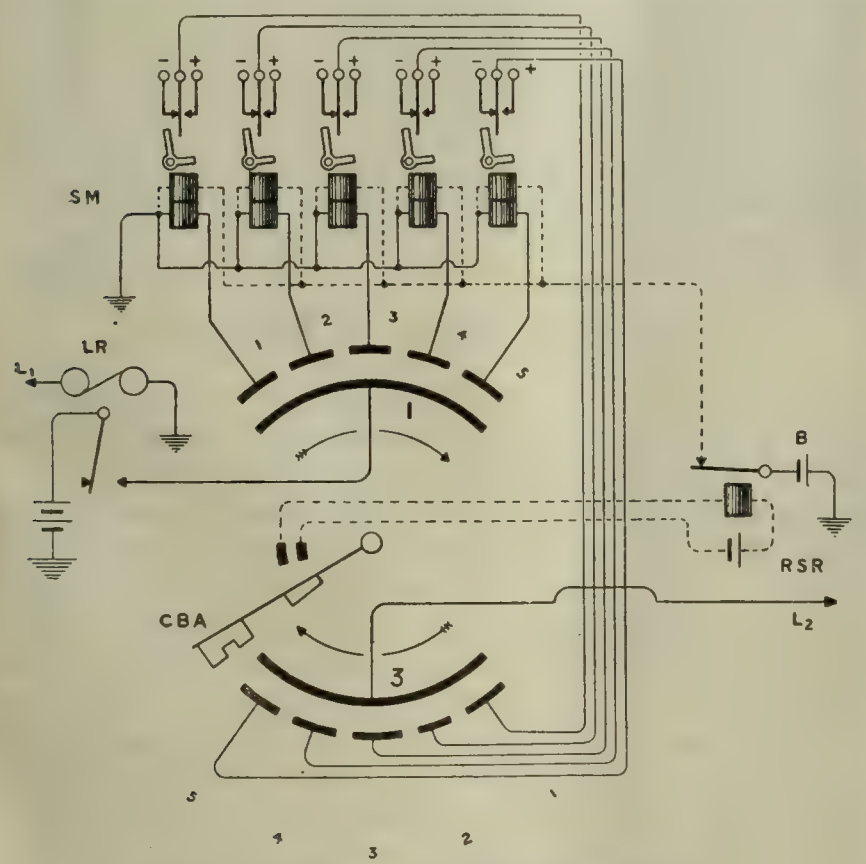


FIG. 8.—PRINCIPLE OF THE RE-TRANSMITTER.

are operated in accordance with the letter signal received. These magnets have two windings and are arranged for marginal operation, so that the signal is stored although the setting currents are transient. Each setting magnet controls five contact springs which represent the transmitter at the originating station. The re-transmitter is, in fact, a remotely controlled transmitter, and it may be remarked that it can be replaced by a receiving perforator controlled by sector 1, the tape being placed in an automatic transmitter for retransmission over the second section of the line. In this case, if required, the further section of the line may be connected to a second distributor more or less independent, both as to speed and phase, of the distributor through which the signals are received.

When the contact-brush arm passes over sector 3 the stored signal is sent out and it is evident that this will be perfect and identical with the signals at the originating station. After re-transmission, the re-set relay RSR is energised through contacts on the distributor, and battery B is momentarily disconnected, the magnets SM thereby releasing their armatures which go to normal ready for the next signal. The phase difference allowable between the setting and re-transmitting cycles greatly increases the flexibility of the multiple printing telegraph, as the examples following clearly show.

Using re-transmitters, it is possible to repeat in both directions from circuit-worked quadruple to a 2-way or double. In connecting a channel on the double to a channel on the quadruple, it is only necessary to observe that transmission from the one to the other does not take place in the similar semi-diameters of the two distributors. That is to say if the setting process occurs between 0 deg. and 180 deg., the transmitting cycle must take place between 180 deg., 360 deg. Both the double and the quadruple revolve at the same speed. The storage feature of the re-transmitter makes this possible.

The succeeding illustration, Fig. 9, shows transmission on two channels from a quad to a triple.

This arrangement has been applied to the circuit from Paris to Algiers, Marseilles being the repeating station. Two cables across the Mediterranean are involved, one for the up and the other for the

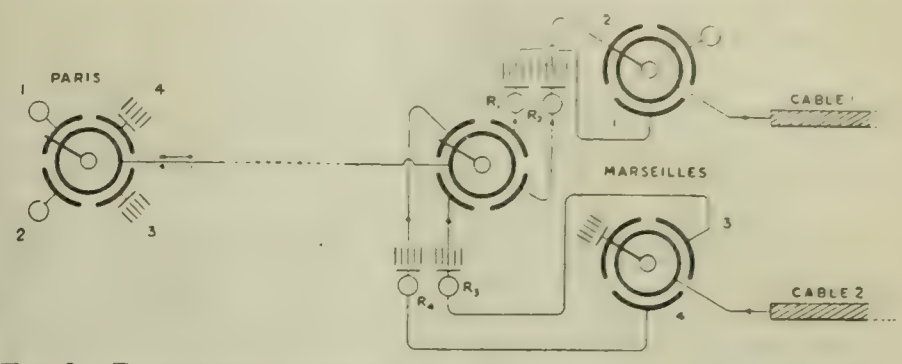


FIG. 9.—REPETITION BETWEEN QUADRUPLE AND TRIPLE DISTRIBUTORS BY MEANS OF RE-TRANSMITTERS.

down traffic. This is necessary as the difference of phase due to line lag is about 90 deg., and 2-way working on a single cable would waste line time as only a single channel each way would be possible.

(*To be concluded.*)

COAL-CUTTING MACHINERY IN 1914.*

Compared with 1913, there is a considerable diminution in the quantity of coal cut by means of these machines, the total being 24,274,517 tons, showing a decrease of 335,441 tons.

In the following table is given the number of machines and kind of motive power used in the divisions inspected during 1914 :—

Division.	No. of collieries where machines are at work	No. of machines.	Worked by		Mineral obtained (tons).	No. of conveyors at coal face.
			Electricity.	Compressed air.		
Scotland	230	913	747	166	9,195,645	128
Northern	92	702	156	546	3,574,312	68
York & N. Mid. .	117	725	350	375	7,133,139	116
Lanc., N. Wales and Ireland ...	95	399	34	365	2,089,572	27
South Wales.....	58	131	44	87	634,821	63
Mid. & Southern	60	223	84	139	1,647,028	6
Total in 1914 ...	652	3,093	1,415	1,678	24,274,517	408
Total in preceding year.....	676	2,897	1,307	1,590	24,609,958	377

In the table below will be found the location and type of machines installed :—

Kind of machine.	Number in use.						
	Scotland.	Nrthn.	York and N. Mid.	Lanc., N. Wales & Ireland.	South Wales.	Mid. and Sthrn.	Total.
Driven by electy.							
Disc	515	58	157	7	3	35	775
Bar	216	33	87	19	38	20	413
Chain.....	12	63	104	8	3	29	219
Percussive	2	2	...	...	...	...	4
Rotary heading .	2	...	2	...	...	...	4
Total	747	156	350	34	44	84	1,415
Driven by compressed air—							
Disc	119	61	175	117	1	14	487
Bar	7	15	60	34	50	6	172
Chain.....	...	8	35	5	7	20	75
Percussive	40	451	99	209	29	94	922
Rotary heading .	...	11	6	...	...	5	22
Total	166	546	375	365	87	139	1,678
Total in 1914 .	913	702	725	399	131	223	3,093
Total in preceding year	876	665	673	393	115	175	2,897

* From Part II. of the "Annual Report on Mines and Quarries for 1914."

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A MYTH AND A MORAL.

Encouraged by the non-technical press, electricity users have come to the conclusion that the principles underlying the sale of electrical energy are so many and varied, and of so complex a character as to make it impossible for them to understand the facts on which the charges are based. Nothing is more harmful to the development of electrical enterprise than the encouragement of the absurd belief that there is any fundamental difference between the principles underlying the sale of electrical energy and of, say, pots and pans, dry goods and drapery. In the past there has been far too much talk about the mystery of electricity, and in many cases, even at the present time, it is this so-called mystery which sorely puzzles the user when the question of tariffs is discussed. The many systems of charging for current used for lighting purposes are, of themselves, sufficient to scare prospective customers. Not only are different systems in use in different towns, but, to make matters worse, in some cases the user has the option of several alternative systems in a given town, and this forms one of the most important assets of the gas industry.

In an address to the Junior Engineering Society nearly a quarter of a century ago the late Dr. JOHN HOPKINSON laid down the principle that "the charge for a service rendered should bear some relation to the cost of rendering it." In electricity supply the cost of rendering a service is made up of two parts, of which one, in a given generating station, is independent of the output, and the other is directly proportional to the output. The several items entering into each of these charges are well-known. This is the principle underlying Mr. ARTHUR WRIGHT'S maximum demand system of charging for electricity supply—a system which in theory and practice is equitable both to the supply authority and to the user. Of the "Wright" system it may be said that as a rational method it is unique. In practice, however, it is found that the system is regarded unfavourably by those who realise that the base price depends

on circumstances over which they have little control. Moreover, with the maximum demand system the ordinary consumer has difficulty in determining the base price, and the indicator does not discriminate between peak and off-peak demands.

We agree that the charge for a service rendered should bear some relation to the cost of rendering such service, but we are strongly of the opinion that this applies with greater force to a well-established enterprise than to a newly-founded one. To ensure the ultimate success of the latter it is necessary to encourage custom in the first place by making sacrifices, particularly if the business of the keenest competitor happens to be sufficiently old established, well conducted and organised to be in a position to make sacrifices with little more than temporary inconvenience. As an illustration of this may be mentioned the campaign conducted by the late National Telephone Co. on the inauguration of the municipal telephone services. It will be remembered that the campaign was conducted relentlessly, and had the charge for the service been made by the new-comers to bear proper relation to the cost of rendering it, they would not have been able to put up as game a fight as they did.

In private power supply companies and in municipally-owned power stations, controlled by far-seeing business men strong enough to carry the votes in Council chambers, it is a relatively easy matter to provide for contingencies and to make momentary sacrifices. But when the profits resulting from immature enterprises are unwisely distributed, or are dealt with by financial profligates, the inevitable result is that those responsible for the conduct of such enterprises find it impossible to tide over a period of acute depression. On account of unwise distribution of profits and of profligacy during successful years the finances of the electric supply stations in some of our non-industrial towns are to-day crippled. We admire those who have had the pluck to encourage the power consumer by offering attractive tariffs, and who have obtained power loads in spite of fierce opposition and hostile criticism. But for these loads some of our power stations would undoubtedly be insolvent at the present time.

In these columns we have repeatedly urged the advisability of building up large reserve funds, of lowering the price of current, of developing the power load and of buying plant out of revenue. By some the power load has been looked upon as a kind of by-product, and the opinion has often been expressed that power loads are furnished at the expense of the lighting customers. The past year has proved the fallacy of this in many of our industrial towns, and if the power load is a by-product it is a case of the tail wagging the dog with a vengeance. During the next few years we shall not be surprised to find the power load regarded as the principal source of revenue of electric power stations, as indeed it should be, no matter whether people derive their means of livelihood from industrial or agricultural pursuits. As yet, and notwithstanding the progress of the last decade, we are barely on the fringe of the electrification problem. Many people do not yet realise that for lighting his home man requires relatively little power, and progress in the art of lamp manufacture will lessen this. To help him in his industry he finds it necessary largely to augment his power, and experience shows that the ratio is an ever-increasing one.

The talk of economy must necessarily be mere verbiage as long as we have millions of horse-power of steam engines each gnawing at the vitals of prosperity, and as long as each member of the community is allowed to squander that which has appropriately been called the heritage of all the ages. When we begin to practise economy in earnest, the lighting load—a load of a few hours' duration per day and for only six months in the year—will itself be the by-product saleable without meter at a graded percentage of the rateable value of a consumer's premises.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s Add 10 per cent. for abroad or for foreign books.]

A Treatise on Light. By R. A. HOUSTOUN, M.A., Ph.D., D.Sc. (London: Longmans, Green & Co.) Pp. xi.+478. Price 7s. 6d. net.

Many text-books on light have recently been published, and at first sight it would appear unnecessary to add to their number; but the able manner in which Dr. Houstoun has dealt with the application of modern electrical theory to the study of light renders his book a most valuable addition to the literature of the subject.

The work is divided into four parts. Part I. deals with geometrical optics, and in addition to the matter usually discussed under this heading, it contains an instructive chapter on the properties of thick lenses, and the defects of lenses and mirrors due to chromatic and spherical aberration. Part II. is concerned with interference, diffraction and polarisation. The section on diffraction is treated graphically, in the main, and in the author's able hands the evaluation and use of Fresnel's Integrals is shorn of all "frightfulness." Chapter XIII. on Optical Rotation should be of peculiar interest to engineers in that it contains a full description of the optical determination of the distribution of stress in those structures which are not amenable to elementary mathematical treatment. Small xylonite models of the structure under investigation are placed between two Nicols set to extinction. The unstrained parts of the model appear black, the other parts taking on tints according to the degree of strain they experience By placing in the field a model of simple form for which the stress distribution is thoroughly understood, and comparing tints, the stress at any point in the unknown model is obtained from its colour directly in lbs./sq. in. Part III. deals with spectroscopy, photometry, &c., and contains a detailed description of recent research in the study of ultra-violet, and infra-red rays and spectro-photometry. The "Electron" explanation of the Zeeman effect is cleverly handled.

Part IV. on the mathematical theory of the nature and propagation of light is absorbingly interesting, and the author is to be heartily congratulated on the very able manner in which he has presented his facts. The whole is based on the hypotheses of the electron theory. Maxwell's equations are modified to meet the requirements of this theory, and are subsequently used to obtain, among other things, the well-known dispersion formulæ for prisms. This forms a distinct advance on anything which has yet found its way into text-books on light. The whole work is well got up, is profusely illustrated, and abounds in examples of a practical nature. It is to be unreservedly recommended. W. H. BILSON.

Experimental Harmonic Motion. By G. F. C. SEARLE, Sc.D., F.R.S. (Cambridge: University Press.) Pp. x.+92. 4s. 6d. net.

To many it will come as a surprise that at one of our oldest seats of learning, mechanics, heat, light, electricity and magnetism are taught in the same rooms, which means that nearly all the apparatus has to be such that it can be readily moved from place to place. The author of the book under review tells how in his class at the Cavendish Laboratory they have to be content with what he describes as rapid physics, and goes on to state that there have been sometimes over 50 students working in the class at the same time. Students working through the course on "Experimental Harmonic Motion" at the Cavendish Laboratory under Dr. Searle will think nothing of the inconvenience under which their work is carried out, and such conditions have compensating advantages.

The book contains two chapters and an appendix. In the

first chapter the elementary theory of harmonic motion is given, and in the second chapter are given notes and 14 experiments. The latter are decidedly good, and it is pleasing to note that much of the apparatus may be made in practically any laboratory by those possessing slight mechanical skill. The author gives an introductory note on most of the experiments, and follows up with the theory of the experiment; concise experimental details are then given, and in every case a practical example brings the section to a close. We have nothing but praise for the book, and the fact that the author treats the subject more from the point of view of the physicist than of the engineer does not limit the usefulness of the book. Much of an engineer's work consists in the making of accurate measurements and in the recording of data. In this work the engineer has much to learn from the physicist. We believe that a further volume on the same lines dealing with damped vibrations and allied matters would be appreciated by many students as well as by those teachers, who, like the author, have to be content with rapid physics.

Elementary Lessons in Electricity and Magnetism. By S. P. Thompson, F.R.S. (London: Macmillan & Co.) Pp. xvi.+744. 4s. 6d.

This volume is a new edition of a book that needs no recommendation. The book is probably more widely used than any other on the subject, and is, beyond question, well known to most of our readers. The first edition was published nearly 35 years ago, and after being reprinted 18 times, a new edition appeared in 1895. This edition was re-printed no less than 21 times.

For the purpose of the present edition the entire work has been completely revised, and in many parts re-written. Progress in the development of the industrial applications of electricity has been so great in the past decade as to necessitate the remodelling of the latter half of the book, and new chapters dealing with wireless telegraphy and modern conceptions of the electron have been added.

We venture to think that the book owes much of its popularity to the fact that the author is an experienced teacher. As such he is able to present the several branches of the subject in logical sequence, and to give the exact amount of information required by a beginner. The latter will not regard his education as complete when he has finished reading "Thompson," but being *properly grounded* he will be able to turn to more ambitious works. For this reason "Elementary Lessons in Electricity and Magnetism" may be regarded more as an institution than as a mere book. The only criticism we have to make is in connection with the index. The numbers given refer to the numbered paragraphs, as in the former editions, instead of to the pages. From experience we know that this is liable to make one a little impatient.

MEANS FOR PRODUCING A SPARKLESS BREAK OF AN INDUCTIVE CIRCUIT.

BY T. F. WALL, D.SC., D.ENG.

Summary. The author investigates mathematically the current and voltage curves when an inductive circuit is closed. If the resistance is negligible and the circuit is closed at the moment when the wave of applied pressure passes through its zero value, there results a unidirectional current pulsating between zero and a maximum value, and the circuit can be broken sparklessly whenever the current is zero because the voltage is then also zero. The author shows that the effect of resistance may be compensated by superimposing a continuous current pressure, and thus sparkless breaking may be secured also in this case. Practical results confirm the theory.

For many years attempts have been made to provide means for obtaining a sparkless break of an inductive circuit in which a large amount of energy is involved.* An example of such a circuit is found in the case of a solenoid employed to give a reciprocating motion to a plunger. As far as the writer is aware, however, the method explained under the heading Case 3, in the following, is the first practical solution of this problem.

In order that the subject may be dealt with as clearly as possible, the ideal case of a circuit with a negligibly small resistance will be examined first. The modification of the conditions due to resistance will then be discussed and finally, the means for compensating for the harmful effect of resistance will be explained.

Case 1.—Suppose that we have a coil of which the resistance is negligibly small and the inductance is L henrys. If a P.D. $e=E \sin \omega t$ be applied to the terminals of this coil, the following relationship will hold, viz., $L\frac{di}{dt}=E \sin \omega t$. The solution of this equation is

$$i=A-\frac{E}{\omega L}\cos \omega t,$$

in which A is a constant.

The magnitude of the constant A is determined by the initial conditions. At present we shall only consider the case for which the circuit is closed at the moment when the E.M.F. is zero. Hence we have $t=0$, $i=0$, $e=0$. From this it follows that $A=\frac{E}{\omega L}$, and therefore the current is given by the expression

$$i=\frac{E}{\omega L}(1-\cos \omega t).$$

This expression shows that if the circuit be closed at the moment when the E.M.F. is zero and if the P.D. at the terminals of the coil vary sinusoidally, the current in the circuit is unidirectional. It may be noted in passing that it can be proved that this result (as regards the unidirection of the current) is also true for any symmetrical wave-form of applied P.D. and not merely for a sinusoidal wave-form. The expression given above also shows that the current reaches a maximum value which is twice the maximum corresponding to the normal conditions of working in which the current wave lags by 90 deg. on the wave of the P.D.

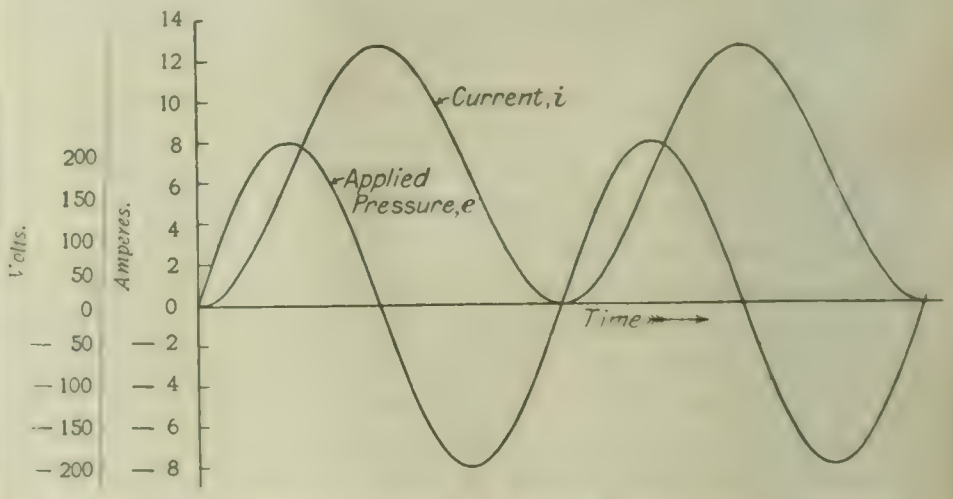


Fig. 1.—Ideal Case of Circuit without Resistance. Circuit closed when the Applied Pressure is Zero.

Applied pressure $e=200 \sin 314t$. Current $i=6{\cdot}37(1-\cos 314t)$.

As an example, let us suppose the value of the inductance L to be 0·1 henry, the maximum value of the applied P.D. to be 200 volts, and the supply frequency to be 50 cycles per second, *i.e.*, $\omega=2\pi 50=314$. The current will then be

$$i=6{\cdot}37(1-\cos \omega t).$$

In Fig. 1 the curves of the applied P.D. *e*, and the current *i* are shown as functions of the time. Two cycles only of these curves are shown. These two cycles are identical, as are all succeeding cycles. It will be noticed that the current reaches the zero value when the P.D. is zero, and also that the current never becomes negative. It follows that if the circuit be closed at the instant at which the pressure is zero the current reaches zero after one cycle of the pressure wave. Consequently, if the circuit be opened at the moment at which both the pressure and current are zero there can be no spark because at that instant the circuit is completely dead. Moreover, the

* One of the most recent attempts is that of L. Schuder, "E.T.Z.," 1914, pages 563 and 589.

current curve is very flat in the neighbourhood of its zero value and hence there will be little danger of sparking if the circuit is opened at some moment which is nearly, but not precisely, the most favourable.

This case is, however, an imaginary one, since in practice a coil cannot be obtained such that its resistance is negligibly small.

Case 2.—We shall now consider how the behaviour is modified due to the resistance of the coil.

Let the inductance of the coil be L henrys and the applied P.D. be $e=E\sin\omega t$ as before. Further let the resistance of the coil be R ohms.

The equation for the current in the circuit is now

$$L\frac{di}{dt}+Ri=E\sin\omega t.$$

The solution of this equation is

$$i=\frac{E}{\sqrt{R^2+(\omega L)^2}}\sin(\omega t-\beta)+A.\varepsilon^{-\frac{R}{L}t},$$

where $\tan\beta=\frac{\omega L}{R}$ and A is a constant depending on the initial conditions. If the circuit be closed at the instant at which the E.M.F. is zero we have $t=0$, $e=0$, $i=0$. This gives

$$A=-\frac{E}{\sqrt{R^2+(\omega L)^2}}\sin\beta.$$

Hence

$$i=\frac{E}{\sqrt{R^2+(\omega L)^2}}[\sin(\omega t-\beta)+\varepsilon^{-\frac{R}{L}t}\sin\beta].$$

This expression shows that the current is compounded of two terms, viz., (1) a term $i_1=\frac{E}{\sqrt{R^2+(\omega L)^2}}\sin(\omega t-\beta)$, which corresponds to the normal condition of the current lagging by an angle β on the terminal P.D.; and (2) a logarithmic term

$$i_2=\varepsilon^{-\frac{R}{L}t}\frac{E}{\sqrt{R^2+(\omega L)^2}}\sin\beta,$$

which decays at a rate depending on the ratio of the resistance to the inductance of the coil.

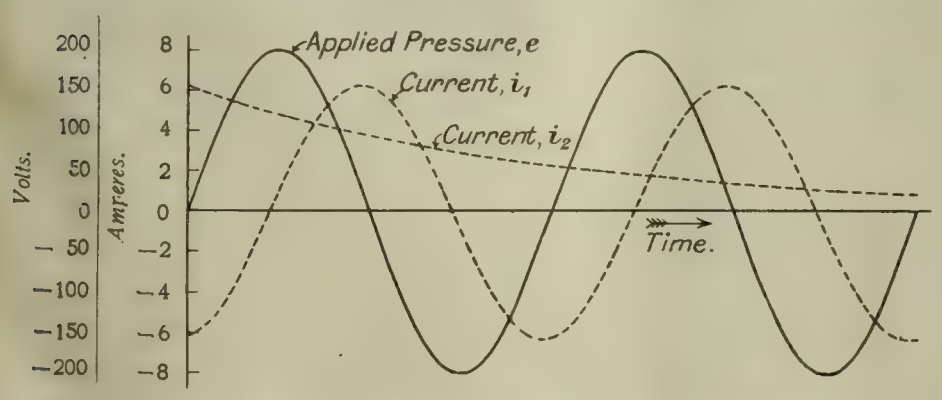


FIG. 2A.—SHOWING THE DISTURBING EFFECT OF THE RESISTANCE OF THE CIRCUIT. CIRCUIT CLOSED WHEN APPLIED PRESSURE IS ZERO.
Applied pressure $e=200\sin 314t$. Current component $i_1=6{\cdot}29\sin(314t-81°)$. Current component $i_2=6{\cdot}29\varepsilon^{-50t}\sin 81°$.

After an indefinitely long time the second term disappears and the first term alone remains. In practice the logarithmic term will usually become negligibly small after the applied P.D. has passed through the first few cycles. As an example, suppose that L=0·1 henry, E=200 volts, $\omega=2\pi 50=314$, R=5 ohms. The current will then be

$$i=6{\cdot}29[\sin(\omega t-81°)+\varepsilon^{-50t}\sin 81°].$$

In Fig. 2A two cycles of the wave of applied P.D. are shown and the two components of the corresponding current wave are also shown.

In Fig. 2B two cycles of the wave of applied P.D. are shown, and also the resultant current wave which is obtained by adding algebraically the corresponding ordinates of the two component current waves of Fig. 2A.

From Fig. 2B it is obvious that if the circuit is closed when the E.M.F. is zero, the current and P.D. never again reach their zero values simultaneously. The current gradually settles down to a sine wave-form lagging by 81 deg. on the wave of the terminal P.D. It is thus impossible to open the circuit without generating a spark in those cases in which the circuit has an appreciable resistance. Such cases are the only ones which occur in practice.

If it be attempted to open the circuit when the current is zero, there is a large E.M.F. in the circuit. The least deviation from this moment will cause sparking and clearly, in practice, it is impossible to obtain the mathematical precision of operation which is implied by the requirement of opening the circuit when the current is zero. Even if this were possible, the P.D. across the break in the circuit would probably cause a spark to jump across the gap. If the circuit be opened when the pressure is zero, there is a current flowing and this must be interrupted, thus causing a spark.

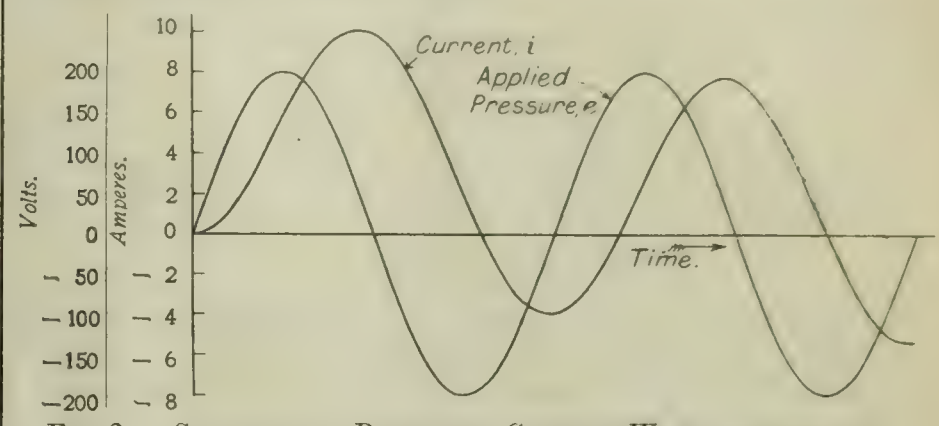


FIG. 2B.—SHOWING THE RESULTANT CURRENT WAVE OBTAINED BY TAKING THE SUM OF THE COMPONENTS i_1 AND i_2 OF FIG. 2A.

Case 3.—The writer has now succeeded in so compensating the effect of the resistance of the circuit that the ideal conditions of Case 1 may be actually realised in practice.*

Suppose we apply to the terminals of the inductive coil a P.D. which is compounded of a sinusoidal alternating pressure wave and a continuous current pressure. Such a composite P.D. would be obtained by connecting a storage battery or a continuous current generator in series with the source of alternating pressure. The resultant P.D. at the terminals of the coil would then be alternating, but the maximum value on one side of the zero line would be greater than on the other.

An example of such a composite pressure wave is shown in Fig. 3. If we assume the time at which the resultant pressure

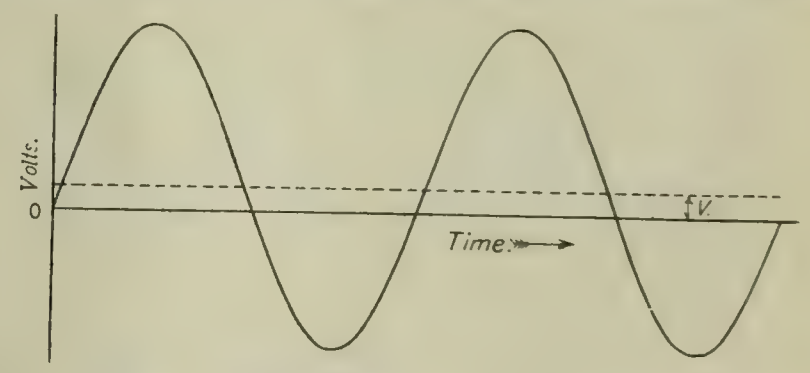


FIG. 3.—PRESSURE WAVE COMPOUNDED OF A CONTINUOUS CURRENT COMPONENT V AND AN ALTERNATING COMPONENT $e=E\sin\omega t$.

is zero to be the zero of time, the sinusoidal component of the pressure-wave may be written $E\sin(\omega t-\alpha)$.

If V be the magnitude of the continuous current component of the pressure wave, we have for the pressure at any time t

$$e=V+E\sin(\omega t-\alpha).$$

Since for $t=0$, $e=0$, it follows that $V=E\sin\alpha$, and this gives the value of the angle α in terms of V and E. The following equation will then be true:

$$L\frac{di}{dt}+Ri=V+E\sin(\omega t-\alpha).$$

The solution of this equation is

$$i=\frac{V}{R}+A\varepsilon^{-\frac{R}{L}t}-\frac{E}{\sqrt{R^2+(\omega L)^2}}[\sin\{(\alpha+\beta)-\omega t\}]$$

where A is a constant depending on the initial conditions, and $\tan\beta=\frac{\omega L}{R}$

* T. F. Wall, British Patent Nos. 5883 and 6253, of 1915.

If the circuit be closed when the pressure is zero, *i.e.*, at time $t=0$, we have $t=0$, $i=0$, $e=0$.

Hence $$A=\frac{E}{\sqrt{R^2+(\omega L)^2}}\sin(\alpha+\beta)-\frac{V}{R},$$

Now since $$E=\frac{V}{\sin\alpha}: \quad \cos\beta=\frac{R}{\sqrt{R^2+(\omega L)^2}},$$

it follows that $$A=\frac{V\cos\beta}{R\sin\alpha}\sin(\alpha+\beta)-\frac{V}{R},$$

and therefore

$$i=\frac{V}{R}+\varepsilon^{-\frac{R}{L}t}\left[\frac{V\cos\beta}{R\sin\alpha}\sin(\alpha+\beta)-\frac{V}{R}\right]-\frac{V\cos\beta}{R\sin\alpha}[\sin(\alpha+\beta)-\omega t].$$

This expression for the current again contains an exponential term. We can, however, in this case, cause the exponential term to vanish. The condition is that

$$\left[\frac{\cos\beta}{\sin\alpha}\sin(\alpha+\beta)-1\right]=0.$$

From this it follows that $\cot\alpha=\tan\beta$, *i.e.*, $(\alpha+\beta)=90°$.

If we satisfy this condition we get by substitution

$$i=\frac{V}{R}(1-\cos\omega t).$$

This shows that the current is a pulsating unidirectional current, precisely similar in form to that of Case 1, and the current becomes zero simultaneously with the applied pressure.

Since $E=\frac{V}{\sin\alpha}$, $\cos\beta=\frac{R}{\sqrt{R^2+(\omega L)^2}}$, and $\sin\alpha=\cos\beta$,

we have

$$E=\frac{V}{\cos\beta}=\frac{V}{R}\sqrt{R^2+(\omega L)^2}, \text{ and } \frac{V}{R}=\frac{E}{\sqrt{R^2+(\omega L)^2}}.$$

The expression for the current may, therefore, be written

$$i=\frac{E}{\sqrt{R^2+(\omega L)^2}}(1-\cos\omega t).$$

The magnitude of the continuous-current component of the applied pressure is given by the expression

$$V=\frac{E\,.\,R}{\sqrt{R^2+(\omega L)^2}}.$$

As an example let us consider a circuit of which the constants

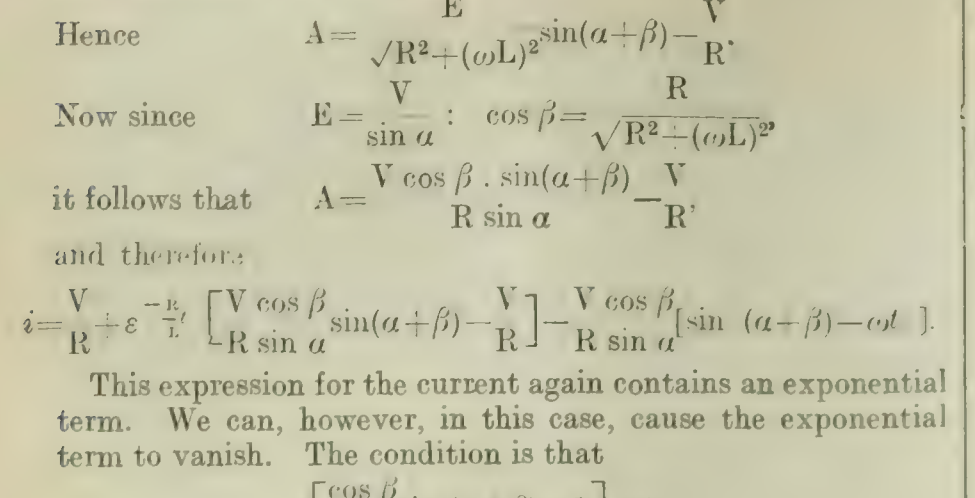


Fig. 4.—Circuit Closed when the Applied Pressure is Zero.
Applied pressure $e=31{\cdot}46+200\sin(314t-9°3')$ Current $i=6{\cdot}29(1-\cos 314t)$.

are the same as those given in the example to which Figs. 2A and 2B refer, viz.—

$E=200$ volts, $\omega=2\pi f=314$, $L=0{\cdot}1$ henry, $R=5$ ohms.

We have

$$\cos\beta=\frac{R}{\sqrt{R^2+(\omega L)^2}}=0{\cdot}1573, \quad V=E\cos\beta=31{\cdot}46 \text{ volts.}$$

$\sin\alpha=0{\cdot}1573$, $\alpha=9°3'$, $e=31{\cdot}46+200\sin(314t-9°3')$.

Hence $$i=\frac{V}{R}(1-\cos\omega t)=6{\cdot}29(1-\cos 314t).$$

In Fig. 4 two cycles of the resultant pressure wave are shown and the corresponding two cycles of the current wave. The comparison of the ideal case of Fig. 1 and the practical case of Fig. 4 shows that by connecting in series with the alternating current pressure a continuous current pressure of suitable magnitude, the disturbing effect of resistance as illustrated in Fig. 2B may be compensated and the applied pressure and current may be caused to become zero simultaneously.

In order to obtain experimental confirmation for the conclusion arrived at in the foregoing argument, the oscillogram shown in Fig. 5 was taken for the following conditions, viz., an inductance was connected in series with a resistance and supplied by an E.M.F. compounded of an alternating current wave and a continuous current E.M.F. The supply was controlled by means of a contact maker such that the circuit was

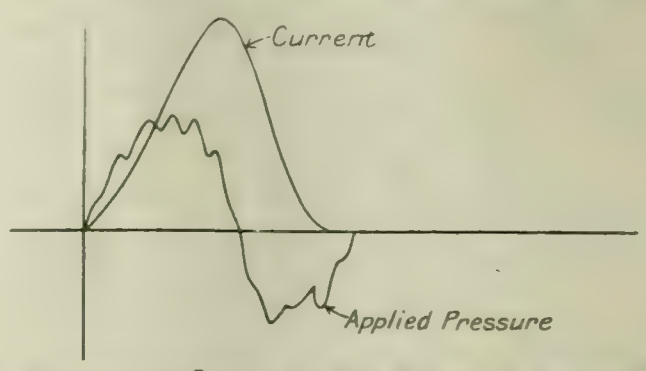


Fig. 5.—Oscillogram showing the Wave of Applied Pressure and the Wave of Current in a Circuit of Resistance 3·05 ohms and Inductive Reactance 11 ohms.

made when the resultant terminal pressure was zero, and the circuit was opened after one cycle of the supply pressure. The reactance of that part of the circuit between the terminals of the pressure coil of the oscillograph was 11 ohms, and the resistance was 3·05 ohms.

THE MAGNETIC TESTING OF BARS OF STRAIGHT OR CURVED FORM.*

BY ALBERT CAMPBELL, B.A. AND D. W. DYE, B.SC.

In this Paper the authors measure the value of "H" directly by means of search coils instead of calculating it. They claim that this eliminates the uncertainty regarding the length of the magnetic circuit. For iron surfaces the coils were flat where possible, and semi-

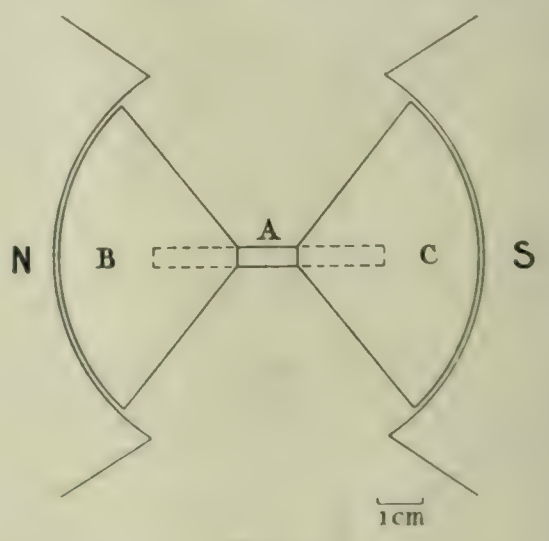


Fig. 1.

circular when round rods were used. A ballistic galvanometer having a sensitivity of 800 mm. at a metre, and a resistance of 280 ohms was used.

Null Method of Measuring H.—When either B or H is measured by the help of a search coil, the simplest procedure is to observe the throw on a calibrated ballistic galvanometer when the B (or H) is either reduced to zero or reversed. It has been suggested by C. W Burrows† that for measuring B a null method could be used in which the change of flux in the iron is balanced against the change of flux in air produced by the same magnetising current in an adjustable mutual inductance. With a ballistic galvanometer of moderately long period (8 seconds) we have not found this method workable, for the "iron flux" and the "air flux" rise at such different rates that the galvanometer light-spot nearly always gives a double kick,

* Abstract of a Paper contributed to the "Journal" of the Institution of Electrical Engineers.

† "Bulletin" of the Bureau of Standards, Vol. VI., p. 31, 1910

and an exact balance is out of the question. Moreover we have not been able to get over the difficulty by the use of condensers or other means of smoothing out the sudden voltage impulses. The measurement of H, however, by this null method does not present nearly so much difficulty, for the " air flux " by which the H is determined often follows much the same curve of rise (or fall) as that in the secondary coil of the mutual inductance. When this is the case the null method may be safely employed. The unfavourable cases are those in which the H to be measured is considerably affected by free magnetism, which occurs in regions near leaky parts of the magnetic circuit. As will be explained below, in certain tests the measurements are much facilitated by the use of mutual inductance to balance out part of the flux through the search coil.

Simple Apparatus for High Magnetisation.—In May, 1913, we set up a very simple modification of Ewing and Low's Isthmus Method. In the original form of this method rather elaborate coned pole-pieces

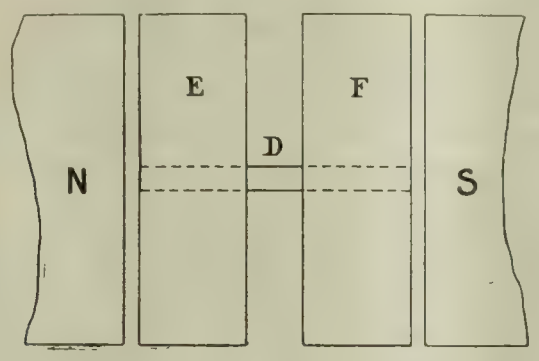


Fig. 2.

are required, with accurate mechanism by which the test-bar along with these pole-pieces can be quickly turned end for end in a strong magnetic field. This system is illustrated in Fig. 1, in which the small test-rod A fits into the coned pole-pieces B and C, the whole being rotatable between the poles NS of a powerful electromagnet. A much simpler system, shown in Fig. 2, was found to be quite satisfactory. Instead of the cones, thick soft-iron discs E and F form the pole-pieces, and these do not touch the magnet poles, but are separated from them by small air-gaps (1 mm. or 2 mm. distance). The test-piece D is fitted into central holes in the flat pole-pieces, which are clamped in an independent frame so that they can be removed together from between the poles. Instead of reversing the direction of the test-piece the magnet is so designed as to allow quick reversal of the magnetic field. It consists (Fig. 3) of a well-laminated iron core of nearly square section (8 cm. × 7 cm.) formed of ring stampings of about 22 cm. mean diameter, the polar air-gap *ab* being

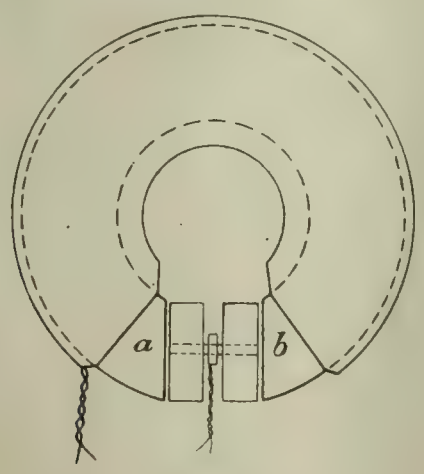


Fig. 3.

about 8 cm. across. The winding consists of about 1,000 turns of copper wire of 2 mm. diameter (No. 14 S.W.G.), with a total resistance of about 2·2 ohms.

The whole construction is extremely simple; the laminated magnet had not been specially designed for the purpose. The entire absence of fitted or clamped magnetic joints is a distinct advantage from the point of view of construction, and appears to have no disturbing effect in the tests, although the presence of the outer air-gaps lowers somewhat the maximum H obtainable in the central gap.

Variation of H with Magnetising Current.—When the pole-pieces are not inserted, the H at the centre of the wide air-gap is practically proportional to the magnetising current (over the working range), 10 amperes giving a central H of 800. In the normal case with the pole-pieces leaving a central air-gap of 1·3 cm., when a test-rod is in position, the H near the middle of the rod is very nearly proportional to the current, the relation between them depending slightly on the section and magnetic quality of the test-piece D. For example, with a certain iron rod $H \doteqdot 390(I_1 - 0{\cdot}2)$ for a range of I_1 from 1 ampere upwards.

Thus 10 amperes will give H=3,820.

Form of Test-piece.—The specimen tested is in the form either of a rod 7 cm. long and 0·5 cm. in diameter, or an equivalent bundle of strips or wires. One of the chief objections to the whole system lies in the smallness of the specimen tested, which does not allow such good sampling, and increases the relative effects of the mechanical treatment (turning, cutting, &c.) used in preparing the sample. At the high magnetisations for which this apparatus is intended, the effects of the preliminary mechanical treatment are, however, comparatively trifling. This was proved by various experiments. For example, a bundle of strips was tested from H=150 up to H=2,500. Each strip was then cut in two longitudinally by shears, all being considerably bent and re-straightened in the process. The results on retesting showed a slight lowering of the permeability below H=500, but above that value the effect of the cutting was practically negligible. It does not seem essential that the strips should be so closely packed as nearly to fill the holes in the pole-pieces, for, when the section of the bundle is reduced by 50 per cent. by removing some of the strips, the total observed reduction in permeability is only of the order of 1 per cent. From H=1,000 up to H=3,000, rods shorter than 7 cm. gave satisfactory results so long as they entered the holes in the pole-pieces to a depth of at least 0·5 cm.

Time Lag of Electromagnet.—With such a large electromagnet, when the current is suddenly reversed, difficulties may occur due to the slowness with which the reversed current rises. A rough calculation showed that in the worst case the current reaches 99·3 per cent. of its full value 0·5 second after the circuit is closed. When experimentally investigated, several effects due to time lag were distinctly

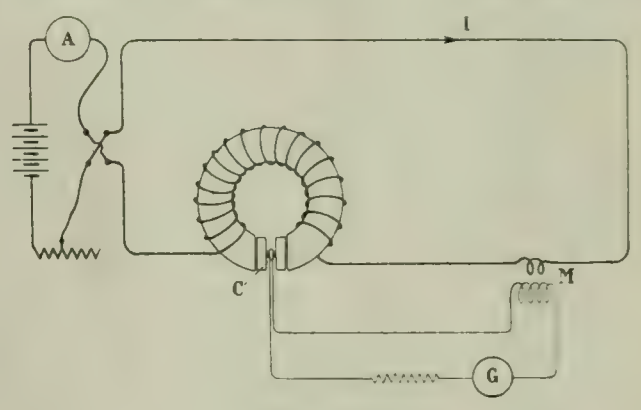


Fig. 4.

observed, but with a ballistic galvanometer of 8 seconds complete period the possible errors due to this cause appeared to be practically negligible.

Uniformity of H.—At the middle point of the test-rod is placed a small ebonite bobbin with an inner winding of 40 turns for measuring B, and three outer coils of 400 turns each, used differentially as already described, for determining H. These coils are of enamelled copper wire of 0·06 mm. diameter (No. 46 S.W.G.); with an axial length of 4 mm., the mean diameters of the inner and outer annuluses being 6 mm. and 12 mm. respectively. From the results of a large number of experiments with various materials it has been proved that the magnetic field round the central portion of the rod is wonderfully uniform from H=150 up to H=3,000. One rarely finds the field shown by the outer annular coil to be as much as 1 per cent. greater than that given by the inner one. Explorations of the whole interpolar space by means of a minute search coil (of 3 mm. mean diameter and 400 turns) have corroborated these results.

Correction for Inactive Area.—With rods of small section, and more particularly with small bundles of strip, the difference between the cross-section of the iron and the area of the search coil for B is considerable, and this necessitates a large correction on the observed value of B. If s=area of iron, s_1=search coil area not occupied by iron, then True B=Observed B$-Hs_1/s$. The correction increases in proportion to H. To avoid the trouble of applying this varying correction to each observation, we have found it convenient to eliminate the term Hs_1/s by means of a compensating device shown in Fig. 4.

A small mutual inductometer M is arranged with its primary coil in series with the magnetising circuit of the magnet, and its secondary coil connected in opposition to C, the search coil for B, in the ballistic galvanometer circuit. As will be seen below, the interpolar value of H is approximately proportional to I_1, the magnetising current; thus $H \doteqdot hI_1$, where h is approximately known. Now let the small inductometer be set so that $M = 10^{-9} hs_1$.

If Φ' be the flux in the secondary coil of M, due to current I_1, then

$$\Phi' = 10^{-9} M I_1 = h s_1 I_1 = H s_1,$$

and hence the inductometer automatically subtracts the term Hs_1/s and gives the true value of B for all values of H. A range of from 0 to 50 microhenries is convenient.

Hysteresis Loops, Remanence and Coercivity.—The apparatus can be used, not only for the determination of permeability curves, but also for hysteresis loops, including the remanence and coercive field. The remanent magnetism of the electromagnet, although it makes its appearance, does not introduce any errors, since the true values of H are given by the search coils. The authors refer to definitions of "coercive force," and to methods of measuring it.

Typical Permeability Curves.—In Fig. 5 are given a number of H-B curves obtained by the apparatus already described, the samples being in the form of thin rods or bundles of strips. As will be seen from Fig. 5, most of the materials are of interest from a practical point of view.

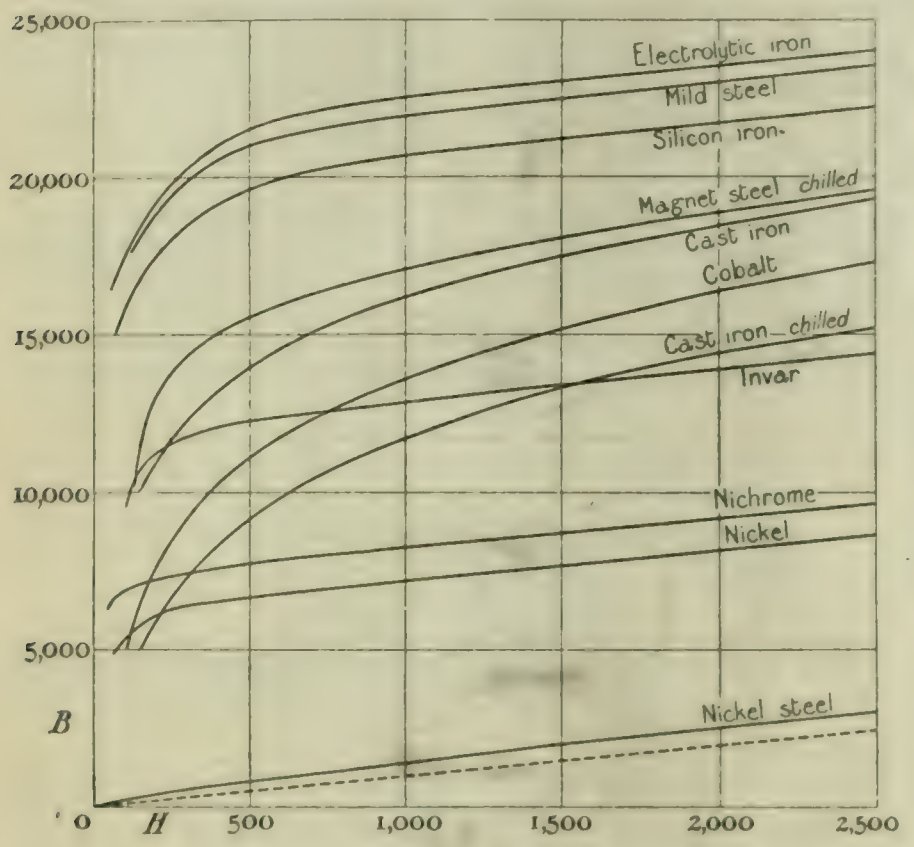


FIG. 5.

The lowest curve in the diagram is the straight line for air (permeability=1). All the other curves ultimately tend to become parallel to the air line as the magnetisation is increased, close parallelism indicating that the material has reached the condition of magnetic saturation.

The general agreement with similar curves already published by Gumlich* is interesting. In the case of the very pure electrolytic iron the agreement is close; for saturation the intensity of magnetisation [*i.e.* $(B-H)/4\pi$] deduced from our curve is 1717, which appears to be practically identical with the value 1719 given by Gumlich.

It appears, however, that this is not the maximum value that can be obtained with very pure iron, for B. O. Peirce† found the value 1740 for Norway iron. According to P. Weiss‡ cobalt iron (30 per cent. Co) gives a still higher value.

The authors then deal with a ring yoke apparatus, reversible search coils for "H" measurement and tests on curved bars. In an appendix Chattock's magnetic potentiometer is discussed, and other devices by Rogowski, Goldschmidt and Goltze are dealt with.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free (unless otherwise stated), on receipt of published price; price, at least 3s. for books published at under 2s. and 5 per cent. for books published net. Add 10 per cent. for extra postage for foreign books.]

"Proceedings" of the Institute of Radio Engineers. Edited by A. N. Goldsmith. (New York: The Institute of Radio Engineers.) Vol. III. No. 4. 5s. 6d.

"Spons' Architects' and Builders' Pocket Price Book," 1916. (London: E. & F. N. Spon.) Pp. viii. + 304. 2s. 6d. net.

"McGraw Electrical Directory," October, 1915. (New York: McGraw Publishing Co.) Annual subscription $10.

"Willing's Press Guide," 1916. (London: James Willing, Ltd.) 1s.

* "Elektrotechnische Zeitschrift," Vol. XXX., pp. 1065 and 1096, 1909.

† "Proceedings" of the American Academy of Arts and Sciences, Vol. XLIX. p. 117, 1913.

‡ "Comptes Rendus," Vol. CLVI. (1), p. 1970, 1913.

CORRESPONDENCE.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITORS OF THE ELECTRICIAN.

Serious complaints have been levelled at the I.E.E. Council at various times that they do not bestir themselves in this, that and the other direction to safeguard and advance the interests of the profession and its work in divers commercial and political ways.

Whether the Council is right in not overstepping the limited bounds it seems to set upon its actions depends on the meaning of the main object of the Institution as set forth officially as follows: "*To promote the general advancement of electrical and telegraphic science and its applications.*" Although the wording is somewhat old fashioned, one would think that it permitted the Council to do much more than it does.

Speaking generally, I am on the side of the progressives every time; but I recognise that there is not much hope of progress in the directions indicated without *combination. With combination anything could be done.* The period of stress and change through which we have been, and are still, passing ought to have produced one or more well-known, capable and masterful leaders, who knew how to get together a strong following. That effected, the rest would have been easy. It is still not quite too late to do something.

If anyone should ask what there is to be done I would refer him to articles and letters that have appeared from time to time in this and other journals since the commencement of the war. If these do not make his blood boil he must be superlatively supine.

Our Institution, dealing as it does with some of the most advanced phases of applied science and engineering, ought to be go-ahead in every way, but it does not seem to be very progressive, even in its own house.

The procedure at meetings might be improved in various respects, some of the more obvious being indicated as follows: I would have the name of every speaker in turn thrown on the screen or written boldly on the slate or board. The interest of the proceedings would be greatly enhanced, for we cannot all catch the rapid and sometimes feeble announcement of the names, and most of us know many speakers by name and repute, but not by sight. Some of our famous pioneers and foremost men are unknown by sight to many of the younger members of the audience.

I would abolish the ineffective blackboard and instal a lantern telautograph. The screen would then show to everyone what the speaker was sketching or writing on the small pad in front of him. An incidental advantage of this arrangement would be that the speaker would not have to turn his back to the audience, and all semi-private conversation with the blackboard would be stopped.

Surely everything that is possible should be done for the audience. At a meeting in the Library a few weeks ago only the top of the blackboard could be seen from the back rows. I expect they manage these things better in Council schools.

Oh, for a few more blackboard operators like Prof. Silvanus Thompson, and oh, for a few more voices like that of Dr. Stanley Parker Smith!

When a Paper has been read and *adequately discussed* (perhaps at two or more meetings), the "Journal" ought to contain (besides the Paper itself) a well-digested summary of the points dealt with, and of the criticisms of those points. Thus, suppose we have a Paper advocating single-phase traction on ordinary as distinguished from tube and other self-contained railways; and supposing the general trend of the criticism is against single phase. I would submit that every endeavour should be made to weigh the points for and against, and arrive at a definite conclusion.

I said something at the beginning about superlative supineness. We shall probably see an example in regard to this letter of mine. Many readers may agree with some of the points raised, but just one or two or none will take the trouble to say

so in these columns. If 20 or 30 were to exert themselves a little, and the Editors mentioned the names of those whose letters had been left out for want of space, the attention of the I.E.E. Council might be aroused.

West Norwood, S.E., Jan. 26. W. PERREN MAYCOCK.

[When we read the beginning of Mr. Maycock's letter we expected to find many important suggestions in regard to the electrical industry, and we were, therefore, surprised on reaching the end of the letter to find merely a few suggestions as to the conduct of the meetings. We agree that some modifications might be made in this direction with advantage, but, at the risk of being called "supine," we hope the Council will take no such foolish step as the balancing of pros and cons in a discussion. Every interested reader, including Mr. Maycock, should do this for himself. Otherwise, we are sure that Mr. Maycock would find himself in disagreement with the "official referee" appointed by the Council on the very first occasion.—EDS. *E.*]

NEW GENERATING STATION OF THE PHILADELPHIA ELECTRIC CO.

In view of the interest that is being taken in the development of the large capacity turbo-alternator, we give below a short account of the units installed in the recently completed A-2 Christian-street generating station of the Philadelphia Electric Co. The new structure measures 188 ft. in length by 262 ft. in width, and is 98 ft. high. The part devoted to station switching apparatus and turbine room comprises one-third of the total building floor area, and the boiler-house takes up the remainder. The total rating of station A-1 and the adjoining station A-2 is 151,000 kw. in nine generating units, the seven sets of station A-1 having an aggregate rating of 86,000 kw. The traction demand is nearly one-third of the load on the stations of the Philadelphia Electric Co. Part of this is furnished at 25 cycles and part at 60 cycles for feeding energy to synchronous converters of the same frequency. In addition, 25-cycle, single-phase energy will be used at the rate of several thousand kilowatts by the Pennsylvania Railroad electrified section. Last year the total output of the Philadelphia Electric Company's generating station was 250,697,952 kw.-hour, and the peak load was 77,728 kw. The new Christian-street station, with its 65,000 kw. in turbo-generators, is, therefore, the outcome of these growing conditions and provides for meeting economically the conditions in Philadelphia.

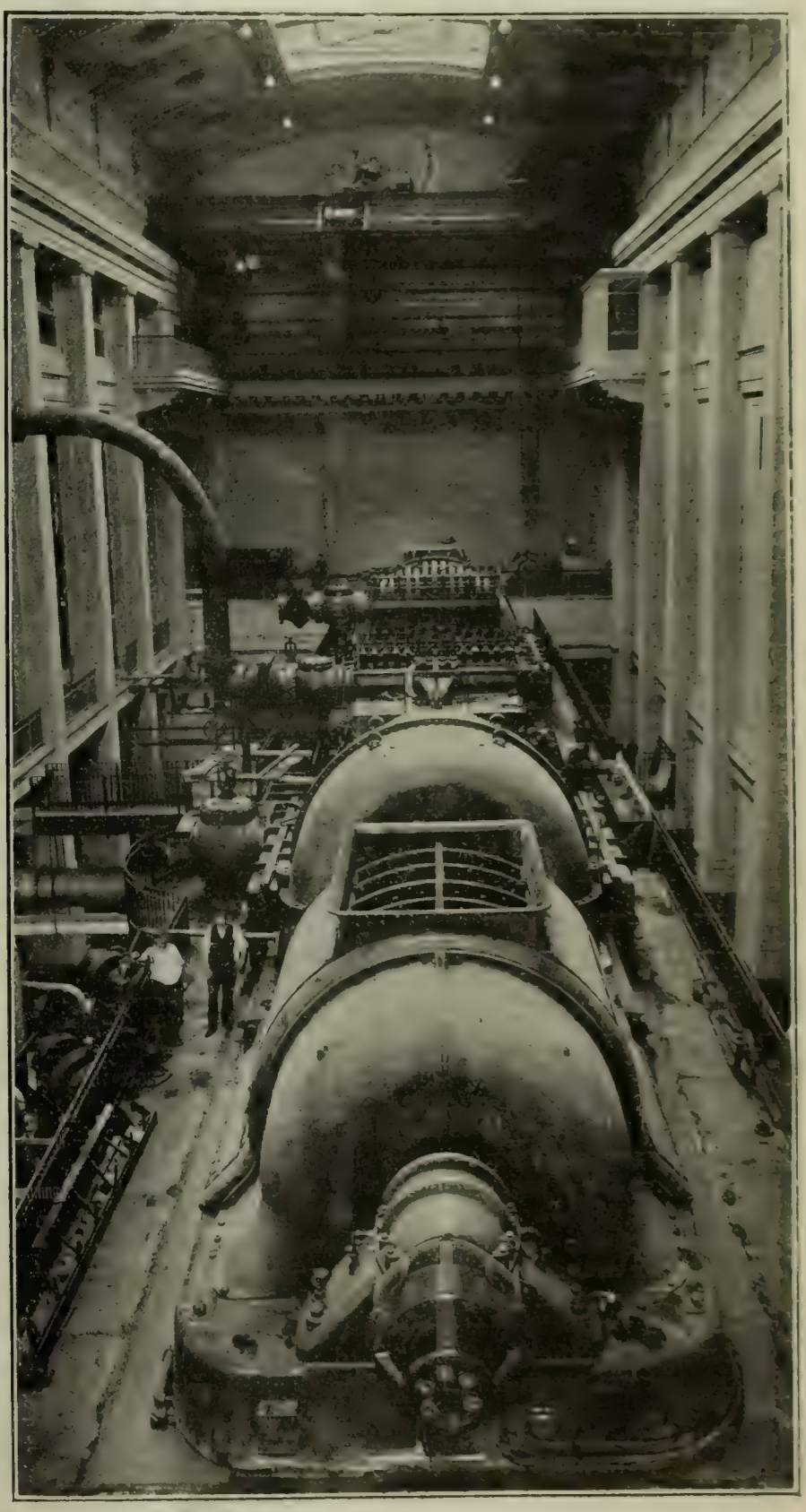
We are indebted to the "Electrical World" for the interior view of the new A-2 station. This shows the two largest steam turbo-generating sets ever built. They are designed for generating directly at 13,200 volts for distribution without step-up transformers. The turbo-generator set in the foreground is rated at 30,000 kw., 25 cycles, three-phase; and the one in the background is rated at 35,000 kw., 60 cycles, three-phase. This 35,000 kw. set has a current output of 1,460 amperes per phase at full load at 0·9 power-factor, and the rotating field is of six-pole type, driven at 1,200 revs. per min. with a 150-kw., 250-volt, 600-ampere shunt-wound exciter mounted on an outboard bracket. The smaller machine has two poles and a speed of 1,500 revs. per min.; its exciter, similarly carried, is a 110-kw. 250-volt shunt machine. In addition to the direct-connected exciters, there is a 500-kw. exciter driven through reduction gear (speed ratio 5,000 to 900) by a steam turbine. An interesting feature of the generators is the use of temperature coils permanently located in the armature windings and connected to switchboard instruments to show temperatures of the high-tension windings. Cooling air is secured by an induced-draught system, there being an independent air-washing and cooling plant for each unit; 60,000 and 85,000 cubic ft. per minute are furnished to the two generators.

The principal dimensions and ratings of the 35,000-kw. and 30,000-kw. turbo-alternators are given in the table

According to "Engineering News" the surface condenser for each turbine is a two-pass counter-flow type having a cooling surface of

Data of Philadelphia Electric Co.'s Turbo-Alternators.

——	30,000 kw.	35,000 kw.
Frequency, cycles per second	25	60
Voltage	13,200	13,200
Poles	2	6
Length, overall	59 ft. 4½ in.	63 ft. 1⅞ in.
Extreme width	19 ft. 8 in.	21 ft. 5 in.
Extreme height, from floor	15 ft. 2 in.	15 ft. 10½ in.
Weight, tons	436	536
Speed, revs. per min.	1,500	1,200
Throttle valve, diameter	18 in.	20 in.
Exhaust outlet	14 ft. × 12 ft.	14 ft. × 12 ft.
Free exhaust, diameter	36 in.	36 in.
Steam pressure, lbs. per sq. in.	215	215
Superheat, deg. Fahrenheit	200	200
Exhaust pressure, in ins. of mercury	1·5	1·5
Steam consumption (lbs. per kilowatt-hour)	12·45 at 15,000 kw. 11·9 at 22,500 kw. 12·75 at 30,000 kw.	12·9 at 15,000 kw. 11·9 at 25,000 kw. 12·0 at 30,000 kw.



INTERIOR VIEW OF THE PHILADELPHIA ELECTRIC CO.'S NEW POWER STATION.

50,000 sq. ft. composed of 1 in. diameter tubes of 18-gauge. The arrangement of steam and water paths is novel. The tubes are arranged in concentric circular rows, with the whole group placed eccentrically in the shell to give a surrounding steam space of diminishing cross-section. Cooling water enters through a 48-in. pipe at the bottom and discharges at the top through a similar pipe. The discharge is sealed to give a siphon system, thus reducing the work of the circulating pump to that of overcoming friction of tubes and pipes. Turbine-driven air pumps of the Leblanc (water jet) type are placed immediately below the condensers.

For each unit there are two tri-rotor centrifugal pumps with geared steam-turbines having a reduction ratio of 2,880 to 320.

Each pump has a capacity of 37,500 gallons per minute. A pair of two-stage turbo-driven condensate pumps rated at 1,500 gallons per minute are provided for each condenser.

The new steam raising equipment consists of 20 water-tube boilers with superheaters. Each is guaranteed to evaporate 60,000 lb. of water per hour from 160°F. to 250 lb. and 600°F. Steam-flow and CO_2 meters, recording thermometers for the flue temperatures, &c., are provided for each boiler. For each furnace there is one multi-vane blower driven by a 60 H.P. geared steam turbine (3,600 to 510 speed ratio). These blower turbines are guaranteed to have a steam consumption not exceeding 28 lb. per brake-horse-power hour.

THE FLOW OF ELECTRICITY THROUGH DIELECTRICS.*

BY S. W. RICHARDSON, M.A., D.SC.

Curie,† Hopkinson‡ and other observers have shown that when a condenser was charged by means of a battery of constant E.M.F. the charging current diminished as the time of charging increased. Results obtained by the author when the dielectric consisted of glass, paraffin, ebonite, quartz and Iceland spar are in agreement with this conclusion.

The author found that if (during charging) the applied E.M.F. E is suddenly reduced to E′ (say), then, provided that E′ is greater than a certain value, P, a current flows through the specimen in the same direction as the original charging current; but that if E′ is less than P a current flows (for some time) in the opposite direction to the charging current.

P is taken as a measure of the E.M.F. of polarisation of the dielectric in the given conditions. P increases with the time of charging, very rapidly at first, but more slowly afterwards.

He calculated the rate at which the charge was accumulating in a specimen of quartz, cut perpendicular to the optical axis, and a specimen of Iceland spar, cut parallel to a cleavage plane (of known areas and thicknesses), from the data given by him in a previous Paper published in the transactions of the Royal Society of October, 1915.

A relation between these various quantities can be obtained which enables the true electrical resistance of the specimens to be determined.

For if γ = the charging current, E = the applied E.M.F., P = the E.M.F. of polarisation of the dielectric, dQ/dt = the rate at which the charge is accumulating in the dielectric, then we have

$$\gamma = \frac{dQ}{dt} + \frac{E - P}{R},$$

where R is the true electrical resistance of the specimen.

In the case of the specimen of quartz, the values of R obtained in this way for times of charging are in general agreement. The results for Iceland spar seem to indicate a diminution in the value of R as the time of charging increases.

In the Paper referred to above he showed how small quantities of electricity escaping from a dielectric during discharge can be measured. To measure the charging current the same apparatus has been used. One surface of the specimen was connected to the battery, the other surface (and the electrometer and subsidiary condenser) being to earth. When the current had been flowing for a time, t_1, this surface was disconnected from the earth, and at a later time, t_2, it was disconnected from the electrometer and subsidiary condenser. The quantity of electricity ΔQ which had accumulated in the subsidiary condenser was measured as in the previous experiments.

Then we have

$$\gamma = \frac{\Delta Q}{t_2 - t_1},$$

where γ represents the value of the charging current after it has been flowing for a time $\frac{1}{2}(t_1 + t_2)$.

To obtain the E.M.F. of polarisation a second battery and a potential divider were used, and the subsidiary condenser was dispensed with.

The apparatus was set up as shown in Fig. 1. The current was first caused to flow through the specimen, and the direction of the movement of the line of light on the scale when K_1 was operated was noted.

Both surfaces of the specimen were then connected to the earth until all trace of previous charging had disappeared. The battery I was then connected to one surface of the specimen for a given time. The sliders, having been clamped together in such a way that K_1 and K_1 could be operated in succession by one movement of the hand, were pulled rapidly across the frame, and the movement of the line of light was noted. This experiment was repeated for different values of *ab* until the line of light remained stationary for an appreciable time after the sliders had been pulled across the frame. The difference of potential between *a* and *b* was then measured with an accurate voltmeter. This difference of potential is equal to the E.M.F. of polarisation of the dielectric in the given conditions. The results obtained for a specimen of quartz cut perpendicular to the optical axis at 26·5 C., and for a specimen of Iceland spar cut parallel to a cleavage plane, at 27·8°C., are given below.

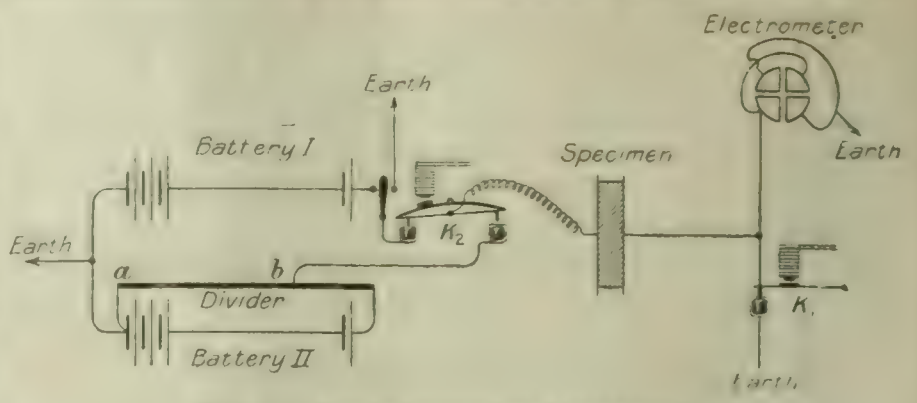


FIG. 1.—ARRANGEMENT OF APPARATUS.

Table I.—*Quartz.*

Time of charging.	γ.	dQ/dt.	P.	Apparent resistance.	R.
20 minutes .	$1{\cdot}64\times10^{-21}$	$0{\cdot}09\times10^{-21}$	0·82	$6{\cdot}10\times10^{20}$	$1{\cdot}16\times10^{20}$
5 ,, .	$1{\cdot}68\times10^{-21}$	$0{\cdot}20\times10^{-21}$	0·81	$5{\cdot}95\times10^{20}$	$1{\cdot}28\times10^{20}$
2 ,, .	$1{\cdot}92\times10^{-21}$	$0{\cdot}28\times10^{-21}$	0·80	$5{\cdot}20\times10^{20}$	$1{\cdot}22\times10^{20}$
1 ,, .	$2{\cdot}08\times10^{-21}$	$0{\cdot}39\times10^{-21}$	0·80	$4{\cdot}81\times10^{20}$	$1{\cdot}18\times10^{20}$
10 seconds .	$3{\cdot}80\times10^{-21}$	$0{\cdot}88\times10^{-21}$	0·65	$2{\cdot}63\times10^{20}$	$1{\cdot}20\times10^{20}$
				Mean	$1{\cdot}21\times10^{20}$

The area of the silvered surface being 29·7 sq. cm., and the thickness of the specimen 0·18 cm., the specific resistance ρ is obtained from the relation

$$\rho = R\frac{29{\cdot}7}{0{\cdot}18} = 2{\cdot}0\times10^{22}.$$

Table II.—*Iceland Spar.*

Time of charging.	γ.	dQ/dt.	P.	Apparent resistance.	R.
10 minutes .	$4{\cdot}66\times10^{-22}$	$0{\cdot}02\times10^{-22}$	0·33	$2{\cdot}15\times10^{21}$	$1{\cdot}44\times10^{21}$
8 ,, .	$4{\cdot}68\times10^{-22}$	$0{\cdot}03\times10^{-22}$	0·32	$2{\cdot}14\times10^{21}$	$1{\cdot}46\times10^{21}$
5 ,, .	$4{\cdot}71\times10^{-22}$	$0{\cdot}06\times10^{-22}$	0·31	$2{\cdot}12\times10^{21}$	$1{\cdot}48\times10^{21}$
3 ,, .	$4{\cdot}79\times10^{-22}$	$0{\cdot}14\times10^{-22}$	0·30	$2{\cdot}09\times10^{21}$	$1{\cdot}50\times10^{21}$
2 ,, .	$4{\cdot}86\times10^{-22}$	$0{\cdot}20\times10^{-22}$	0·29	$2{\cdot}06\times10^{21}$	$1{\cdot}53\times10^{21}$
1 ,, .	$5{\cdot}12\times10^{-22}$	$0{\cdot}35\times10^{-22}$	0·26	$1{\cdot}95\times10^{21}$	$1{\cdot}53\times10^{21}$
30 seconds .	$5{\cdot}42\times10^{-22}$	$0{\cdot}47\times10^{-22}$	0·23	$1{\cdot}84\times10^{21}$	$1{\cdot}56\times10^{21}$
				Mean	$1{\cdot}51\times10^{21}$

The area of the silvered surface being 25·35 sq. cm., and the thickness of the specimen 0·386 cm.,

$$\rho = 9{\cdot}9\times10^{22}.$$

B.E.A.M.A. ANNUAL MEETING.

The annual general meeting of the B.E.A.M.A. was held at the Connaught Rooms (London, W.C.) on Thursday last, and Mr. F. R. Davenport (Willans & Robinson, Ltd.), chairman of the Council, presided over a good attendance of members. In submitting the annual report and balance-sheet the chairman said that notwithstanding the handicaps under which members were suffering due to shortage of labour, difficulties in obtaining materials, Government control, &c., &c., they had, compared with some other trades, no reason to be dissatisfied with the situation.

Mr. Davenport said that public attention was at present being largely directed to the question of the probable situation after the war, and several associations purporting to look after that matter and working more or less on parallel lines had sprung up. The B.E.A.M.A. had been invited to join some of these associations, but up to the present had not done so, though they had given considerable time to the exchange of views and the holding of conferences and were still directing their attention to the efforts made towards creating some central and representative

* Abstract of a Paper read before the Royal Society.

† Annales de Chimie et de Physique, 1888.

‡ Phil. Trans. (1897).

body which would embrace the common interests of all British traders. Suggestions had been made by the B.E.A.M.A. to the Colonial Office that money raised within the Empire should be expended on British goods, and whilst the Secretary of State for the Colonies was unable to give any definite assurance, there appeared now to be a far more favourable atmosphere surrounding the whole question of Colonial and Allied trade. The association had been in conference with the Advisory Committee of the Commercial Intelligence Department of the Board of Trade, to whom memoranda had been submitted, many of the recommendations put forward being (the chairman understood) embodied in the report made by that committee. They had been in conference with the Government Research Committee which was appointed by the Board of Education to inquire into the broad question of scientific and industrial research and for granting money in aid of research. Although he had nothing to say at the moment as to probable results, their committee was a strong one, and there was every sign that good results would flow from the effort.

With a view to organising and extending the export work of members, additions had been made to the export staff, and Overseas Committees had been appointed in India, Australia and South Africa. Others, it was hoped, would be shortly appointed. Home conditions of contract and standardisation still remained amongst their fundamental activities, and they had been actively engaged in these directions. He thought they might say that their position as an association, both nationally as well as in relation to their own trade circles, had been strengthened without in any sense alienating, as far as he was aware, customers' minds and their general opinion of the B.E.A.M.A.

In the discussion which followed Mr. Lundberg (A. P. Lundberg & Sons), Mr. Longbottom (Electromotors, Ltd.) and Mr. Berry (Berry, Skinner & Co.) referred to the unsatisfactory position in regard to patents. Practically all members were now controlled firms, and their patents were naturally in a state of suspension, although patent fees had to be paid. That meant that the useful life of the patent would be shortened by the duration of the war. It was considered that notwithstanding the unsympathetic attitude of the Board of Trade the matter should be persevered with.

The report was adopted, and Callender's Cable & Construction Co. (Ltd.) were elected members of the Council.

PARLIAMENTARY RECORD FOR 1915.

At the conclusion of each Parliamentary Session it has been our custom to give a brief record of the work of the session so far as it affects the electrical industry. On this occasion our task is comparatively light, for though the output of legislation is higher than usual, it is mainly concerned with the conduct of the war, and the measures that have been passed, with the exception of those relating to taxation, are only temporary expedients adopted for the more effective prosecution of the war.

In regard to private bill legislation, the record is not up to the average of recent years. The number of provisional electric lighting orders was somewhat below the usual figure, and many of them were extension orders granted to existing electric supply undertakers. The number of private Acts was much below the average, but in a few cases useful powers were conferred upon local authorities for carrying on their electric supply and tramway undertakings. Some comment on certain aspects of the past year's legislation appears in another column.

PUBLIC ACTS.

- Customs (Exportation Restriction).
- Defence of the Realm Amendment.
- Defence of the Realm (Amendment) (No. 2).
- Finance (No. 3).
- Expiring Laws Continuance.
- Legal Proceedings against Enemies.
- Munitions of War.
- Munitions of War (Amendment).
- Patents and Designs Act (Partial Suspension).
- Postal and Telegraph Rates (Statutory Limits).
- Price of Coal (Limitation).
- Trading with the Enemy Act (1914) (Amendment).
- Trading with the Enemy (Amendment).
- Trading with the Enemy Amendment (No. 2).
- Trading with the Enemy (Extension of Powers).

PROVISIONAL ORDER CONFIRMATION ACTS.

Electric Lighting Provisional Orders (No. 1) : [Clifden, Enniscorthy].

Electric Lighting Provisional Orders (No. 2) : [Haworth Urban District, Irlam, Kingston-upon-Hull (Extension), Knaresborough, Litherland, Normanton Urban District, Ryde (Amendment), Skipton, Stanley (Yorkshire), and Tenby].

Electric Lighting Provisional Orders (No. 3) : [Andover, Boston and District, Chipstead and District, Connah's Quay, East Grinstead Urban District, Selby and District, Southampton (Extension), and Street and District].

Electric Lighting Provisional Orders (No. 4) : [Harrogate (Extension), Keighley (Extension), Teignmouth, Tunbridge Wells (Extension), Warrington (Extension), and Ystradgynlais].

Electric Lighting Provisional Orders (No. 5) : [Urban Districts of Wath-upon-Dearne, Bolton-upon-Dearne and Thurnscoe].

Tramway Provisional Orders : [Bury, Hull].

CONFIRMATORY ACTS UNDER PRIVATE LEGISLATION PROCEDURE (SCOTLAND) ACT, 1899.

Aberdeen Corporation Order Confirmation.
Dunfermline & District Tramways (Extensions) Order Confirmation.

PRIVATE ACTS.

- Aberdare Urban District Council (Tramways, &c.).
- Ascot District Gas & Electricity.
- Bristol Tramways.
- Dewsbury Corporation.
- Doncaster Corporation.
- Glasgow (Celluloid).
- Halifax Corporation.
- Ilfracombe Gas.
- Lincoln Corporation.
- London County Council (Celluloid) and Cinematograph Films).
- London County Council (Tramways and Improvements).
- Lurgan Urban District Council.
- London Electric Railway Companies' Facilities.
- Mersey Railway.
- Metropolitan District Railway.
- Ormskirk Gas & Electricity.
- Plymouth Corporation.
- Rhondda Urban District Council (Tramways Extensions, &c.).
- Rotherham Corporation.
- Sheffield Corporation (Tramways).
- South Shields Corporation.
- Spennymoor and Tudhoe Gas.
- Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board.

BILLS WITHDRAWN OR ABANDONED.

London & District Electricity Supply. (*Not proceeded with.*)
London Electric Supply. (*Withdrawn after First Reading.*)
Yorkshire Electric Power. (*Withdrawn.*)

LEGAL INTELLIGENCE.

Electrical Engineers' Slander Action.

On the 27th ult., before Mr. Justice Atkin and a special jury, Messrs. Berkeley & Young (Ltd.), electrical engineers, claimed damages for alleged slander from Mr. R. H. N. Lindley, of Dalston. Defendant denied that he spoke the words complained of, and pleaded alternatively that if he did so it was on a privileged occasion.

Mr. ALEC NEILSON (for plaintiffs) said that defendant had slanderously used language to the effect that plaintiffs' firm was a German concern. Plaintiffs were now engaged on Government work, and they had nothing whatever to do with Germany. They did not desire damages, and if an apology was offered by defendant they would be satisfied. Every one connected with the management of plaintiff company was, and always had been, English. Mr. Arthur Bergtheil and Mr. Edward Bergtheil, the only two shareholders in the company, were both born in England. Their father had been in the Natal Parliament. In March, 1915, a Mr. Stent, who was in the employment of plaintiffs, went to defendant, who was head of Messrs. C. Lindley & Co., a firm of tool makers. Mr. Stent sent into defendant a card with the name of plaintiff firm on it, and defendant thereupon came out of his private office, and in the presence of several of his own employés said to Mr. Stent : "Are you from Bergtheil & Young ? It is a German firm, and we will do no business with them whatever. They are a German firm, and it is a German name." Counsel added that, in order to dissociate themselves entirely from Germany plaintiff firm recently, with the full consent of the Board of Trade, had changed their name to "Berkeley & Young."

At this point counsel interviewed his Lordship in his private room, and upon their return Mr. DALE (for defendant) said that, while defendant considered that he was perfectly justified in defending the action, and while he repeated that he himself never said, or intended to say, the words complained of, but had only inquired into the nationality of plaintiffs and of the goods offered by them, he was willing to say he was sorry for what had occurred, if any construction could be placed upon his alleged utterance which would be in any way damaging to plaintiffs. Defendant admitted, and always had admitted, the explanation as to their nationality given by plaintiffs. They were an English firm and a reputable firm.

Mr. NEILSON said that the plaintiffs were satisfied now that allegations made against their nationality were withdrawn.

Mr. Justice ATKIN said that there was no longer any imputation on any of the parties, and the record was withdrawn.

Blatch v. Port of London Authority.

On Friday the Court of Appeal (Lords Justices Swinfen Eady, Pickford and Bankes) heard an appeal by the Port of London Authority against the refusal of the Lord Chief Justice to enter judgment in their favour in an action brought against them by the widow of an electrician named Blatch, who fell into a graving dock belonging to appellants and was drowned. The accident occurred on a dark and foggy night, when deceased was returning from the Millwall Dock, where he had been employed on a ship. At the trial the jury disagreed, and defendants applied for judgment. The learned judge, however, would not accede to this, and plaintiff set the case down for re-trial. The present appeal was advanced so that it might be disposed of before the case was re-heard.

Their lordships allowed the appeal, and entered judgment for defendants, holding that there was no evidence called by plaintiff of any breach of duty by defendants towards deceased, nor any evidence that defendants omitted any precautions usually or ordinarily taken by the owners of graving docks.

Leiston Gas Co. v. Leiston-cum-Sizewell Urban Council.

On Tuesday Mr. Justice Low delivered his reserved judgment in this action, in which plaintiffs claimed £157. 15s. 9d. for lighting services rendered to defendants under a contract dated June 2, 1911. In delivering judgment his Lordship said plaintiffs' claimed three quarterly payments, said to be due under an agreement dated June 2, 1911. The agreement was for five years from Aug. 1, 1911, and was to remain in force until determined by either party giving six months' written notice expiring on July 31, 1916, or on July 31 of any subsequent year. No notice to determine had been given. By clause 2 of the agreement plaintiffs understook to provide columns, lanterns and burners, and to connect them to their mains by Aug. 1, 1911, the whole of the plant to remain the property of plaintiffs. That obligation was performed, and, so far as that was concerned, the contract was executed. Further, by clause 4 it was provided that, during the contract, plaintiffs were to supply gas, light, extinguish, clean, repair and maintain the lamps, &c. It was not alleged that that obligation had not been performed, with the exception that the supply of gas light was stopped. Under the Defence of the Realm Acts, 1914 and 1915, orders had been made by a competent military authority stopping the lighting of the lamps referred to in the agreement. In those circumstances it had been contended that, when the order was made forbidding the lighting of the lamps, the agreement came to an end, and plaintiffs were entitled to remove and dispose of the lamps and other plant, and defendants were absolved from making any further payments. In support of that proposition defendants relied on certain decided cases. The contract was not only a contract to supply light, but also a contract to supply (for a period) the necessary plant, and it was impossible to distinguish in the amount agreed to be paid per lamp how much was deferred payment spread over the period for supplying the plant and how much was for the actual gas consumed. He had, therefore, to consider whether the provision of plant and supply of gas in defendants' district had become unlawful within the meaning of the cases cited. He did not think that it was correct to say that, because in time of emergency, power was given for a competent authority to suspend the actual lighting in a given area for such times as may be considered necessary for national safety and because such power was exercised a provision for lighting within that area became unlawful within the meaning of those cases. Nor did he think that it rendered it impossible within the meaning of the cases referred to. What the Court in those cases considered was a state of things which rendered the carrying out of the contract absolutely and completely unlawful or once for all impossible. In the present case it was impossible, from day to day, or from week to week, to tell whether it might be necessary to stop all or some only of the light or whether it would be possible to resume lighting altogether, and, in his view, plaintiffs must be ready on the repeal or relaxation of the restriction to go on providing the light and must keep the whole of the apparatus in working order ready for that purpose; it did not appear to be material that the restriction, which might possibly have been a very short one, had turned out to be one of considerable length. He was also of opinion that that contract was an executed contract in the sense which he had stated above, and that it was impossible to divide the charge per lamp and say so much only was due for plant and so much for gas actually burnt. He came to the conclusion that, through the exercise by the authorities of their powers under the Defence of the Realm Acts the performance of that contract had not been rendered either unlawful or impossible within the meaning of the cases to which reference had been made. In his opinion, the suggestion made by plaintiffs that they should credit defendants with the gas not consumed was a wise and fair one, and it was a pity that defendants did not accept it instead of spending ratepayers' money in litigation. Perhaps Parliament would insert in one of the emergency statutes a clause providing for equitable adjustment of such disputes. As to the defendants' contention that the contract should be treated as suspended during the time that the order was in force, he could see no ground for taking such a course.

Devonport Tramways Arbitration,

Mr. B. H. Blyth, the arbitrator appointed to ascertain the price to be paid by Plymouth Corporation for the undertaking of the Devonport & District Tramways Co., has issued his award. In the award the Corporation are directed to pay the company in respect of the tramway undertaking, the light railway and the profits the company might have been expected to earn between Oct. 2, 1915, and Aug. 12, 1919, the sum of £103,970. 1s. 4d. Each party is to bear its own cost of the reference, and the arbitrator's costs are to be borne in equal shares by the Corporation and company. The company claimed £257,000, but for the Corporation the value of the undertaking and compensation payable were assessed at £93,000.

Irish Electric Lighting Contract.

Arbitration proceedings have recently taken place in Dublin on disputes between the Marquis of Sligo and T. E. Brunker, electrical engineer, of Dublin, in respect of the installation of electrical plant for lighting Westport House, Sligo, the residence of the Marquis of Sligo. The questions in dispute were in connection with items amounting to £109, which were claimed as extras and disallowed by the architect, Mr. R. E. Mellon, Dublin; a sum of £156 deducted in respect of work alleged to be not in conformity with the contract, and a counterclaim by Lord Sligo for penalties for delay in execution of the work.

Evidence was given by Mr. Brunker, his manager (Mr. Clery) and workmen; and by Mr. R. E. Mellon and Mr. Shelton, the estate steward of the Marquis of Sligo.

The arbitrator (Mr. A. E. Porte) intimated he would make his award after an inspection of the premises.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

24,335 HUGHES. Electric arc lamps.

24,701 SEELAY & NEWMAN. Automatic phonographic responding and receiving devices for use with telephones. (30/12/13.)

24,937 HUNT & SANDYCROFT (LTD.) Alternating-current dynamo-electric machines, adapted for synchronous working.

A method of starting alternating-current dynamo-electric machines having windings on the rotor adapted to operate in cascade, and to co-operate with a direct-current field on the stator in order that the machine may run as a synchronous machine at cascade speed, according to which method the slip-rings connected to opposite terminal points are connected in pairs to variable resistances adapted to be varied simultaneously, while a short-circuiting switch is provided which may be closed to short-circuit one set of terminals, leaving the other set connected in star through the resistances, so that such resistances can be gradually increased until these slip-ring are open-circuited.

24,838 HUNT & SANDYCROFT (LTD.) Dynamo-electric machines.

A winding applicable to dynamo-electric machines designed to run as synchronous machines at a cascade speed, but which can be started and run up to speed as induction motors with one of the basal pole numbers, said winding having two or a multiple of two neutral star-connected points through which the direct-current excitation can be applied, while the main alternating currents are led in to pairs of terminals providing parallel paths which are united in the said neutral or star-connections.

24,839 HUNT & SANDYCROFT (LTD.) Alternating-current dynamo-electric machines.

1915 SPECIFICATIONS.

32 MORANO. Electric current modulators, more particularly for microphoness electric vibrators and the like.

A current modulator constituted by a suspension or gripping contact or suspension or gripping contacts which is or are submitted to the action of an exciter, and inserted into an electric circuit in series, in shunt or combined in any manner.

127 DOHRN. Means for lighting theatrical stages and other areas.

130 NORTH & ALLEN. Magneto-electric machines.

188 PRESSLAND. Cord-gripping means suitable for incandescent electric lampholders. (Cognate application, 562/15.)

190 WUILLOT. Electrical combined lighting and starting systems for motor vehicles and other purposes. (24/1/14.)

398 SIGNAL GES. Wireless telegraphy. (9/1/14.)

A system of electric wave telegraphy by radiation below the surface of water, in which alternating current of such frequency is employed that the dielectric alternating-current resistance of the medium becomes equal to or less than the ohmic resistance.

484 VAN SWAAY & KEUS. Electric transformer and circuit arrangements therefor. (27/1/14.)

491 B. T.-H. Co. (G.E. Co.) Systems of electric motor control and controllers therefor.

A control system for electric motors comprising a controller adapted to advance automatically at a rate determined by an electromagnetic retarding device, said device being controlled by a relay responsive to the motor current and arranged to produce several different predetermined retarding effects.

580 RELAY AUTOMATIC TELEPHONE CO. & AITKEN. Manual and semi-automatic telephone systems. (Cognate application, 869/15.)

723 SIEMENS SCHUCKERTWERKE GES. Stray-wave protection devices for electric circuits. (17/6/14. Patent of addition not granted.)

The application of a vacuum relay arranged in a magnetic field due to the conductor to be protected, for the purpose of protecting such conductor from the action of stray waves, this vacuum relay being so adjusted that it responds to the stray waves but not to fluctuations in the magnetic field.

1,802 KAPP. Phase-advancers for dynamo-electric machines. (Cognate application 4,795/15.)

Comprises the employment with each of the rotor phases of a dynamo-electric machine the field of which is produced as hereinafter described by current passing through separate field windings from each of the rotor phases, and the armature of which is in series with one of the rotor phases and the corresponding field winding; also means whereby the excitation produced by the winding which is in series with the armature can be increased for increased motor load and slip and decreased for decreased motor load and slip; also comprises the utilisation of the phase advancer to assist the main motor or drive one or more synchronous generators from which current can be delivered into the supply circuit, and the use of any suitable automatic electrical or mechanical apparatus which makes the aforesaid field controlling means dependent on the condition of the rotor current.

2,344 BEAVER & CLAREMONT. Bonding connector for bonding the armouring of electric cables.

2,570 GE[illegible]AN & THE BRITISH ELECTRIC TRANSFORMER CO. Means for protecting and indicating the condition of electric circuits.

3,710 PATTERSON. Frames or racks for use in charging secondary electric batteries.

3,774 WALKER. Electric signalling apparatus.

4,564 HORNBY. Electric motors.

5,594 DOD. Field telephone or telegraph wire reel.

5,909 REID. Telephone call recorder.

6,344 C[illegible]BER & KAHL. Telephone transmitters.

6,685 WESSEL. Coin-operated electric supply apparatus. (4/5/14.)

6,997 SIEMENS SCHUCKERTWERKE GES. Dynamo-electric machinery. (11/5/14.)

7,473 SIEMENS SCHUCKERTWERKE GES. Switch-closing devices for dynamo-electric machinery. (30/5/14.

9,386 HAMILTON & FERRANTI (LTD.) Casings for electricity meters. (Divided application on 24,792/14. Dec. 30.)

10,676 LANDIS & GYR AKT.-GES. Alternating-current ampere-hour electricity meters. (27/7/14.)

15,081 FORRESTER. (Dunham.) Joint for electric light fittings, particularly applicable to portable electric lamps.

APPLICATIONS FOR PATENTS

*NOTE.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. These marked * are open to inspection 15 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 28, 1915.

[illegible] LANDIS & GYR AKT.-GES. Electric [illegible]-meters. (Addition to and divided [illegible] 30/6/1915. Switzerland.)*

[illegible] TAYLOR. Telephone [illegible]. (Divided [illegible] 6,480/15. April 30.)*

[illegible] EISLER. Polarised [illegible]. (24/12/14. U.S.)*

December 29, 1915.

[illegible] WILSON. Means [illegible] electric [illegible]. (9/7/15. U.S.*)

[illegible] WILSON & [illegible]. Alternating-current [illegible]. (16/6/15. U.S.)*

[illegible] MARTIN. Dynamo-electric machines. (1/7/15. U.S.*)

December 30, 1915.

[illegible] GLENNIE. Lubricant for tramway cars.

[illegible] BROWN. Electric [illegible].

28,171 ESCOTT & AITKEN. Electric torches for pencils, pens and the like.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	649	Control Equipments for Machine Tools. Illustrated	122
Imports and Exports of Electrical Manufactures	650	Air Regulating Device for Diesel Engine Compressors. Illustrated	124
Educational Notes	650	"Lamlok" Specialities	125
Business Notices	650	Half-Watt Projectors for Theatre. Illustrated	126
Bankruptcies, Liquidations, &c.	650	New Catalogues	126
Electricity Supply	650		
Traction Notes	651	Tenders Invited	653
Telegraph and Telephone Notes	652	Tenders Received & Accepted	653
Empire Notes	652	Companies' Meetings and Reports	654
Miscellaneous Notes	652	New Companies, &c.	654
		City Notes	655
The Round Table	119	Electrical Companies' Share List	655
Electricity in the Paper Mill. Illustrated	120		
"Angelus" Electric Fire. Ill.	121		

COMMERCIAL TOPICS.

Trade after the War. An important report has been issued by a sub-committee of the Advisory Committee of the Board of Trade, which was appointed to suggest measures to secure certain branches of British industry after the war. A number of far-reaching recommendations are made in regard to certain trades and articles of manufacture.

The sub-committee concerned itself with the paper manufacture, the printing and stationery, jewellers, and silversmiths' trades, glass, china and earthenware, toys, electrical apparatus, hardware, and the magneto industry. It recommends as follows :—

Research and Training.—Larger funds should be made available. The universities should be encouraged to maintain and extend industrial research work and the manufacturers encouraged to co-operate. A record of consultant scientists, chemists and engineers should be established for the use of manufacturers only.

Copyright.—The United Kingdom copyright law should be brought into line with that of the United States.

Patents.—Uniformity of patent law throughout the Empire should be aimed at. The law as to the compulsory working of patents in the United Kingdom should be more rigorously enforced. The fullest possible information as to enemy patents should be given to British firms during the war and every practicable assistance for their use.

Trade Marks.—All German and Austrian goods imported into the United Kingdom should be required to be marked with an indelible mark, "Made in Germany" or "Made in Austria-Hungary," and goods imported from other foreign countries should be similarly marked either with the country of origin or with the words "Foreign Made" or "Not British." Such marking should be on the goods, and not on the package. Alien firms and alien-owned companies should be prohibited from registering in the United Kingdom trade marks containing English words.

Transport Facilities.—No preference should be accorded to traders in other countries by British shipping companies or shipowners or by home railways. The canal system of the United Kingdom should be improved and extended. Shipping companies should be prohibited from charging higher rates of freight from British ports than from North European ports.

Financial Assistance.—The joint stock banks should be invited by the Government to afford greater assistance to British industrial enterprise. Government departments, local authorities, &c., should be required to purchase, so far as possible, only goods produced within the British Empire. British financial houses concerned in the issue of foreign loans in the United Kingdom should be urged to endeavour to secure preferential treatment for British contractors and manufacturers in respect of the public works to be carried out by means of such loans.

Trade Exhibitions should be held under the Board of Trade's control, and should be exhibitions of manufacturers' wares for traders and not organised to attract the general public.

Protection of British Trade Marks Abroad.—H.M. consular officers should be directed to watch for and report immediately cases of apparent infringement or attempts to pass off foreign-made goods as British.

Ministry of Commerce, &c.—The formation is recommended of a separate Ministry charged solely with the safeguarding and extension of British industry and trade. The appointment of trade commissioners should be extended to the principal foreign countries.

Consular Service.—Should be reorganised with a view to increasing its commercial utility.

Tariff Protection.—The members of the sub-committee : "We are of opinion that where the national supply of certain manufactured articles which are of vital importance to the national safety or are essential to other industries has fallen into the hands of manufacturers and traders outside this country, British manufacturers ready to undertake the manufacture of such articles in this country should be afforded sufficient tariff protection to enable them to maintain such production after the war." It will be necessary to impose some widely spread import duties, and they are prepared to recommend that a larger proportion of the revenue should be raised by reasonable import duties. Such duties would go a long way towards satisfying the requests for special protective treatment for the industries which the sub-committee has had under consideration. Approximate tariff rates are given, but on glassware (table and lighting glass) they recommend total prohibition of German and Austrian glass for three or five years, then 33⅓ per cent. ad val. On optical and chemical glass 25-30 per cent. ad val. for five years; on common glassware 10-15 per cent. ad val.; and on glass bottles 5 per cent. ad val. On china and earthenware 20 per cent. ad val. (with a higher rate on fancy wares); on mechanical toys an absolutely prohibitive rate; and on magnetos 33⅓ per cent. ad val.

The report is signed by Sir Algernon F. Firth (President of the Association of Chambers of Commerce), Mr. A. J. Hobson, Mr. Stanley Machin (chairman of the London Chamber of Commerce), Mr. E. Parkes, M.P., and Sir Albert Spicer, with Mr. P. Ashley as secretary.

* * * *

Mining Machinery in Mexico. Some evidence of an improvement in Mexican affairs may be found in the fact that the Mines Co. of America has recently placed an important contract with the Westinghouse Electric Co. for new machinery for installation at its mines in Mexico. It is expected that there will be a large saving in cost of production per ton of ore. The purchase of this machinery would indicate that preparations are being made to resume operations, and that Mexico is very slowly returning to peaceful occupations.

* * * *

Trade in War Time. The thirteenth annual meeting of the Wholesale Traders' Association for the Protection of the Hardware, Furnishing & Metal Industries (Ltd.) since its incorporation was held at Birmingham on the 18th ult. The chairman (Major J. H. Cartland, J.P.), in presenting the report and balance-sheet, said that the operations of the Association had been fully maintained, and that the members had made extensive use of its various departments. During the past year, 189 members had joined bringing the total membership of the Association up to 3,082. Notwithstanding the war and the fact that a large number of firms were doing Government work (and, therefore, were not seeking to open new accounts, the number of status inquiries sent in during the year had reached a total of 92,173, thereby showing that there was still a good general trade being done by the various manufacturers and merchants throughout the country, and that a large number of orders had been received from foreign and colonial markets which they were unable to execute at present. The debt recovery department had 19,233 cases for collection, against 18,126 during the previous year, representing a total credit of upwards of £171,000, and out of this sum only about 10 per cent. proved irrecoverable or bad. With regard to the insolvency department, companies' liquidations, &c., a large number of cases were reported during the year, meetings attended and action taken in the interests of members. In several instances the result had been an increased dividend for creditors. It was reported that a Bill would be introduced in the House of Lords for the registration of persons and firms carrying on business in Great Britain and Ireland, and that was a measure which the Association had advocated through different channels for some time past.

* * * *

Pan-American Scientific Congress. At the second Pan-American Scientific Congress, which was recently held in Washington, several resolutions were passed in favour of closer relations between the United States and the Latin-American republics. The resolutions included one in favour of the adoption of the metric system throughout the Western Hemisphere; also one recommending the appointment of an American committee of radio communication to assist in the development of radio communication. It was agreed that Spanish should be taught more generally in the United States schools, and English in those of Latin-America; that the Governments of the American republics be petitioned to further the interchange of instructors and students; and that a Pan-American library in the different languages of the hemisphere be established.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 24, 1916, *to* Jan. 29, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. *(See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Unenumerated, 10 pkgs.
Holland: Elec. Lamps, 20 cases.
GRIMSBY.—*France:* Unenumerated, 29 pkgs.
Holland: Unenumerated, 5 pkgs.
LIVERPOOL.—*U.S.A.:* Electrodes, 52 pkgs.; unenumerated, 13 pkgs. *France:* Carbon candles, 12 pkgs. *Spain:* Elec. carbons, 105 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £1,318; carbon candles, £171; elec. lamps, £155; telephone material, £96; lamp parts, £628; unenumerated, £2,561—317 pkgs. *Holland:* Elec. lamps, £1,728—106 pkgs.; unenumerated, £429. *France:* Carbon candles, £375; lamp parts, £68; unenumerated, £303—48 pkgs. *Switzerland:* Carbon candles, £540; elec. machinery, £17; unenumerated, £451. *Denmark:* Elec. machinery, £1,345; unenumerated, £1,663. *Japan:* Lamp parts, £153. *Italy:* Elec. wire, 135 pkgs.; elec. machinery, £190.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. machinery, £50; unenumerated, £199. *Melbourne:* Wire and cable, £203; elec. machinery, £161; unenumerated, £588. *Sydney:* Elec. machinery, £1,378; wire and cable, £5,600; unenumerated, £716. *Wellington:* Wire and cable, £459; unenumerated, £1,405. *Adelaide:* Wire and cable. £140; unenumerated, £573. *Perth:* Unenumerated, £44. *Christchurch:* Unenumerated, £729. *Dunedin:* Wire and cable, £77; unenumerated, £59. *Lyttelton:* Elec. machinery, £1,303; unenumerated, £136. *Hobart:* Wire and cable, £189; unenumerated, £60. *Brisbane:* Unenumerated, £294. *Newcastle:* Wire and cable, £400. *Napier:* Unenumerated, £18. *Bluff:* Unenumerated, £29.
AFRICA.—*Durban:* Elec. machinery, £318; wire and cable, £523; telegraph material, £93; unenumerated, £1,125. *Cape Town:* Unenumerated, £912. *Port Elizabeth:* Unenumerated, £79. *East London:* Unenumerated, £124. *Mauritius:* Unenumerated, £77.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Unenumerated, £1,856. *Pernambuco:* Unenumerated, £209. *Rio de Janerio:* Unenumerated, £211. *Santos:* Unenumerated, £108.
SOUTH SEA ISLANDS.—*Fiji:* Unenumerated, £27.
HOLLAND.—*Amsterdam:* Wire and cable, £545; unenumerated, £73.
CANADA.—*Montreal:* Elec. machinery, £117; unenumerated, £467.
NORWAY.—*Christiana:* Elec. cable, £67.
DENMARK.—*Copenhagen:* Wire and cable, £1,752.
SWEDEN.—*Gothenburg:* Wire and cable. £693. *Stockholm:* Wire and cable, £317.
U.S.A.—*New York:* Unenumerated, £120.
PORTUGAL.—*Lisbon:* Unenumerated, £102.
SPAIN.—*Barcelona:* Unenumerated, £48.
ITALY.—*Genoa:* Unenumerated, £409.
WEST INDIES.—*Barbados:* Unenumerated, £10.
EGYPT.—*Alexandria:* Unenumerated, £58. *Port Said:* Unenumerated, £115. *Suez:* Unenumerated, £13.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Telegraph material, £190; unenumerated, £879. *Balowan:* Unenumerated, £58. *Calcutta:* Unenumerated, £1,167. *Singapore:* Unenumerated, £54. *Penang:* Unenumerated, £53. *Karachi:* Unenumerated, £166. *Ceylon:* Unenumerated, £181. *Madras:* Glow lamps, £333; unenumerated, £596.
CHINA.—*Hongkong:* Elec. machinery, £62; unenumerated, £350. *Shanghai:* Elec. glow lamps, £85; unenumerated, £52.
FRANCE.—*Dieppe:* Unenumerated, £106. *Paris:* Unenumerated, £267. *Calais:* Unenumerated, £45. *Boulogne:* Unenumerated, £120.
CHANNEL ISLANDS.—Unenumerated, £10.

FOREIGN GOODS (duty paid and free).

Bombay: Unenumerated, £61. *Boulogne:* Unenumerated, £12. *Cape Town:* Unenumerated, £207. *Havre:* Unenumerated, £85. *Madras:* Unenumerated, £283. *Marseilles:* Unenumerated, £125. *Wellington:* Unenumerated, £75.

IN TRANSIT.

Melbourne: Elec. lamps, £460. *Sydney:* Elec. lamps, £780. *Shanghai:* Elec. lamps, £397.

EDUCATIONAL NOTES.

University of Liverpool.—The Lent term began on Jan. 11. The special matriculation examination or the entrance examination must be passed to secure admission to the courses of instruction in the Faculty of Engineering. Prospectuses and full particulars of the courses in electrical, civil, mechanical and marine engineering, design and drawing, mathematics, physics and inorganic chemistry may be obtained from the registrar, Mr. Edward Carey. There are well-equipped laboratories, and facilities for practical and research work are available.

Birmingham University.—The annual report of the Council was issued on Tuesday last.

It is stated that the Council has agreed to accept a year of service in H.M. forces as a substitute for the third year of attendance at the University. The income was £62,545 (compared with £76,792 in previous year) and the deficit £2,874 (against £1,591). The City Council's grant has been reduced from £15,000 to £13,000 for one year. The number of students of all kinds last session was 786, a decrease of 246.

BUSINESS NOTICES.

The Curtis Mfg. Co. ask us to announce that they have just received a letter from their principal (Mr. F. C. Curtis) in which he wishes to be kindly remembered to all his friends in the trade. Mr. Curtis, after putting in seven months signal work in the trenches with the Royal Naval Division R.E. at Gallipoli, is now at ——— in charge of the motor cycle maintenance for the division. The business is being carried on as usual in his absence, and the excellent standard of work is fully maintained, with the best possible delivery under the present circumstances.

Manufacturer Wanted.—An advertiser requires a manufacturer to make small dynamos in quantities.

Agencies Wanted.—A Danish firm advertise for the sole agency for electrical novelties.

A London heating company advertises that it can accept the selling rights of electrical heating and cooking appliances (other than electric fires) for London and district.

Increase of Prices.—Owing to the continued increase of the price of raw material and labour, the Jackson Electric Stove Co. notify that they have increased all their prices by a further 10 per cent. as from Feb. 1, making a total increase of 20 per cent.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Geo. Edwd. Bonner, electrical engineer, Asheroft, 103, Fox-lane, Palmer's Green, Middlesex, the first meeting of creditors will take place on Feb. 11 at 14, Bedford-row, London, W.C., and the public examination on Feb. 21 at the Court House, Edmonton.

A meeting to receive an account of the winding up of the Sheffield Electrical Engineering Co. (Ltd.) (in vol. liq.) will be held at the office of Messrs. Hurst & Hewitt, 8, Park-parade, Ashton-under-Lyne, on Feb. 29.

A meeting to receive an account of the winding-up of the Electric Railway Signalling Synd. (Ltd.) will be held on March 1, at 32, Great St. Helens, London, E.C.

ELECTRICITY SUPPLY.

EXTENSIONS.

Glasgow.—There has recently been a great increase in the demand for electric power, and additional generating plant will have to be provided at a cost of £54,000.

The Electricity Committee recommend that orders be placed for two 8,000 H.P. turbo-alternators, condensing plant, &c. One set will be erected in Port Dundas station and the other in St. Andrew's Cross station. Completion of the orders is promised by September next.

Stoke-on-Trent.—The Corporation have agreed to equip a sub-station upon Messrs. Kerr, Stuart & Co.'s works, in order to give supply of current on the three-phase system. The supply is additional to that given under the company's existing agreement, and will entail an estimated cost of £1,200, Application has been made to the L.G. Board for sanction to borrow this amount and the Board have notified that they will do everything possible to expedite the loan.

The Engineer was authorised at the last meeting to place orders for the necessary switchgear and transformers required, in order to give the additional supply.

Wigan.—The Electricity Committee recommend the Corporation to put down an additional 3,000 k.w. turbo-alternator, surface condenser, two rotary converters, a water-tube boiler, &c., at the electricity works at an estimated cost of £30,450.

GENERAL.

Aberdeen.—In the monthly report of the city electrical engineer (Mr. J. Alex. Bell) it is reported that the units generated during December were 1,486,770, an increase of 170,870 units compared with the corresponding period last year.

Birmingham.—It is stated that, owing to the increased cost of fuel and the general advance in the price of all kinds of commodities, the Electric Supply Committee are considering a proposal to increase the charges for electrical energy.

Since the outbreak of war there has been no advance in prices, but at present the Finance Sub-committee is going into the position and will report to the next meeting of the full Committee. The members are stated to be in favour of a revision of the charges.

The Tramway Committee propose to give £50,000 out of the profits of the tramway undertaking to relief of rates, an increase of £20,000 over 1915.

Last year the tramways, electric supply and gas departments contributed collectively £102,735, as compared with £135,690 in the previous year and £155,711 the year before that. Of the £102,735, the Gas Committee contributed £37,350, the electric supply department £35,385 and the tramways £30,000, these figures comparing with £65,584, £25,134 and £44,971 respectively in the previous year. It is stated that the Gas Committee have offered a contribution of £40,000 this year, but the Electric Supply Committee's contribution will be some thousands less than they gave a year ago, and a figure approximating closely to that of 1914.

Commenting upon this, the "Birmingham Daily Post" says: "If this be true, it will be a surprise and perhaps a disappointment, because

the department have had an unusually good year in their trading. It is said, however, that the reduction has been brought about mainly by the high price of fuel, and that, as a matter of expediency, it was inadvisable to quarrel with the coal merchants who had entered into specific contracts for the supply of coal, and then found that owing to the war the cost of fuel and transport was much greater than had been estimated."

Dover.—The Council have agreed to the conditions of the Admiralty for the renewal of the loan of £157,519 in connection with the electric supply undertaking.

The loan is, therefore, to be renewed for five years at 5 per cent. per annum, with right at the end of five years to pay off at six months' notice.

Gloucester.—At last week's meeting of the City Council the Electricity and Light Railways Committee reported that Mr. J. B. Feltham, chief assistant engineer, had been unanimously appointed Chief Electrical Engineer of Mexborough, and that he wished to be released from his engagement at the end of January.

After reference had been made to the very efficient services which Mr. Feltham had rendered to the Corporation during a long term of years, it was resolved unanimously that the Council be recommended to accept Mr. Feltham's resignation as requested. The chairman and Electrical Engineer were asked to report upon the question of filling the vacancy.

The City High Sheriff reported that the electricity output for December was 215,000 units, against 209,000 units for the corresponding period of 1914.

Grimsby.—The charges for electrical energy are to be again increased, the revised scale coming into effect on April 1 next.

Haslingden.—The Finance Committee has instructed the treasurer to appeal against the assessment of the electricity works.

An arrangement has been made with Rawtenstall Council, with the consent of Accrington Corporation, for taking a supply of electric current, thus relieving Accrington from supplying about half the quantity usually supplied to Haslingden.

Heston and Isleworth.—Mr. S. Price, assistant shift engineer at the electricity works, who recently returned to his duties after being discharged from the Army, has now resigned in order to take up less exacting duties, as his recovery from his injury is likely to be slow. Mr. Nicholls, a shift engineer who was wounded at the Dardanelles, has been released for munition work, and this would enable him to resume his duties at the electricity station.

Hornsey.—The Council has agreed to the Electricity Committee's proposal to increase, as from March 31 next, the prices for current for private and street lighting and power and also meter rent by the addition of 10 per cent. on existing charges.

Ledbury.—The Council have agreed to allow the erection of poles and overhead wires for the supply of electricity in the side streets.

Leek.—At the recent meeting of the Council, Mr. Furmston, chairman of the Lighting Committee, made a statement with regard to the breakdown of the Diesel engine at the electricity works.

The Diesel engine was insured, and the insurance company had accepted liability, but under the circumstances the committee thought it would be desirable to have the advice of an expert, and they proposed to call in Prof. Watkinson to make a thorough examination into the condition of the works and give an opinion as to the cause of the breakdown. A new crank-shaft for the Diesel engine had been ordered, but every engineering works where such things were done was controlled by the Government, and it might be a considerable time before they could get a new shaft unless the authorities would grant a certificate for the work to be expedited. The committee would ask the local manufacturers to meet them and discuss the whole situation, and see what arrangements could be made to deal with the situation. The other engines were all running at present, but it was not desirable to run them continuously, and the committee had to ask for the forbearance of the manufacturers, as they had gone through a very trying time lately. They would have put in a new engine 12 months ago if they could have borrowed the money, but the Government would not allow a loan, and they had to go on as well as they could.

Liverpool.—The Tramways and Electric Power and Lighting Committee have set aside for relief of rates £100,000 from tramway profits, and £50,000 from the electricity undertaking, this being £25,000 more than last year.

Manchester.—At the meeting of the Electricity Committee last week it was reported that in the quarter ended Dec. 31 there was an increase of nearly five million units in the consumption of electrical energy, compared with the amount consumed in the December quarter of 1914. The power load increase was 24 per cent.

The committee have received a letter from the L.G. Board giving them permission to divert £83,000 of the sum authorised in respect of the Barton scheme, to cover the cost of the machinery put in temporarily at Stuart-street station in order to meet the present heavy demand upon the department.

The coal question is no longer a source of anxiety, as the committee is now getting coal from Northumberland, and the extra cost will be balanced by the higher rates and the augmented consumption of current for power.

The chairman stated that every man of military age in their employ had been started by the Government. They could not possibly release any more men and meet the great demands for current.

Monaghan.—At a recent public meeting the Council were authorised to sanction the erection of overhead poles and wires by Mr. Wm. Martin, who proposes to form a local electric supply company.

Poor Law Institution Lighting.—Exeter guardians have decided to introduce electric lighting into their Institution by instalments.

Rugeley.—The local gas company have notified the Urban Council of their intention to apply for a provisional electric lighting order.

Salford.—The Corporation are recommended to increase the price of electric current from 7½ per cent. on existing prices to 10 per cent. for lighting and 15 per cent. for power. The increases would operate as from April 1 next.

The Electricity Committee have entered into a new agreement with the Lancashire Electric Power Co. for the supply of electricity in bulk for a period of two years.

The agreement is conditional upon the Corporation taking current in bulk to a minimum value of £300 per month. The standing charge per kilowatt of demand is to be abolished, and the Corporation will be entitled to a normal demand of 1,000 kw., to be increased to 2,000 kw. by giving 15 minutes' notice, with a further increase to 3,000 kw. by giving one month's notice. The charges per annum will be as follows: 0·45d. per unit for first million units, 0·45d. per unit, less 5 per cent., for second million, and less 10 per cent. for all units in excess of two millions. The charges are to be subject to variation as the cost of coal increases or falls below 0·18d. per unit sold.

The Electricity Committee recommends application being made to the L.G. Board for sanction to borrow £13,660 for the provision of additional plant, &c.

Shipley.—The Council are recommended to increase the charge for electric current for power (not covered by special agreement) by 10 per cent. from April 1 next.

Slaithwaite.—The Urban Council have applied to the L.G. Board for an extension of two years from July 8 for carrying out the terms of their provisional electric lighting order.

Swinton and Pendlebury.—The Urban Council have decided t extend their agreement with the Lancashire Electric Power Co. fo the supply of electricity in bulk to the district until 1923.

West Bromwich.—The revenue from the sales of the electricity undertaking for the past quarter show an increase of £1,256, compared with the corresponding period in 1914.

TRACTION NOTES.

Birmingham.—The report of Col. Druitt, the Board of Trade inspector, on the recent tramway accident has been issued.

Col. Druitt states that there could be no doubt that the brakes on the tramcar were in perfect order at the time of the accident, and that what probably happened was that Motorman Owen after leaving the stop at Park-road let the car coast down the gradient, keeping it under control by means of the hand-brake, and that when, after passing Pugh-road and approaching the compulsory stop at the bottom of Victoria-road, he found he was going rather too quickly to make an easy stop, so he suddenly applied the magnetic track brake to its full extent instead of gradually stop by stop, and so caused the wheels to pick up. That would perhaps account for the sudden jump the car gave between Pugh-road and the "stop" described by the conductor. If the speed was not greater than nine miles an hour (as stated by Owen) the car would have gone round the curve, which was of 150 ft. radius, with a super elevation for the outer rail of about ½ in., without being derailed if the wheels had been revolving freely, but if they had picked up owing to the sudden application of the magnetic brake to its full power they could not accommodate themselves to the curve, and so the right-hand leading wheel hit the nose of the crossing between the two tracks, and so the car became derailed and overturned. He thought the accident was entirely due to Owen's bad management of the brakes, and possibly also to his not using sand.

Croydon.—Women are to be employed as conductors on the Corporation tramway system.

Edinburgh.—The Tramway Committee have decided to obtain information as to the state of the tramway undertaking in anticipation of the termination of the lease.

Glasgow.—The Corporation are now employing 26 women as tramcar drivers.

L. & S.W. Railway.—The electric train service between Waterloo, Wimbledon, Kingston, Richmond and Shepperton was inaugurated on Sunday last.

Middlesex Tramways.—In the Bill of the Metropolitan Electric Tramways (Ltd.) power is sought to extend until three years after the termination of the war the time for constructing the lines authorised in 1911 and the erection of railless trolley vehicle equipment in Wood Green and Tottenham from Green-lanes to Ferry-lane.

Woolwich.—The L.C.C. has advised the Borough Council that it proposes to construct additional tram tracks in Beresford-street, Plumstead-road and Bostall Hill, in order to improve the existing services.

TELEGRAPH & TELEPHONE NOTES.

Guernesy Telephone Service.—The accounts of the States of Guernsey's telephone undertaking for the year ended Dec. 31 last show receipts £7,511. 8s. 9d. (compared with £7,536. 6s. 2d. in previous year), and the net profit was £540. 14s. 9d. (against £769. 4s.).

There are 1,785 subscribers' lines connected (increase 13), and the mileage of metallic circuit was increased by 40 miles during the year. The State loan has been reduced from £32,000 to £28,367. 10s. 6d., depreciation reserve fund amounts to £18,444. 14s. 2d. and reserve for contingencies to £5,533. 1s. 11d. The total expenditure on construction account is £59,358. 10s. 7d., and the special sinking fund for redemption of amounts employed in construction work stands at £1,871. 14s. 5d.

Radiotelegraph Notes.—It is announced that the ships of the United States Atlantic and Pacific Fleets exchanged wireless messages across about 2,500 miles of intervening land. Both ships report that the messages were strong and easily read.

It is announced that the United States Government is erecting high-power radio stations which will be in operation by January, 1917, and have a range of 4,700 miles.

It was announced on Wednesday that the Secretary of the U.S.A. Navy had signed contracts for the equipment of radio stations now under construction at San Diego (Cal.), Cavite (Philippine Islands) and Pearl Harbour (Hawaii). The completion of these stations within the next year will practically ensure radio communication from Washington, not only to the American insular possessions, but to almost any point of the world where there may be a receiving plant. The stations at Pearl Harbour and Cavite will, it is said, be the most powerful in the world. Each will be able to communicate across the Pacific Ocean from the Philippine Islands to Alaska and the Canal zone.

EMPIRE NOTES.

Australasia.—On Dec. 7 the formal transfer took place of the Hobart Gas Co.'s electricity supply undertaking to the Government. The purchase price was £108,000.

The annual report of the Prahran Malvern (Victoria) Tramways Trust shows that the total equivalent single track mileage is 58, and this will be increased shortly by the completion of the Burke-road tramway, but no further extensions are to be entertained until normal conditions prevail. Revenue was £121,016, and operating costs £110,493, leaving £10,523, from which had to be deducted £3,168 for loss on Caulfield and Point Ormond extensions. The whole of the street lighting of the track was provided by the Trust at a cost of £3,336. The balance to the credit of renewals, reserves and sinking fund was £30,997. Capital expenditure was £654,599. Car mileage run was 2,068,264, and passengers carried 18,359,593. Renewal fund, sinking fund and redemption of loan required £11,250, leaving a surplus of £1,191.

Although the Electric Supply Committee of Melbourne Council has rejected a plan for wiring city buildings on the instalment system, it has substituted a hire purchase scheme of its own. The committee thinks that, unless a scheme be devised for assisting owners to wire comparatively old premises in the city, the supply of current to residences will always be limited, and it is proposed to undertake wiring on the following conditions: At signing of agreement 10 per cent. of estimated (or ascertained) cost of installation to be deposited; the balance of cost to be paid in equal quarterly instalments, plus interest at 6 per cent. On the assumption that each year 500 installations of the average size will be wired, the annual outlay on the part of the Council would be about £3,500. With regard to hiring of electric motors, heating, cooking and other current consuming devices, it was reported that the department had on hire 2,516 electric motors (aggregating 12,160 h.p.) at a capital cost of £60,000. The results obtained in the direction of increased revenue form the sale of current are very satisfactory. It is also proposed to engage in hiring appliances such as electric irons, but so far as electric cooking is concerned, the committee is disposed to wait until a supply of reliable and reasonably priced cooking appliances is available on the market. In order to foster a demand for electricity for cooking it will be necessary to arrange for hiring of cooking apparatus and at present the Council's powers are restricted to the supply of electricity. It will be necessary therefore, to apply to Parliament for additional powers.

MISCELLANEOUS NOTES.

Customs Duties.—Ordinance No. 18 of 1915, published in the Uganda "Official Gazette," fixes the export duty on india rubber and rubber (other than plantation rubber) at 4 per cent. ad val., instead of the old rate of 10 per cent.

The export duty on concentrated accumulator acid (consolidated sulphuric acid) upon importation into Union of South Africa, according to a recent decision, is 20 per cent. ad val. There is a rebate of 3 per cent. on British goods. The import duty on the same kind of acid in Southern Rhodesia is 20 per cent. under the general and 9 per cent. under the British Preferential Tariff.

According to a recent decision, the following articles are dutiable under the U.S.A. tariff of import duties (under No. 167) at the rate of 20 per cent. ad val.—viz., *metal flashlight cases*, being the outer casings of electric flashlights, composed wholly or in chief value of metal, lacking only batteries and light bulbs to render them complete articles, valued above 20 cents per dozen pieces, and properly dutiable as manufactures of metal not plated with gold or silver.

Under the Venezuela Customs tariff, pocket and portable electric lamps are dutiable under Class IV.—*i.e.*, at 7·20 cents per kilog (4½d. per lb.), plus 30 per cent. specific.

Fatality.—On the 26th ult. Richard Tinsley, who had been employed as electrician at Bickershaw Collieries, Leigh, was repairing wires in the 7 ft. shaft when he slipped, fell down the shaft and was killed.

Inquests.—An inquest was held at Sheffield on the 28th ult. on Francis Hannah, a worker at a rolling mill.

The foreman of the rolling mill said he noticed that Hannah had started the "hot saw" on which he was about to work. The saw was working, and then he noticed Hannah looking strange. His head was resting on a wooden bracket near the starter of the machine, and his left hand was on the starter. He could see there was something wrong with him, so he pulled the switch, stopped the motor and then pushed him to the floor. When he touched Hannah he received a slight electric shock. It was common for a man, before grasping the hand wheel of the starter, to take his cap in his hand to use as a non-conductor.

Robert Wilson, storekeeper at the works, said he put Hannah on a chair in a sitting position, and tried to give him a restorative. Almost immediately afterwards he appeared to go off as though he were dying.

The Coroner: Did anyone try artificial respiration?—No, he was gone before I could operate on him. Artificial respiration should have been attempted, but he said everybody was upset.

Mr. W. East, assistant engineer at the works, said that since the affair he had been through the procedure of starting the machine without receiving any shock. When Inman told him that he had received a shock from the body after pulling the switch out, he was inclined to disbelieve him. The c.i. cover of the starting box had been removed, although it should have been on for protection. He had approved of its being taken off, because the machine, being a hot sawing machine, the particles of steel flying off used to get into that part of the cover, which was saucer-shaped, and finally work its way into the box, until it formed a connection with the handle. In this way men had received shocks from the handle. The cover had been off for about three months, and had answered quite satisfactorily.

Medical evidence was to the effect that if the man had had an electric shock and was unconscious it was not correct treatment to put him in a sitting position on a chair. He should have been laid down. Artificial respiration was one of the main treatments for electric shock, and it was necessary to continue it for a long time, notwithstanding that he might be apparently dead. The post-mortem examination disclosed a recent burn on the index-finger of the right hand, and death was due to electric shock. Artificial respiration was not tried at the infirmary, because, after about half an hour, death could be presumed in such cases.

The Coroner said that so far as he could see there appeared to have been some slight breach of the electricity regulations, but he thought the jury had better leave that with the authorities and the firm.

The jury returned a verdict of accidental death through an electric shock.

At Islington (London) last week an inquest was held into the death of Edward Norvell.

Deceased had been employed by the Electrical Power Storage Co., and he had been under treatment for colic or lead poisoning. He had a "drop wrist," and when war broke out he was transferred to the North Metropolitan Electric Power Supply Co. as a battery attendant at the stations in North Finchley and at Wood Green. In December he complained of being unwell. He went to the Great Northern Central Hospital, where he was treated for a week as an out-patient. Becoming worse, he was admitted as an in patient, and subsequently died.

In answer to questions by Mr. Parkes, Inspector of Factories, it was stated that at Millwall and North Finchley the special precautions issued by the Home Office in regard to workers in any way connected with lead were properly carried out.

Medical evidence was to the effect that deceased suffered from chronic kidney disease, due to lead poisoning, and that was the cause of death.

The jury returned a verdict to this effect.

Royal Assent.—On Jan. 27 the Royal Assent was read to the Munitions of War (Amendment) Act, 1916, Parliament and Registration Act, 1916, and Trading with the Enemy (Amendment) Act, 1916.

TENDERS INVITED.

Electrical and Tramway Stores.

HAMMERSMITH (London) Borough Council invite tenders for the supply of various stores for the electric supply department for the year ending March 31, 1917. The articles include Small Engineers' Tools, Metal, Steam Tubes and Fittings (Screws, Bolts and Nuts), Steam Packing and Jointing, Oilmen's Goods, Electric Lighting Sundries, Insulated Wires, Joint and Fuse Boxes, Insulating Compound, Ironmongery, &c. Forms of tender and further particulars from the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, W., and tenders must be delivered at the Town Hall by 4 p.m. of Wednesday, Feb. 16. *See also an advertisement.*

PORTSMOUTH Tramways Committee require tenders by 10 a.m. Feb. 15 for six months' supply of Stores and Materials, including Tramway Tyres, Insulating Materials, Lamps and Motor Windings, Overhead Line Materials, Castings, Oils, &c. Specification from the Engineer.

BATTERSEA (London) Council require tenders for Electricity Meters, Joint Boxes, Troughing Conduits, Insulators, Oils, &c. Forms of tender from the Electrical Engineer, Lombard-road, S.W.

The Tramways Committee of MANCHESTER Corporation invite tenders for the supply of General Stores, including Motor and Controller parts, Resistances, Armature and Field Coils, Trolley Poles and Bases, Lightning Arresters, Lamps, Car Switches, Bells, Cells, Telephones, Carbon Brushes and Carbons, Overhead Equipment Material, Trolley Wheels, &c., Cable, Wire, Timber, Lubricants, Oils, Tools, Iron and Steel, Car Axles and Tyres, Castings, Fuel, &c. Schedules, from the General Manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by 10 a.m. Feb. 15.

PEMBROKE (co. Dublin) Urban Council require tenders by noon Feb. 7 for 12 months' supply of Electrical Goods, Oils and Colours, &c. Specification, &c., may be obtained at the Town Hall, Ballsbridge, co. Dublin.

BERMONDSEY (London) Guardians require tenders by 6 p.m. Feb. 10 for one year's supply of Electric Lamps, Oils, &c. Forms of tender from the Clerk, 283, Tooley-street, S.E.

MIDDLESBROUGH Corporation require tenders by first post Feb. 7 for 12 months' supply of Electric Lamps, Bolts and Nuts, Oils, Paints, &c. Specifications from Borough Engineer.

The BIRMINGHAM TAME AND REA DRAINAGE BOARD require tenders by Feb. 8 for one year's supply of Electrical Stores. Specification, &c., from the Board's offices, Tyburn, Birmingham.

HALIFAX Corporation require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their electricity department, including Lighting Fittings and Electrical Accessories (Lamps, Switches, Tapes, &c.), v.r. Cables and Phosphor Bronze Wire, &c. Forms of tender from Foundry-street, Halifax.

HALIFAX Corporation also require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their Tramways Department, including Lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor Bronze Wire, Trolley and Overhead Line Materials, Oils, Paints, &c. Forms of tender from Tramways Engineer, Skircoat-road, Halifax.

SHEFFIELD Health Committee require tenders by noon Feb. 12 for 12 months' supply of Electrical Fittings, Engineering Goods, Ironmongery, &c. Forms of tender from Superintendent of Cleansing Department, Town Hall, Sheffield.

Telegraph and Telephone Material, &c.

Tenders are invited for the supply of Wheatstone Automatic High-speed Receiver, a Wheatstone Automatic Receiver, &c., to the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Tenders to the Deputy Postmaster-General, Brisbane (Queensland), by Feb. 23.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Turbo-Alternators, Electric Generators, Water Turbine, &c.

LEIGH (Lancs.) Council require tenders for a 2,000 kw. Turbo-Alternator, Surface Condenser, &c. Tenders by noon Feb. 18.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department intire tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

The Public Works Office, Wellington (N.Z.), invite tenders until noon Feb. 11 for supply of Pipe Line and Accessories for LAKE COLERIDGE electric power scheme (section 60), until noon March 8, for supply at Lyttelton of 3,000 kw. Generator (section 61) and 4,300 H.P. Water-turbine (section 62). Specications, etc., from the Public Works Office, Wellington, N.Z. Specifications can be seen at the Office of the High Commissioner for New Zealand, 13, Victoria-street, London, S.W.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Wiring, Fittings, &c.

ST. MARY, ISLINGTON (London), Guardians require tenders for Alterations to Wiring, Supply of s.p. Motors, &c. Tenders by 4 p.m. Feb. 17 to the Clerk, St. John's-road, London, N.

SWANSEA Education Committee require tenders by noon Feb. 7 for the Electric Lighting of Brynmill Infant School. Specifications from the Clerk, 9, Grove-place, Swansea.

Electrically-operated Pumps and Motors.

The Metropolitan Board of Water Supply and Sewerage, SYDNEY, require tenders by 2 p.m. Feb. 7 for the supply and delivery at the No. 1 pumping station at Ultimo, Sydney, N.S.W., of Two Units, consisting of Centrifugal Pumps and Electric Motors (each to pump 4,000 gallons per minute), with Switchboards, Starters, &c., (Contract No. 1,301.) Specifications from the offices of the Board, 341, Pitt-street, Sydney, N.S.W.

Oil (or Gas) Engine, Generator, Accumulators, &c.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Feb. 28 for the supply of an Oil or Gas Engine, Generator, Accumulators, Power Board, Distribution and Fuse Cases and Test Table Tablet (schedule 370) for Townsville Post Office, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from Deputy Postmaster-General, Brisbane.

Submarine Electric Cables.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

Boiler Tubes.

JOHANNESBURG Council want tenders (by noon Feb. 15) for supply of 250 18 ft. by 4 in. Tubes for Water-tube Boilers. Specification, &c., from the Municipal Offices, Johannesburg.

Electricity Supply.

The Municipal Authorities of PONTE DO LIMA (Portugal) require tenders by 4 p.m. Feb. 10 for the supply of Electrical Energy for the lighting of the town. Conditions of tender, &c., may be consulted at the Secretaria Municipal, Ponte do Lima.

TENDERS RECEIVED AND ACCEPTED.

WEST BROMWICH.—The Electricity Committee recommends the acceptance of the following tenders :—

J. Dallow & Sons (at £8,850) for erection of engine room walls and foundations and brickwork for steel chimney at the electricity works, and New Conveyor Co. for extensions to coal conveyor.

TWICKENHAM.—The Council has accepted the tender of the Twickenham & Teddington Electric Supply Co. for wiring the temporary fire station.

WINDSOR.—Chamberlain & Hookham (Ltd.) have secured the contract for the supply of electricity meters for 12 months.

WINDSOR.—The Council have accepted the tender of the Pulsometer Engineering Co. for an electrically operated pump at £200.

LONDON COUNTY COUNCIL.—The Council have accepted the tender of Veritys Limited for a dynamo for the fire brigade workshops at £28.

CAPE TOWN (SOUTH AFRICA).—The Council have accepted the tenders of the South African General Electric Co. for a B.T.-H. alternator at £12,160, and S. Sykes & Co. for a rotary converter at £3,050.

Commonwealth Contracts. The following tenders have been accepted by the Australian Government Departments:—

Postmaster General's Dept., Melbourne.—J. Bartram & Son, 100 armatures 1s. each, 500 carbon blocks 9d. each, 100 bone bushes 1d. each, 40 induction coils 3s. 6d. each, 2,500 heat coils 4½d. each, 5,000 ditto dummy ¾d. each, 1,500 diaphragm 1½d. each, 1,000 300 ampere 5½d. each, 200 generator handles 2s. 3d. each, 50 hooks and escutcheon plate 2s. 3d. each, 100 receiver hooks 1s. 3d. each, 25 microtelephones 23s. 6d. each, 500 pairs nuts 1¾d. pair, 200 plugs 3s. 5d. each, 500 paper rings ½d. each, 50 battery switches 3s. each, 1,000 screws 1d. each, 400 ditto 1½d. each, 200 ditto 1d. each, 500 gravity indicators 4s. each, 500 jacks 9d. each, 100 ditto 1s. 5d. each, 650 1s. 5d. each, 3,000 ditto 1 1½d. each, 3,000 pairs protectors £3. 12s. per strip of 20, 1,000 pairs ditto £1. 16s. per strip of 10, 500 cord weights 7d. each.

Postmaster-General's Dept., Perth. India Rubber, Gutta Percha & Telegraph Works Co., 250 mica discs 4½d. each; British Insulated & Helsby Cables, 5 galvanometers; E. A. Machin & Co., 50 telegraph switches 17s. 3d. each, 1 scale for reflecting instruments 15s. each; H. Rowe & Co., 2 bridge megger ranges, £32. 18s. each; Western Electric Co., 100 lightning arresters 4s. 3d. each, 20 Morse sounders 9s. 9d. each, 1 wire meter £4. 4 calculagraphs £18. 5s. each; Siemens Bros. Dynamo Works, 6 resistance or rheostat boxes £31. 5s., 10 condensers £51. 5s., 2 galvanometers £12. 5s., 6 mirrors for reflecting galvanometers £1. 7s. 6d. Bullers (Ltd.) (per A. J. Chamberlain & Co.), 10,000 porcelain insulators 1s. 0⅜d. each, 1,000 3s. 5¾d. each, 2,000 1s. 0⅜d. each, 2,000 ditto 5¼d. each.

Postmaster-General's Dept., Brisbane.—British Insulated & Helsby Cables, 1 test table tablet £3. 12s., 2 distribution and fuse cases £54. 10s., 11 miles wire £3. 14s. 9d. per mile, 12 miles ditto £2. 7s. 6d. per mile; Lawrence & Hanson, 1 mile wire as per schedule No. 357 (item 3); Stewarts & Lloyds, 700 cross-arms 3s. 9½d. each, 400 ditto 5s. 11½d. each, 68 poles £6. 4s. each, 730 ditto £4. 2s. each, 14 ditto £6. 16s. each Falkiner Electric Co., 1 power board, £174. 10s.; Western Electric Co., 880 yds. cable, £176 per mile; W. T. Henley's Telegraph Works Co., 220 yds. ditto, £294 per mile, 11 miles ditto £5. 18s. 7·82d. per mile, 1 mile (item 3) and 12 miles ditto (item 4), schedule 357 £3. 9s. 3·58d. per mile. This cancels notice of acceptance of tender of the British Insulated & Helsby Cables for items 1 and 4; and Lawrence & Hanson for item 3 of schedule No. 357.

Postmaster-General's Dept., Sydney.—Jas. Paton & Co., 160 magneto bells 7s. 6d. each, 160 strips, protectors, £2. 3s. per strip, 540 cords 6¼d. each; Lawrence & Hanson, 2,000 cords 8d. each, 600 ditto 2s. 4d. each; Western Electric Co., 400 plugs 1s. 3d. each; Edison & Swan United E.L. Co., 1,500 16 c.p. English standard carbon filament lamps, 6¾d. each.

Victorian Railway Commissioners.—Australian General Electric Co., electrical equipments for bogie cars on St. Kilda–Brighton Electric Street Railway, at rates; Austral Otis Engineering Co., 2 three-throw vertical triplex pumps for State Coal Mine, at rates; British General Electric Co., electric lighting materials for Jolimont car repair shop, at rates; W. T. Henley's Telegraph Works Co., rubber-covered cable, £28 per mile; British Insulated & Helsby Cables, overhead line material for Sandringham to Black Rock electric street railway, at rates; Harvey, Shaw & Drake, air ducts and mouthpieces for turbo-alternators during period ending June 30, 1918, at rates; Australian General Electric Co., neutral track relays for electrical circuits, £4. 6s. 6d. each.

W.A. Government Tender Board.—J. A. W. Gardam, static transformers, £63. 15s. each and £268 each.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—The net earnings for 1915, after paying debenture interest, &c., was £18,132, and with £2,977 brought forward, the total was £21,109. An interim dividend for the six months ended June 30 at rate of 4 per cent. per annum absorbed £3,000, leaving £18,109. 11s. The directors recommend payment of final dividend of 4½ per cent. (making 8½ for year) on the share capital, absorbing £6,750, placing to depreciation reserve £915, to general reserve £5,490, writing down value of investments in railway stock £995 and carrying forward £4,249. 12s. 2d.

CIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AIRES (LTD.)—At the recent meeting it was reported that the gross receipts for year ended July 31 last from the supply of light and power were £177,888, against £190,766 the preceding year, a decrease of 6·75 per cent., and the total receipts (£178,819) showed a decrease of 6·48 per cent. The combined cost of operating the individual undertakings in the Argentine was £106,133, an increase of 1·66 per cent. owing to the higher cost of fuel. The net profit is £61,159, against £69,746. After providing for all expenses and fixed charges, and placing £5,000 to reserve, the balance of £314 has been carried forward. The result of operations do not permit payment of a preference dividend. Although there was a decrease in the gross receipts and units sold, the number of customers increased by 8·06 per cent. During the year £15,572 has been expended on capital account. At an extraordinary general meeting a resolution to reduce the capital from £1,350,000 to £825,000 in 300,000 7 per cent. cumulative preference shares of £1 each and 262,500 ordinary shares of £2 each, was submitted.

DEVONPORT & DISTRICT TRAMWAYS CO.—At the meeting last week the chairman (Mr. C. S. Hilton) said the arbitrators had fixed the amount payable to the company at £103,970. The balance on revenue account for the period in the report amounted to £10,679. 10s., which the directors recommended should be distributed among the shareholders. In addition to the amount of the award the company owned Leigh Ash Garden and other land which stood in the balance sheet at £1,131. They had not heard from the Corporation as to whether they intended to deal with the matter at once. Out of the amount of the award they had to pay their own costs. The company had power to go into liquidation and would do so when advised.

DUBLIN UNITED TRAMWAYS CO (1896) (LTD.)—The report for 1915 states that the amount available for division is £25,844 8s. 8d. Interim dividends, amounting to £20,906. 5s. were paid in August last, leaving £4,939. 3s. 8d., out of which it is recommended that a dividend at rate of 6 per cent. per annum (less tax) be paid on the preference shares, and a final dividend at rate of 5 per cent. per annum (less tax) be paid on the ordinary shares for the half-year ended Dec. 31, and that £18,000 be set aside towards renewal of rails, and £5,000 to reserve and renewals fund, leaving £13,045. 8s. 8d. to be carried forward.

YORKSHIRE ELECTRIC POWER CO.—The net profit for the year 1915, after payment of mortgage and other interest, was £21,209, against £20,535 in 1914 and £15,401 in 1913. With £3,049 brought forward the total is £24,258, and after deducting the preference dividend (paid to June 30, 1915) the disposable balance is £19,192. The directors recommend payment of a dividend (less tax) at rate of 6 per cent. per annum on the preference shares for the half-year ended Dec. 31, 1915 (£4,951) and a dividend of 1 per cent. on the ordinary shares for the year 1915 (absorbing £2,356. 7s. 3d.), to write off the cost of the Yorkshire Electric Power Bill, 1915 (£1,908), to transfer £7,500 to general reserve fund, and to carry forward £2,477. 18s. 5d. The year has been a difficult one, but on the results of the 12 months' trading the directors feel justified in recommending payment of a dividend on the ordinary shares at the same rate as for 1914. The costs of all materials, especially that of coal, have been very heavy, and whilst there has been a substantial growth of revenue the expenses of production have also materially increased. Over 27 per cent. of the staff have enlisted, whilst almost without exception the men of military age have attested under Lord Derby's scheme. The company's supply has been largely used both directly by the Government and by consumers who have turned to the making of munitions of war. In addition, the demands upon the company in connection with collieries and coke ovens, with their associated chemical works for the extraction of valuable products from coal, have grown considerably. The buildings, plant and mains have been maintained out of revenue.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

W. J. BURROUGHES & SONS (LTD.) (42,842).—Reg. Jan. 26. capital £1,000 in £1 shares, to take over business of a heating and lighting engineer carried on as W. J. Burroughes & Sons, to carry on the business of heating, ventilating and electrical engineers, &c. Private company. First directors are W. J. Burroughes (permanent governing director) and S. P. Burroughes. Reg. office: 143 and 144, Holborn, E.C.

H. & E. LEA (LTD.) (142,813) Reg. Jan. 24, capital £1,000 in £1 shares, to carry on the business of builders, electrical and sanitary engineers, plumbers, furnishers, &c. Private company. A. Grace is to be managing director for five years. Reg. office: 10, Brewer-street, W.

SHEPHERD'S PARGING BLOCK CO. (LTD.) (142,756.)—Reg. Jan. 18, capital £2,000 in £5 shares, to take over the business of a manufacturer of patent tram rail parging blocks carried on at Rochdale (Lancs) as Shepherd's Parging Block Co., together with the benefit of certain existing inventions relating to improvements in connection with the laying of setts with respect to tramway lines or rails and blocks or sections used in connection therewith. Private company. W. Shepherd is first permanent director. Reg. office, Exeter-street, Milkstone, Rochdale.

F. R. WADE & CO. (LTD.) (142,761.)—Reg. Jan. 19, capital £1,000 in £1 shares, to take over the business of F. R. Wade & Co., to carry on the business of engineers, manufacturers of electrical instruments and machinery, &c., and to adopt an agreement with F. H. Wade. Private company. F. R. Wade is the first life director.

STATUTORY RETURNS.

BARBADOS ELECTRIC SUPPLY CORPN. (LTD.)—According to return to Nov. 11, 1915, capital is £60,000 in 40,000 preferred and participating and 20,000 ordinary shares of £1 each. 35,172 preferred and 20,000 ordinary shares taken up. £34,672 paid on 34,672 preferred. £20,500 considered as paid on 20,000 ordinary and 500 preferred. Mortgages and charges: £12,500.

BLACKPOOL & GARSTANG ELECTRIC LIGHT RAILWAY CO. (LTD.)—In return to Dec. 31, 1915, capital is £10,000 in £5 shares. 361 shares taken up. £4 per share called up. £1,707 paid (including £323 received on application for further shares not allotted), leaving £60 calls unpaid. Mortgages and charges nil.

DICK, KERR & CO. (LTD.)—Capital in return to Nov. 4 is £650,000 in £1 shares (350,000 preference), 305,000 preference and 260,000 ordinary shares taken up. £565,000 paid. Mortgages and charges, £331,665.

ELECTRIC REDUCTION CO. (LTD.)—Return to Dec. 7, 1915, gives capital as £50,000 in £1 shares (16,200 preference and 33,800 ordinary). 16,200 preference and 28,800 ordinary shares taken up. £1 per share called up and paid on 13,000 preference and 5,000 ordinary. £27,000 considered as paid on 3,200 preference and 23,800 ordinary shares. Mortgages and charges, £25,000.

MONTEVIDEO TELEPHONE CO. (LTD.)—Capital in return to Nov. 10 was £160,000 in £1 shares (87,000 preference). 86,492 prefercnee and 72,680 ordinary shares taken up. £159,172 considered as paid. Mortgages and charges, nil.

MUIRHEAD & CO. (LTD.)—In return to Dec. 29, 1915, capital £50,000 in £10 shares. 3,382 shares taken up. £10 per share called up on 382. £3,820 paid. £30,000 considered as paid on 3,000 shares. Mortgages and charges, £13,500.

NEWTONS (LTD.)—Return to Oct. 5, 1915, gives capital as £40,000 in £10 shares. 3,265 shares taken up, and £18,650 paid. £14,000 considered as paid. Mortgages and charges, £14,000.

PIRELLI (LTD.)—According to return to Sept. 13, 1915, capital is £8,000 in £5 shares. All shares taken up, and £8,000 paid. Mortgages and charges, nil.

RUTHIN ELECTRIC SUPPLY CO. (LTD.)—Capital at Dec. 9, 1915, was £5,000 in 400 preference of £5 each and 1,000 preferred and 2,000 ordinary shares of £1 each. 126 preference, 675 preferred ordinary and 1,110 ordinary shares taken up, and £2,388 paid. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

CITY OF OXFORD ELECTRIC TRAMWAYS (LTD.)—Memorandum of satisfaction to the extent of £1,100 on Dec. 17, 1915, of charge dated Feb. 20, 1914, securing £46,000, has been filed.

KEYNSHAM ELECTRIC LIGHT & POWER CO. (LTD.)—Memorandum of satisfaction in full on Dec. 31, 1915, of third debentures dated Dec.4, 1913, securing £1,000, has been filed.

LAMPLOUGH & SON (LTD.)—Memoranda of satisfaction in full on Dec. 16, 1915, of two debentures and a mortgage created by the receiver and dated June 17 and Jan. 4, 1913, and May 14, 1914, securing £500, £700 and £1,500 respectively, have been filed.

M. & G. TRUCK & ENGINEERING CO. (LTD.)—Particulars of £1,500 debentures, created Jan. 5, 1916, have been filed, amount of present issue being £1,400. Property charged: Company's undertaking and property, including uncalled capital. No trustees.

RECEIVERSHIP.

GLOBE ELECTRIC CO. (LTD.)—E. C. Pegler, 60, Watling-street, E.C., ceased to act as receiver and manager on Dec. 14, 1915.

CITY NOTES.

MEMORANDA (Feb. 2).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 58 11/16. Consols Pay Day, March 1. Stocks and Shares Ticket Days, Feb. 9 and 23. Pay Days, Feb. 10 and 24. Price of silver, 27d.

COMPANIES STRUCK OFF THE REGISTER.—The following were struck off the Register of Joint Stock Companies on Jan. 21:—

Brabbins' Engine Synd., Budleigh Salterton Elec. Light & Power Co., Central Engineering Co., Ellwood Motor Co., Liverpool Traction, Light & Power Investment Trust, Maximum Magneto Co., Oil & Gas Turbine Synd., Power Synd. of South America, Russian Wireless Telegraph Co., Telenews, Transvaal Mica Co., Vacuum Electric & Gas Heating Appliances, Walker Reversible Turbine Co.

LONDON & SUBURBAN TRACTION CO. (LTD.—A dividend at the rate of 5 per cent. per annum has been declared on the cumulative preference shares for the half-year ended Dec. 31.

METROPOLITAN RAILWAY CO.—A dividend at rate of 1 per cent. per annum has been declared for the past half-year, making 1 per cent. for 1915, and carrying forward about £13,000 after placing £15,000 to general renewals fund.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The share transfer books will be closed from Feb. 4 to 18 inclusive, preparatory to payment of dividends for half-year ended Dec. 31, 1915.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared subject to final audit, a dividend on the ordinary shares at the rate of 5 per cent. per annum for the year 1915, with a carry forward of £2,900.

TOTTENHAM DISTRICT LIGHT HEAT & POWER CO.—The profit for the half-year ended Dec. 31, after meeting interest charges, was £11,586. Dividends of 7½ per cent. on the "A" stock, and 5⅝ per cent. per annum on the "B" stock, with 5 per cent. per annum on the preference stock, are recommended, leaving £2,185 to be carried forward.

TRACTION & POWER SECURITIES CO. (LTD.)—A dividend of 4s. 6d. per share on the ordinary shares for the past year has been declared. £561 has been placed to reserve and £8,579 carried forward.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Feb. 1. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Feb. 1.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9⅜	7 5 5	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9 13/32	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	9 1/16	6 0 9	Feb Aug
5	10%	Brompton & Kensington Ord	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 9	Jan, July
5	2/3	Do. 4½% Pref.	3 15/32	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	2 5/32	8 7 1	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	12 1/16	7 9 2	Feb, Aug
10	6/0	Do. 6% Pref.	10⅝	5 10 4	Mar, July
St.	5%	Do. 5% Deb. St.	99½	5 0 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	9 1/16	7 0 11	Mar. Sept
10	6%	Do. 6% Pref.	10 1/16	5 18 2	Feb, Aug
St.	4½%	Do. 1st Deb.	86½	5 4 1	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	9%	Kensington and Knightsbridge Ord.	6 3/16	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79	5 1 3	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 3/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75¼	6 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 1/32	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S. 5% 2d Mt. Db. St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/16	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	2 13/16	7 2 3	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 1/32	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	5⅓	5 19 2	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 3/32	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	3 1/32	5 11 9	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82 1/32	6 0 10	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	68 1/32	5 16 9	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 [illegible]	..
St.	4½%	Do. 4½% Pref.	99 1/32	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93 1/32	4 5 9	Jan, July
St.	4%	City & S. London Deb.	65	6 1 3	May. Nov
St.	5%	Do. Pref. 1896	80	6 5 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1 1/32	3 16 11	Jan, July
St.	4%	Do. 4% Pref.	61 1/32	6 9 10	Mar. Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24 7/32	4 0 4	Feb, Aug
St.	3½%	Do. 3½% Pref.	77 1/32	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74 1/32	4 13 8	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82 1/32	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83 1/32	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St	4%	Do. 4% Debs.	70 1/32	5 13 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	70	5 14 3	Jan, July
St.	4%	Do. 4% Guar. Stock	67 1/32	5 18 10	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 1/32	..	..
1/0	..	Do. A Ord.	1/16	..	..
St.	6%	Do. 6% Inc. Debs.	106 1/32	5 12 5	Mar, Sept

† Ex dividend or interest

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	NAME.	Price, Tues., Feb. 1.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electric Railways and Tramways	—*cont.*		
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	83¼	7 4 0	Mar, Sept
..	4½%	Do. 4½% Bds.	101¼	4 8 5	Jan, July
5	..	Yorkshire W. Riding Ord.	⅞	..	March
5	6%	Do. Pref.	4¼	7 1 2	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2¼	5 5 5	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 14 1	Mar
100	5%	Do. Prior Lien Debs.	88	5 13 8	Jan, July
1	6%	Do. 6% Pref.	⅝	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅞	7 3 9	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5¼	5 17 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	7 2 4	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	65½	6 2 2	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅞	6 12 7	Jan, July
5	2/6	Do. 5% Pref.	4¼	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3⅝	6 6 9	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	1¾	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A: £3 pd.	½	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	¼	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	71	5 12 8	Jan, July
5	10%	General Electric Ord.	10⅛	9 7 2	July
10	6%	Do. 6% Pref.	9¼	6 4 8	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13½	7 8 2	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4¼	4 14 9	..
St.	4½%	Do. 4½% Db.	87½	5 3 4	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9½	10 19 9	Feb, Aug
10	5%	Do. Pref.	7⅛	6 7 0	Apl, Oct
100	4%	Do. 4% Debs.	99¾	4 0 8	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	36	6 13 4	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82¼	4 16 8	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jun, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100¼	5 19 6	Fb,My,Aug,N
St.	1½%	Do. Def. Ord. x d. and bonus	21⅛	6 17 6	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69¼	5 14 11	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅜	6 15 7	May, Nov
10	10%	Do. 10% Pref.	15¼	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅜	6 13 4	..
10	4%	Direct United States	5⅛	6 14 9	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127	5 10 3	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	75	5 6 8	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	80½†	5 0 5	Feb, Aug
10	7%	Do. Ord.	12⅛	5 10 4	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 4	34	6 9 5	Ja, My, Jly
25	13%	Indo-European	48½	6 14 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜	5 6 8	April
1	7%	Do. 7% Pref.	1⅛	4 1 5	July
10	1%	West India & Panama Ord.	1⅛	8 17 9	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 8 9	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	76	5 5 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	94	4 15 9	May, Nov.
		Telephones.			
..	$2	American Telephn. & Telgh. $100 Cap.	131½	6 0 6	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	77½	6 13 1	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101½	4 8 9	May, Nov
1	10%	*Oriental Telephone Ord.	1⅛	5 14 3	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅛	6 12 8	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	97½	5 2 10	Jan, July
		Financial and Investment.			
10	6%	GlobeTelegh. & Trust	10½	5 14 3	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10¼	5 18 6	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80½	6 4 7	Ja Apl,Jly,O
..	4%	Do. $100 Pref	67½	5 13 0	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	122½	4 18 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	80	6 5 0	Jun, Dec
St.	4½%	Do. 4½% Debs	77½	5 15 10	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 2	Jan, July
5	5½%	Do. 5½% 1st Pref.	5⅛	6 15 5	Jan, July
5	5½%	Do. 5½% 2nd Pref.	5⅛	5 0 0	Jan, July
100	£1	Brazilian Traction Ord.	51¼	7 16 6	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	89	6 14 10	Ja,Apl,Jly,O
5	8%	Brisbane Trams Ord.	6⅜	6 1 1	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64½	6 12 4	..
5	9½%	Calcutta Elec. Trams. Ord.	6⅜	7 10 9	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	90	5 11 1	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4¾	6 2 4	..
100	5%	Manaos Trams 5% Debs.	6⅛	6 1 3	Jan, July
..	..	Mexico Trams Common St.	13		Fb,M,Aug,N
..	5%	Do. 5% Bds	47	10 17 1	May, Sep
St.	4½%	Montreal Street Ry. 4½% Debs. (1922)	94½*	4 1 6	Feb, Aug
100	5%	Rio de Janeiro Tram. L. & P. 5) yr. Bds	75¼	6 12 5	Jan, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅛	6 1 6	Mar, Sept
St.	5%	Do. 5% Debs.	99	5 1 3	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	11⅛†	5 14 3	..
St.	4½%	Do. 4½% Debs.	81¼	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	7⅛	7 5 10	May, Nov
5	5%	Do. 5% Pref.	4	5 11 11	May, Nov
..	7%	Canadian Gen. Elec. Common St.	13⅜	6 3 4	Ja,Ap,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt. Debs	90	5 5 4	June, Dec
St.	5%	Do. 5% Cons. Deb. St.	95	5 7 4	Apl, Oct
..	..	Mexican Light & Power Ord.	22¼	..	Jan,Apl,Jly,O
..	..	Do. Pref.	37	..	May, Nov
81¼	5%	Shawinigan Water & Power 5% Bds.	103¼	4 16 6	Jan, July
..	6%	Do. Cap. Stock	135½	4 8 7	Ja,Apl,Jly,O
St.	4½%	Toronto Power 4½% Deb St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	80½	5 12 0	May, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	1	..	Jan, July
..	5½%	Do. 5½% 2nd Mort. Debs.	92½	5 18 11	Jan, July

* And 13½% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Feb. 1, the following as the present basis prices of

New Metals.	per lb.		per ton.
Solid Drawn Brass Tubes	15½d.	English Lead	£33 0 0
Solid Drawn Copper Tubes	16½d.	Antimony	Nominal.
Best Copper Tubes	16½d.		
Brazed Brass Tubes	17½d.	Old Metals.	per ton.
Best Wire	14½d.	Clean Scrap Copper	£89 10 0
Copper Wire	14½d.	Brazier Copper Scrap	£78 0 0
Rolled Brass	14½d.	Clean Scrap Brass	£62 0 0
Best Sheet	15½d.	Old Lead	£26 10 0
		Old Zinc	£60 0 0
	per ton.	Hollow Pewter	£115 0 0
Copper Sheets	£129 0 0	Black Pewter	£75 0 0
Spelter	£91 0 0	Gun Metal	£70 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Feb. 1 the following approximate prices of Scrap Metals:—

	per ton.		per ton.
Aluminium Cuttings	£130 0 0	Old Lead	£27 0 0
Clean Mixed Brass	£64 0 0	Tea Lead	£25 0 0
Clean Copper	£88 0 0	Old Zinc	£66 0 0
Braziery Copper	£82 0 0	Hollow Pewter	£120 0 0
Gun Metal	£78 0 0	Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £76; Commercial Tinman's Solder, £98; Blowpipe Solder, £108.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

LINE.	Week ended.	Amount	Inc. or dec. (a).	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 26	1.662	+ 177	24	61.940	+ 4,013
Accrington Corporation	,, 29	47,476	— 1.252	4	196.071	— 6.691
Ashton-under-Lyne	..	..	..	..	..	..
Ayr Corporation	,, 29	256	+ 48	37	14.121	+ 930
Birkenhead Corporation	,, 30	1.407	+ 270	44	60.322	+ 5.363
Birmingham Corporation { Trams	,, 22	15.707	+ 3.534	43	613.763	+ 92.014
Birmingham Corporation { Buses &c	,, 22	815	+ 166	43	35.873	+ 18,886
Blackburn Corporation	,, 26	1.093	— 80	44	55.286	— 45
Blackpool Corporation	,, 27	673	+ 127	44	72.098	+ 2,349
Blackpool and Fleetwood	,, 29	294	+ 31	4	1.356	+ 111
Bolton Corporation	,, 30	2.617	+ 179	44	117.980	— 615
Bournemouth... { Trams	,, 26	1,903	+ 295	43	90.584	+ 4,866
Bournemouth... { Buses	,, 26	7	+ 2	43	957	— 86
Bradford Corporation	,, 25	6.345	+ 665	42	276.013	+ 11.257
Brighton Corporation	,, 30	913	+ 169	44§	48.523	+ 859
Bristol Trams. { Trams	,, 28	4.629	+ 538	4	18.605	+ 1.073
Bristol Trams. { Buses &c	,, 28	4.737	— 1.039	4	19.250	+ 2.832
Burmah E. Trams & Ltg	,, 29	R3.327	+ R359	4	..	+ R6.804
Burnley Corporation	,, 29	1,608	+ 232	17	37.608	+ 3.323
Burton Corporation	,, 30	264	+ 5	44	12.525	— 296
Bury Corporation	,, 30	1.267	— 155	40§	59,066	— 282
Calcutta Tramways Co.	,, 29	R65.342	+ R2.431	4	..	+ R17.535
Camborne-Redruth	,, 29	143	+ 23	4	584	+ 101
Cardiff Corporation	..	..	..	..	..	..
Cork Electric Trams Co.	,, 27	446	+ 39	4	1.792	+ 78
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	..	..	..	..	..	..
Dover Corporation	..	..	..	..	..	..
Dublin & Lucan Railway	,, 28	118	+ 11	4	458	— 5
Dublin United	,, 28	5.919	— 731	4	24.149	— 1.840
Dundee Corporation	,, 26	1.281	+ 123	37§	50.105	+ 2.891
East Ham Council	,, 29	1,271	— 156	43	56.846	+ 5.882
Exeter Corporation	,, 28	324	— 52	43	16.329	+ 924
Glasgow Corporation	,, 29	22.297	+ 2.691	35‡	759.192	+ 54.410
Glossop Trams	,, 29	132	+ 31	5	675	+ 141
Gloucester Corpn	,, 26	308	— 30	43	14.314	+ 190
Halifax Corpn... { Trams	,, 25	1,959	— 75	43	95.227	+ 855
Halifax Corpn... { Buses	,, 25	40	— 3	43	2.090	— 21
Hastings Elec. Trams Co.	,, 28	756	— 158	4	5.055	— 263
Huddersfield Corpn	,, 29	2.666	+ 487	43	116.372	+ 15.828
Hull Corporation	,, 29	3.191	+ 244	43	134.746	— 1.247
Ilford District Council	,, 29	614	+ 75	43	28.228	+ 3.210
Ilkeston Corporation	,, 26	129	+ 23	43	5.788	+ 294
Ipswich Corporation	,, 29	474	+ 257	42	23.747	+ 4.039
Isle of Thanet Co.	,, 29	254	+ 38	17¶	4.470	— 944
Kilmarnock Corporation	,, 29	160	+ 20	37	6.261	+ 246
Lanarkshire Trams Co.	,, 27	2.049	+ 390	4	8.641	+ 1.240
Lancashire United	,, 26	1.633	+ 188	4‡	6.199	+ 452
Leeds Corporation	,, 29	9.035	+ 1.325	44	391.404	+ 31.227
Leicester Corporation	,, 29	3.197	+ 432	4	13.520	+ 1.836
Lewes Corporation	,, 29	774	+ 141	37	28.603	+ 2.212
Lincoln Corporation	,, 29	137	+ 19	44	6.184	+ 726
Liverpool Corporation	,, 22	13,744	+ 1,360	3	43 859	+ 3.797
Llandudno&ColwynBayR	..	..	..	..	..	..
London County Council	..	..	..	..	..	..
Lowestoft Corporation	,, 29	128	— 13	17	2.245	— 749
Maidstone Corporation	,, 27	181	+ 42	43	5.482	+ 433
Manchester Corporation	,, 29	17,745	+ 1,730	43	778.294	+ 28.221
Nelson Corporation	..	..	..	..	..	..
Newcastle-on-Tyne Corpn.	..	..	..	..	..	..
Newport (Mon.) Corpn.	,, 29	845	+ 152	44	36.880	+ 1.450
Nottingham Corporation	,, 28	695	+ 164	43¶	31.510	+ 5.520
Nottingham Corporation	,, 27	3.740	+ 510	43	161.618	+ 17.969
Oldham Corporation	,, 30	2.318	+ 391	45	100.282	+ 5.196
Portsmouth Corporation	,, 22	1.170	+ 182	43	101.486	..
Preston Corporation	,, 26	1.000	+ 179	42••	42.173	+ 2.336
Rochdale	,, 29	1.700	+ 297	..	74.[illegible]	+ 3.881
Rotherham Corporation	,, 26	1.258	+ 344	43	[illegible]	+ 6.751
Salford Corporation	,, 31	5.181	+ 702	44‡	[illegible]	+ 10.476
Sheffield Corporation	,, 31	9.713	+ 1.909	43	[illegible]	+ 56.483
Southampton Corpn.	,, 26	1.429	+ 298	43	65.070	+ 7.067
Southport Corporation	,, 26	601	— 50	43	35.037	— 7.933
South Shields	,, 22	732	— 73	42	33.867	+ 1.509
Southend-on-Sea Corpn.	..	..	..	..	..	..
Stockport Corporation	,, 30	1,525	+ 280	44	65.123	+ 1.850
Sunderland Corporation	,, 26	603	+ 77	13	7.398	+ 655
Swansea Corporation	..	..	..	..	..	..
Todmorden Corporation	,, 19	498	+ 5	3	1.362	— 59
Wallasey Corporation	,, 29	1,132	+ 144	43‡	55.579	+ 1.290
Walsall Corporation	,, 29	884	+ 147	5	3.434	+ 872
Warrington Corporation	,, 29	782	+ 98	44	38.870	— 3.773
Wednesbury Corporation	..	..	..	..	..	..
West Hartlepool Corpn.	,, 27	3.009	+ 527	43	133.918	+ 11.612
Widnes Corporation	,, 27	435	— 88	43	65.675	— 2.744
Wigan Corporation	,, 29	1,149	+ 188	17	19.157	+ 1.988
Yorkshire (W. R.) Trams	,, 31	1,641	— 324	5	8.254	+ 1.216

(a) Taken with the corresponding period last year. * Partly electrical.
† Plus 2 days. ‡ Minus 2 days. § Minus 3 days. ¶ Plus 3 days.
•• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 657
Arrangements for the Week .. 660
The Testing of Underground Cables with Continuous Current. By O. L. Record. Illustrated 661
Overhead Contact Systems, Construction and Costs. By E. J. Amberg. Illustrated 663
The Equipment and Protection of Outdoor H.-T. Sub-Stations. By J. Lindley Thompson, M.Sc., and S. Austen Stigant. Illustrated 665
The Principles of Modern Printing Telegraphy. By H. H. Harrison. Illustrated. *Concluded* 669
An Oscillograph for High-Tension Work. Illustrated 672
The Fatal Accident at Eastbourne 672
BRITISH TRADE AFTER THE WAR 674
Selenium Cells. By W. R. Cooper, M.A., B.Sc. Illustrated 676
Artificial Insulating Materials. Illustrated.—*Concluded* 679
CORRESPONDENCE 681
"Business and Engineering" (Charles C. Garrard).
LEGAL INTELLIGENCE 682
The "Electrician" Commercial and Industrial Section .. 683–690

NOTES.

The Central Station as a Controlled Works.

THERE are quite a number of important works at the present day, even in the case of controlled establishments, where it is difficult to ensure that workmen shall remain until permission is granted to them by the authorities to leave their particular employment. In the case of establishments which are not controlled the difficulty is even greater, and there is no denying the fact that the importance of some of these establishments is quite equal to that of munition works. A case of this kind is the electricity supply undertaking. Most of the firms manufacturing munitions at the present day depend for their source of power on electricity works, and yet the Government has given very tardy recognition to this fact. Even some of the electricity authorities themselves have been quite prepared to let the greater part of their staff enlist, leaving the conduct of affairs more or less to chance. On the other hand, there are some engineers who take a much more serious view of things. Among these is the engineer of one of the London electricity undertakings, who we congratulate upon having brought the case before the Local Munitions Tribunal for the Metropolitan District, and to have obtained a decision in his favour. The case arose over the desire of a sub-station attendant who wished to leave the employment of the Council on the ground that his engineering skill might be better employed in some other direction. As permission was refused by the engineer, an application was made by the attendant to the Munitions Tribunal. In opposition to this application, the engineer gave evidence as to the indispensability of sub-station attendants, with the result that the Tribunal was unanimous in refusing the application for release. We think that this case is most important for two reasons. Firstly, the Tribunal felt that the case was one which they could hear, thus admitting that it came within their jurisdiction; and, secondly, because the decision showed that, in their opinion, electricity works are of national importance from the munitions point of view. Although this decision applies only to one particular district, we think it should do something towards strengthening the hands of supply engineers throughout the country.

Discussions and Early Closing.

MODESTY perhaps deters those who discuss Papers from bringing their grievances to the notice of the Councils of the respective societies and institutions. They send in their grievances to us, however. A common cause of complaint is that, after allowing Councillor Y. E. Dryasdust, Sir Jabez Windbag and Mr. Dignified Verbosity each to speak for 10 minutes on relevant matters, and for 15 minutes on irrelevant matters, the chairman announces that, on account of the lateness of the hour, he will be obliged if others desiring to take part in the discussion will send in their remarks in writing. It is for this reason that Papers are often futile and discussions barren, and that many of our institutions and societies are dead. Attendance at such meetings leads us to the conclusion that the members are too tame. We feel that those desirous of taking part in discussions would do well to use their lungs and feet a little more when men, with nothing useful to say, talk for long periods on any and every subject except the one under discussion. Some time ago we attended a meeting of an influential association, and an important subject was being discussed. Each speaker was allowed 10 minutes to state his case. At the end of the eighth minute a warning was given, and at the end of the tenth minute the bell was rung. If we remember rightly, only one speaker, and he a Prince, ignored the bell. He was an expert on the subject, and he kept to the subject, but shortly after the ringing of the bell we imagine that he was glad to sit down. An appeal to the chairman is neither desirable nor necessary if members will exercise their common sense, and if they will get rid of a good deal of the stuff they regard as dignity, which, in reality, ill becomes many of them. One of these days we hope to find meetings of societies composed of business men conducted on business lines, as distinct from the benevolent neutrality principles now in force. Such principles take the life out of our institutions, and in the long run make men forget how to fight. We need hardly tell our readers that we are referring to no institution or society in particular. It is unnecessary to particularise, since to a greater or less extent they are all tarred with the same brush.

Fools and Fool-proof Starters.

CURIOUS evidence was given at a recent inquest at Sheffield on the death from electric shock of a workman at a rolling mill. It was stated by one of the witnesses that it was common for a man before grasping the hand-wheel of the starter to take his cap in his hand to use as a non-conductor. Another witness stated that artificial respiration was not attempted, as everybody was too upset; and a third witness told the coroner that, although the cast-iron cover of the starting box should

have been on for protection, he had sanctioned its removal because metal dust entering at the sides was liable to form a connection with the handle. For good and sufficient reasons, the Home Office issued regulations for the use of electricity in factories and workshops, and we are strongly of opinion that these regulations were framed with the object of promoting sanity in the use of electricity in those places. What is the use of experience extending over a quarter of a century if it is still common for a workman to take his cap in his hand to use as a non-conductor? In their own interests, we urge makers of control apparatus to endeavour so to arrange the design of all industrial starters as to make it impossible for anyone to operate a starter without the cover. Furthermore, it is regrettable that artificial respiration was not resorted to in this case, and coroners should censure those who are too "upset" to attempt to save the life of a fellow-creature. Surely the branch of the Home Office which is entrusted with the administration of these rules should see that they are enforced.

"Crystallisation Doubtful."—Under this heading the "Engineering Record" refers to the report on the Division-street Bridge failure at Spokane. The idea of crystallisation occurring during service is an old one, and, pending further investigation, they prefer to regard the failure of the eyebars in tension as due to heating in the shops without subsequent annealing.

The Engineer as Administrator.—Dr. Hollis Godfray in a Paper read recently before the American Society of Mechanical Engineers, brings to the front the importance of engineering methods in the administration of large affairs. The engineer knows by experience or instinct when extreme precision is required, just as he knows where to save labour by carrying his work as far as is necessary.

60,000-kw. Turbo-Alternator Units.—Tenders are being considered by the Interborough Rapid Transit Co. of New York, for two 60,000-kw. steam-turbine units. According to the "Electrical World" each unit will be made up of three separate electric generators driven by one high-pressure and two low-pressure turbines, the latter being connected in multiple. It is stated that the choice rests between single 60,000-kw. units or the equivalent in 30,000-kw. turbines.

Protection Against Lightning.—In the form of appendixes to an informative Paper on "Protection of Life and Property against Lightning," issued by the Bureau of Standards, Mr. O. S. Peters gave in considerable detail some of the rules and recommendations concerning the installation and maintenance of lightning rods that have been adopted by various authorities or technical organisations in England, Germany and the United States. He also gave a bibliography containing references to most of the important works which have appeared in recent times.

Utilisation of Peat.—Interesting particulars are given in "The Times" Engineering Supplement of the Wiesmoor power station. The Ems-Jade Canal passes north of it, and Wilhelmshaven is only 30 miles away. Including Wilhelmshaven the station supplies energy to Emden, Aurich, Bant, Norden, Oldenburg and Rustringen. All the power for cutting the peat and transporting it to the station is also supplied by the generating plant. The plant cost about £200,000, and has been working successfully since 1909. The calorific value of the peat briquettes is 5,400 B.Th.U., and the power house has three turbo generators of 1,250 kw. each. The current is generated as 6,000-volt, three phase, and stepped up to 20,000 volts before transmission. The station consumes about 75 tons of peat briquettes per day, or 25,000 tons a year, and a year's supply of peat is always in hand.

Bituminous Coal.—Mr. R. V. Farnham read a Paper recently on "A Suction Gas Producer using Bituminous Coal" at the Institution of Engineers and Shipbuilders, Glasgow. He said that, on account of its low ash content, anthracite was chiefly used in suction and pressure gas producers up to 500 H.P. Coke was troublesome to gasify, and the calorific value was only 10,000 to 11,500 B.T.U.s per lb., compared with 14,500 units from anthracite. He considered the gas engine for marine work would never succeed if it depended only on non-bituminous coals. He referred to experiments made on the "Farnham" type of engine and producer, which was able to gasify ordinary bituminous coal, the cost of which was 13s. to 20s., as against 30s. to 40s. per ton for anthracite. Consequently an enormous saving in the cost of power resulted.

One-Man Cars.—Mr. W. A. Haller, writing in the "Electric Railway Journal," discusses the one-man cars at Tucson (U.S.A.) The total weight of the tramcar is 11,000 lb., of which 4,000 lb. is due to the motors. There are four motors to each car. Each motor is of 7 B.H.P., and they drive through a concentric gear which reduces the speed in the ratio of 10/1, the voltage being 250. The motors for opposite wheels are connected two in series for a 550-volt circuit. The wheels have rolier bearings and the armature journals have ball bearings. The speed on the level is 20 miles per hour, and with an 8 per cent. gradient 9 miles per hour. The car is 27 ft. long by 7 ft. 6 in. wide, with doors at each end. The brakes work by pedal, and can be applied from either end of the car. The emergency brake system is independent, and can be applied by a ratchet hand lever on the platform.

Rolling Mill Equipment of the Inland Steel Co.—According to the "Iron Age," this company, whose works are situated at Indiana Harbour, Ind., will include electric driving of main rolls in their new equipment. The contract with the Westinghouse Electric & Mfg. Co. includes one 15,000 H.P. direct-current motor and equipment, two 8,000 H.P. motor equipments, and several thousands of horse-power of auxiliary plant. The 15,000 H.P. motor is to be directly connected to a 40 in. reversing blooming mill. The structural mill includes one 32 in. reversing roughing mill and one 28 in. finishing mill of three-high mills. Each mill is driven direct by an 8,000 H.P. motor. One flywheel motor-generator set with a generator unit for each of the motors supplies the power for the mills. Although the fluctuations of power in the mills are very great, the control is such that it will be regulated to reduce the power fluctuations to a 10 per cent. plus or minus variation.

Output of Coal in the United Kingdom in 1914.—The total output of coal in the United Kingdom for the year 1914, according to the annual report of the Chief Inspector of Mines, amounted to 265,664,393 tons, and the value £132,596,853, showing a decrease in the output of 21,766,080 tons and in the value of £12,938,816, as compared with the figures for 1913. The average price of coal was 9s. 11·79d. per ton in 1914, as against 10s. 1·52d. in 1913.

The quantity of coal exported (exclusive of coke and manufactured fuel and of coal shipped for the use of steamers engaged in foreign trade) was 59,039,880 tons. Of this, France received over 12¼ million tons, Italy over 8½ million tons, Germany over 5¾ million tons, Sweden over 4¼ million tons, Russia over 3 million tons, Denmark over 3 million tons, Spain nearly 3 million tons, the Argentine over 2½ million tons, Egypt over 2¼ million tons, Norway nearly 2½ million tons, and the Netherlands nearly 1¾ million tons. The amount of coal remaining for home consumption was 184,670,503 tons, or 3·977 tons per head of the population. 36,289,010 tons were used in the manufacture of coke and briquettes, and 18,381,106 tons in the blast furnaces for the manufacture of pig iron, as against 39,560,489 tons and 21,223,607 tons respectively in 1913.

The Nitrate Industry.—In a Paper on the Chilian nitrate industry, read by Mr. E. Cuevas at the Pan-American Scientific Congress, the following figures were given, which are of interest in connection with projects for manufacturing nitrates by hydro-electric power:—

According to the latest official report, the zone of nitrate-bearing ground comprises 200,000 sq. km., of which less than 3 per cent. has been surveyed and prospected. In this surveyed portion alone there remains enough nitrate to supply the world for an additional 100 years, measured at the present rate of production. These calculations take no account of known areas of low-grade material. The industry is divided into two principal operations: mining and transportation of the crude material,

and production of nitrate. Methods employed in both branches leave room for improvement. Under present practice, the cost of producing commercial nitrate is estimated at 27·5d. per cwt. Trade specifications require a content of nitrate of sodium equal to at least 95 per cent. This is used as a fertilis r. The refined product, with over 96 per cent. nitrate of sodium, is applied to manufacturing uses, such as glass, explosives, fusing mixtures and nitric acid. There can be no competition between Chilian nitrate and atmospheric nitrate under any conditions which may be foreseen at present. The deposits of the great Pampa Salitrera (nitrate plain) are too vast and the business of manufacturing and marketing the material is too well systematised.

Reflecting Power Standards.—In the "Abridged Scientific Publications" of the Research Laboratory of the Eastman Kodak Co., U.S.A., there is an interesting Paper on the above by Messrs. P. G. Nutting, L. A. Jones and F. A. Elliott. Using a Nutting absolute reflectometer, they determined the reflecting powers of various powders. They found the reflecting power varied considerably with fineness of grain, reaching a maximum with grains approximating 0·01 in. diameter. The surface of the powder was made uniform by pressing a glass plate on it. The following are a few of the results obtained :—

Magnesium carbonate block freshly scraped	88·0 per cent.
Barium sulphate	85·4 ,,
Boric acid	86·2 ,,
Magnesium oxide	84·9 ,,
Sodium sulphite	81·2 ,,
Starch	83·4 ,,

The results they obtained agreed very well with those of the Bureau of Standards, Washington, and they consider them correct to within 0·2 per cent. when reasonable precautions are taken as to the purity of material, fineness of grain and the condition of surface.

Electric Railway Progress in U.S.A.—The following summary, published recently in the "Electric Railway Journal," shows the single-track mileage of new track built, steam line electrified, and total new electric mileage placed in operation since 1907 in the United States and Canada :—

	New electric railway track built.	Electrified steam line.	Total new electric mileage.
1907	—	—	1,880·0
1908	1,174·5	84·0	1,258·5
1909	774·7	112·4	887·1
1910	1,204·8	192·4	1,397·2
1911	1,105·0	86·5	1,191·5
1912	869·4	80·8	950·2
1913	974·9	119·0	1,093·9
1914	716·5	229·9	946·4
1915	596·0	448·2	1,044·2

The total mileage of new track, 596 miles, shows a decrease of 17 per cent. from that recorded last year. This decrease, however, is offset by the high record electrified mileage during 1915 of 448·2 miles, which makes the total new electric mileage placed in operation 1,044·2 miles, or a 9 per cent. increase over the similar figure for last year.

Quebec Bridge.—In a recent number of "Engineering News," Mr. H. P. Borden described the erection progress in 1915 on the above. When the work of erection ceased, about the middle of November, the north anchor and cantilever arms had been completely erected, and the south anchor arm out to and including the main post, with the exception of a certain amount of riveting in the latter, which will be finished during the coming season. The maximum amount of material erected by one traveller in one day was 670 tons. There were several days in which the tonnage exceeded 600. In the erection of the main post an average of over 350 tons a day was maintained. July was the biggest month, 4,200 tons being erected. This refers to one traveller and in each case on the south shore. The ease with which the enormous members were put in place and fitted was almost phenomenal, practically no delay whatever being occasioned at any of the joints. If everything works according to the schedule, before the end of the year it should be possible, after many years' effort, to have the two sides of the St. Lawrence linked together at this point, finally carrying the great Government railway, the National Transcontinental, across the St. Lawrence to its connections reaching the Atlantic coast.

New York State Barge Canal.—There is an interesting article in the "General Electric Review," by Mr. E. W. Pilgrim, on the above. The gates, valves and capstan machinery used in passing boats through the locks are all operated electrically. At the Crescent Dam in the Mohawk River there is an alternating-current station.

The dam is 1,922 ft. long, 39 ft. high, and is built on a 700 ft. radius. The generators are of the vertical-shaft type, 50 kw. or 75 kw. at 250 volts, the speeds varying from 155 to 660 revs. per min., depending on the head of water available. The weight of the armature and water-wheel is carried on a roller thrust-bearing on the top of the generator, and runs in oil. The power is used for the operation of the Waterford flight of five locks and two gates. The valves are controlled by a master-switch and an electric interlocking arrangement, the opening of the valves being indicated by different coloured lights. At each lock there are two capstans for pulling vessels through. The motors are 20 H.P. 230-volt 550 revs. per min. compound-wound. They are watertight, and fixed in a recess in the wall of the lock. By pressing with the foot on a pedal the motor is started one step at a time, and the resistance is so arranged that the speed can be nicely regulated. This type of capstan is used at all the locks with the exception of a few on the Erie section, where the motor is a 20 H.P. 650 revs. per min. 230-volt of mill-type, installed with the gate and valve motors in a concrete cabin.

Mathematical Printing.—A notice has been issued to members of the London Mathematical Society calling attention to the desirability of simplifying the printing of mathematics. For example, the horizontal bar frequently used in continuation of a root sign presents difficulties to the compositor; it is therefore preferable to use a bracket, as in $\sqrt{(ax^2+2bx+c)}$. Similarly, bars and dots over letters should be avoided. For the same reason $\underline{n}$ should be written $n!$; fractions should be avoided, the solidus / being used instead, unless it is confusing; the solidus is particularly useful in printing fractional indices. On the other hand, there is no objection to printing fractions in the usual form when they are set out on separate lines. Ambiguity in the meaning of symbols containing the solidus may be removed by the use of brackets; but combinations such as $p/(q+r/s)$ and $(p/q+r)/s$ are generally found difficult to read, and might be replaced either by $\dfrac{p}{q+r/s}$ and $\dfrac{p/q+r}{s}$, or by $p\Big/\left(q+\dfrac{r}{s}\right)$ and $\left(\dfrac{p}{q}+r\right)\Big/s$. The value of the solidus is largely discounted when, through want of attention, its use is pushed to unsightly extremes. It may be well to say explicitly that the affixing of indices, suffixes, or accents involves none of the complications already mentioned; at least so long as superposed indices or suffixes are avoided. Thus it is easy to print

$$1+x+x^2+x^3, \quad y_1+y_2+y_3, \quad \Sigma a_n z^n, \quad f''(x).$$

The leaflet concludes with a useful set of examples. Those interested can obtain copies by sending a stamped addressed envelope to the Hon. Sec., Dr. T. J. l'A. Bromwich, 1, Selwyn-gardens, Cambridge.

PERSONAL.

We are pleased to learn that Mr. T. K. Richardson, station superintendent of the Marylebone (London) electricity department, has much improved in health during his three months' leave of absence. The Electric Supply Committee recommend that a further three months' leave be granted to allow of his complete recovery.

It is announced that the marriage of Mr. H. F. Parshall to Miss Ellen Payne took place on Jan. 31st.

APPOINTMENTS VACANT AND FILLED.

A consulting engineer requires an assistant with first-class electrical experience. Applications to Mr. H. Ravenshaw, Rutland House, Hanwell, W.

Bispham-with-Norbreck Council require an assistant electrical engineer. Applications to the clerk to the Council, Mr. J. W. Tickle, Council Offices, Bispham.

The Council of the Indian Institute of Science invite applications for the post of assistant professor of electrical technology. Salary, 625 rupees per mensem, with a house. Further information from Messrs. Jeremiah Lyon & Co., 4, Lombard-court, London, E.C., and applications must be sent to the Director of the Indian Institute of Science, Bangalore, India, by Feb. 15.

An electrician is required for Gold Coast Government waterworks. Salary £300, rising to £350 per annum. Applications to Messrs. Hunter, Duff & Middleton, 17, Victoria-street, London, S.W. *See an advertisement.*

An engineer is wanted to take charge of electric lighting plant and superintend wiring, &c. A fitter driver and an engine driver are also required. Applications to the Division Officer, R.E. Office, Beacon Gardens, Crowborough, Sussex. *See advertisements.*

Mr. G. Dixon, of Brotton, has been appointed resident electrical engineer for the Council's electrical supply undertaking, at £177 a year, Mr. Dixon to be allowed to continue his appointment as engineer for the Cleveland & Durham Electric Power Co. in East Cleveland.

The following appointments have been made in the Tasmanian Government's hydro-electric department :—

Mr. H. H. A. Curtis, power station superintendent ; and Messrs. B. S. Marshall, P. S. McArthur and G. F. Evans, shift engineers. Mr. Curtis has taken up his duties and the shift engineers will take up theirs when the plant is running.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers.—*Expulsion of Enemy Members.*—As soon as the approval of the Board of Trade is obtained the Council propose to call a special general meeting of the corporate members to consider and, if approved, to adopt the following addition to the articles of association :—

Addition to Article 41.—(*a*) In the event of a state of war arising between Great Britain and any other country or State, any member of any class who at any time during such war shall be a subject of such enemy country or State shall forthwith cease to be a member of the Institution, and in the case of the European War of 1914 all such members shall cease to be members of the Institution on an after..... .....

(The date to be inserted will depend on the date of confirming the resolution.)

The Council have also received a petition signed by 17 corporate members in regard to the expulsion of enemy aliens, asking that, in accordance with Article 80, the Council call a special general meeting for the purpose of dealing with the matter. It is understood that the signatories are of opinion that the alteration proposed by the Council will effect the object of the petition.

Croydon Wireless Society.—On Saturday last, Dr. Annesley Eccles, radiographer to the Croydon General Hospital and the Croydon War Hospital, gave the members of the above Society and their friends an instructive lecture on "Foreign Bodies : Their Detection and Localisation by Means of X-Rays"; Dr. J. Erskine-Murray, F.R.S.E., M.I.E.E., occupied the chair. The lecturer described the use of X-rays and exhibited an instrument termed a radiochronometer, by which the penetrating power of the X-rays could be measured, and he stated that the rays, in addition to being employed in the detection of foreign bodies in the human body, had various other uses, *e.g.*, the discovery of contraband in bales of cotton, &c. He explained that different substances possessed different degrees of opacity to the X-rays. For instance, cloth, cork, leather and paper are opaque in a slight degree, while metals are the most opaque.

Royal Institution.—In his last lecture on "Fuel Economy from a National Standpoint," Prof. W. A. Bone, F.R.S., dealt with various economies that were possible in the utilisation of coal on a large scale. By reducing the temperature of the exhaust gases of a gas engine from 600 C. to 200 C., and passing them through an exhaust steam boiler for this purpose, the efficiency of the plant could be raised to 25 per cent. Ordinary gas-fired boilers were very inefficient for such a purpose, but by using the Bonecourt process an efficiency of 92·7 per cent. had been reached and an evaporation of 14·1 lb. of water per square foot of heating surface, as compared with 7·5·1 per cent. and 4·3 lb. in a coal-fired boiler. Similarly, the combination of a gas producer, with ammonium sulphate recovery plant, a Bonecourt boiler and a steam turbine would give 18 per cent. of the heat for use. In the opinion of the lecturer, inefficient plant should be ruthlessly scrapped, and the State should advance money to enable users to put in efficient plant. There was a great deal to be said in favour of manufacturers combining to take all their power from one large company, to whom they would sell their waste gases. The electric power system of the north east coast was cited as an example of what might be done in this way. Turning to gas, the lecturer mentioned that at Birmingham gas at a low price was now supplied at a pressure of 12 in., and was largely used in small met. Largest and annealing furnaces. Sheffield also was doing something in this direction. The South Staffordshire Mond Gas Co. distributed and sold Mond gas at 1½d. (equivalent to 7d. for coal gas) per 1,000 cubic ft. Lastly, the lecturer dealt with the waste that occurred through coking ovens. If the coking ovens were combined with steel works, so as to utilise the waste gases, about one-third of the 30,000,000 tons of coal annually used in this way would be saved.

The Royal Society.—The following Papers were read on Thursday, February 10th : "The Theory of the Helmholtz Resonator," by Lord Rayleigh, O.M., F.R.S. ; "The Consumption of Carbon in the Electric Arc. III.—The Anode Loss," by Messrs. W. G. Duffield and M. D. Waller.

Electrical Association of Australia.—*Victorian Section.*—At the annual meeting in Melbourne recently Mr. W. H. Alabaster, retiring president, reported that the question of licensing of wiremen had been engaging the attention of a Special Committee in conjunction with the Contractors' Association and Wiremen's Union, and it is expected that a scheme will be submitted in the near future.

The officers elected for next session were as follows : President, F. A. McCarty ; vice-presidents, A. W. Kendall and W. N. Kernot ; hon. secretary, A. Maling ; hon. treasurer, G. B. Lincolne ; Council, E. B. Brown, F. W. Clements, H. R. Harper, K. McDougall, A. McKinstry, W. J. Newbigin, H. C. Newton, Prof. Payne and W. H. Alabaster.

N.S.W. Section.—At the annual general meeting of this section in Sydney, the retiring president, Mr. H. W. Myers, occupied the chair. The office bearers elected were as follow : President, A. C. F. Webb ; past presidents, J. P. V. Madsen and H. W. Myers ; vice-presidents, F. P. Kneeshaw and H. G. Holle ; hon. treasurer, Mr. G. R. Hodson ; hon. secretary, Mr. F. McAlister ; secretary, Mr. C. E. Foxall ; Council, W. Corin, G. A. Julius, A. E. Kaleski, T. P. Strickland, J. P. Tivey, W. F. Barton and R. Vine Hall ; hon. auditors, Messrs. E. Martyn and R. V. Morse.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Feb. 11th (to-day).

PHYSICAL SOCIETY OF LONDON.

5 p.m. Annual General Meeting at the Imperial College of Science, South Kensington, S.W. Followed by Papers "On a General Bridge Method for Comparing the Mutual Inductance between two Coils with the Self-inductance of One of Them," by Prof. C. H. Lees, F.R.S. ; and "An Enclosed Cadmium Vapour Lamp," by H. J. S. Sand, D.Sc.

SATURDAY, Feb. 12th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. Meeting at Swan Hotel, New-street, Birmingham. Paper on "Electric Welding," by Mr. W. H. Wolton.

MONDAY, Feb. 14th.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

6 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Paper on "The Western Electric Co.'s Semi-automatic Telephone System," by Mr. J. Hedley.

ELECTRO-HARMONIC SOCIETY.

6:15 p.m. Concert (Ladies' Night) at Holborn Restaurant, King's Hall.

WEDNESDAY, Feb. 16th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W. Paper and exhibition by Messrs. Heron-Allen Earland & Rousselet "On the Progress and Development of Vision and Definition under the Microscope" ; also a demonstration on "An Experiment with the Ultra-Microscope," by Mr. J. E. Barnard.

THURSDAY, Feb. 17th

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment, W.C. The Seventh Kelvin Lecture on "Terrestrial Magnetism," by C. Chree, D.Sc., F.R.S.

FRIDAY, Feb. 18th.

ROYAL INSTITUTION.

5 30 p.m. Meeting at Albemarle-street, W. Discourse on "Polarised Light and its Applications to Engineering," by Prof. E. G. Coker, M.A., D.Sc.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Commanding Officer, Lieut.-Col. C. B. CLAY, V.D.

Orders for week commencing Feb. 14, 1916 :—

Drills, 6:25 to 7:25 ; 7:25 to 8:25.

Monday, Feb. 14.—Sections 1 and 2, Technical ; Sections 3 and 4, Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, Feb. 15.—School of Arms, 6 to 7 p.m.

Thursday, Feb. 17.—Shooting for Sections 3 and 4.

Friday, Feb. 18.—Sections 3 and 4, Technical ; Sections 1 and 2, Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, Feb. 19.—Adjutant's Instruction Class at 2:30 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for shooting parade at miniature ranges.

Unless otherwise ordered all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate hill, as soon as possible.

Payment for uniform to be made to the Adjutant.

THE TESTING OF UNDERGROUND CABLES WITH CONTINUOUS CURRENT.*

BY O. L. RECORD.

Summary.—After referring to dielectric strength and insulation resistance, the difficulties of testing with alternating current are dealt with. The Delon apparatus is described, and its application to the practical testing of cables is discussed.

Introduction.—The present state of knowledge regarding dielectrics does not permit us to say that there is no relation between the two phenomena—resistance and dielectric strength. On the other hand, however, we cannot say that any relation does exist; in fact. it is easy to find various important differences between the two. For instance, the insulation resistance varies considerably with the temperature, so that an alteration of only a few degrees in the temperature will double the insulation resistance; whereas, although it cannot be said that the dielectric strength is independent of temperature, it must be admitted that at all ordinary temperatures the voltage which will produce a breakdown does not vary very much.

The relation between dielectric strength and temperature is not known, nor has it been proved that it is the same for different materials. Our ignorance on this subject is easily explained. The determination of the dielectric strength of solid insulating materials is a proof of everything or nothing. The sample under test resists at a certain temperature a known voltage and breaks down at a value slightly increased; but then the material is destroyed and a test at another temperature necessitates a further sample. Under these conditions it is necessary to have a dielectric remarkably homogeneous in order to obtain results which will allow us to determine the law of variation, especially as the phenomenon does not vary considerably with the temperature.

Another feature seems to indicate that there is no direct relation between the mean insulation of the cable and the dielectric strength.

Since the measurement of the insulation resistance gives no indication of the dielectric strength of the cable, it is necessary to measure the latter directly, allowing a coefficient of safety sufficient to ensure that the voltage will never rise beyond that used for the test.

With medium-pressure and low-pressure cables there is little or no difficulty in making the verification after laying, and it is usually sufficient to take a small transformer to any desired position for conveniently testing the cable; but as soon as it is a question of high-tension cables, and of cables of great length, the problem becomes complicated. The apparent power, and in consequence the dimensions of the transformer necessary, increase as the square of the test pressure and directly as the total capacity of the cable. It is easily seen, therefore, that one very soon arrives at a transformer of such dimensions as to render transport very difficult. The author refers to the object of testing a cable after laying and the importance of high-tension testing.

Difficulties in Testing with Alternating Current After Laying.—The question becomes complicated when it is a matter of testing, for example, at 40,000 volts, a network extending to something like 12 miles. The charging current might then reach as much as 27 amperes, corresponding to a power of 1,000 kilovolt-amperes. The dimensions of such a transformer can be imagined.

If a test is to be made, not in the factory but on site, the transport and drying-out of the apparatus involve practical impossibilities. Even if the transformer could be installed in the factory it would be extremely costly; and the fact that it could only be used once would often prevent its adoption on account of the expense involved, since this test should not be repeated—and in this lies one of the chief drawbacks to testing with alternating current. Breakdown voltage is next dealt with, and the relation between breakdown voltage and duration of test discussed.

It appears, and is well recognised not only by cable manufacturers but also by the majority of supply authorities, that this fatigue of insulating materials is permanent.

The author would enlarge on this by pointing out that, from the general opinion of manufacturers, if one charges a cable to a certain voltage, say, 10 minutes, then removes the part where the fault is produced, and submits the rest to the same pressure, the rupture will occur at the end of a very much shorter time, 5 minutes, for example, and perhaps even instantaneously for a voltage less than the original voltage.

A first breakdown, even if precautions have been taken to suppress pressure-rises of an oscillatory origin, produces the same effect as an increase of frequency; it lowers the breakdown curve. The application of a voltage in the neighbourhood of the breakdown value lowers the curve in a similar manner. The author cannot cite official experience to establish this fact, but he believes that the greater number of manufacturers have been convinced on this matter by their personal experiences. It is pointed out that manufacturers oppose tests with pressures above the working pressure for the above reasons.

Advantages of Testing with Continuous Current After Laying.—The continuous-current test, whilst it requires a certain amount of current to charge the cable, absorbs no more after this charge is complete whatever the capacity of the cable, provided the insulation be sufficient. As can at once be seen, it therefore allows tests to be carried out with apparatus of small power after laying. Moreover, it does not fatigue the dielectric; at least, observations made in the case of continuous currents have not shown any of the phenomena of fatigue observed with alternating current. Consequently it is shown in the Paper that continuous current conditions of testing is what is wanted by supply authorities.

The Delon Apparatus.

This apparatus works on the following principle:—

The essence of the apparatus is a high-tension contact maker which charges condensers by making, at each half period, a connection through a short spark between the transformer and condenser to be charged. By means of a suitable arrangement the contact is made at the moment when the E.M.F. is at its maximum value, and, by means of auxiliary condensers, the voltage of one-half period is added to that of the other, with the result that finally the principal condenser is charged to a pressure double the maximum of the alternating current employed. Diagrammatically, the apparatus is reduced to that represented in Fig. 1.

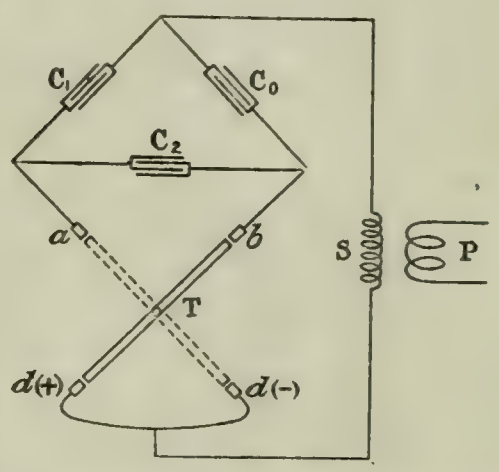


Fig. 1.—Principle of the Delon Apparatus.

The contact-maker formed by a conductor, T, embedded in an ebonite disc revolves round a spindle perpendicular to the plane of the disc. Four fixed brushes are placed a very short distance from the disc in such a manner as almost to make contact with the conductor when the latter passes between them. These four brushes are placed at the extremities of two diameters which are perpendicular to the axis of the disc. Two of the adjacent brushes are joined together and connected to one of the secondary terminals of the transformer. The other two brushes are connected each to an apex of the triangular group of condensers to be charged, the other apex being joined to the second terminal of the transformer.

The disc is driven by means of a synchronous motor fed from the alternating-current circuit which furnishes the high-tension current by means of the transformer. The group of fixed brushes can be placed at a convenient angle to allow of their coming opposite the moving conductor at the moment of maximum voltage; the condenser C_2 to be charged, and the two auxiliaries C_0 and C_1, form a triangle of which the apices are connected to the brushes a and b and to the transformer.

At the outset, the synchronous motor being started, if the primary circuit of the transformer is closed the moving conductor T passes, say, first of all between the pair of fixed brushes b and d (+). The condenser C_0 takes a charge which depends on the self-induction of the transformer and the maximum voltage of the secondary current. The other two capacities C_1 and C_2 take a charge such that the sum of their potentials U_1 and U_2 is equal to the potential, U_0, of the condenser C_0.

At the following half period it is the condenser C_1 which is directly connected to the secondary, and as the direction of the current is changed this condenser is charged in the same direction as in the previous case. The capacity C_0, on the contrary, receives a charge in the opposite direction to the first. As a result the capacity C_2, which is the one that it is desired to charge up to a high potential,

* Abstract of a Paper read before the Institution of Electrical Engineers on the 10th inst.

receives charges which are always in the same direction, whatever the position of the moving conductor. The quantity of electricity supplied at each contact will then charge simultaneously one of the two auxiliary condensers in parallel with the group formed by the secondary auxiliary condenser and the capacity C_2. As the time during which contact is established between the transformer and the capacities is very short, and as, moreover, the self-induction of the secondary of the transformer is considerable, the quantity of electricity that can be introduced into the system at each half period is limited, but the repetition of the phenomenon is so rapid that at the end of a relatively short time the capacity C_2 reaches a potential equal to twice the maximum pressure of the alternating current. In practice the charging-up is effected in less than a minute at a frequency of 50, that is, in less than 6,000 contacts. One can easily conceive that with such a system it is possible to reach continuous charges as high as desired by using transformers of only comparatively small power.

The apparatus about to be described meets these conditions in a very practical manner. The whole of the apparatus is contained in a handcart. the total weight of which is just over half a ton, so that it is quite easy for two men to wheel it.

The transformer is furnished with two primary windings which can be placed in parallel or series, allowing a voltage of 15,000 or 30,000 to be obtained on the secondary with a pressure of 110 volts on the primary side. With this apparatus it is therefore possible to test cables up to approximately $2 \times 30{,}000 \times 1{\cdot}4$, *i.e.*, 84,000 volts; and by increasing the primary voltage it is possible to test up to 100,000 volts.

With regard to the method of testing, either the two auxiliary condensers can be used, or in the case of multi-core cables they can be dispensed with, one or two of the conductors and the lead taking their place. Fig. 2 shows the connections with the condensers.

Fig. 3 shows the connections for a two-core cable. In this case one of the conductors of the cable is subjected to a pressure always of the same sign and equal to the maximum positive value of the

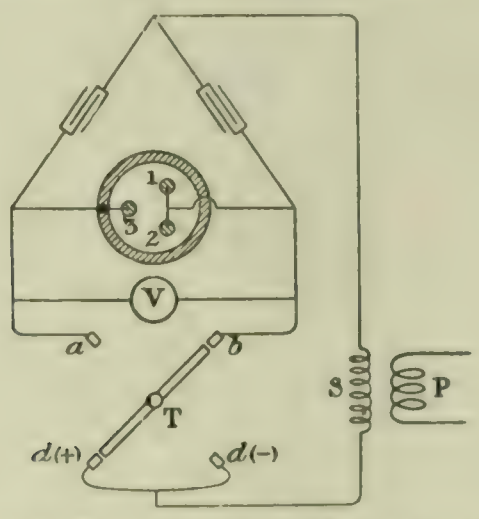


Fig. 2.—Diagram of Connections for a Three-core Cable.

alternating E.M.F., viz., $+E\sqrt{2}$, and the other to a pressure equal to the maximum negative value, viz., $-E\sqrt{2}$, so that there is at any instant between the two conductors under test a difference of potential equal to double the maximum voltage, viz., $2E\sqrt{2}$. The arrangement of the apparatus is then detailed and the question of the potentials obtained is gone into.

In practice the maximum pressure is always obtained within a few minutes on a well-insulated cable system. The author next deals with methods of testing cables having various numbers of conductors, and with regard to the Abraham-Villard electrostatic voltmeter, states: It is based on the principle of the Kelvin electrostatic voltmeter, but the moving system and the pointer are enclosed in a metal case in the side of which moves a plunger that is protected by means of a large guard disc, the whole being connected to one of the high-tension terminals. A foot moving in a slide carries another disc which is connected to the other terminal. Between these two discs, and particularly between the surface of the plunger placed in the centre of the first disc and the second disc, a perfectly uniform field is established. The instrument can measure up to 100,000 volts either continuous or alternating. It is quite handy, easy to set up.

The Potential to Adopt.—The experience of M. Laporte has shown that a continuous potential will only produce the same breakdown effect as an alternating potential of one third to one fourth its value, whilst one would have expected only the ratio $\sqrt{2}$ to 1. These are merely the results of laboratory tests, and the author fully recognises that practical engineers will perhaps only accept them for what they are worth. They are, however, confirmed by other results obtained in practice.

Burning-out of Faults.—By the application of continuous current with such a small amount of power is it possible to reduce sufficiently the resistance of a fault as to enable it to be easily located by the ordinary methods, viz., by a "loop" test or the "drop of potential" method?

Practical experience has shown that the desired result can be obtained in less than a quarter of an hour. The resistance of the fault on a cable was reduced in a few minutes to 14,000 ohms, and examples are sufficiently numerous for it to be said that the apparatus, such as it is, meets all the conditions arising out of the tests of cable networks.

Indefinite Repetition of Tests.—Finally, and this seems one of the greatest advantages of the system, continuous-current tests do not fatigue the dielectric, even if they are applied at frequent intervals, thus fulfilling the requirements of supply authorities as previously mentioned. Indeed some of the large electric supply undertakings on the Continent have definitely adopted the system.

Practical Tests.—The apparatus shown has already been tested in practice, in particular in the case of some tests carried out as long ago as 1910. The apparatus in question was used in Lyons for testing a cable 2 km. long, laid for the Société Grénobloise. It was required to test a three-core cable of 40 sq. mm. section, designed for a working pressure of 10,000 volts. This cable was to be tested at 30,000 volts, *i.e.*, at approximately $2\sqrt{2}$ times the normal working pressure. As the cable ran near a cable factory, the current was taken from this factory supply at 180 volts, and was reduced to 110 volts by means of a choking coil. The connections were as shown in Fig. 2, auxiliary condensers being used, each having a capacity of 0·015 mfd. The capacity of the cable was about 0·4 mfd. If it had been necessary to make the test with alternating current a transformer of 50 k.v.a. capacity would have been necessary. With continuous current, experience showed that a pressure of only 105 volts at the primary terminals and a current of 2·9 amperes, *i.e.*, 305

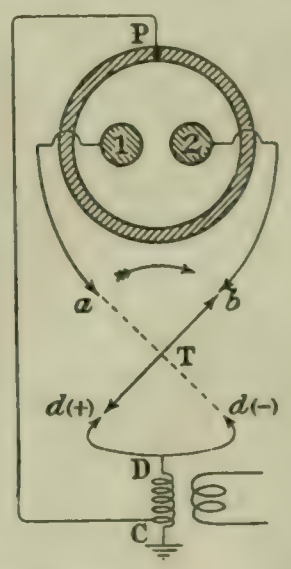


Fig. 3.—Diagram of Connections for a Two-core Cable.

volt-amperes, were necessary, whilst the potential reached was 31,000 volts.

Conclusion.—Tests with the oscillograph have shown that the quantity of electricity taken at each contact is less than 2·8 microcoulombs, the maximum current being less than 7 milli-amperes and the duration of each charge less than 1/50 period. The corresponding pressure variation was less than 8 volts, which is perfectly negligible compared with the total pressure of 30,000 volts. One can even say that the pressure is infinitely more constant than that supplied by a dynamo.

It is evident, therefore, that the apparatus shown allows of tests on underground cable systems being easily carried out with constant pressure.

Various objections have, however, been raised to the method. For instance, some engineers think that the causes of puncture of cables are quite different with alternating current from what they are with continuous current; also that the test gives a false security and that in specifying a continuous-current test quite new conditions are imposed on the manufacturer, conditions which are quite useless from the point of view of the service for which the cables are required. It appears, however, quite a simple matter to establish the relation between the alternating and continuous pressures which will produce the same disruptive effect. Objections would, however, disappear if a definite test pressure was agreed upon.

The author refers in an Appendix to a Paper in the "Elektrotechnische Zeitschrift," by Dr. Lichtenstein, and states that the ratio of pressure by Delon apparatus to the alternating pressure is about 2·35 to 2·45. A portable Delon apparatus in use by Siemens Schuckert is also described briefly.

OVERHEAD CONTACT SYSTEMS, CONSTRUCTION AND COSTS.*

BY E. J. AMBERG.

Summary.—This Paper, written with special reference to the New Haven electrification, gives a brief analysis of the systems and points to be considered in equipping trunk lines with overhead catenary construction. The Paper is subdivided into five parts—viz., catenary systems, supporting structures, sectionalisation, special construction and cost data.

This section of the Paper is written with special reference to the electrification of the New York, New Haven & Hartford Railroad between New York and New Haven, the New York, Westchester & Boston Railway, and of the Hoosac Tunnel section of the Boston & Maine Railroad, the writer having been closely associated with this work under the direction of Mr. W. S. Murray.

The N.Y., N.H. & H.R.R. section covers an entire engine district, consisting of 75 route-miles of four and six-track main line, 6 route-miles of single-track branch line, large freight yards, station sidings and industrial spurs. The New York, Westchester & Boston Railway section consists of 17½ route miles of four and two track main line, with yards and sidings. The Boston & Maine Railroad section consists of 8 route miles of double track, with yards and sidings, and includes a tunnel section of 4·75 miles. These electrifications total 575 miles on a single-track basis. Several types of catenary construction were necessary to meet the various requirements.

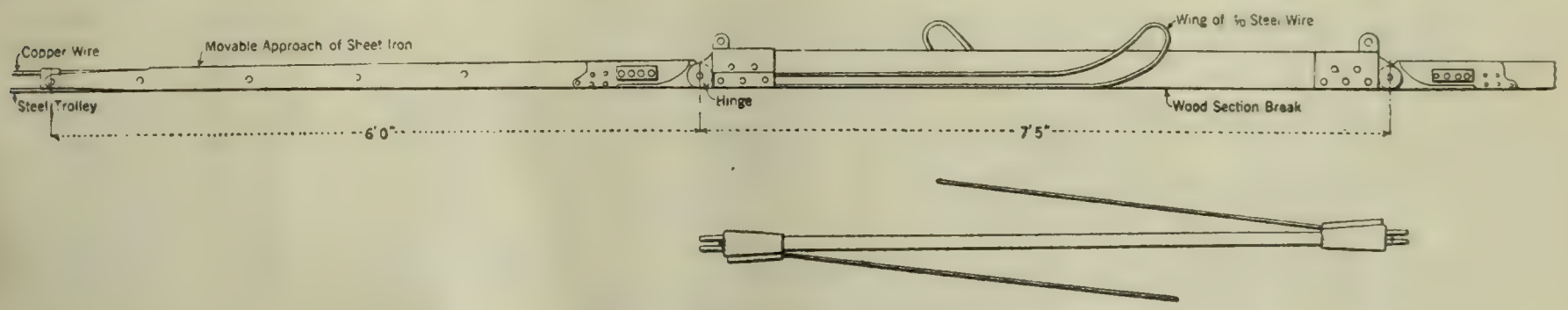


FIG. 1.—WOOD SECTION BREAK.

For convenience, the Paper is subdivided into the following general parts: (1) Catenary Systems; (2) Supporting Structures; (3) Sectionalisation; (4) Special Construction; (5) Cost Data—General

CATENARY SYSTEMS.

A catenary system may be either rigid or flexible, but the two should never be combined, for operating experience has shown that where flexible and rigid parts meet trouble is especially liable to occur.

Double Catenary.—This was the pioneer catenary installation in the world as applied to trunk lines with heavy traffic density. When installed it was considered necessary to provide stiffness against wind to keep the trolley within reach of the locomotive pantagraphs. Two $\frac{3}{16}$ in. steel messenger strands were used, to which triangular hangers were fastened, these supporting the copper trolley wire. This provided horizontal stiffness and vertical rigidity; thus the construction was a combination of a rigid and flexible system, the rigid section being the two messengers with trangular hangers, the flexible part the copper trolley wire between hangers. Initial operation showed that this combination was not adapted to high-speed service, and it was readily changed to a flexible system by the addition of a steel trolley wire supported by clips from the copper conductor. These clips were installed midway between triangular hangers. The double catenary system also has the advantage that if one messenger broke the other would prevent the catenary from falling.

The system has several disadvantages. On account of the two live messengers being carried over the bridges, it is impossible to do work on the trusses, such as installing signals or running taps from one side to the other, without having power cut off. No ground wires were installed, as it was thought that lightning arresters of the spark-gap type would be adequate to prevent trouble from lightning; but the protection was insufficient, and electrolytic lightning arresters have now replaced them. The trouble from lightning has been reduced considerably, but is still greater in this section than on any other part of the electrification.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Compound Catenary.—This was first developed and installed on the 1 mile section at Glenbrook, Ct. The type was further developed and applied to the Harlem River branch, the New York, Westchester & Boston and the section between Stamford and New Haven. It was considered desirable to install a grounded messenger over each track, which would remove the live parts of the catenary from the trusses, eliminate lightning trouble and at the same time be used to keep the trolley wires nearly over the centre line of track without the use of pull-off poles. The $\frac{7}{8}$ in. messenger is carried over the catenary bridges and is supported on cast-iron saddles instead of insulators, as in the double catenary type, and is thereby grounded to the bridges. These messengers, strung over each track, are connected at the quarter points of the spans by 3 in. I-beams running across tracks. The suspension insulators are attached to these I-beams for carrying the single catenary, which consists of a $\frac{5}{8}$ in. stranded steel messenger clamped to the insulators, a 4/0 copper conductor supported from the strand by $\frac{1}{2}$ in. rod hangers every 10 ft., and a 4/0 steel contact wire fastened to the copper conductor by clips placed half-way between the rod hangers. On curves the "Murray" hanger is used. This is clamped to the messenger and is held at a suitable angle by the acting forces. Fastened to the lower end is a duplex clip to hold the copper and steel trolley. Length and angle of hanger are adjusted so that the clips are true to line, and the contact wire is held over the centre of track. With this type of construction it is possible to maintain 300 ft. spans on curves up to three degrees without pull-offs; for sharper curves it is necessary to shorten the spans. Even on reverse curves no difficulty has been experienced in keeping the contact wire in its proper location. On curves above two degrees the temperature has an influence on the alignment of the contact wire, requiring the use of pull-offs spans between bridges.

Single Catenary.—In this construction the insulators are attached to the underside of the trusses and the single catenary suspended from them. This also keeps the live wires of the catenary below the steel work. For tangent sections the bridges can be spaced 300 ft., but for curves this distance must be reduced unless pull-offs are used. Adequate lightning protection was secured by stringing ground wires on the feeder supports.

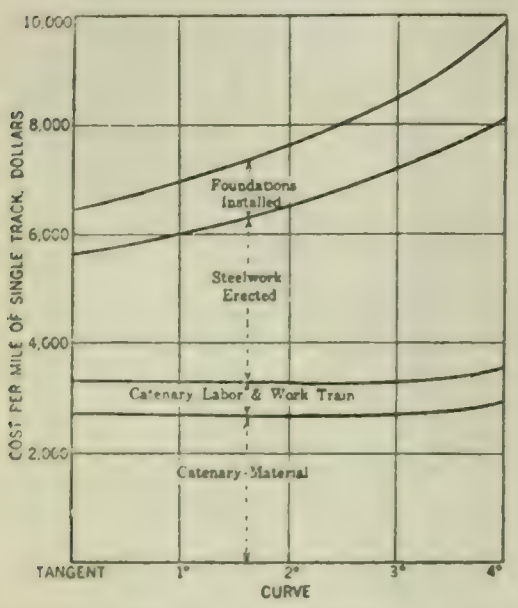
Single catenary may be used both for main line and yard work. In yards the copper wire may be omitted, for the reason that in the average yard the trolley wires have sufficient current-carrying capacity, since several tracks are connected in multiple.

To make the yard construction as light as possible, a $\frac{3}{8}$ in. messenger, 2/0 trolly and $\frac{3}{8}$ in. hangers were used, except for tracks with frequent movements; these were equipped with $\frac{5}{8}$ in. messenger, 4/0 trolly wire and $\frac{1}{2}$ in. rod hangers.

Contact Wire.—The steel trolley wire rusts considerably; this rust is washed off by rain and drips on to coaches and locomotives operating in the zone, making them unsightly and necessitating more frequent painting. Where frequent locomotive movements are made, the underside of the trolley wire is kept bright, and presents a good collecting surface; but where locomotives are operated infrequently rust collects, causing increased sparking and burning of pantagraph shoes. In the Woodlawn–Stamford section the steel trolley wire has been in service since 1907, and at points of greatest wear phono-electric trolley wire has been installed, with very satisfactory results. For future electrifications doubtless steel contact wire will be less used, although the difference in first cost is much in favour of it.

Insulators.—Insulation is a very important part of any catenary system, and the slight additional cost for insulators with a high factor of safety is good insurance. The types used on the New Haven electrification were all tested for 110,000 volts. The pin, suspension and some of the strain insulators are of the porcelain type; other strain insulators are of wood. Temperature strains in porcelain insulators should be given most careful consideration, especially in the dead-end type. Failures have been caused by steam

train operation in the electrified zone, breakdowns being most frequent where clearance between the locomotive stack and insulator is restricted, or where steam engines stopped under or near an insulator. Where clearances are restricted it is advisable to locate the insulators off the centre line of track or to use two insulators in parallel, spaced several feet apart. In tunnels two insulators in series are advisable, and this form was sucessfully used in the electrification of the Hoosac tunnel; in this case each insulator was tested for 150,000 volts.



IG. 2.—COST OF COMPOUND CATENARY FOR SIX-TRACK SECTION.

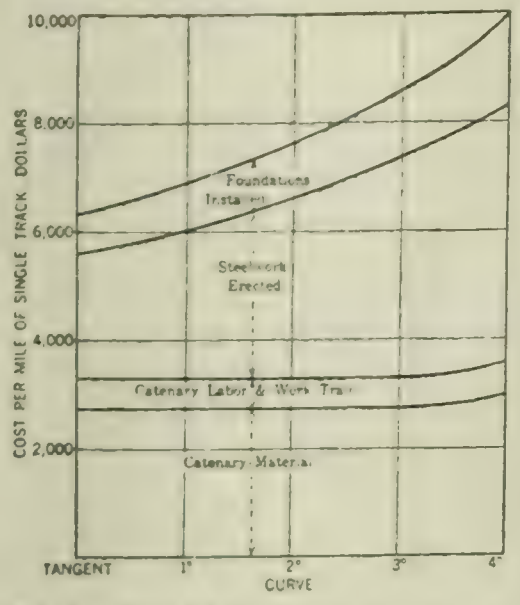


FIG. 3.—COST OF COMPOUND CATENARY FOR FOUR-TRACK SECTION.

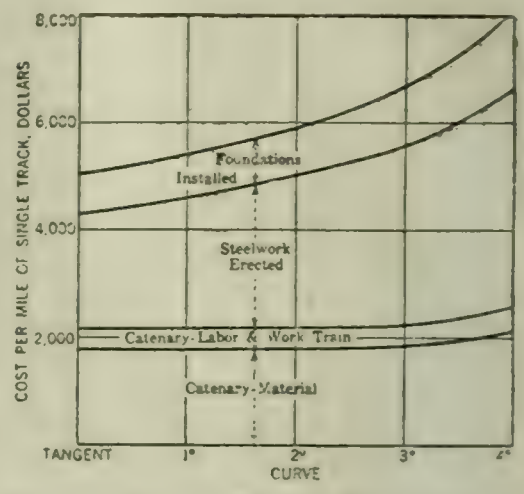


FIG. 5.—COST OF SINGLE CATENARY FOR FOUR-TRACK SECTION.

SUPPORTING STRUCTURES.

The supporting structures can be divided into three classes: Bridges, steel or wood poles with cross spans and poles with brackets. Choice of the supporting structure is governed by the load to be carried, number of tracks to be spanned and other conditions.

A bridge was the only structure which would fulfil the conditions on the New Haven and on the New York, Westchester & Boston line.

The cross-span construction is especially well adapted where a large number of tracks are to be equipped with single catenary. This applies to main line as well as yards. The cross-span messenger is supported by poles, which may be either self supporting or guyed. On the New Haven electrification most structures are self supporting.

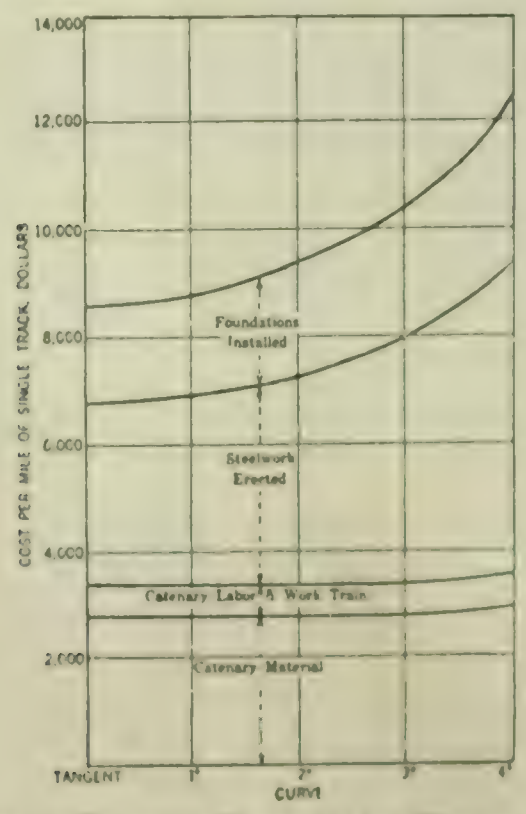


FIG. 4.—COST OF COMPOUND CATENARY FOR TWO-TRACK SECTION.

The cross-span construction was used in all yards and at certain points for main-line work.

Poles with brackets have been used for single track sections and for station and industrial sidings. It is cheaper but not so reliable as the others, although suitable for the purpose.

SECTIONALISATION.

It is necessary to sectionalise the contact system to locate trouble and to make repairs with the least interference to operation. Main-line tracks should be sectionalised from each other and each should again be divided into sections. The sectionalising points should preferably be at or adjacent to principal cross-overs, which are generally controlled from signal towers. There are always employés at such places who may be charged with the small additional duties of operating the electrical apparatus. To disconnect a defective section quickly, automatic oil circuit-breakers are used. These breakers should be of ample size and staunch construction, as they are subject to a severe service. On the New Haven and the New York, Westchester & Boston Railway systems the breakers are of the outdoor type mounted on sectionalising bridges. The switchboard, with the control switches and relays, is located in the signal tower.

The actual break or gap in the track catenaries can be made in different ways. Two distinct types, however, with various modifications were used on the New Haven, one rigid, the other flexible. The rigid type was a wood section insulator, which gives a very simple construction but produces an undesirable hard spot for high-speed operation. By installing a movable approach to the wood section break, the effect of the hard spot is somewhat reduced. The flexible wings shown on the wood section break (Fig. 1) are arranged to prevent an engine from getting stalled at that point.

In the flexible type air is used as an insulating medium; insulation is obtained by having the trolley wires of the two adjoining sections overlap, spaced about 18 in. apart, and then dead-ending each in opposite directions.

Yard sectionalisation is easily arranged. On account of the slow movement of trains, the wood section break can be used without movable approach.

SPECIAL CONSTRUCTION.

This covers the work at cross-overs, river crossings, arrangements for joint use of the same overhead wire in yards and sidings by the 11,000 volt alternating-current locomotives and the 600 volt direct-current trolleys at different times, grade crossings of 11,000 volts alternating current and 600 volts direct current, and many other problems which, although of minor importance, are links in the complete chain.

Cross-overs are all equipped with a single catenary, omitting the 4/0 copper wire. Wherever possible, air sectionalisation is used, but there are a number of places where wood section breaks could not be avoided. Perfect alignment is necessary where main line and cross-over catenaries meet, and at these points deflectors are used to prevent the pantagraph shoe catching in the wires. The construction for river crossings presents unique studies.

COST DATA.

It is of little value to give costs without at the same time stating fully the exact conditions under which they have been obtained. The information in the following diagrams and tables is intended to give an idea of the cost of the various types of construction under "normal conditions" met within the New Haven territory, and also show how this may vary under more difficult conditions.

Catenary Construction.— Figs. 2, 3 and 4 give the respective cost per mile of single track for compound catenary construction of the New Haven type for a six-track, four-track and two-track section, exclusive of feeders, transmission lines and sectionalisation. Figs. 5 and 6 give the respective cost per mile of single track for single catenary construction of the New Haven type for four-track and

two-track sections, exclusive of feeders, transmission lines and sectionalisation.

These curves apply to the following normal conditions :—

1. *Foundations.*—The ground on both sides of the tracks is level ; no piling or rock blasting necessary.

2. *Bridges.*—To carry one catenary, one signal, one 4/0 feeder per track ; duplicate 4/0 three-phase lines ; duplicate signal lines, each consisting of two No. 3 control wires and two $\frac{3}{8}$ in. steel ground wires.

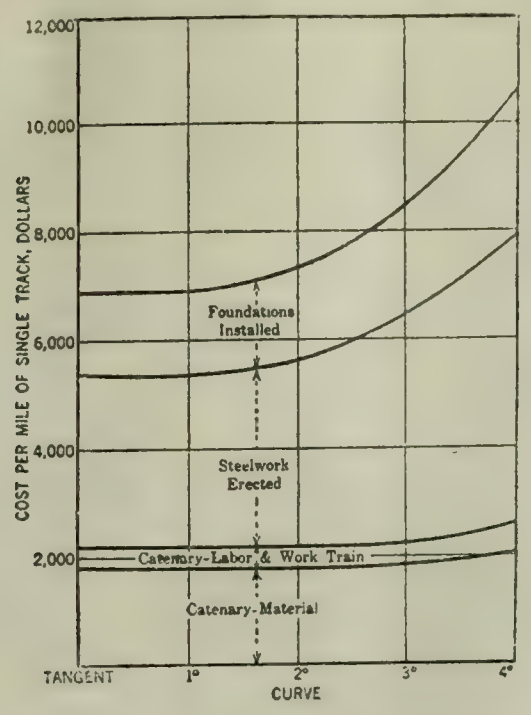


Fig. 6.—Cost of Single Catenary for Two-track Section.

No bridge to span more than the standard number of tracks nor carry additional load, such as yard cross-spans, brackets, &c. None of the feeder supports to be moved in from the posts to the trusses.

3. *Labour and Work Train Conditions for Installation of Catenary.*—Gangs and work trains occupying tracks assigned for construction purposes to be allowed reasonable freedom from interruption.

Tables are given showing the cost of items of erection and of catenary material as a percentage of the whole.

The erection cost of feeders and transmission lines varies from $20.00 to $50.00 per mile of wire. With regard to yard construction, the costs under favourable conditions may be approximated as follows :—

Foundations installed	$700.00
Supporting structures erected	800.00
Catenary material	1,000.00
Labour and work train service	500.00
Total per mile of single track	$3,000.00

THE EQUIPMENT AND PROTECTION OF OUTDOOR H.-T. SUB-STATIONS.

BY J. LINDLEY THOMPSON, M.SC., AND S. AUSTEN STIGANT.

Summary.—After referring to the advantages of outdoor substations and the districts to which they are suitable, the authors deal with the various types that are available, and with the details of equipment. The points that are particularly discussed are the protection of plant against the effects of weather and protection against lightning discharges. In conclusion some figures are given of cost.

The evolution of the outdoor high-tension sub-station has proceeded as a direct and natural outcome of the appreciation of the community of the benefits and attractions afforded by the application of electricity. The specialisation necessary for the design and manufacture of the various types of gear has been most marked in those countries possessing concentrated sources of electrical energy situated at a considerable distance from the point of application. Since the problem is to offer an attractive proposition to the small consumer, the usual housed-in station is out of the question, and therefore engineers are confronted with the necessity of producing apparatus sufficiently substantial to operate in the open and under severe conditions, both as regards weather extremes and possible mechanical injury. On the Continent, and in America particularly, these conditions have been the means of producing suitable high-class apparatus of a substantial and reliable design. In this article it is intended briefly to enumerate and describe the various conditions of use and types of apparatus involved in consideration of the needs of the relatively small consumer.

Although outdoor sub-stations have been in vogue on the Continent as well as in the United States for a number of years, the authors regret that, owing to the present situation, they have been unable to obtain illustrations of Continental manufacture. It may be said, however, that the systems in operation on the Continent are similar to those in use in America, of which we are able to show a few representative types. Regarding Great Britain, with its thickly populated industrial districts, the use of outdoor sub-stations has not in the past called for much attention ; but, due no doubt to the fact that supply companies have been energetically seeking customers in the more remote districts, and also due to the energetic pursuance by manufacturers of their foreign trade policy, the outdoor sub-station is now receiving its due at the hands of the home manufacturers, and of later years British firms have been competing with much success against the Continental and American producers of this type of apparatus.

The principal features of outdoor sub-station equipment can be tabulated as follows :—

1. Advantages of outdoor sub-stations.
2. Districts in which outdoor sub-stations may be profitably erected.
3. Types of sub-stations for particular districts and loads.
4. Protection of sub-station and consumer's load.
5. Equipment of sub-station.
6. Types and characteristics of gear.
7. Prices.

Advantages of Outdoor Sub-stations.—Outdoor sub-stations have originated primarily on account of their comparative low initial cost, which in certain cases is of paramount importance.

This conservancy of capital outlay is necessary in cases where customers have to be dealt with whose maximum load is of such a character as can be obtained from static apparatus. Since static apparatus such as transformers can supply lighting and power loads, and in the supplying of the same require only intermittent (but regular) inspection, it will be readily understood that such apparatus can be installed in places remote from public traffic and in the open if constructed in such a manner as to successfully withstand all sevère climatic conditions to which the particular district is liable. Outdoor sub-stations, therefore, relieve capital expense to the extent that no costly housing or building construction is required, and no permanent attendant is needed for the installation.

Against this saving there is a slight additional cost—say 10 to 15 per cent.—in the manufacture of weatherproof apparatus. A further advantage, from the consumer's point of view (and also that of the supply company's), is that new customers, within reasonable radius of an existing transmission line, can be speedily coupled up and supplied with power, since the erection of the necessary gear is much more speedily effected than the building of a permanently enclosed station.

Districts in which Outdoor Sub-stations may be Profitably Erected.—A few of the more important applications of the outdoor sub-station to industrial and social conditions are as follow : (*a*) Remote surburban districts ; (*b*) small towns and villages ; (*c*) isolated industrial concerns, such as factories, mines and farming districts ; (*d*) for feeding alternating-current railways ; (*e*) for supplying power to contractors on new developments

Types of Sub-station for Particular Districts and Loads.—The type of sub-station of economic value is regulated by (*a*) the voltage of the transmission line ; (*b*) the consumer's load (size and application), and approximates closely to the particulars given in Tables I. and II

Table I.

Line voltage.	K.v.a. rating of smallest economical sub-station, 3 phase.	Type.
Up to 6,500/440.....	Up to 30	Single pole.
Ditto	30 to 75	Two pole.
16,500 and upwards ...	75 to 150	Steel tower or platform.
Any voltage	150 and upwards	Railed in on concrete base.

Table II.

Consumers.	Application.	Type of sub-station.
Small towns	Lighting, power, railway, household devices	Semi-portable.
Farms	Harvesters, separators, threshing machines, cutters, lighting.	Portable.
Mines and quarries ...	Cable ways, crushers, drills, hoists, lighting, locos, pumps, vent. fans	Semi-portable and portable
Pumping installations	Irrigation, refrigeration, water supply	Semi-portable
Manufacturing plant...	Heat, power, light	Ditto.
Contract jobs	Cable ways, compressors, cranes, dredges, drills, hoists, locos, lighting, pumps	Portable.

Protection of Sub-stations and Consumers' Loads.—Even at this present stage of manufacture of high-tension outdoor sub-stations there exists considerable diversity of opinion regarding the adequate protection of transforming apparatus

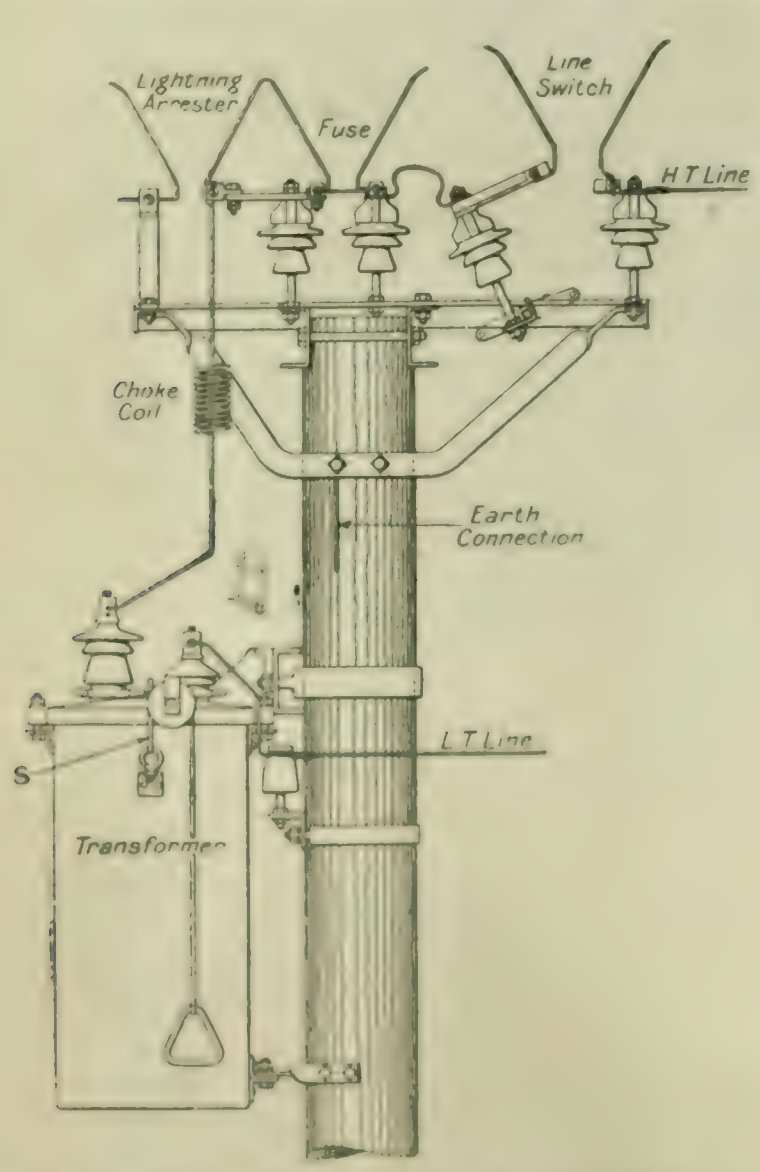


Fig. 1.—Pole-mounted Transformer with High and Low-tension Line Equipments.

and consumers' load. That this is so seems hardly to be wondered at when one studies the various reports of consulting and operating engineers regarding the operation of transmission lines and equipments with which they have been concerned. The actual design of protective apparatus greatly depends on the general atmospheric conditions prevalent in the district and on the line voltage and power behind the system. The protection, apart from that afforded by the special design of the transformers, essentially consists of some type of lightning arrester, together with suitable choke coils, overload fuses and isolating switches.

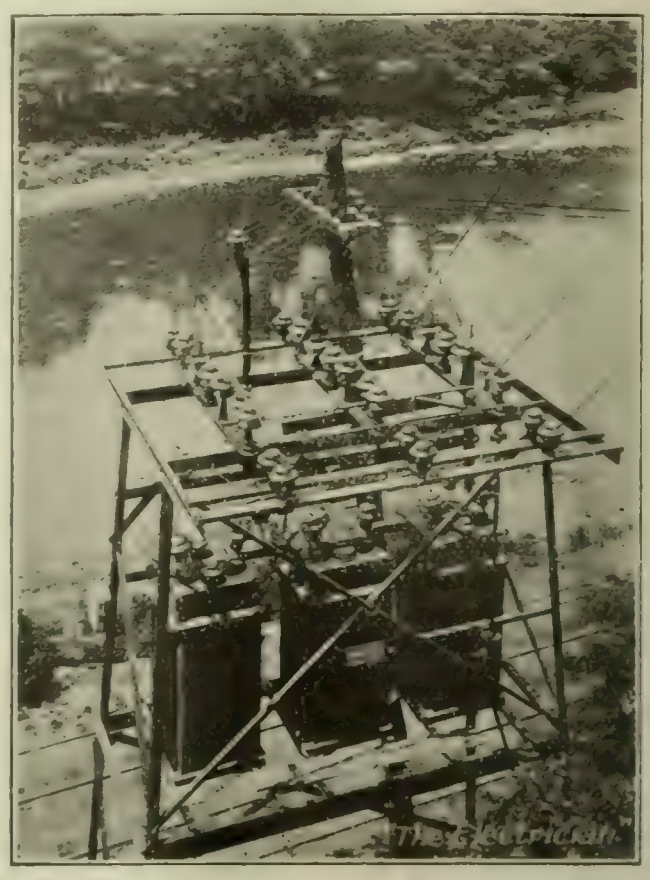


Fig. 2.—Typical Outdoor Sub-station, Three-phase 22,000 Volts.

These accessories are in general mounted adjacent to the transformer and in an accessible position, on suitable insulators, carried by the transmission pole or tower. It is of paramount importance that all apparatus used in conjunction with outdoor sub-stations should be of strong mechanical construction and



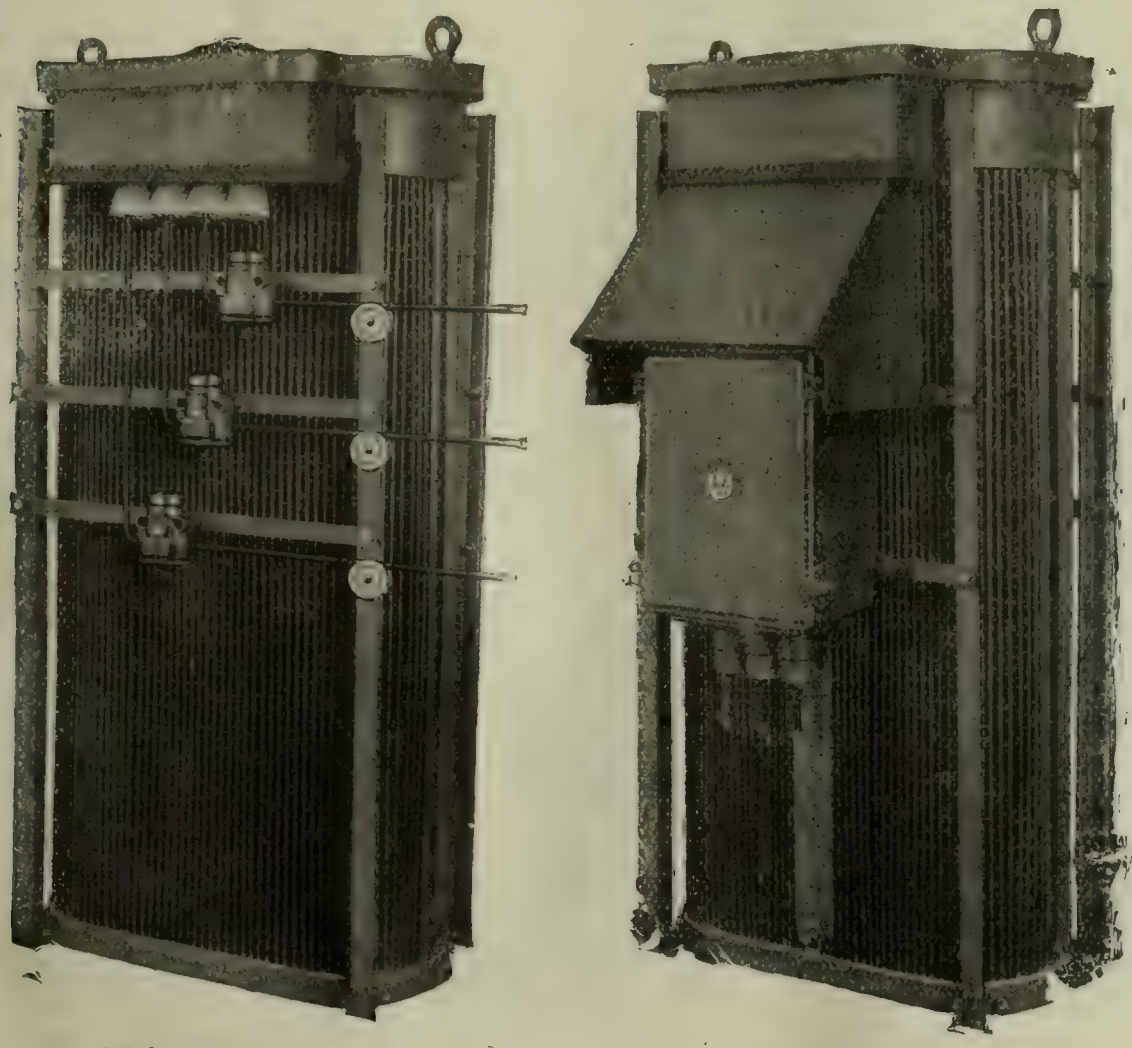
Fig. 3.—Typical Outdoor Sub-station, Three-phase.

devoid of any possibility of corrosion and derangement. As a rule, circuit-breakers are not installed on outdoor sub-stations, since these are always provided at the consumer's end of the sub system, and therefore all possibility of excessive overload is taken care of by the insertion of primary fuses. This being the case, and the possibility of the blowing of the fuses being

frequent, they must be of such a mechanical construction as to be easily removed from the line by means of an insulated pole.

Equipment of Outdoor Sub-stations.—The equipment of the average medium output sub-station essentially consists of a weatherproof transformer, isolating switches, fuses, lightning arrester and choke coils. The efficiency of these component parts is largely dependent on the insulation characteristics of the porcelain mountings, as well as on their mechanical rigidity. Since these insulators are required to withstand all weather extremes, they should be of a homogeneous nature, and constructed on the petticoat or watershed principle. They should be so designed as to possess a creeping surface under the petticoat that will safely withstand any abnormal pressures to which the sub-system may be subjected, since the external surfaces when moistened by rain or snow become ineffective. The design of the insulators is entirely dependent on the working line voltages combined with a safety factor, allowing for abnormal pressure rises, to which the particular districts may be liable. All bolts and metallic parts clamping insulators should preferably be of non-corrosive metal, especially if they are threaded, since moisture would creep down the channel provided by the threads, and so render breakdowns certain. All other metallic parts should be galvanised or treated with moisture-proof paint or red lead. This point is essential for sound mechanical construction, since moisture is one of the greatest enemies to be guarded against. The arrangement of the protective gear and transformer is similar to that shown in Fig. 1, which illustrates a typical outdoor equipment. The earthing of all metallic parts other than those directly connected with the system is advisable from the point of human safety.

The equipment is mounted on various types of structures according to the line voltage, &c., as detailed out under heading No. 3. That is, for small outputs and comparatively low voltages, the transformer is hung from a substantial pole, directly beneath the transmission line, while the gear is mounted on cross bars between the line and the transformer, the transmission line being carried on the summit of the pole. Transformers of larger output or higher voltages are mounted on platforms arranged on steel towers of substantial construction, while the protective gear is carried on an extension of the steel tower immediately above the transformer. Typical examples of this type of equipment will be seen in Figs. 2 and 3. For the largest outdoor sub-stations the transformers are mounted on guarded concrete platforms, while the protective gear and transmission lines are carried on steel towers of strong construction in an adjacent position. Sub-stations of the portable type, as used on contracting work and railway systems, have their complete equipment mounted on a suitable truck for road or railway use, as the case may be. The high-tension protective gear is mounted on the roof of the truck, while the low tension gear and incidental apparatus is mounted in a cabin shielded in a suitable manner. The incidental apparatus here mentioned may refer to rotary converters, special driving plant and the like. The sub-stations are connected to the transmission line at the requisite points by means of temporary leads suitably clipped to the transmission system.



High-tension side. Low-tension side.

FIG. 4.—100 K.V.A. THREE-PHASE 50 CYCLES, 3,000 VOLS, TRANSFORMER IN CASE.

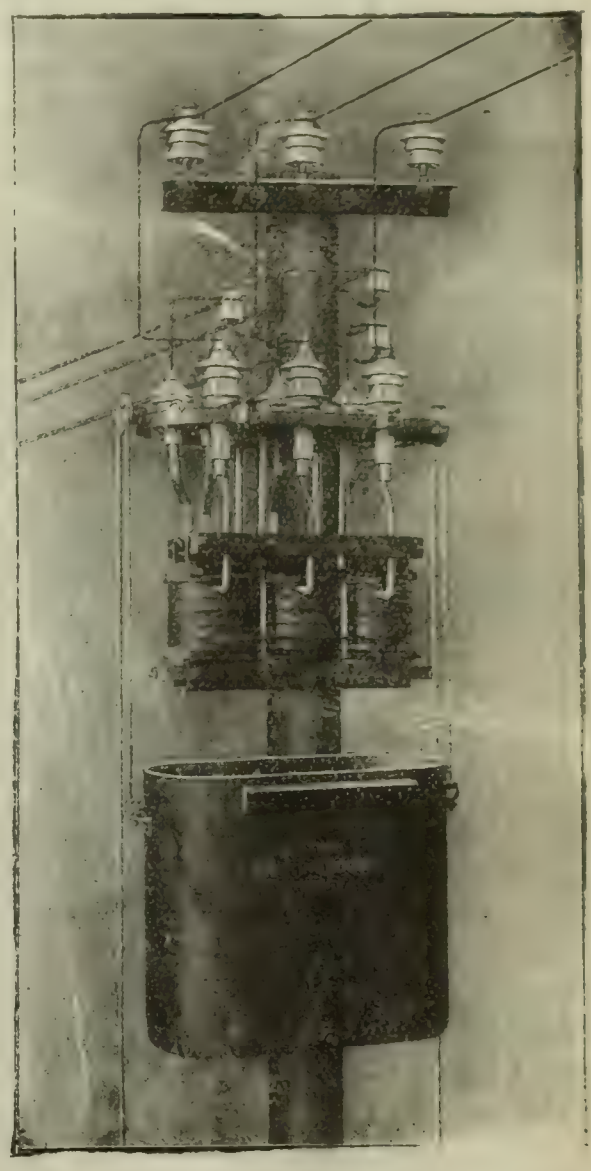


FIG. 5.—THREE-PHASE POLE-MOUNTED TRANSFORMER, 10,000 VOLTS.

With reference to outdoor sub-stations of the very largest outputs, it may be said that the equipment of these is necessarily extended and modified by the total rating of the station as much as by the heavy line voltage, but in their essential principles are much the same as above described.

Types and Characteristics of Gear.—The chief desirable characteristic of all types of outdoor apparatus is undoubtedly that of mechanical solidarity of construction, coupled with the minimum labour output necessary for efficient erection, and the authors are of the opinion that too much stress cannot be laid on this point.

It is not proposed in this article to deal to any great extent with the many theoretical considerations limiting the use and applications of the various types of apparatus, since these have been, and are even now being, widely discussed in the columns of the technical press and in the "Proceedings" of the technical societies. It may, however, not be out of place to briefly refer to the main considerations which should be borne in mind in selecting apparatus for a certain purpose and under certain

specific conditions. Essentials in the manufacture of weather-proof transformers are that the windings and oil shall be thoroughly protected from all possibility of contact with moisture. Also that the insulation shall be of such character as to be safe from the accumulation of foreign matter or the reduction of insulating surface by moisture. Should the sub-station be situated in districts where great variations in temperature of the atmosphere occur over short periods of time (*i.e.*, over 24 hours), the transformer main tanks should be of strong construction and airtight, for the following reasons :—

During the period of high atmospheric temperature (apart from that due to load) the air at the top of the tank will expand and discharge into the atmosphere. As the atmospheric temperature falls the air remaining in the tank contracts, and therefore sucks in air from the atmosphere, which may have become laden with moisture during the day. It will, therefore, be appreciated that in this manner moisture will be gradually drawn into the transformer tank, which would condense on the cover, and finally find its way into the oil and in contact with the windings. To obviate this it is necessary to make the tank completely airtight and of a sound mechanical construction, such as to withstand the variation of internal pressure due to atmospheric conditions.

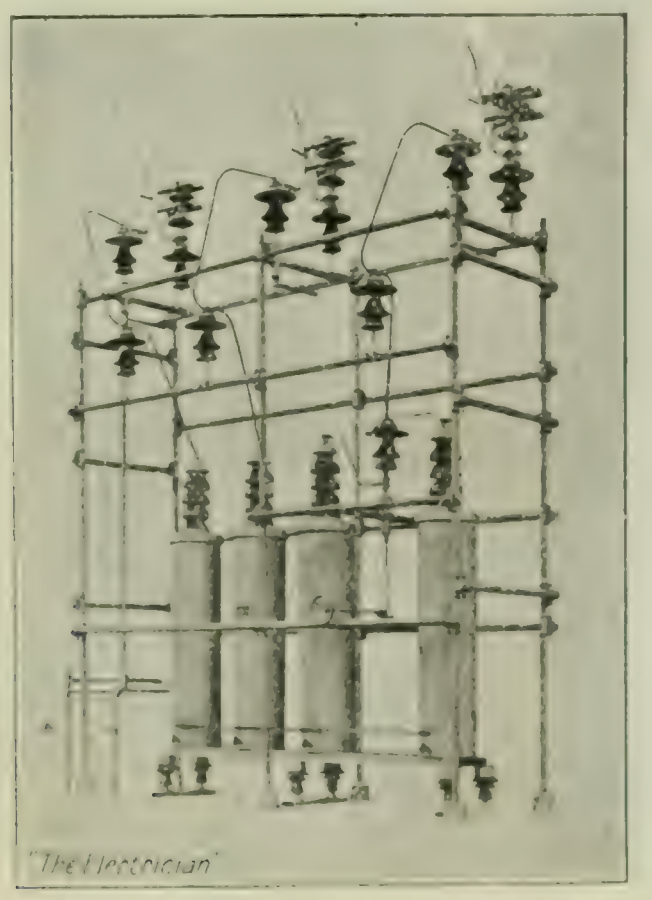


Fig. 6. Three phase Aluminium Lightning Arrester, 45,000 volts.

Fig. 4 shows the high and low-tension side of a three phase transformer fitted with high-tension weatherproof fuses, and terminals being protected by substantial hoods, while Fig. 5 illustrates a further example of a three phase pole mounted transformer fitted with petticoat insulators and provided with slinging arrangement to facilitate inspection of the transformer while in position. As regards protection against surges, all modern transformers are provided with reinforced end coils, and these, in conjunction with external choke coils, are in the majority of cases sufficient to afford adequate protection.

As regards the design of choke coils, it may be said that opinions of designing engineers vary considerably. With some, large choke coils are advocated, whilst others hold to the opinion that relatively small coils are of ample means for procuring protection on outdoor systems. The conditions under which the plant has to operate—*i.e.*, climatic conditions, power behind the system, length of transmission line and voltage of supply—have to be taken into account by the engineer before putting forward any definite design or scheme. Opinions in the main, however, lean to the use of small coils, since large coils are expensive to manufacture, and under certain conditions are a danger to insulation, due to their high inductance unless horn gaps or arresters are placed on either side. This danger does not, however, refer to transformer sub-stations, since the coils are immediately in front of the transformer winding. The authors' opinions lean towards the use of small choke coils for lightning protection, for even though their normal inductance is low, they present, when subjected to high frequency lightning discharges or surges a high ohmic inductance, and perform the object for which they are installed by holding back the surge and building up a high voltage wave at their front for sufficient time to allow the surge to discharge through the auxiliary apparatus to earth. Another function of the choke coil is to lower the frequency of any oscillation that might pass through the coil, and thus reduce the potential stress on the end turns of the transformer winding. This stress is, of course, dependent on the frequency of any travelling wave that may penetrate through, and the interposing of a choke coil assists in smoothing out the wave front of the disturbance. There are several points which must be borne in mind when designing these coils, which are briefly as follows : (*a*) They must have no appreciable static capacity between their adjacent turns, since the same would neutralise their inductive effect and render ineffective their operation.

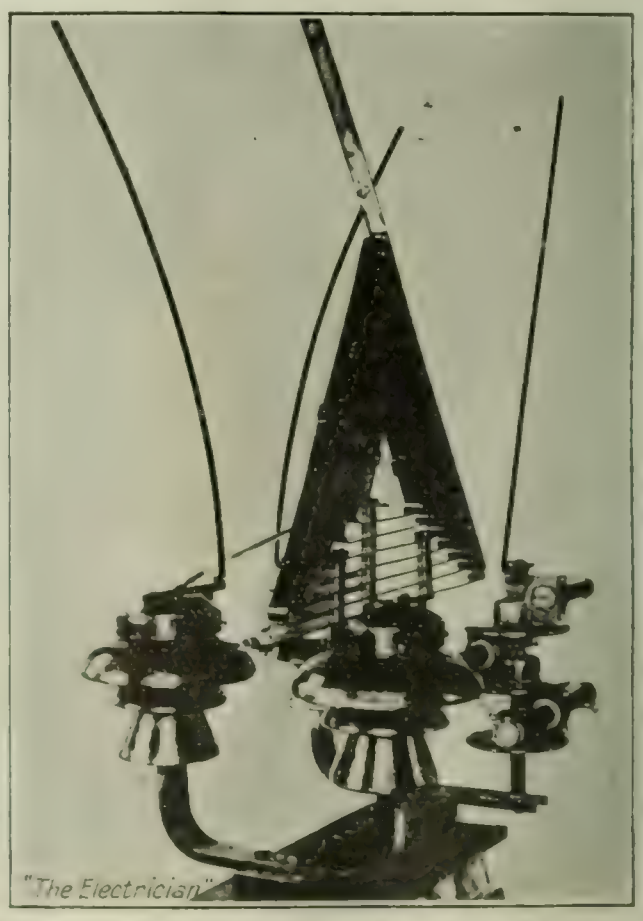


Fig. 7.—" Burke " Horn-gap Lightning Arrester.

(*b*) The several turns should be efficiently insulated from each other, thus preventing any arcing from turn to turn. (*c*) The inductance should be equal to that value which will reduce the disturbing wave or surges to such a value as can be safely withstood by the premier turns of the transformer winding. (*d*) They should be of rigid mechanical construction, and if of the spiral type should be braced to prevent sagging at the centre of the spiral, since sagging will diminish the insulation (air) between turns, and thus render ineffective several turns.

All these points should be borne in mind when designing this type of gear. Immediately in front of the choke coil is placed a horn gap, the distance of spacing between the gap being such that the discharge across it will take place whenever any abnormal voltage is experienced on the line or built up in front of the choke coil. This horn gap may be connected direct to earth, and thus discharge the high voltage when it exists to earth. While this discharge continues the line from which it is drawn is reduced to earth potential, and if the system be a three-phase one with unearthed neutral, one phase will become temporarily earthed. This may be permissible or not, according to the system of which it is a part. If the system is an earthed one, the direct connection to earth would not be per-

Table III.—*Single Phase, Pole mounted,* 16,500/110-220 *volts.*

K.v.a.	Transf. cost per k.v.a.	Station equipment cost per k.v.a.
5	...	...
10	£3 17 0	£7 1 6
15	3 3 6	5 6 0
20	2 13 0	4 7 6
25	2 8 0	3 15 0
30	2 3 0	3 6 0
35	2 0 0	2 19 6
40	1 17 6	2 14 0
...	...	...
...	...	...

Table IV.—*Three phase, Pole Mounted, Three Transf.,* 16,500/110-220 *volts.*

K.v.a.	Transf. cost per k.v.a.	Station equipment cost per k.v.a.
30	£3 17 0	£5 8 6
40	3 5 6	4 19 0
50	2 18 6	3 18 0
60	2 12 0	3 10 0
70	2 9 0	3 3 6
80	2 5 0	2 19 0
90	2 1 6	2 14 6
100	1 19 6	2 11 0
110	1 17 6	2 8 6
120	1 15 6	2 6 0

Table V.—*Three-phase, Wood-pole or Tower Mounting, Three Transf.,* 16,500/2,200 *volts.*

K.v.a.	Transf. cost per k.v.a.	Station equipment cost per k.v.a.
30	£3 15 0	£6 2 0
40	3 6 0	5 0 0
50	2 18 6	4 7 6
60	2 13 0	3 16 0
70	2 10 0	3 8 0
80	2 5 0	3 3 6
90	2 1 6	2 18 6
100	1 19 6	2 14 0
110	1 17 6	2 11 0
120	1 15 6	2 8 0
...	...	...
...	...	...
...	...	...

Table VI.—*Three-phase, Steel Tower Mounted, Three Transf.,* 35,000/2,200 *volt.*

K.v.a.	Transf. cost per k.v.a.	Station equipment cost per k.v.a.
30	£6 5 0	£10 8 0
40	4 18 0	8 7 0
50	4 3 0	6 18 0
60	3 13 0	5 19 0
70	3 5 6	5 4 0
80	2 18 0	4 13 6
90	2 14 0	4 3 6
100	2 10 0	3 17 0
110	2 8 0	3 13 0
120	2 5 0	3 6 6
130	2 3 6	3 4 6
140	2 2 0	3 2 6
150	2 1 6	3 0 0

missible, since a discharge across the gap would short-circuit one phase, and should there be a large amount of power behind the system the arc, although rising to the top of the horns, would continue to pass, causing serious results. In this case, therefore, an electrolytic or other type of arrester (according to the voltage of the system) will be necessary between the horn gap and earth, and such that the normal potential of the line to earth may be maintained, and at the same time discharge the excess voltage to earth. In addition to these electrolytic arresters, auxiliary horn gaps, together with series resistances, may be required in order to limit the flow of current to earth, and thereby automatically extinguishing the arc. The attention necessary to ensure satisfactory operation is of daily occurrence, which, of course, militates against these being used in the case of isolated sub-stations, and should, therefore, only be installed in those places where daily supervision is available. A typical example of the aluminium electrolytic arrester fitted with charging resistances is shown in Fig. 6, this being designed for a three-phase system at 45,000 volts pressure.

As regards the isolation of the sub-station from the transmission line, isolating switches of special outdoor construction are required. These are, of course, placed on the line side of the protective gear. For protection against overloads fuses are provided of distinctive pattern, such as to be readily and easily withdrawn by means of insulated poles.

With regard to purely portable sub-stations, a similar type of apparatus is employed to that already described. As a peculiar though now familiar type of choke coil and lightning arrester, Fig. 7 shows that as manufactured by the Railway & Industrial Engineering Co. (Ltd.), of Pittsburgh, U.S.A., and is known as the " Burke " arrester. That shown consists of a triangular choke coil (one side of which constitutes one of the discharging horns), a horn type fuse and damping resistance. The advantages accruing from this unique design are compactness of structure, economy of space and material, and increased magnetic blow-out effect, which very materially assists in extinguishing the arc. This type of construction is also applied to isolating switches in which the horns take and break up the arc at the moment of breaking the circuit. A recent improvement on this principle is that known as the automatic resistance horn arrester, in which one horn is divided up into a number of segments with air-gaps between each segment. This is the earth side of the arrester. Each segment is connected to a damping resistance rod, in such a manner that as the arc rises up the horns, resistance is automatically cut into the circuit step by step, thereby rapidly reducing the current and ensuring a smooth break of the arc without any serious rise of potential. The phenomena resulting from the breaking of an arc by horn-type switches is still a matter causing considerable debate. Experiments undertaken, however, by various investigators show conclusively that pressure rises occurring from the breaking of an arc by horn-type lightning arresters are of considerably lesser amplitude than those resulting from extinction by any oil-immersed apparatus. Further information on this particular subject can be obtained by referring to the abstract in THE ELECTRICIAN for December 25, 1914, of Dr. Linke's Paper on " Switching Phenomena," and also to Kenelm Edgcumbe's series of articles on " Protective Gear " in the " Electrical Review " of November 27 to December 18, 1914, inclusive. In the case of consumers requiring power for lighting loads only, where a constant distributing voltage is essential, automatic voltage regulators are installed. These are self-contained in substantial cases and usually pole mounted. Where it is desirable to measure the power delivered to consumers over lines of a higher voltage than 6,000 volts a combined meter and transforming set is installed. This is a self-contained unit, and consists of current transformers, potential transformers and watt-hour meter mounted in a suitable weatherproof housing.

Prices.—Tables III. to VI. inclusive give approximate cost of outdoor transformers and sub-station equipments at the ratings and types of mounting specified.

In conclusion, the authors would like to express their thanks to the several manufacturers who have so readily responded to requests for photographs and information.

THE PRINCIPLES OF MODERN PRINTING TELEGRAPHY *

BY H. H. HARRISON.

(*Concluded from page* 637.)

Summary.—This Paper is divided into five sections. The first deals with the fundamental principles and leads up to automatic stop and start. After that follows translation of signals, page printing and the principles of letter counting mechanism. The third section deals with low-speed printing telegraphs and chain relay systems. The fourth discusses synchronism, control of phase, leading to synchronism between printer and distributor units. The last part deals with automatic multiple-circuit arrangements, échelon working, repeaters, distribution of signals and quadruple duplex.

Transmission in the direction Paris-Marseilles is effected as follows: From 0 deg. to 180 deg. the signals from Paris are set up on the re-transmitters R_1R_2. Re-transmission takes place from R_1 through the triple distributor connected to cable 1 during the time that the brushes sweep through the angle 120 deg. to 240 deg., and from R_2 through the angle 240 deg. to 360 deg. respectively, reckoned from 12 o'clock. Signals from Algiers are received on cable 2, and the phase relation between the setting and re-transmitting cycles will be evident from the explanation above.

A third cable is used for traffic in alternate directions between Marseilles and Algiers, and by means of appropriate switches can be used to furnish further channels to and from Paris.

A type of circuit which is coming more and more into use, largely due to the successful pioneer work of Mr. A. C. Booth, is the quadruple duplex, a diagram of which is given in Fig. 10. It scarcely requires any explanation. The capacity of a wire is at once doubled, and as previously explained 2-way working does not, with this arrangement, involve loss of line time.

The art of type-printing telegraphy has now reached such a stage of development that it is possible to answer many questions hitherto shrouded in the mists of doubt.

The last few years have seen the triumphant advance of the five-unit equal-letter alphabet.

* Abstract of Paper read before the Institution of Electrical Engineers on January 13, 1916.

The use of the Morse code for high-capacity printing telegraphs means delicately constructed machines at both ends of the line, and all the complexity imposed by the necessity for differential feed devices where unequal letter alphabets are adopted. This involves high first cost, and though no information is available, maintenance must be heavy also. The maximum possible speed, even with specially constructed translating mechanisms, is about 130 to 150 words per minute, and experience has shown that this speed is too high if the maintenance cost is to be kept down to a commercial figure. 120-130 words per minute represent the all-round useful speed and this can easily be beaten by other methods. The same remarks largely apply to automatic systems using the five-unit code.

In recent years a number of highly efficient amplifying devices have been invented which considerably increase the speed of a cable core. Among these may be mentioned the magnifying relay due to Heurtley and the jet relay invented by Axel Orling.

The drawback to all these devices lies in the fact that in duplex working, owing to their extreme sensitiveness, it is not possible to secure a balance sufficiently precise to eliminate "jars" when the home transmitter is operated.

By applying the sine-wave method recently invented by Colonel Squier, the balancing trouble might be largely overcome, and the method would seem to have further advantages. Mechanical and electrical resonance could be taken advantage of.

A further drawback to the use of the magnifying relay is that by its use a long cable is made extremely sensitive to disturbances, which the syphon recorder does not reveal.

The modern multiple system with keyboard perforators, automatic stop and start of transmitter, and distributor driven by phonic wheel, will work regularly at 160 to 180 words per minute, or 40 to 45 words per minute per channel. Thus it is clear that printer units

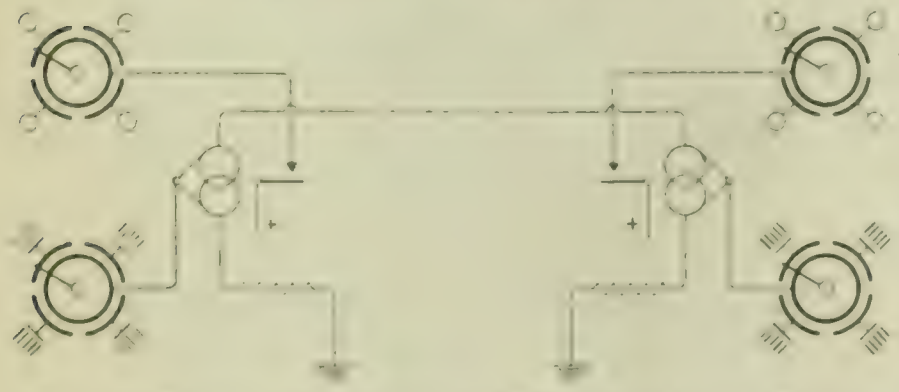


Fig. 10.—General Arrangement of Quadruple duplex Circuit.

can be easily made having a higher speed than 40 to 45 words per minute, and the only barrier to speeding up channels or adopting a large number of channels is the transmission limit of the line. The main telegraph circuits of this country are now run underground and a lower speed of transmission is a necessary consequence.

Another aspect, and one of fundamental importance, is the precise means to be used for securing the synchronous operation of the distributors. The author next refers to the generation of correcting impulses from the signals, and points out that the French, who have most experience, only use it in a few cases. He concludes as follows: The only other questions about which there have been differences of opinion are matters of detail and not fundamental. They are: (1) Page or tape printing? (2) Type-wheel or type-bar translators? On the less important circuits, the type wheel tape printer, on account of its low first cost, has, the author believes, a large field.

For the high-capacity circuit, the page printer, as it provides the maximum of labour saving, will hold undisputed sway. That the type-bar page printer will come to be the pattern adopted, the author has very little doubt; since typewriters being in commercial demand by the million, we have a translating mechanism much more durable than any type-wheel apparatus.

DISCUSSION.

Sir William Slingo said they had been told by Mr. Harrison that printing telegraphs were among the earliest of telegraph inventions. He imagined that they were not brought into general use partly because of conservatism in the matter of handwriting and a preference for hand-written messages. Also the keeping of an office copy was not possible with the printing telegraph, unless two slips were run through the receiving apparatus. But we had accepted the position that office copies were not essential, and therefore the printing telegraph could now be employed, with an increase of legibility, a saving of time in transcription, and other advantages. It had come to stay, and the question was now "high speed automatic v. multiplex." The battle round that question was almost as keen as that of the brakes in bygone years. He was sorry to find no reference in the Paper to the photographic systems such as for example, as the one which was tried in this country, and was capable of giving an output of 200 words a minute, but which had the disadvantage of being a 12-unit code. The Creed system might also have had a little more attention, that being an important instance of the high-speed automatic. A few more points might have been brought out about the Siemens automatic. It was one of the few novelties in the telegraphic world of German origin. Very little original telegraphic work had come from Germany, and therefore the Siemens automatic was particularly welcome, and it was, at the same time, particularly good. It was a simple printing arrangement. No perforated slip was required at the receiving end, as in the Creed, and the perforator used for sending could be applied also for receiving work when it was desired to re-transmit the message on another line. The Siemens allowed of a working speed under commercial conditions of 166 words a minute, which was better than they had got from other instruments. It had carried a great amount of traffic with a minimum of trouble. He did not want to deprecate the five-unit code, but the figures given in the Paper did not prove the Morse to be twice as long as the five-unit. It happened because Mr. Harrison chose the word "London," which contained the letter "O"—the longest vowel—twice. If he had taken the word "letter" it would have taken only 44, and that would have brought it more nearly into line with the five-unit code. The speaker referred to automatic stop and start and paper-feed mechanism, and said the Siemens automatic came into phase with remarkable promptitude. He continued: The ordinary Wheatstone repeater placed in circuit gave all that was required. They must always have Morse operators so long as they had multiplex or high-speed systems. At every stage of the circuit there were conversations during balancing and preparatory periods, and that work was always done by means of the Morse. The five-unit code was not limited to 130 to 150. They got 166 regularly out of one of them. The Eastern Company had one line from London to Alexandria on which they abandoned the cable code and were using the Morse code with the Creed apparatus. The Heurtley and Orling relays were a matter of promise, but if a very sensitive device were introduced on to a line in order that it might respond to very feeble signals, it would also respond to disturbances. He thought page printing would in the end prove more suitable than tape printing, because of the economy and the saving of time.

Col. Squier said he thought it best to call attention to the necessity for a general stocktaking of the whole of telegraphy. The speaker pointed out that wireless telegraphy appealed to the imagination, and so had received attention from able physicists and engineers. He continued: They had borrowed from wire telegraphy Morse printers, relays, sounders, choking coil and anything else they needed, and they had so taken from telephony that each circuit had every one of its parts, simply changing the microphone to the key. They received wireless messages principally by telephone now. They threatened to take from the cable people Orling's relays and Heurtley's magnifier. He commended that action, and advocated the retaliatory method of borrowing back from that storehouse of information what was needed for the other branches of telegraphy and telephony, both for land lines and ocean cables. The speaker thought "wireless" an unfortunate word, since they were concerned with propagating alternating currents upon or along wires. The phenomena in this connection were applicable to the matter being discussed. He continued: Considering as a spectrum the whole range of alternating-current frequencies, submarine cable work used those at the lower end, above those were the frequencies used in land lines; but above the land-line frequencies and below the wireless frequencies there was a block of frequencies not in use yet, but which had a great future. The time had arrived when they could appropriate strips of ether, which were free, and use them to great advantage. The frequencies used would be those below what was used in wireless and above what was used in ordinary telephony. The reason this proposition had been in abeyance for years was that there had been no generator of a small, cheap type which could be used in multiples, so as to use the high-frequency waves. But the phonic generator had now come into prominence, so he did not see why they should not induce circuits about wires without interfering with the present circuits. He had found such induced circuits were not capricious like all aerial circuits, which varied according to the time of day, and so on. They were reliable, and could be used with the same definiteness as a wire circuit. It was an advantage for telephony itself. He never realised what a silent line was until using one of these circuits. There was no distortion in the telephony, although the attenuation was quick. With this system, also, the telephone repeater came into its own. At present, on wires, the resistance had to be 40 to 70 ohms, because the line was noisy. When the induced circuit he had mentioned was in use the speech came out from a perfect background of silence. A microphone was used in the two primary circuits with no reactance, so that it controlled the current in the primary, which gave fine articulation. The whole of the printing telegraph systems' circuits could be crowded on the outside of the wire, and the line circuit could be used at the same time for any other purpose. At the other end of the spectrum, for the very low frequencies, special dynamos were required, and the diagram needed there turned out to be exactly identical with the diagram for the wireless connections. The only difference was the magnetism in the cable. At the end where the strain came they must load the end of long conductors. The whole phenomena was one of conduction and radiation. The real ocean cable would begin 100 miles from the shore at each end. That part of the cable should be designed for the minimum line loss. The trouble with land line telegraphy was that there had been no adequate attention given to the power plant. Great attention was paid to the circuits, but the impulses were sent wrong. They telegraphed at present by taking the main power switch as the key and closing it to send the dots and

dashes. It seemed very crude from the power standpoint. In wireless telephony the microphone changed and put on the amplitudes, and that was interpreted into waves. In concluding, he suggested that there should be more co-operation between the different branches, and attention should be paid to the progress of wireless work during the last few years.

Mr. WALTER JUDD said the whole of the Eastern cables that landed in England were fitted with printing telegraph apparatus, and all worked into England direct. All the traffic was received printed off ready for delivery. They had one circuit working direct between Alexandria and London, two between Gibraltar and London, one between Lisbon and London, and two between Cape Verde Island, St. Vincent, and London. They were using both the Morse and the cable codes. The speed and the amount of traffic they could carry was found to be about the same. In London they were using the Creed system on one or two of the cables, and perforators of their own on the others. They were largely due to his friend Mr. Fraser, who designed them. The five-unit alphabet would not suit them, because five units to a letter was obviously more than the 3·7 units which formed the cable code. In 1901 they had brought to them by Mr. Donald Murray a three-unit alphabet which was ingenious, and worked out at about 3·3 units per letter, taking the word spaces into consideration. The advantage, therefore, in changing from their present one—the universal alphabet—would be very small. Supposing the gain in speed were considerable, both the five and three-unit alphabets were illegible at the distant end of a long cable, on which there were deformations, distortions and disturbances. Readability of signals was a *sine qua non* with them. The same troubles did not occur in land-lines, and he thought they would continue to extend the use of receiving perforators and printers all over the service, but the war had delayed the delivery of perforators.

Mr. DONALD MURRAY said the Paper gave in a generalised form practically all the known movements of printing telegraphy. With that Paper before him any competent engineer could design a printing telegraph. The inventive stage was nearly over—the mystery was gone. There was only one portion of the subject left for a future Paper—the means for linking-up individual circuits of the printing telegraph networks that were spreading over all civilised stations. Printing telegraph translators also were remarkable in this respect of dating back, and the lion's share of credit in that department seemed to be due to Baudot, who had also tried the permutation disc plan, and the similar device described in the Paper was identical with one used by the Western Electric Co. The early electrical translator of Baudot was also of special interest in view of its recent use in the Siemens automatic system. He (Mr. Murray) suggested the use of the idle signal for a multiplex system synchronising from the signals themselves in 1903, and, quite independently of him, the Siemens automatic system adapted the same plan at a later date, and Picard developed the idea, adding the arrangement shown in the Paper, and that device was strangely like the device subsequently invented by Rainey. He next dealt with Picard's and with Dixon's patent, and said Mr. Harrison had illustrated metal pin storage transmitters in a generalised form. He (Mr. Murray) made a ring transmitter for the Post Office about nine years ago. There was a rotating ring with a motor in the centre ; on the periphery of the ring were sliding letter blocks in which were small levers or " leaves " capable of being set in one of two positions by the means of the keyboard. These transmitters were cadence free, but the keyboard could not be struck so rapidly as in keyboard tape perforators. There was a good field for them on minor circuits where the pressure of traffic was not great. Those machines could re-transmit from any one channel of a multiplex circuit into any other channel of another multiplex circuit, and they could be arranged to re-transmit perfect from imperfect Morse signals. There was an extreme slowness in getting printing telegraph apparatus established in commercial use. The use of the phonic wheel motor and vibrator to drive the Baudot distributor and printers had been deferred more than 20 years, but were now coming into their own for multiplex work. He suggested an arrangement for automatically alternating transmission of messages in a confidential Paper in 1903, and Mr. John Gell also hit upon the same idea independently, and patented it and applied it to Wheatstone working. Mr. Gell had been working for several years to get it into use, but up to the present it had not secured a permanent footing. He had arranged terms with Mr. Gell for the use of the Murray multiplex, and had repeatedly urged its value during the past two years, but so far with little effect. It enabled each of two typists to transmit, say, 60 messages an hour to one printer, printing, say, 120 messages an hour, thereby raising the operator's average from 60 to 80 messages an hour. It was unquestionably valuable and would no doubt be used after Mr. Gell and he had passed on to the inventors' heaven, where all inventions were adopted at once, and huge royalties were paid to the inventors.

Mr. E. RAYMOND BARKER said Mr. Harrison in submitting a telegraph Paper had given a lead to the submarine cable authorities and their engineers. Electrical departments of the leading cable companies teemed with interesting data and new departures. They could supply first rate material for an occasional telegraph Paper as an interlude to the Papers on the heavy engineering side. Referring to the alphabet comparison, and taking the word " London," the cable code—with equal time value dots and dashes—would give 49 units compared with 69 on Morse. He thought it probable that on the majority of high K.R. lines the cable code would hold its own against any form of Morse, except, perhaps, Morse worked on Pierre Picard's perfectly self-neutralising system of inverse-current momentary impulses. The late Mr. John Gott's two-power inverse current system, and Col. Squier's beautiful sine-wave alternating-current system (using three amplitudes) were both based on the cable code. As far back as 1898 Picard, whose Baudot work on the Mediterranean cables had been mentioned by the author, made the following claims for his momentary impulse inverse-current transmission in his specification 2,382/1898 : " Even the Baudot instrument at a reduced speed compatible with the length of the cable could be used between, say, Paris and New York with relays at the land ends." Mr. Harrison referred to a certain working speed as being *too high* if the maintenance cost was to be kept down to a certain figure. The author recommended moderate speed direct printing on several Baudot sets over one cable (Fig. 10), in preference to a high-speed system with all the traffic confined to one set of instruments, and he showed that the former system was more useful. Mr. Harrison referred to a certain drawback as impeding the usefulness of magnifiers—viz., the magnification of disturbances. Thanks to Mr. Axel Orling's kindness, he had been able to confide to Mr. Harrison that evening particulars of a simple device (specification 17,920/1914) patented by Mr. Orling, and which prevented abrupt disturbances which were agitating the multiplier from affecting the local siphon recorder, which, however, itself remained free to record incoming cable signals.

Major A. C. BOOTH said the comparison of Hughes, step-by-step, Morse and five-unit in the Paper could not be taken as an indication of the value of the instruments for line working. The machine brought from America by Mr. Murray about 1900 had become a practical machine. but the automatic working had caused it to be turned down by Mr. Murray himself. He found it of no further use, and he then changed on to the multiplex system, which was defended by both Mr. Murray and Mr. Harrison. The Post Office took the Hughes instrument, and were surprised to find it printed at the rate of 125 words a minute ; but, unfortunately, the letters were not intelligible. They were simply printed out in a mass of letters. That old-fashioned instrument worked as fast as Mr. Murray's up-to-date automatic, and there were some 3,000 of them on the Continent. The present Paper amounted to the advocacy of the duplex and multiplex. The Baudot existed as a simplex-multiplex for some 30 years, and did good work in France, Brazil and other places ; but it was not until it was duplexed that real progress was made in the printing telegraph. John Chapman, in 1892, duplexed the Hughes, Sir William Slingo extended it in 1898; the Murray automatic was commenced in 1906, he thought, but was not put into practice until 1910. Mr. Murray got his duplex to work in 1911. There was now the Western duplex-multiplex doing good work in the States, and in England Murray's duplex-multiplex was doing good work on the Manchester line. The Western Electric multiplex was quadruple to Manchester, and there was six Channel duplex from London to Birmingham—12 channels in all. The speed was 30 words a minute—*i.e.*, 180 words actual output. About 1902 a system was tried with the Morse signals, but not representing Morse letters, and it controlled a page printing machine. It did 80 words a minute, and the printing gear was complex—a wonderful box of tricks if anything went wrong. But that system did good work. He did not agree with the author that " the art of type printing telegraphy has now reached such a stage of development that it is possible to answer many questions hitherto shrouded in the mists of doubt," but he thought the type bar page printer was the one which would come to be adopted.

Mr. J. T. TYRREL reminded Major Booth that he had not given credit to the Russians, who preceded the British in adopting the Baudot duplex (Major Booth dissented). The fact that the Belgians took so well to it was worthy of record, as was also the fact that that Baudot lasted up to the very last minute that the wires worked between this country and Antwerp, although the enemy were endeavouring to tap the line and to upset the synchronism. Sir William Slingo seemed to think people looked askance at printing telegraphs many years ago ; but 30 years ago as many as 10,000 printed telegrams were being issued from Throgmorton-avenue office, then in the hands of the Submarine Telegraph Co.

Mr. HARRISON, replying to the discussion, said he had not dealt with photographic printers because he had always regarded such systems as impracticable. Such instruments had had a short life. Sir William Slingo would remember the photographic system employed on the Mediterranean cable. There was a certain amount of time between the sending of the message and the fixing, developing and drying. The Siemens automatic was only a one-channel Baudot. The really novel point about it was the Kirk-Himrod overlap ; but if one was going to have automatic, the Siemens & Halske was about one of the best types. Sir William said a speed of 166 words could be obtained with Siemens & Halske. His (the author's) figure of 120 to 130 was for automatic type printers with differential feed devices, where a speed of 166 words could not be maintained many days without heavy maintenance. He admitted that his comparison of codes was not accurate. He had not thought it necessary to go elaborately into the question of codes. The actual ratio of Morse to five-unit was 8 to 5. He agreed that the automatic stop and start was not necessary, but it was a convenience to have it. It commended itself to him from the traffic point of view. He was interested to hear from Mr. Judd that the Eastern had been doing so much work with printing telegraphy. From time to time ingenious specifications appeared under the name of Mr. Angus Fraser, and he had referred to them in the present and a previous paper. The storage transmitter had decided limitations, but it had advantages apart from the fact that it rendered the keyboard approximately free. In repeating between a quadruple and triple or a quadruple and double any channel could be chosen for repetition if a simple storage transmitter were used. He was glad Major Booth agreed that duplex-multiplex was a good thing. In regard to his suggestion to use the Siemens' automatic system, it was merely as a trial to ascertain the maximum possible transmission using

the five-unit code. In regard to the type-bar printer, the Universal printer for multiple channels was good worked from 45 to 50 words a minute, and at that speed it would be more durable than any type wheel printer. Sooner or later the type-bar type of translator for high-capacity multiplex printing systems would be the one. The cost of typewriters was low if they were made in large numbers.

A vote of thanks to the author concluded the proceedings.

AN OSCILLOGRAPH FOR HIGH-TENSION WORK.

The tendency of electrical engineering practice seems to incline more and more to the use of alternating current in preference to direct-current machinery. Indeed, for the large turbo-generator units now so commonly employed, direct-current generators are commercially an impossibility. The ease and economy with which alternating current can be transmitted and transformed necessitates its adoption in all large power distributing schemes in which the source of supply is at any distance from the consumer, and with the increase in distance of transmission it becomes necessary, in order to minimise transmission costs, to use higher and higher voltages.

No one denies the importance of the wave-form in alternating current work, but with the rise in voltages it has become increasingly difficult to make instruments to record and analyse the wave forms. It has frequently been the practice to introduce into the main circuit a "step down" transformer to the oscillograph, and so reduce the difficulties of insulation. This, however, must always introduce distortions which can neither be neglected nor yet allowed for in analysing the record. Special interest is, therefore, attached to an oscillograph outfit recently completed by the Cambridge Scientific Instrument Co., which has been designed to operate directly, and without the introduction of a transformer, with potentials up to 110,000 volts. A brief description of this outfit will prove of interest.

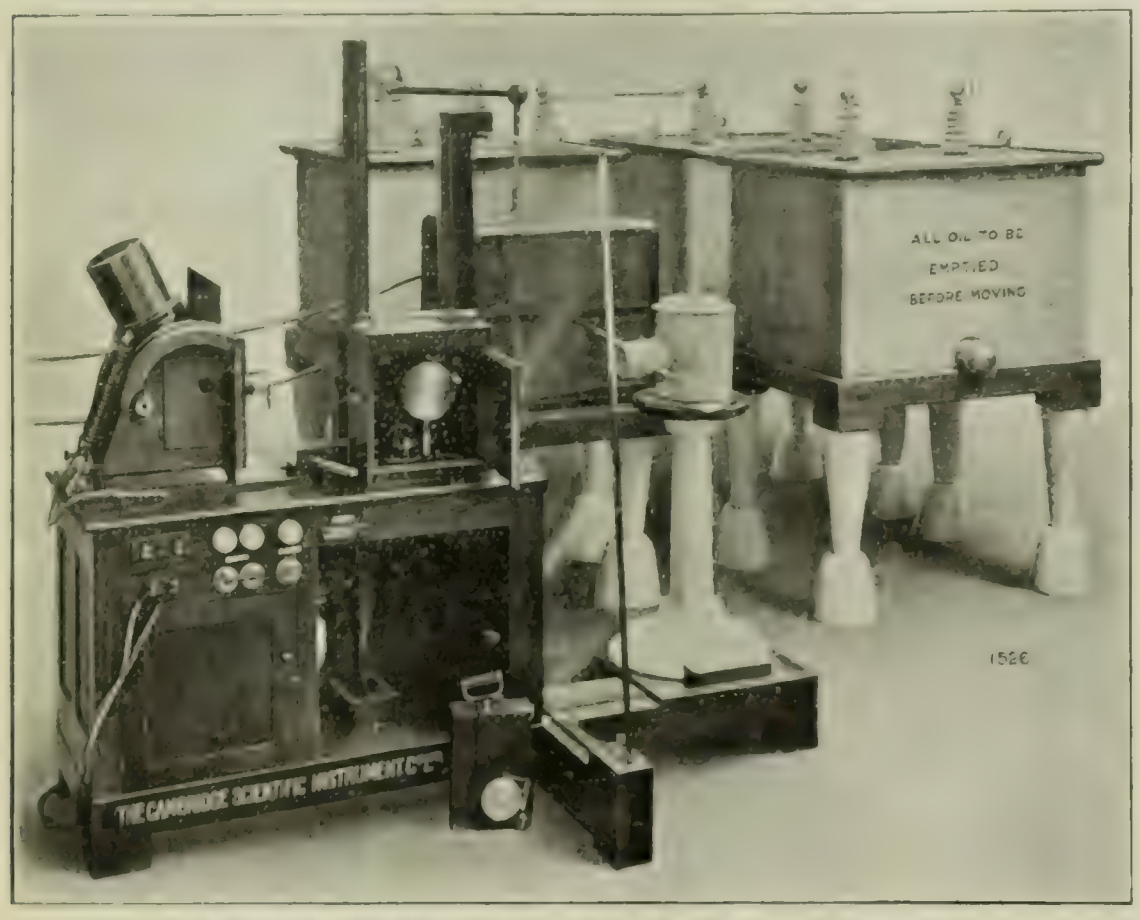


Fig. 1.—View of Oscillograph for High-tension Work.

Fig. 1 is reproduced from a photograph showing the whole outfit as it appears when erected for taking a record. The extreme precautions which have been taken to ensure adequate insulation are the most obvious feature. In the centre, mounted on a tall porcelain pillar is the oscillograph instrument itself, and this when in use is enclosed in a porcelain cover, shown in the illustration as a glass. Fundamentally, the oscillograph proper is a highly specialised form of moving coil galvanometer having a permanent magnetic field and an extremely light moving system stretched so tightly that its own free period of vibration is extremely small, and thus it can be used to trace out accurate records of wave-forms even when the frequencies are very high. The instrument comprises an oil bath containing two entirely separate moving systems or "vibrators," which can trace two wave forms simultaneously, and each of these "vibrators" is separately removable and interchangeable, so that, in the event of an accident during an experiment, a spare vibrator may be quickly inserted.

The two resistance boxes for adjusting the sensitivities of the vibrators are enclosed in a Faraday cage to shield them from electrostatic charges. This cage rests on a wooden base with tall porcelain legs, resting in porcelain feet shod with lead discs.

The light for the optical system is provided by a Zeiss automatic arc lantern, which slides accurately in guides on a marble slab. This marble slab is necessary to protect the rest of the apparatus from the heat developed by the lamp. The latter is operated from a separate 110-volt alternating-current circuit controlled by a rheostat fixed conveniently to the wall.

There are two cameras, one of which employs a falling plate, and is used when only a short record covering two or three periods is required. In the illustration this camera is shown in use. At the foot of the instrument stand the "moving film" camera can be seen, which may be substituted at any time for the falling plate camera, when a record extending over some period of time is needed. This camera uses ordinary cinematograph film, and is driven at any pace required by a small electric motor, cone pulleys being fitted to facilitate this.

The three large tanks, each standing on its own insulated base, contain the main circuit non-inductive resistances, each of 250,000 ohms, and one of these resistances is sub-divided into four sections—viz., 25,000, 50,000, 75,000 and 100,000 ohms, and tapping points of values 5 and 50 ohms are provided for the voltage vibrator circuit. All the reistances are built up of bare wire woven into the form of a net with asbestos, supported on porcelain insulators and fixed in metal cages attached to the lids of the tanks so that they may be readily withdrawn for inspection. Each tank is filled with a light transformer oil.

In designing these large resistances, and also the Faraday cage, special care had to be taken to avoid any points from which brush discharges could take place. All terminals, plugs, &c., are made with spherical tops, and all edges rounded, as may be seen in the photograph.

The operator has all the switches and controls within easy reach while he is manipulating the camera, and he is protected by the large sheet of plate glass shown. It is of interest to note that this is tilted at an angle so as to avoid reflected images.

This particular outfit has been installed in the cable works of Ing. V. Tedeschi & Co., at Torino, and by their courtesy we are able to reproduce the record shown in Fig. 2, which was taken by them in making a breakdown test on a porcelain insulator. The curve of greater amplitude is the voltage curve.

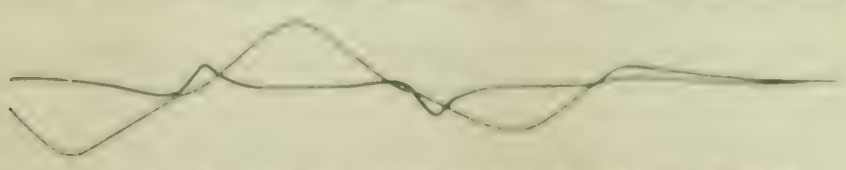


Fig. 2.—Example of Oscillograph Record at 64,000 Volts.

THE FATAL ACCIDENT AT EASTBOURNE.

The following report to the Board of Trade has been made by Mr. A. P. Trotter, their electrical adviser, on the fatal accident which occurred at Eastbourne through the destruction of a high-tension switch pillar:

In accordance with the instructions contained in your minute of December 29, 1915, I went to Eastbourne on December 30th and inspected the electric switch pillar which caused the deaths of two men through a motor car colliding with it. I also attended the adjourned inquest at the Town Hall, Eastbourne, on January 5, 1916.

On December 26, 1915, a large motor car, proceeding at a moderate speed along the west side of a broad thoroughfare in Eastbourne, named Seaside, unaccountably swerved to the left and smashed an electric switch pillar into fragments. It was brought up by collision with a tree a few feet further on. The occupants of the car, two nurses and two children, were unhurt, but two men who afterwards tried to move the car were killed by electric shock. There are no obscure or doubtful points about the accident. The circumstances are quite clear.

The pillar was about 4 ft. by 2 ft. 2 in. by 1 ft. 9 in. It was constructed of cast iron, the minimum thickness was about ½ in. It stood at the edge of the footpath, which was not provided with any curb. The pillar contained three switch fuses of the cartridge type for the purpose of connecting cables branching in three directions from this point. The cables are lead-covered, paper-insulated, concentric, for a supply of single phase alternating current at 2,200 volts. At about 6 in. above the ground level there was a horizontal 'bus bar to which the external conductors were connected by links. The lower part of the switch fuses was about 3 ft. above the ground level, and they were connected with the inner conductors of the cables by "tails" of 7/16s about 18 in. in length. When the pillar was destroyed no connections pulled out, but the "tails" were cut through, and the end of one showed signs of fusion.

The pillar was supplied through a feeder, and owing to a momentary earth at the instant of the collision the oil switch on this feeder at the works, tripped. The switchboard attendant replaced it, and it held in, showing that there was no short circuit or heavy earth. The supply was further complicated by being fed from a sub-station, and by the stepping up through transformers of the low-pressure supply, but that need not be considered.

Two men tried to push the car back on to the road. Several persons who touched it received shocks. The driver alighted and opened the bonnet and received a slight shock which he attributed to the electric accumulator on the car. The severe shocks received by the two men may have been due to the firm grasp which they gave, or perhaps the car did not make contact with the upstanding wire until it had been moved. It was not clear from the evidence given at the Coroner's inquest whether the car was moved or not. That is of no importance.

The driver attempted to pull one of the men off, by grasping his waist with both hands. In doing this he received a shock of sufficient strength to knock him down. An attempt was made by the bystanders to pull the men off with a wire rope. They received severe shocks and burns. If a hemp rope had been used, the day being dry, they might have rescued the men without difficulty, or they could have pulled them away by loose parts of their clothing. If after getting them clear the well-known method of artificial respiration had been practiced, the lives of these two men might have been saved.

If the pillar had been smashed by a runaway vehicle constructed mainly of wood, such an accident would hardly have occurred, and if by a traction engine with iron wheels, it would have been impossible, for a better contact with earth would be made by the wheels than by the feet of the bystanders. The insulation of the car on its rubber tyres was an important cause of the fatal result.

The Board of Trade regulations recognise sub-stations and street boxes. The former are receptacles for transformers, large enough to admit the entrance of a person after the transformers, &c., are in position. It is recommended that they should be above ground wherever possible.

The regulations relating to street boxes imply that they will be constructed below the level of the road or pavement, and will be provided with covers forming part of the surface of the street. In addition to regulations relating to sub-stations and to street boxes, regulation 18 provides that "every portion of any high-pressure electric line placed above the surface of the ground . . . . shall be completely enclosed either in a tube of highly insulating material embedded in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected with earth."

Pillar boxes of a kind similar to the one which was destroyed at Eastbourne have been broken by collisions with vehicles, and until recently a pillar of the dimensions and construction of this one, might have been considered to comply with the regulation. But in view of the increased speed and weight of street vehicles and their imperfect control and skidding, further attention must be given to the use of such electric pillars in the streets. This is not the first case in which the cast-iron case of a pillar has been destroyed without causing a dead earth or short-circuit among the live conductors contained in it.

Various troubles with underground street boxes resulted in the introduction of pillars, but local authorities have, with but few exceptions, permitted their use only on their own electrical undertakings. For low-pressure work, pillars present many advantages over street boxes, and are to be recommended. In the case of high-pressure distribution the accident to be feared was the possibility of the pillar becoming alive, due to the bad action of a fuse or to some other defect. It was anticipated that both in the case of large transformer kiosks, and of such pillars as are used at Eastbourne and elsewhere, that any serious damage by a collision would cause an earth or a short-circuit which would trip the supply switch.

In most of the larger modern systems of electrical distribution, supply is given at extra high pressure to sub-stations from which medium or low-pressure mains distribute the supply to consumers. In such cases there are no high-pressure mains, and no switch pillars are used.

In older systems, such as that of Eastbourne, high-pressure feeders originally radiating from the generating station, have become a highly complicated network. This generally arises from the necessity for trapping tees to feeders for the supply to new districts. It would be desirable in these cases that sub-stations should be increased in size or in number, and that the use of street-box transformers should be restricted, and that the lay out of the feeders should be so simplified that tee joints are avoided, and that switch pillars or boxes need be used only in exceptional cases.

Before proceeding to consider what modifications should be made in electric-switch pillars, the employment of high-pressure switches in underground street boxes may be mentioned. Many engineers have strong objections to this alternative chiefly on account of danger to workmen who have to use them, and on account of failure of such apparatus to work properly. But investigation shows that this is another way of stating the fact that many objectionable kinds of street-box switches have been tried, the unsatisfactory results have been very apparent and sometimes serious; while a few well-designed underground high-pressure switches have worked well for years and neither require nor attract attention. Besides these, which are non-automatic and do not contain fuses, totally enclosed oil switches with over-load trip are used in mines and could easily be adapted for street boxes.

Recommendations as to Electric Pillar Boxes for Use with High-pressure Supply.

1. The suggestion made by the Coroner's jury that pillar boxes should be placed further away from the side of the road is good. It is better to place them in side streets than in main thoroughfares. If possible they should be built into the walls of houses or gardens. Local authorities should use their influence to obtain accommodation for such boxes on reasonable terms.

2. Where pillars can be moved back from the curb by slewing the cables without entailing undue expense in cutting and rejointing, this is desirable.

3. A curb not less than 6 in. high extending not less than 10 ft. on each side of the pillar is desirable.

4. Where pillars are set near a curb, fenders or "spurs" of rounded blocks of stone or of strong iron castings could be usefully set at the corners of pillars facing the road. A door opening on to the street must be shaped to clear them.

5. Cast-iron pillars should be reinforced by a cage of wrought-iron rods, incorporated in or attached to the cast iron, which will tend to hold the fragments together in case of destruction, or an inner lining of sheet or of expanded metal or wire mesh should be attached to the pillar and to the doors, and the pillar should be connected to a substantial earthplate as well as to the lead of the cables.

6. Loose "tails" of rubber-covered wires are highly objectionable, and should be avoided by enclosing them in a metal tube carefully earthed, and filled in solid with compound.

7. It is not desirable that transformers should be placed in pillars above ground, unless loose wires and cables and exposed live parts can be altogether avoided. Where street boxes are used as transformer chambers they should be placed below ground, and properly designed switch pillars may be set over them, or preferably, they may be built into a wall.

8. The foregoing recommendations may be applied also to low- and medium-pressure pillars.

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BRITISH TRADE AFTER THE WAR.

In our last issue we gave a brief account of the recommendations made by a Sub-Committee of the Advisory Committee of the Board of Trade with respect to securing the position of British trade after the war. The report was only issued as we went to press, and, therefore, we were unable to comment upon it, but we think it is worth while to return to the subject, as the report is of considerable interest.

The first point that will probably strike the reader is the comparatively few British industries—namely, 13—with which the report deals. Reference is made chiefly to what may be described as the lighter branches of industry. Although paper manufacture, china, earthenware and electrical apparatus find a place, there is no reference to the textile industry and the many heavier branches of engineering. We suppose this is due to the fact that the Sub-Committee was appointed to report on the steps necessary to secure the position of firms who have undertaken industries in consequence of the "exchange meetings" leading up to the British Industries Fair held under the auspices of the Board of Trade. In other words, the report is practically limited to manufactures which were, previous to the war, in German hands.

The Committee appears to have been in touch with representatives of the various trades considered, and therefore the opinions expressed should carry some weight. On the other hand, the names of witnesses are not given, though such bodies as the British Electrical and Allied Manufacturers' Association are mentioned as being officially represented. Further, only the trend of the evidence is appa-

rent, the actual evidence not being given. It is interesting to note that the value of industrial scientific research was generally recognised, though it was admitted that British manufacturers and workmen have not always shown themselves in the past sufficiently appreciative of the value of such work, or of technical training. The representatives of some of the industries expressed a strong desire for Government assistance towards certain investigations. Further, it was felt that greater importance should be attached to technical training in this country, though, on the other hand, it was admitted (in connection with the jewellery trade) that in Birmingham it was difficult to induce boys to attend art classes even when their fees were paid, and when they were given time to attend the classes in the afternoon, and that in the jewellery trade the apprenticeship system had broken down altogether. We doubt if there is any remedy for this except the German one of compulsion. In certain directions employers and employed alike failed to appreciate the full importance of technical training, though it seems that there is a marked improvement in this direction in the glass industry.

A recommendation is made that the United Kingdom copyright law should be brought into line with that of the United States. Exactly what is meant by this we do not understand. At present it is impossible for the majority of authors to obtain copyright in the United States, because they cannot afford to have their works printed over there, and so it is easy for American authors and publishers alike to adopt methods of piracy. But all such matters resolve themselves into those of mutual interests. If a threat of similar measures would induce the United States to adopt a copyright law similar to our own, then by all means let us make such a threat, but we certainly cannot admit that the copyright law of the United States is one to be copied. This part of the report would have been more valuable if some of the members of the Committee had been identified with copyright and the working of patents.

In regard to patents, much might be done to bring about an improvement, as we have said on previous occasions, but it must not be thought that the system adopted by Germany or by the United States results in only valid patents being granted. What we should like to see, among other things, is the adoption of patents for the British Empire as a whole, and a similar measure in regard to trade-marks. It might take some considerable time to bring everything into line, owing to the fact that existing patents or trade-marks in a colony should not be rendered invalid by the granting of a patent or a trade-mark in this country; but the ideal is worth an effort, and can only be rendered more difficult of attainment by being deferred.

From time to time we have heard much made of the point that cheaper transport facilities are given to Continental goods than to goods by our own manufacturers in this country. The report just issued is of a judicial character, and there does not seem to be so much evidence in favour of this idea as might have been expected. It must be remembered, for example, that foreign goods are liable to come over in shiploads for which specially favourable rates can be quoted, as against charges for small quantities. On the other hand, it is admitted that the German export trade has been largely stimulated by the specially low rates granted by the German railways. The suggestion has been put forward that an impartial tribunal of the Government should be set up to adjust grievances existing between railway and transport companies and traders, but the opinion was expressed that the Railway and Canals Commission is not a suitable body for this purpose. As an example of the difficulties to be faced in this direction is the fact that before the war German manufacturers on the Rhine could obtain their supplies of clay from Dorset, Devon and Cornwall at a cost of carriage 3s. per ton less than the cost at which the same clays from the same ports could be placed at the factories in the Potteries. In making a statement of this kind we think that an analysis of the charges should also be given. Our railways, on the one hand, are burdened with much unproductive capital; and our canals, on the other hand, are mostly in the hands of railway companies who have no great inducement to work them. Moreover, the cost of obtaining Parliamentary powers is a drag on enterprise of this character. A detailed analysis should throw some light on these matters, and show whether less handling is required in the case of transport to the German works. There is no use in making vague statements—we have too many of them. It is necessary to go to the root of the matter if there is to be a useful result.

One of the recommendations made by the Sub-Committee is that there should be a Ministry of Commerce charged solely with the safeguarding and extension of British industry and trade. We think there is no question that such a body should be formed, the only point being whether an efficient body of this kind could be obtained simply by reorganising the Board of Trade. It is always difficult, however, to break away from set traditions, and there is a good deal to be said in favour of the view expressed by one of the witnesses that a Ministry of Commerce should not only promote trade but champion its cause against other departments which seek to impose restrictive conditions, and that on this account the Board of Trade is unsuitable, as it issues regulations in regard to public safety and other numerous regulations of this character. The recent action of the Board of Trade in regard to the Bill of the Yorkshire Electric Power Co. is a case in point. On the other hand we see no reason why the Board of Trade should not be reformed into a body very much more useful than it is at present—it is already more useful than it was some years ago.

Lastly, we come to the delicate subject of tariff protection. This, on the part of trade representatives, was considered to be more important than any other point, and a general fear was expressed that imemdiately after the war this country would be flooded with German and Austro-Hungarian goods sold at almost any price. We thoroughly agree with this view of the future, and we think it would be folly to disregard it. Very naturally the position is felt most keenly by those firms who have taken up, sometimes at the instance of the Government, the manufacture of products which formerly came from Germany. They are naturally reluctant to commit themselves to further capital outlay on account of these particular lines of manufacture unless the Government is willing to come to their assistance. It appears to us that some measure of protection in these cases will be necessary, or at least a means of ready retaliation. We notice that Sir ALBERT SPICER, one of the members of the Sub-Committee, is of the opinion that the question of such tariffs can be left until after the war. We disagree with this view. As a nation we move slowly. After the war the Germans will not wait for us to enact legislative measures; they will swamp our markets without delay, and we should be prepared for this by having our protective measures ready. We trust that the report will not suffer the fate of most other reports, though in our opinion it is not sufficiently comprehensive. Generally speaking, we have had more than enough talking; it is a time for action, and, therefore, let the Government formulate their plans without delay.

SELENIUM CELLS.*

BY W. R. COOPER, M.A., B.SC.

Summary.—A general account is given of the properties of the various varieties of selenium, this being followed by a discussion of the effects of light, the dependence of sensitiveness on wave length and the measurement of sensitiveness. In the latter part of the article is given some account of the theories which have been put forward to account for these facts. In conclusion some details of construction are given, and applications are briefly described.

Increasing attention has of late been given to the utilisation of selenium, and therefore a short account of the properties of this element may be of interest.

The effect of light upon selenium may be divided into two general classes as follows :—

I. When light falls upon what is called "metallic" or crystalline selenium its electrical conductivity is affected and generally increases.

II. If one of the plates of a voltaic cell is made of crystalline selenium, the E.M.F. of the cell varies (positively or negatively according to the elements) when light is allowed to fall on the selenium plate.

An electrical effect can, therefore, be obtained by the action of light (*a*) by making selenium part of a circuit through which a current is flowing, since the value of the current will change with the illumination of the selenium ; or (*b*) by using selenium voltaically without any extraneous E.M.F. Selenium resistances made up in such a way as to be suitable for method (*a*) are commonly called selenium cells, but the term so applied is a misnomer, and should be restricted to the voltaic cells used in method (*b*). W. G. Adams and R. E. Day† found that light is also capable of producing an E.M.F. in selenium itself.

General Properties of Selenium.

Selenium was discovered in 1817 by Berzelius in the deposits from sulphuric acid chambers. It is closely akin to sulphur in many of its properties, and, like that element, it exists in several allotropic modifications. The information given on this point in text-books is not very dependable, and we shall, therefore, rely upon a careful investigation of the more chemical properties by A. P. Saunders.‡ According to this investigator, selenium exists in the three following forms : (1) Vitreous and amorphous, (2) red crystalline, perhaps in two closely allied forms, and (3) grey crystalline, or metallic, which is conducting. The first two classes are non-conducting. In the three following paragraphs the properties of these modifications are given in detail.

Vitreous and Amorphous Selenium.—If any variety of selenium is heated above 220° C., it forms an ordinary liquid, but if this is cooled quickly it becomes more and more viscous, remaining soft even below 60° C. ; but at 30° C. to 40° C. it becomes hard, and is then known as *vitreous selenium*, having a conchoidal glassy fracture. In its plastic condition it may be drawn into long threads, which are transparent and of a ruby colour by transmitted light.

If selenium is deposited from an aqueous solution of selenious acid (for example, by passing a current of sulphur dioxide through the solution) a precipitate is obtained which, when dry, forms an impalpable powder without any trace of crystalline form. This is known as *amorphous selenium*.

Vitreous selenium gives a red streak on paper. When powdered it is gray ; but if powdered very fine it becomes red, and is then indistinguishable from the red amorphous selenium.

If amorphous selenium is warmed to 40°C. it darkens and coagulates to a soft mass, which, on cooling, becomes hard and brittle, assuming somewhat the features of the vitreous form.

Apparently the vitreous and amorphous varieties differ only in the state of aggregation. It is found that liquefied selenium is slightly soluble in carbon bisulphide. Also, freshly precipitated amorphous selenium under certain conditions is soluble in water, and is then known as soluble selenium. This property, however, is lost with the lapse of time.

The vitreous form is quite stable by itself at ordinary temperatures, and is the form in which selenium is ordinarily sold.

The specific gravity of amorphous selenium is 4·26 and of vitreous selenium 4·28.

Red Crystalline Selenium (*non-conducting*).—This variety separates from solutions in carbon bisulphide, or it may be obtained by allowing the vitreous or amorphous form to stand in carbon bisulphide, or soem other solvents, at ordinary temperatures. Saunders is of the opinion that it is probably able to exist in two different forms, both belonging to the same crystal system and both soluble in carbon bisulphide. There are indications of an unstable melting point at 217°C. The specific gravity of red crystalline selenium is 4·28.

Grey Crystalline Selenium (*conducting*).—The grey crystalline, or metallic, form is obtained from the other varieties by heating, and in the presence of certain liquids this change takes place even at ordinary temperatures. This variety may be regarded as the stable form of selenium, into which the other forms tend to pass, being stable at all temperatures up to the melting point, which is 217 deg. The other forms are unstable, the red crystalline being intermediate between the grey crystalline and the vitreous. Although it is a simple matter to change from the two other varieties into the grey crystalline, Saunders was unable to bring about a change in the reverse direction.

It has been noticed by some observers (notably by Saunders) that quinoline and some kindred organic bodies have the property of converting amorphous selenium, at least superficially, into the metallic form.

Selenium is polymorphous, the form of the crystals depending on the conditions in which they are produced. F. C. Brown* has obtained a number of different forms by vaporising selenium and allowing it to condense on a cool surface. All these were conductors of electricity, and all but one were doubly refracting. Some crystals are soluble in carbon bisulphide and some are insoluble.

The specific gravity of grey crystalline selenium is 4·80.

Electric Conductivity.—The resistivity is high, being of the order of 2×10^{16} ohms per centimetre cube in the dark ; but the figure varies enormously, according to the mode of preparation and with the value of the applied P.D.

There has been some discussion as to whether the conduction is simply metallic or whether it is electrolytic in its character. In support of the electrolytic view there is the fact that the resistance is generally found to vary with the applied pressure ; in other words, the resistance does not simply follow Ohm's law, but decreases in proportion to the P.D. when this is small, the original state being slowly regained when the pressure is removed. The proportionality and the lag are noticeable in Fig. 1, which is due

* From a forthcoming edition of "Primary Batteries." (Copyright.)

† *Proceedings*, Royal Society, Vol. XXV., p. 113, 1876.

‡ *Journal of Physical Chemistry*, Vol. IV., p. 423, 1900.

* *Physical Review*, Vol. IV. (2nd series), p. 85, 1914.

to L. S. McDowell.* Moreover, after a current has been flowing, it is found that the selenium is polarised; but, unlike the corresponding phenomenon in electrolysis, the E.M.F. of polarisation, according to Luterbacher,† is in the *same* sense as the current by which it is produced; in other words, the polarisation current flows in the same direction as the current that has been applied, instead of in the inverse direction. The polarisation so produced, therefore, differs essentially from what is generally meant by this term. On the other hand, W. G. Adams and R. E. Day‡ found that the polarisation was in the opposite direction to the current by which it was produced.

The variation of resistance with the applied pressure, as observed by J. Luterbacher,§ is very large, as seen in Fig. 2, and to fall off considerably at the higher voltages. The curve is approximately a parabola. Alternating current produces the same effect, but not to such a marked degree. This is shown in Fig. 3. Possibly the smaller effect at the higher pressures may be due to the fact that a steady state is reached more slowly with high than with low pressures: the creeping is greater, as pointed out by Ries.‖ Any

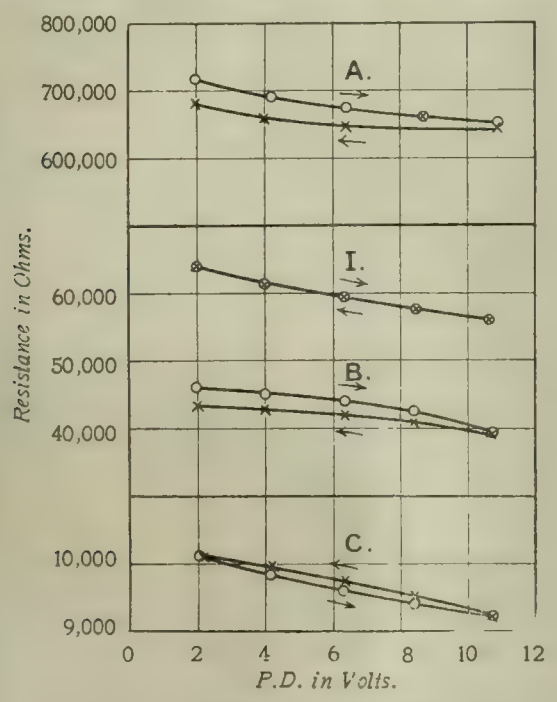


Fig. 1.—Variation of Resistance of Selenium with Applied P.D. (McDowell).

heating up of the selenium by the passage of the current would also lower the resistance, but it is pointed out by Luterbacher that the effect of such heat would be least with small currents, whereas the reduction of resistance is more marked with the smallest currents than with larger currents. A curve showing the heat produced is given in Fig. 103.

E. E. Fournier d'Albe¶ has shown that the variation in the resistance for all pressures above 1 volt is proportional to the logarithm of the voltage. The observations in one case were carried beyond 100 volts.

On the other hand, V. Chiarini** found that the P.D. required to cause a current to flow varied from as low a value as 0·02 up to 0·9 volt; and A. H. Pfund†† found that certain old selenium resistances failed to show polarisation, even when the applied pressure was as high as 110 volts.

A. Pochettino‡‡ states that if the primary current is not applied for more than two minutes the initial intensity of the secondary, or polarisation, current increases with the voltage applied and with the square root of the time of application. The polarisation currents continue for a considerable time. Thus, taking the case of the application of 54 volts, the secondary current was $1{,}100 \times 10^{-9}$ ampere seven seconds after the primary current ceased, and was still 8×10^{-9} after 2,010 seconds.

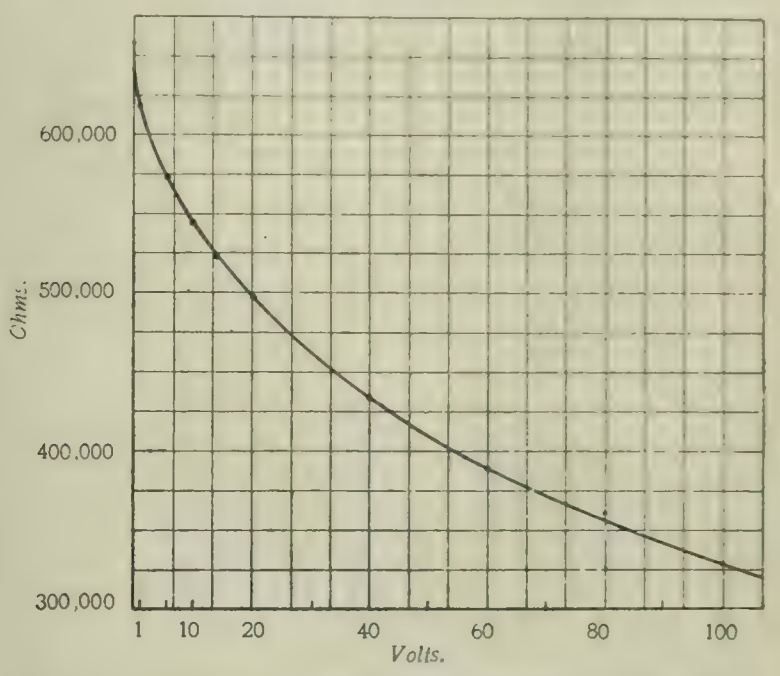


Fig. 2.—Variation of Resistance of Selenium with Applied P.D. (Luterbacher).

By allowing the selenium to discharge through a galvanometer immediately after cutting off the applied pressure polarisations were observed by Luterbacher* varying from 7 to 22 millivolts. Assuming that the galvanometer was of high resistance, this shows a very small E.M.F. of polarisation, but possibly its value falls very rapidly. In any case, we cannot look upon polarisation as an explanation of the fall in resistance, for it would have to reach an extraordinary high value to produce any noticeable effect with applied pressures of 100 volts.

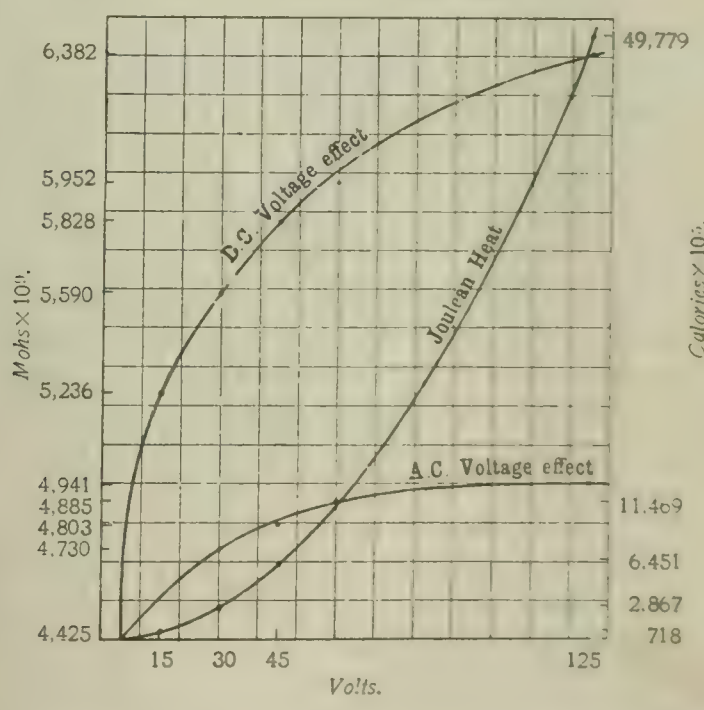


Fig. 3.—Comparison of Continuous and Alternating Pressures as Affecting the Resistance of Selenium (Luterbacher).

It seems difficult to accept an electrolytic view of the conductivity, because we are dealing with a single element, unless selenium is capable of splitting up into two ions which are identical chemically, but which differ electrochemically, one being electro-positive to the other.

* *Physical Review*, Vol. XXIX., p. 1, 1909.
† *The Electrician*, Vol. LXVII., p. 736.
‡ *Proceedings*, Royal Society, Vol. XXV., p. 113, 1876.
§ *Loc. cit.*
‖ *Annalen der Physik*, Vol. XXXVI. p. 1,055, 1911; *Science Abstracts*, 1912, No. 1428.
¶ *Proceedings*, Royal Society, Vol. LXXXVI., p. 452, 1912.
** *Atti*, Accademia dei Lincei, Vol. XVIII., p. 246, 1909; *Science Abstracts*, 1909, No. 884.
†† *Physical Review*, Vol. XXVIII., p. 324, 1909.
‡‡ *Nuovo Cimento*, Vol. XVI., p. 381, 1908; *Science Abstracts*, 1909 No. 693.

* *Loc. cit.*

The conductivity between an electrode and selenium is to some extent unilateral.*

F. C. Brown† has shown that mechanical pressure causes an increase in conductivity. A resistance of 96,000 ohms at atmospheric pressure was reduced to 63,000 ohms at a pressure of 218 kg. per square centimetre, the pressure being applied hydraulically.

It has been pointed out by both Giltay and F. C. Brown‡ that the conductivity is increased by abrasion; for example, by filing. The selenium recovers its original condition after about a month.

Selenium generally has a positive temperature coefficient

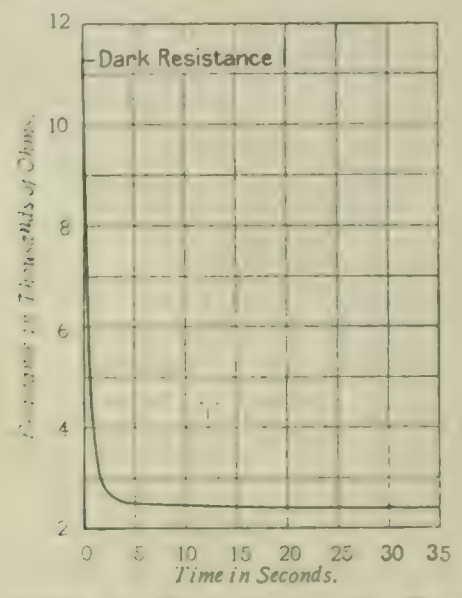


Fig. 4.—Variation of Resistance with Time of Exposure (Torda).

of resistance. Ries§ distinguishes two forms of crystalline selenium, which he terms α and β. The α modification has a negative temperature coefficient, and is obtained by heating up to temperatures below 200°C. (the transformation being most complete by prolonged heating at 195°C.), followed by rapid cooling. The β modification has, within certain limits, a positive temperature coefficient, and is obtained by heating at temperatures above 200°C.

The Effect of Light.

Light-Positive Selenium.—The usual effect produced by increasing the illumination of crystalline selenium is a diminution of resistance. Generally the comparison is made between what may be termed the "dark resistance" (*i.e.*, the resistance of the selenium when all light is excluded) and the resistance when the illumination has some definite value.

The effect obtained is illustrated by the curves in Fig. 4. From these it is seen that the change in conductivity is not instantaneous; it is at first rapid and proportional to the time of exposure, but it very soon becomes slower and slower until a steady state is reached. Hours may be required for the steady state to be attained. This time lag is known by the name of inertia. Although two selenium resistances may have the same sensitiveness (*i.e.*, they may ultimately change in conductivity to the same extent on exposure to a given illumination), they may differ materially in lag, so that the effect of a given illumination for a brief period may be very different. Lag is more apparent in recovery than in excitation.

A feeble illumination produces its full effect less rapidly than a strong illumination. For example, Pfund gives the figures 3 minutes and 15 seconds respectively for two such cases. In considering these matters it must be borne in mind that these observations refer to selenium in thin layers.

When the light is removed or reduced the selenium proceeds to recover its initial conductivity, but here, again, the effect is not instantaneous. In fact, recovery curves are characterised by a slower action than the excitation curves, a fact which is illustrated in Fig. 5. The time of recovery generally increases with both the intensity and the duration of the excitation, and for this reason long exposures are avoided, as far as possible, where selenium is used for practical purposes.

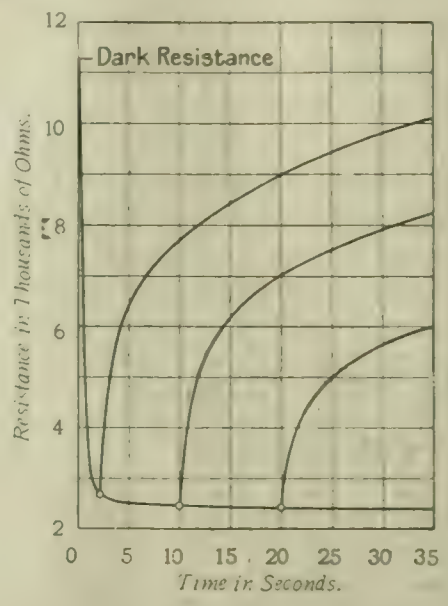


Fig. 5.—Variation of Recovery with Time of Excitation (Torda).

Prolonged exposure sometimes causes a diminution of the effect first produced. This has been observed by F. C. Brown* in the case ot resistances made by Giltay (of Delft, in Holland). Such curves are reproduced in Fig. 6. Generally, however, prolonged exposure has no such effect.

Light-Negative Selenium.—Although the effect of increased illumination is generally to give increased conductivity, the reverse effect has been observed. So far, the method of producing the negative variety of selenium is not

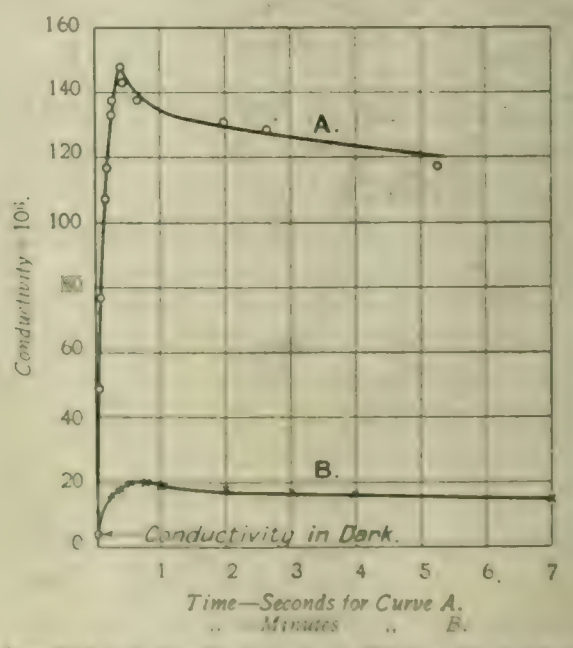


Fig. 6.—Effect of Prolonged Excitation in the Case of Giltay Resistances (F. C. Brown).

well understood. F. C. Brown† has found that such selenium can be obtained by placing the amorphous variety in a mercury vacuum until it becomes black, after which it is pressed between electrodes. Even at atmospheric pressures this change takes place if selenium is held over heated mercury. It does not seem to be due to the absorp-

* Chiarini, *loc. cit.*

† *Physical Review*, Vol. IV., p. 85, 1914.

‡ *Physikalische Zeitschrift*, Vol. XIII., p. 859, 1912; *Science Abstracts*, 1913, No. 232.

§ *Physikalische Zeitschrift*, Vol. IX., p. 228, 1908; *Science Abstracts*, 1908, No. 1,294.

* *Physical Review*, Vol. XXXIII., p. 1, 1911.

† *Physical Review*, Vol. II., p. 153, 1913.

tion of mercury vapour. This method of producing a superficial conducting film was discovered many years ago by R. J. Moss,* and may be carried out either *in vacuo* or by placing the selenium in mercury.

The properties of light-negative selenium have been studied by Lilah B. Crum.† Although the general effects observed were simply the inverse of those shown by light-positive selenium, they were characterised by great unsteadiness and uncertainty. For example, cases were found in which both positive and negative results were obtained from the same resistance alternately within a period of a few minutes.

Negative effects have also been observed by A. Pochettino and G. C. Trabacchi.‡

Light-Neutral Selenium.—A. Knothe§ found that when sublimed selenium was exposed to sulphur dioxide gas it became a very good conductor, but was insensitive to light.

(*To be continued.*)

ARTIFICIAL INSULATING MATERIALS.

(*Concluded from page* 629 .)

Messrs. Mosses & Mitchell are identified with vulcanised fibre, manufactured at their factory in the United States. This well-known material is supplied in two qualities—namely, the hard and the flexible. The hard grade very closely resembles horn in its consistency. It is exceedingly tough and strong, resisting enormous compressive strains and retaining its elasticity under all ordinary conditions. It can be readily turned, drilled, riveted, screwed, punched and will take a clean strong thread; moreover, it takes a fine polish. But it cannot be moulded. The flexible material, which is specially treated during manufacture, very closely resembles leather. It is principally used for packings and similar uses, being uninjured by water, grease or oil. Messrs. Mosses & Mitchell, not only supply vulcanised fibre in tubes, sheets and rods, but also are equipped for turning out a variety of shapes, and are the original manufacturers of vulcanised fibre.

Messrs. G. Schultz & Co., Ltd., of London (a British-owned company), are now manufacturing Pertinax at their works in

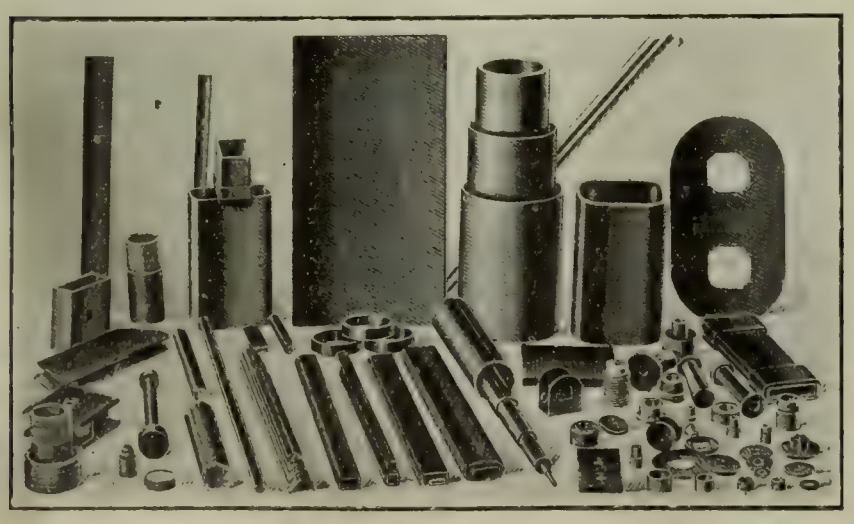


Fig. 4.—Pertinax and Mica Articles by Messrs. G. Schultz & Co.

Manchester. From one of our recent articles it will be remembered that this material is composed of laminations of insulating paper cemented together with a special adhesive by means of heat and pressure treatment in patent tube mills. The tubes which are thus formed are of a very compact nature and have a high dielectric strength. The pressure exerted by the tube mills is sufficient to cause exclusion of all air, which is sometimes found in tubes made by other processes, and hence the material has a correspondingly higher specific gravity. The smallest tubes have a diameter of about $\frac{3}{16}$ in., and larger tubes are made up to any diameter desired.

This material is also manufactured into sheets and plates varying in thickness from about 2 mm. up to 2 in., sufficiently hard to be used as base plates for electrical instruments, and are found to be satisfactory on warships, where the concussion of the guns leads to the breakage of ordinary materials.

Certain grades of Pertinax may be used in hot oils without being affected in its mechanical and electrical properties. The electrical resistance at temperatures over 80°C. does not maintain itself as well as do mica-built tubes and plates, and this appears to be the only disadvantage of the material. Even this defect may be overcome by building such tubes with interior layers of mica. In other respects the makers state that the electrical insulation and dielectric strength of Pertinax stands very little behind that of mica. It is used largely for high-voltage insulation in wireless telegraph installations and similar work.

This firm also manufacture mica plates made up of mica splittings with suitable adhesive material. In many cases the mica tubes are interleaved with paper, made by special tube-making machines, similar to those used in making tubes of Pertinax. Micanite tubes and slabs are made which will resist temperatures up to 850° to 900° without losing their mechanical strength. An idea of the products of this firm is given by Fig. 4.

Messrs. Turners & Manville manufacture a number of materials of which we give some account below. Ebony Grade "Sindanyo" consists of an asbestos base having a special binder. It is manufactured in the form of sheets under hydraulic pressure, being afterwards impregnated with an insulating compound under a special process, and is supplied in standard sheets measuring 3 ft. by 4 ft., or in special sheets measuring 8 ft. by 3 ft. 6 in., and in all thicknesses ranging from $\frac{1}{8}$ in. to 2 in. Rods cut from sheets can also be supplied up to 18 in. in length. Ebony "Sindanyo" is being largely used as a substitute for slate and marble in switchboard panels and other electrical apparatus. It is free from metallic veins, possesses high dielectric properties, and, owing to its high mechanical strength, can safely be used in thinner slabs than would otherwise be necessary in the case of slate. It is non-hygroscopic and the makers state it will neither swell not warp under the most severe conditions. It is recommended for use as a base where the temperature does not exceed 350°F.

Plain Grade "Sindanyo" possesses fire-resisting properties combined with mechanical strength. It is supplied in standard sheets measuring 3 ft. by 4 ft. or in special sheets measuring 8 ft. by 3 ft. 6 in. and in all thicknesses ranging from $\frac{1}{8}$ in. to 2 in. Rods cut from sheet can also be furnished up to 18 in. in length. This material, while possessing no stable dielectric qualities has withstood continuous temperatures of 900°C. successfully without disintegration. Its mechanical strength under this temperature was but slightly affected and no trace of flaws or warping was apparent. It is well adapted for arc deflectors, parts of cooking and heating units, &c.

Vulcabeston probably represents one of the oldest forms of insulating compounds on the market, and, as its name implies, it consists of an asbestos base having rubber as a binder. It is manufactured in a steam press and can be supplied in either sheet or moulded form. Whilst this compound possesses a relatively low mechanical strength, averaging about 3,600 lb. per square inch of cross-section, it may be considered slightly elastic, inasmuch as it is not brittle and will, therefore, withstand stresses under which other materials of equal strength would fail. It possesses a dielectric strength of 80 volts per mil and will withstand temperatures up to 300°F. without alteration. When exposed to an arc or Bunsen flame, volatile constituents are driven off, but upon removal of the flame ignition is not maintained. Vulcabeston is stated to possess an absorption of, approximately, 1·75 per cent. after 48 hours immersion in cold water. Mouldings of this compound possess characteristics similar to those above mentioned, excepting that the dielectric and hygroscopic properties are higher. Vulcabeston in both forms is eminently suitable where a high-grade material possessing toughness, durability and insulating qualities are essential. It can be supplied in standard sheets measuring 18 in. by 18 in. and in all thicknesses varying from $\frac{1}{64}$ in. to $\frac{3}{4}$ in. It can be moulded into almost any shape and is used largely for insulating bolts, controller parts, &c.

What is known as No. 201 Stock Compound is of the phenol group, having as its base asbestos fibre with a special gum as a binder. It is manufactured in a steam press and can be supplied in either sheet or moulded form. This material possesses a dielectric strength of 180 volts per mil. and has an average strength of 8,975 lb. per square inch of cross section. Its heat-resisting qualities are exceptionally high, it being capable of withstanding temperatures up to 500°F. without alteration. Well above this temperature there is a slight inclination to blister on the surface. Upon subjecting the material to the action of a Bunsen flame there is no inclination to warp, or to maintain ignition after the flame is removed. It is also found that the mechanical strength is increased slightly under high temperatures.

* *Chemical News*, Vol. XXXIII., p. 203, 1876.
† *Physical Review*, Vol. XXXIII., p. 538, 1911.
‡ *Nuovo Cimento*, Vol. XIII., p. 286, 1907; *Science Abstracts*, 1907, No. 1 561.
§ *Elektrotechnische Rundschau*, Vol. XXI., p. 23, 1903; *Science Abstracts*, 1904, No. 152.

This compound may be considered non-hygroscopic, the absorption after 48 hours immersion in cold water averaging 0·6 per cent. and after one hour immersion in water at 212°F. 1·7 per cent. It will resist the action of most acids both concentrated and dilute, and is unaffected by the presence of oil. This material is made up in sheets measuring 18 in. by 18 in. and can be supplied in thicknesses ranging from $\frac{1}{16}$ in. to $\frac{1}{4}$ in. Almost any form of moulding can be made from this compound with accuracy, both with or without metal inserts, such mouldings being carried out under high temperatures. Both the density and uniformity of parts can be guaranteed. This material is particularly adapted for insulated parts of heavy electrical machiney where a high heat-resisting material combined with dielectric and mechanical qualities are essential.

Articles are also moulded from "J.-P." Bakelite, which is also of the phenol group, having as its base either asbestos or wood flour with a special gum as a binder. It is manufactured under temperature in a steam press and is supplied in moulded form in a variety

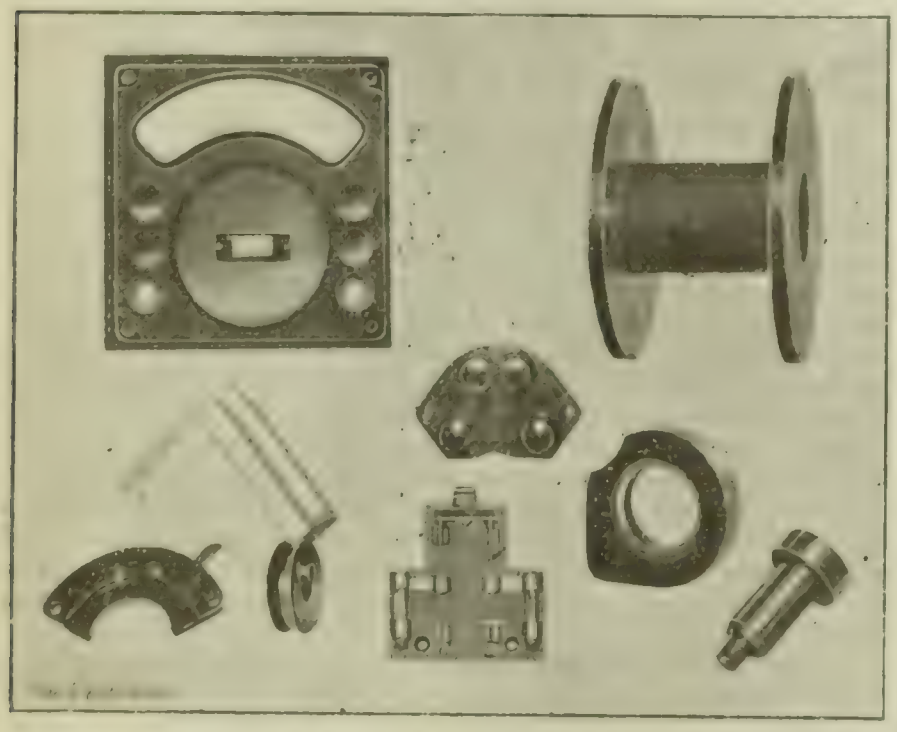


Fig. 5.—Examples of Moulded Material by Messrs. Turners & Manville.

The instrument cover is in "J.P." Bakelite, the bobbin in Vulcabeston, and the arc-shield in Electrobestos.

of colours to meet different requirements. "J.-P." Bakelite with wood flour as a base possesses a dielectric strength of 250 volts per mil. In mechanical strength this grade stands alone amongst moulded compounds, averaging 13,200 lb. per square inch of cross-section. It withstands 225° F. without alteration and has an absorp- of 0·6 per cent. after immersion in cold water for a period of 48 hours. In water at 212° F. the absorption after one hour immersion averages 0·82 per cent. On the other hand, "J.-P." Bakelite with asbestos flour as a base has a slightly lower dielectric strength, but will withstand temperatures up to 300° F. without alteration. Its absorption is reduced to 0·1 per cent. in cold water and 0·16 per cent. in boiling water for the same period. The mechanical strength is approximately the same as in the case of the wood flour base. Both grades mould with a high finish, particularly the wood flour grade, which allows of a glossy surface. Both can be moulded with great accuracy and of uniform density, and will take metal inserts securely. The wood flour grade will resist the action of nearly all acids and alkalis and can be used in the presence of oil. This compound is particularly adapted for parts of electrical apparatus where a high finish and great accuracy is essential, such as for instruments, telephones, and magneto distributor parts.

"Stavol" is an asbestos and rubber compound manufactured in sheets measuring 60 in. by 50 in. by $\frac{1}{32}$ in. thick. This material is of a flexible nature and possesses a dielectric strength of, approximately, 100 volts per mil. It is particularly adapted for lining controller cases, feeder pillars, switch boxes, &c.

Another moulded material, known as Electrobestos, is an asbestos compound possessing high heat-resisting properties. It will withstand temperatures up to 900°C. and can safely be used on circuits up to 500 volts. It is largely used in parts of heating and cooking apparatus and arc lamps, and in other situations where high fire-resisting qualities are necessary.

Messrs. Turners & Manville also supply various forms of moulded compounds where mica and shellac form the component parts, particulars of which are given in the accompanying table. Fig. 5 shows the character of work by this firm.

It may be of some interest to mention the method of testing followed by Messrs. Turners & Manville. Heat tests are made to determine the point at which the insulation first begins to change, either by softening or by swelling. For this purpose the test piece is placed in mercury at the bottom of a cylinder, and has resting upon it three points supporting a weight, the full pressure of the weight being carried by the points. There is also resting on the surface of the test piece a plate free to move if the test piece should swell. Both the plate and the weight are connected to arms which register on a dial. These arms are so proportioned that should the test piece soften so as to allow the points to penetrate one-thousandth of an inch, or should the piece swell to a like extent, a reading on the dial is noticeable. Directly over the test piece is a thermometer which is immersed in the mercury bath. The temperature is raised as rapidly as may be desired by means of heating units. When the pointer has moved to an extent indicating that the piece has softened one-thousandth of an inch the reading of the thermometer is taken. Such softening does not mean that the material can be readily altered in form by the pressure of the fingers, for it is still hard and can only be indented by a knife blade on applying some pressure.

Mechanical tests are carried out on a testing machine of 20 tons capacity. The piece to be tested is placed across a gap $\frac{5}{8}$ in. wide, and the load is concentrated in the centre. The load is gradually increased until the piece gives way. The strength in pounds per square inch is that calculated from the formula $R=\frac{3}{2}\frac{PL}{bd^2}$, in which P equals the breaking load, L is the length of gap, b the breadth of piece, and d the thickness.

In making absorption tests the test piece is placed in water for 48 hours, the weight being taken before and after. In making a hot water test the piece is placed in boiling water for one hour. All test pieces are broken sections, thus exposing a rough surface to the action of the water; otherwise in some materials there would be no change from this test.

Messrs. Watlington & Co., Ltd., represent in this country the Hemming Mfg. Co., of Garfield, New Jersey, their products being known under the trade name of "Hemit" insulating material. Various classes must be distinguished. Thus, Hemit "A" is a direct substitute for porcelain. It can be moulded accurately to a specific size, and metal parts can be embedded in it. It is tougher than porcelain and less brittle and, therefore, less liable to breakage. It will withstand a continuous temperature of 600 F. without

Table showing Properties of Moulded Compounds, the Base being Ground Mica and Asbestos.

	Binder.	Dielectric strength.	Mechanical strength.	Heat test.	Absorption.
Black Mica—					
Suitable for outdoor mouldings	Shellac	331 volts per mil (approx. 13,000 volts per min.)	7,167 lb. per square in. of cross section	120° F.	0·2 per cent. after 48 hours in cold water.
Moulded Mica—					
Suitable for outdoor mouldings, such as tramway overhead equipment	High grade shellac	345 volts per mil (approx. 14,190 volts per min.)	8,500 lb. per square in. of cross section	136° F.	0·15 per cent. after 48 hours in cold water
Mica—					
Suitable for outdoor work	Low grade shellac	285 volts per mil (approx. 11,200 volts per min.)	6,882 lb. per square in. of cross section	134° F.	0·15 per cent. after 48 hours in cold water.
Brown Mica—					
Suitable for indoor or outdoor work	High grade shellac	310 volts per mil (approx. 12,200 volts per min.)	8,500 lb. per square in. of cross section	144° F.	0·15 per cent. after 48 hours in cold water.
Grey Mica—					
For indoor work	Shellac	60 volts per mil (approx. 2,380 volts per min.)	10,500 lb. per square in. of cross section	157° F.	4·7 per cent. after 48 hours in cold water.

deterioration, and will undergo sudden changes of temperature without cracking. It is unaffected by moisture or water and can, therefore, be used out of doors. It will also withstand dilute mineral acids. Its dielectric strength is stated to be 75 volts per mil.

Hemit " B " can also be moulded in all forms, and possesses considerable strength. It is more easily worked with tools than Hemit "A." For this reason, it is recommended where Hemit " A " would not prove strong enough mechanically. On the other hand, it does not resist acids nor exposure to continuous moisture, though it is very stable under all climatic conditions indoors. It will withstand a continuous temperature of 400°F. without deterioration and does not crack under sudden changes of temperature. The dielectric strength is 50 volts per mil.

Hemit " C 1 " can be moulded, but is limited to flat shapes. It is very strong and hard. It is unaffected by moisture or water and can, therefore, be used out of doors, but it will not withstand the action of acids. On the other hand, it will stand a continuous temperature of 800°F. without deterioration ; also it is unaffected by the electric arc and by sudden changes of temperature. The dielectric strength is 50 volts per mil.

Hemit "C 2" is limited for moulding to flat pieces. It is very strong and hard, but it is not intended for use where it is subjected to moisture or water, as moisture, although it produces no physical or chemical change, diminishes the dielectric strength. It is also



FIG. 6.—MOULDED ARTICLES BY MESSRS. WATLINGTON & CO.

affected by acids. The heat-resisting qualities are high, and the makers state that the material will withstand a continuous temperature of 2,000°F. without deterioration. Thus it is unaffected by the electric arc and by sudden changes of temperatures. The dielectric strength is 30 volts per mil.

Fig. 6 illustrates some of Messrs. Watlington & Co.'s Hemit products.

Since the first part of this article was published we have received a communication from the DAMARD LACQUER CO., of Birmingham, stating that they have for many years made varnishes from synthetic resins. Such resins give remarkable results from the point of view of insulation and immunity from corrosion. Thus a thin sheet of this material has been found, after several days in hydrofluoric acid, to remain unattacked ; mineral acids have no effect, and many oxidising salts, such as potassium permanganate, have very little action. The Company, in addition to making synthetic varnish for building up insulating material, have more recently taken up the manufacture of moulding powders with the same base, and with both organic and inorganic fillers. In order to replace supplies which before the war came from foreign countries, the Company have put down much additional plant so as to meet all demands, and thus render the trade independent of German sources.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

" Circulation and Radiation in the Atmospheres of the Earth and of the Sun." By Frank H. Bigelow, M.A. (London : Chapman & Hall.) Pp. xi.+431. 21s. net.

" Electric Lighting." By A. H. Avery. (London : Cassell & Co.) Pp. viii.+150. 1s. net.

CORRESPONDENCE.

" BUSINESS AND ENGINEERING."

TO THE EDITORS OF THE ELECTRICIAN.

Having had my spirits considerably depressed this evening by reading in to-day's paper that we possess in Sandhurst the only military college in Europe where science is not included in the curriculum, I turned to my ELECTRICIAN with a view of discovering an antidote ; but my hopes were dashed to the ground by finding repeated, in a prominent position, without so much as an inverted comma, the extraordinary statement that " an engineer is, as a rule, a poor business man."

I feel this statement must not go unchallenged ; in my opinion it is utterly false and mistaken. Surely but a casual examination of affairs will show that the majority of the most important manufacturing engineering businesses have been founded and managed by engineers. Consider also the electrical supply industry. Will Mr. Hatch, the author whose words you have quoted, seriously maintain that the heads of the electricity departments of Manchester, Birmingham and scores of other large cities are " poor business men." The statement does not bear a moment's serious examination, and really, considered by itself, perhaps does not require contradiction. That the statement should be made, however, is, to my mind, a symptom of a deep-rooted evil in the institutions of our country. I refer to the contempt in which science in particular—in which I include the applied science of engineering, and, in fact, education in general—are held by the mass of English people.

Now I should like to ask Mr. Hatch what is, in his opinion, business capacity ? Does it consist of breadth of vision, capability of taking long views and of separating the essential from the casual, a horror of inefficiency and slipshod methods, an accurate habit of mind and capacity of logical co-ordination of ideas and facts, and a capacity for understanding the correlation between the output and the individuality of men ? If it does, then I submit that an engineering training is one of the best schools where such qualifications may be attained.

What does Mr. Hatch's statement really mean ? If it means anything, it is that an engineering training unfits a man for business activities.

The business man in the wide sense is the organiser and leader of industry. It is a libel on engineers to say they are not fit for such positions. Experience shows that engineers are capable of occupying the highest executive posts with credit and advantage. It is true that by an exclusive concentration upon the commercial side of business a man may acquire a superficial sharpness which may favourably impress the ignorant as to his business capacity. This is, however, but a shallow and pettifogging view of business. The success of a business enterprise does not depend upon the capability of the man who directs it of driving a hard bargain, in saving halfpennies here and pennies there, but upon his broadness of mind, faculty of leadership and power of organisation.

Men of this type are, however, best formed in the strenuous activities necessary to an engineering training and profession. For far too long have engineers endured the flippant suggestion that they are a species of wayward children necessarily to be kept in check and control by people who have not troubled to subject themselves to the engineer's training, or, for the matter of that, to any particular training whatsoever.

In so far as the suggestions I object to have been honestly made they are on a par with the fantastic idea, still very prevalent, that the only suitable education for a Government official or legislator is to be obtained by an exclusive devotion to Latin and Greek. In my humble opinion, however, the ideas, while not being perhaps intentionally, are essentially dishonest in their origin. It is a case of auto-suggestion. It is a very comforting theory for the unqualified or untrained man who has acquired, by devious means, a position of responsibility to hold that his lack of training gives him a special qualification which the trained man, by his very training, is prevented from attaining. The comfort of this idea is such

that the man in question will go on proclaiming it until he becomes to believe it. I cannot agree, however, that it should go forth from a leading engineering journal that engineers accept this position; rather should they, in my opinion, energetically protest against it.

Sutton Coldfield, Feb. 2. CHARLES C. GARRARD.

LEGAL INTELLIGENCE.

Herbert Morris (Ltd.) v. Saxelby.

An important judgment was delivered in this appeal by the House of Lords on Tuesday. Legal arguments, which began so long ago as Nov. 4, 1915, and occupied their Lordships on four subsequent days, were concluded on Nov. 23 and judgment was reserved. The appeal was from an order of the Court of Appeal affirming (by a majority) a judgment of Mr. Justice Sargant in favour of the respondent, Mr. Fred. A. Saxelby.

Sir Robert Finlay, K.C., Mr. A. J. Walter, K.C., and Mr. D. M. Kerby, K.C., appeared for appellant company. Mr. Mark Romer, K.C., and Mr. W. R. Sheldon for respondent.

Sir ROBERT FINLAY said that the only point their Lordships were asked to decide was whether or not an agreement under seal executed on March 17, 1911, by the parties to the proceedings a covenant was unenforceable in law as being unreasonably in restraint of trade—that was, as going farther than was necessary for the protection of appellants in their business. So far as material the covenant ran: "The employee will not at any time during a period of seven years from the date of his ceasing to be employed by the company, whether under this agreement or otherwise howsoever either in the United Kingdom of Great Britain or Ireland, carry on either as principal, agent, servant or otherwise, alone or jointly or in connection with any other person, firm, or company, or be concerned or assist directly or indirectly whether for reward or otherwise in the sale or manufacture of pulley blocks, hand-overhead-runaways, electric-overhead-runaways or hand-overhead-travelling cranes." Appellants manufactured machinery for lifting and moving heavy weights known as "pulley blocks," "runaways" and hand-overhead travelling cranes, for which they had acquired a great reputation. They also made and sold electric overhead travelling cranes (not included in the covenant) in which they did a large and increasing trade. Mr. Saxelby entered their service in 1901 as a junior draughtsman, being then a lad of some 15 or 16 years of age. During the period that elapsed between that date and the date of the covenant in question he had risen successively in their employment until, in 1906, he was leading draughtsman in the pulley block department, which he gave up in 1908 to become resident engineer at the Cardiff branch and South Wales representative for the firm, and a year later he became their London manager. Mr. Saxelby had had no other training and experience other than that which he had in appellants' employment, and he had given his whole energy to this branch of engineering. He subsequently left their employment and entered that of Messrs. Derome, who carried on business in France as manufacturers of lifting machinery, but on March 9, 1914, he returned to England and entered the service of the principal competitors of appellants, Messrs. Vaughan & Son. Plaintiffs thereupon commenced that action and claimed an injunction. The only defence was that the agreement was in undue restraint of trade. Counsel contended that the covenant was not wider than reasonably necessary for the protection of appellants' business, and he asked the House to hold that the dissenting judgment of Lord Justice Phillimore was right and that the appeal should be allowed. The case of employer and employee was not different in principle from that of vendor and purchaser, for the protection of property in each case was the foundation of the principle.

Mr. MARK ROMER, K.C. (for respondent), submitted the order appealed from was right. An employer was entitled to take a covenant from his servant which would prevent him disclosing trade secrets, but there was no trade secret there. An employer was not entitled to say "I will teach you the business, but I will prevent you competing with me afterwards." It was not a case of prohibiting a servant soliciting orders from his former masters' customers.

On Tuesday their Lordships gave judgment, dismissing the appeal.

Lord ATKINSON, in the course of his judgment, said that in all these cases one had to ask oneself what were the interests of the employer that were to be protected and against what was he entitled to have them protected. He was undoubtedly entitled to have his interest in his trade secrets protected, such as secret processes of manufacture which might be of vast value. And that protection might be secured by restraining the employee from divulging these secrets or putting them to his own use. He was also entitled not to have his old customers, by solicitation or such other means, enticed away from him. But freedom from all competition per se apart from both these things, however lucrative it might be to him, he was not entitled to be protected against. He must be prepared to encounter that even at the hands of a former employee. After referring to the facts of the case his Lordship said there was nothing to show that Mr. Saxelby ever came into personal relations with any of the officers of the departments or undertakings with which plaintiffs did business, or that through his acquaintance or personal influence with any of them he might be able to divert their custom away from the plaintiffs to another firm. In his opinion there was no danger whatever of anything of that kind and the question of enticing away of customers might be put aside. Appellants, moreover, had thoroughly organised their business, both on the manufacturing and commercial side. Mr. Justice Sargant found that the information contained in the company's charts and drawings was so detailed and minute that it would be impossible for any employee to carry it away in his head. It was claimed, however, by appellants that that organisation and general method of business were trade secrets which defendant was not entitled to divulge to another or use his knowledge of them in the service of any persons other than themselves. But he could not get rid of the impressions left upon his mind by his experience on plaintiffs' works, they were part of himself, and in his Lordship's view he violated no obligation arising from the relation in which he stood to appellants by using in the service of some other person other than they the knowledge he had acquired of their scheme of organisation and methods of business. Up to the time that respondent left the service of appellants in 1913 his whole engineering training was connected with the manufacture of those four special machines. He said he had tried to get employment as a general engineer and had failed, and he was, therefore, obliged, being unable to live in France, to take service with one of appellants' rivals. His Lordship agreed with the view of the Court of Appeal that although the agreement might be of some advantage to plaintiffs as restraining competition, yet it was not reasonable when viewed from the point of view of defendant or of the public in general. It was not reasonable to require defendant to put aside all the skill and experience that he had acquired during the period that he had been in plaintiffs' employment and to begin life afresh. Accordingly, the appeal must be dismissed with costs.

Lord SHAW'S judgment, which was read in his absence by Lord Atkinson, was to the same effect. He said that Mr. Morris, managing director of plaintiff company, very candidly admitted that the real object of plaintiff company in imposing the restraint was to preclude competition on behalf of defendant after he had left the company's employment. The company objected, he said, to skill and knowledge acquired in its service being put to the disposal of any trade rival, and the skill and knowledge he referred to was the general skill and knowledge which an employee of any ability must necessarily obtain as opposed to knowledge of any matter and skill in any process in which the company could be said to have any property at all. The restraint was in no way required for plaintiffs' protection and, therefore, unreasonable and bad in law.

Lord PARKER OF WADDINGTON, in concurring, pointed out that it had been laid down that all restraints on trade of themselves, if there was nothing more, were contrary to public policy and, therefore, void. It was not that such restraints must of themselves necessarily operate to the public injury, but that it was against the policy of the Common Law to enforce them except in cases where there were special circumstances to justify them. The test he thought was this: That for the restraint to be reasonable in the interests of the parties it must afford no more than adequate protection to the party in whose favour it was imposed. He agreed the appeal failed.

In this judgment Lord SUMNER expressed his entire concurrence, and the appeal was accordinlgy dismissed, with costs.

Muntz v. West Bromwich Corporation.

On Friday Mr. Justice Eve allowed this case, which arose out of a threat to cut off electrical energy to plaintiffs' premises, to stand over for a short time, the Corporation agreeing to abide by the undertaking they had given until the dispute was decided.

Telegraphist's Cramp.

On Feb. 2 application for compensation was made to the judge at the Marylebone (London) County Court, on behalf of Mrs. L. Wren, in respect of the death of her daughter Edith E. Wren, whose death (it was alleged) was caused by "telegraphist's cramp."

Counsel for applicant stated that for over 20 years deceased worked as a telegraph operator in the Post Office, and in 1906 she developed telegraphist's cramp. She was treated for the complaint by several medical men, and invariably improved after a lengthened rest from duty. In February, 1915, she became seriously ill, with nervous disorder, and was pensioned off. In August, 1915, she was moved to an institution for the treatment of nervous patients, where she died on Oct. 1 from a disease which was alleged to have been set up by the cramp.

Medical evidence was to the effect that it was not yet definitely ascertained how sclerosis originated, and that the disease of which the daughter died was not the direct result of the cramp. On this testimony his Honour held that the connection between the disease and telegraphist's cramp was a mere surmise, and that the death was due to sclerosis was remote, or that that disease in any way accelerated her end. Therefore, he found in favour of respondent, the Postmaster-General.

Electric Lighting Plant.

The arbitrator (Mr. A. E. Porter) in the arbitration between Mr. T. E. Brunker, electrical engineer of Dublin, and the Marquess of Sligo, has now given his award. Mr. Brunker's claim was for £373. 10s. 8d., being the balance of a contract for electric lighting plant, &c., and extra work done at Westport House, Co. Mayo. The Marquess of Sligo made three counterclaims. He claimed £109. 1s. 4d. for alterations as to prices and deductions made by the architect (Mr. R. E. Mellon) from the contractor's accounts, and a sum of £35. 13s. 10d. was allowed for this by the arbitrator. He claimed a further sum of £156. 15s. 5d. paid to Messrs. Edmundson's, Ltd., for completing work alleged to have been left undone by Mr. Brunker and the arbitrator allowed £62. 5s. 3d. on this claim. There was also a claim for a penalty of £10 per week for delay, but this was disallowed.

The arbitrator ordered the Marquess of Sligo to pay his own costs, the costs of the arbitrator's expenses, and five-ninths of Mr. Brunker's costs.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	683	D.C. Dynamos and Motors. Illustrated	130
Imports and Exports of Electrical Manufactures	684	Cross Head Type Diesel Engine. Illustrated	131
Business Notices	684	Holophane Interior Illumination. Illustrated	132
Bankruptcies, Liquidations, &c.	684		
Electricity Supply	684		
Traction Notes	685		
Telegraph and Telephone Notes	686	Miscellaneous Notes	687
Empire Notes	686	Tenders Invited	687
Foreign Notes	686	Tenders Received & Accepted	688
		Companies' Meetings and Reports	688
The Round Table	127	New Companies, &c.	689
A High-Voltage Klaxon. Ill.	128	City Notes	689
D.C. Starting Rheostats. Illustrated	128	Electrical Companies' Share List	689

COMMERCIAL TOPICS.

British Engineering. In the "Daily Chronicle" of February 1st Mr. L. Pendred, the editor of our contemporary "The Engineer," makes a public appeal for greater confidence in the British engineer and his work. He declaims against the practice of the past 10 years to decry everything British. He argues that we have been forced into the habit of belittling every one of our established institutions. As he says, "For years past we have made it a practice to decry ourselves, and our astute adversaries have completed our discomfiture by intentionally pitying us." His reference to the electrical industry is very apt and well worth quoting: "There is an idea, quite ill-founded, that the Germans must be better electrical designers because they are more scientific—save the mark!—than English electricians. A certain great British firm employed them on this account. But one day it awoke to the fact that it was not advancing. It fired them all out and put Englishmen in their place. The result was immediate development. The Briton is a greater inventor than the German; he has more imagination. New types of motors and dynamos were put on the market, and progress took the place of inertia." Mr. Pendred's appeal evidently produced many sympathetic letters. One correspondent, Mr. J. M. Bulloch, says "This wailing and weeping has always been more or less a British, or more correctly an English, characteristic. But it has become acute of recent years, especially in a certain type of cheap newspaper and expensive review." Mr. James Keith, of Messrs. Keith, Blackman, also writes and says "that, as practical and scientific engineers, the British have nothing to learn from any other nation in the world, and that in most branches of engineering they are ahead of all other countries." It is refreshing to have such opinions expressed in the daily papers. The confidence in British electrical industries which we have always felt and done our utmost to encourage must of necessity be disseminated in a comparatively narrow sphere. Newspapers which publish such articles as that of Mr. Pendred's are rendering a public service at a time when it is greatly needed.

* * * *

Shipping Reform. A subject of considerable interest to electrical exporting firms is now being discussed in the trade and daily Press—namely, that of the increased efficiency of the mercantile marine and the shipping industry generally. It transpires that in spite of the large increase in working costs, the profits of merchant shipping will in the present year reach the sum of £250,000,000 sterling, as compared with the figure of £20,000,000 recorded in 1913. So far the Government has done little or nothing towards the limitation of profits of this particular branch of industry. It is a matter of national industrial necessity that steps should be taken similar in every respect to those which have been so noticeable in the "control" of other industries, the efficient operation of which is of vital consequence to the conduct of the war. Without wishing to accuse shipping firms of a lack of patriotism, it is a matter of industrial necessity that they also should experience the effect of Government jurisdiction. The industrial and commercial future of the British Empire is now at stake, and it must never be said that any one section of industry failed to make its contribution to the claims of national necessity during a national crisis. At the moment the subject is somewhat in the air. We hope that it will not remain there very long. The future of British electrical manufacturing and commercial enterprise is indissolubly connected with the efficient conduct of the mercantile marine. There are, of course, other national industries of equal, if not greater, importance, which are similarly affected, but it should be recorded that the electrical and allied industries realised the consequence of inefficiency in this direction, and did their utmost to remove it.

* * * *

Enemy Trade-Marks in Australia. The Commonwealth Prime Minister recently announced that all enemy trade-marks in the Commonwealth would be suspended.

Enemy trade marks, which constitute the name by which an article is generally known, may, if the article is to continue in use, have to be used so long as is necessary to enable the public to recognise the old article under the new name. It is, therefore, proposed to suspend these marks in favour of any person who complies with the following conditions: (1) The manufacture of the article under Commonwealth supervision, (2) the supply wholesale and retail at not more than specified prices, (3) that the article shall be put on the market under a new name directed by the Commonwealth, or, alternatively, under a name approved by the Commonwealth, (4) a bond for compliance with the conditions The licensee will be entitled for a limited time to advertise and describe the article as being identical with the old article. At the expiration of the time the articles can only be sold under their new Australian names.

* * * *

Registration of Firms. For many years the commercial interests of this country have been demanding legislation relating to the registration of firms carrying on business under a trade or assumed name, and it is to be regretted that the attempt which was recently made by Lord Southwark to get a bill on the subject through the House of Lords miscarried.

On the second reading of the Registration of Firms Bill Lord Southwark explained that it provided that every firm carrying on business at any place in the United Kingdom under a trade name which did not consist of the full name of all the partners without any addition, and every person carrying on business under any trade name consisting of or containing any name or addition other than the full name of that person, should register the name under which the business was being carried on. He said the Bill was supported by the practically unanimous views of the commercial world. During the past few years trading under assumed names had developed considerably, and it was desirable that traders should, in their own interest and that of the country, know with whom they were really dealing.

For the Government, the Duke of Devonshire said that, though the Government would not oppose the motion for the second reading, they could not do anything to assist in passing it. The Government Department concerned already had its hands too full to undertake a compilation such as was contemplated by the Bill. The measure contained a number of pitfalls which required careful examination, but if the noble lord brought forward the Bill next session it could be referred to a Select Committee.

Lord Sumner said that the Bill contained most extraordinary provisions. It would, for example, prevent any person from becoming a sleeping partner in any business whatever; and Lord Parmoor regarded the Bill as most absurd.

Though the Bill was rejected without a division, we hope that the noble lord will act upon the suggestion that he should re-introduce it is a somewhat modified form in the 1916 session. If the Bill be re-drafted, and the weighty objections of Lords Sumner and Parmoor, who are eminent authorities on commercial law, are met there is no reason why a much needed measure should not be placed on the statute book in the coming session of Parliament.

* * * *

Electricians and the Motor Trade. The following resolution was recently approved by the Motor Trade Association at Leeds:—

In the opinion of this meeting electrical engineers shall be entitled to trade terms on electrical goods, but shall not be entitled to membership of the M.T.A. or Agents' Section, Ltd., or to trade terms on motor goods and accessories other than electrical, and that price maintenance agreements must be obtained from them.

This decision will be received with mixed feelings by that section of the electrical trade which is interested in this matter. The subject is a controversial one, and we doubt whether good-fellowship between the parties concerned will be promoted by an action which is tantamount to the conduct of trade in water-tight compartments. The M.T.A. appears just now to be able to "call the tune" because it happens to be in the position to "pay the piper." Future events may reverse this order of things, for even electricians are capable of organising and passing drastic resolutions.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Jan. 31, 1916, *to* Feb. 5, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE. *France:* Unenumerated, 6 pkgs.
GOOLE. *Holland:* Elec. glow lamps, 47 pkgs.; elec. glass globes 75 pkgs.
LIVERPOOL. *U.S.A.:* Unenumerated, 6 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £2,729; carbon candles, £227; elec. lamps, £2,639; telephone material, £120; elec. insulators, £143; elec. carbons, £280; elec. factory signals, £4,070; elec. batteries, £318. *Holland:* Elec. lamps, £2,330—31 pkgs.; elec. lamps and wire, 36 pkgs.; elec. batteries, £200; elec. lamps and caps, 62 pkgs.; wire and cable, £20; unenumerated, £79. *France:* Elec. carbon, £313; elec. meters, £224; unenumerated, £252—10 pkgs. *Switzerland:* Carbon candles, £668; elec. insulation, £167; unenumerated, £14. *Sweden:* Elec. machinery, £91. *Japan:* Elec. torches, 10 cases. *Italy:* Elec. wire, 52 pkgs.; wire and cable, £6,651; unenumerated, 10 pkgs.
SOUTHAMPTON.—*France:* Elec. lamps, 6 pkgs.; unenumerated, 66 pkgs.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Wire and cable, £80; unenumerated, £230. *Melbourne:* Wire and cable, £4,669; elec. machinery, £571; telegraph material, £201; unenumerated, £1,402. *Sydney:* Elec. machinery, £1,302; wire and cable, £1,778; unenumerated, £200. *Wellington:* Wire and cable, £213; unenumerated, £207. *Adelaide:* Telegraph material, £25; unenumerated, £893. *Perth:* Elec. machinery, £28; unenumerated, £203. *Christchurch:* Wire and cable, £72; unenumerated, £165. *Dunedin:* Wire and cable, £272; unenumerated, £292. *Lyttelton:* Wire and cable, £271; unenumerated, £86. *Brisbane:* Unenumerated, £589. *Fremantle:* Wire cable, £120; telegraph material, £178; unenumerated, £60.
AFRICA.—*Durban:* Telegraph material, £11; unenumerated, £327. *Cape Town:* Wire and cable, £282; unenumerated, £82. *Port Elizabeth:* Elec. machinery, £70; wire and cable, £2,644; telegraph material, £79; unenumerated, £642.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Elec. machinery, £166. *Rio de Janeiro:* Unenumerated, £271. *Valparaiso:* Unenumerated, £206.
WEST INDIES.—*Montserrat:* Unenumerated, £42. *Trinidad:* Unenumerated, £89. *Barbados:* Unenumerated, £35.
HOLLAND.—*Amsterdam:* Wire and cable, £1,844; unenumerated, £172. *Rotterdam:* Wire and cable, £56; unenumerated, £114.
NORWAY.—*Christiana:* Elec. machinery, £921; unenumerated, £65.
U.S.A.—*New York:* Unenumerated, £134.
RUSSIA.—*Petrograd:* Elec. machinery, £306.
PORTUGAL.—*Lisbon:* Unenumerated, £22.
SPAIN.—*Bilbao:* Unenumerated, £345. *Valencia:* Unenumerated, £15. *Seville:* Unenumerated, £162. *Vigo:* Telegraph material, £19.
GIBRALTAR.—Wire and cable, £10; unenumerated, £26.
CYPRUS.—Telegraph material, £74; unenumerated, £10.
EGYPT.—*Alexandria:* Telegraph material, £280; unenumerated, £1,015.
ADEN.—Unenumerated, £26.
MOROCCO.—*Tangier:* Elec. machinery, £73.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £29; unenumerated, £1,795. *Calcutta:* Elec. machinery, £1,565; wire and cable, £692; unenumerated, £2,298. *Singapore:* Wire and cable, £29; unenumerated, £695. *Karachi:* Elec. machinery, £1,140. *Ceylon:* Unenumerated, £277. *Madras:* Elec. machinery, £1,189; wire and cable, £99; unenumerated, £810. *Bankok:* Unenumerated, £117. *Kilindini:* Unenumerated, £176.
CHINA, HONG-KONG AND WEI-HAI-WEI.—Wire and cable, £1,259; unenumerated, £124. *Shanghai:* Unenumerated, £42.
JAPAN.—*Kobe:* Unenumerated, £150.
FRANCE.—*Dieppe:* Unenumerated, £273. *Paris:* Wire and cable, £53; unenumerated, £258. *Bordeaux:* Elec. machinery, £50. *Boulogne:* Unenumerated, £1,342.
PANAMA. Unenumerated, £10.

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £195. *Calcutta:* Unenumerated, £24. *Christiana:* Unenumerated, £1,191. *Lisbon:* Unenumerated, £12. *Lyttelton:* Unenumerated, £82. *Melbourne:* Unenumerated, £575. *New York:* Unenumerated, £26. *Paris:* Unenumerated, £80. *Seville:* Unenumerated, £22. *Port Elizabeth:* Unenumerated, £20.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Messrs. Parmiter, Hope & Sugden have appointed Mr. David Alexander, 43, Mains street, Glasgow, their sole selling agent for Scotland.

At the above address samples will be shown of all the latest Fluvent switch and fuse gear, and enquiries addressed there will receive immediate attention.

Plant for Sale.—Mr. John E. Wake, Darlington, has for sale a 500 H.P. gas engine, direct coupled to 300 kw. G.E.C. generator. The plant is in excellent condition and the engine and generator will be sold separately if desired. Mr. Wake has also for sale a 450 kw. compound wound generator 230 volts d.c. direct coupled to 750 H.P. horizontal steam engine, two coupled 50 kw. compound wound generators, belt driven by 150 H.P. Buck Hargreaves horizontal steam engine, &c. *Further particulars are given in an advertisement.*

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Accumulator Industries (Ltd.) are to be sent by March 8 to Mr. G. E. Corfield, Balfour House, Finsbury pavement, London, E.C., or to Mr. A. W. Sully, 19-21, Queen Victoria street, London, E.C.

The discharge of Jas. P. K. Clerk, lately trading as Geo. Driver & Son, electrical and mechanical engineer, Hythe road, Willesden Junction, London, N.W., is suspended for three years from Jan. 12, 1916.

First meetings of creditors and contributories of the Adnil Electric Co. (Ltd.), Adnil-building, Artillery-lane, London, E.C., will be held on Feb. 29, at 39 Carey-street, London, W.C.

The discharge of Herbert Page (trading as Smeeton & Page), electrical engineer, 63, Queen Victoria-street, London, E.C., is suspended for two years from Jan. 11, 1916.

A meeting to receive an account of the winding-up of the Cicay Magneto Co. (Ltd.) will be held at the offices of Messrs. Poppleton, Appleby & Hawkins, 4, Charterhouse-square, London, E.C., on March 13.

A meeting to receive an account of the winding-up of British Electric Automatic Machines (Ltd.) will be held at 1, Broad-street-place, London, E.C., on March 10.

Deed of Assignment.—Claims against John Bernard Walburn (trading as Walburn & Mills), electrical engineer and contractor, 92, Wharf-road, Sowerby Bridge, under a deed of assignment executed by him on Dec. 3, 1915, are to be sent by March 6 to Mr. Geo. Walker, 37, Southgate, Halifax.

ELECTRICITY SUPPLY.

EXTENSIONS.

Birkenhead.—At the last meeting of the Council it was decided to apply to the L.G. Board for sanction to borrow £6,400 for additional plant, mains, &c.

Bo'ness.—The Town Council has asked Mr. J. M. M. Munro, consulting engineer, of Glasgow and Edinburgh, to report to them regarding the condition and prospects of their electricity supply undertaking and the need for an immediate large extension of their power station by the addition of turbo-generators or otherwise.

London County Council.—On Tuesday the following loans for electricity purposes were sanctioned: St. Pancras, £13,000; Woolwich, £3,290.

Cost of Electric Lighting Acts.—A report was submitted by the Highways Committee as to whether steps could be taken to ensure that the whole cost of the Council's work under the Electric Lighting Acts could be covered by fees received. For 1914-15 the expenses under the Act were £1,583 and the fees received were £987. Inquiry has shown that the unremunerative expenditure is mainly connected with the receipt of notices of intention to lay mains, service lines, &c., and the inspection of the consequent works in the streets in order to see that the conditions imposed by the Council are complied with. The work is undertaken for the protection of the public and in all the circumstances the committee are satisfied that no alteration can be usefully made as regards the imposition or increase of fees.

Shipley.—The formal inauguration of the new plant at the electricity works took place on the 2nd inst.

GENERAL.

Accrington.—There is an increasingly heavy demand for electric current for power.

The Calico Printers' Association have asked upon what terms the Corporation would be prepared to supply their Broad Oak works by July next with an increased supply of about 75 kw., but in the existing state of affairs consideration of the matter has been deferred.

Belfast.—At the last meeting of the Corporation it was stated that a report had been received from the Home Office stating that as the result of investigation it had been found that the recent accident to the turbo-generator was due partly to the generator working at excessive speed and partly to a defect in a casting.

Councillor Gilliland moved that a decision of the Tramways and Electricity Committee declining an application of Messrs. Inglis & Co. for a supply of electricity at the restricted hour rate should be sent back for reconsideration.

The Town Solicitor (Mr. John M'Cormick), being appealed to, said there was a legal question involving the matter of preferential treatment in the way of granting the application.

After discussion the motion of Councillor Gilliland was passed as an amendment to the minutes.

Birmingham.—The Electric Supply and Gas Committees have formed a joint sub-committee to purchase the coal needed by the two undertakings, and in this way it is hoped that a great saving will be effected.

Blackburn.—The Council have referred a proposal to increase the salary of the borough electrical engineer (Mr. P. P. Wheelwright) to a Committee for consideration and report.

Dungannon.—It is proposed to apply for a provisional order to authorise the supply of electrical energy, and to erect hydro-electric works at a waterfall at Atmore, about six miles from the town.

Eastbourne.—The recent collision of a motor car with a high-tension pillar at Seaside was referred to again at the Council meeting on Monday.

The Electricity Committee stated that the electrical engineer Mr. J. K. Brydges) had reported on the fatal accident which occurred on Dec. 26, owing to a motor car colliding with a high-tension switch pillar at Seaside and demolishing same. On that occasion two men had received fatal electric shocks and the jury had returned a verdict of death from misadventure, adding a rider that they considered the switchboxes should be placed further from the side of the road so as to be less likely to come into contact with anything which might be a source of danger.

The TOWN CLERK also reported that Mrs. Novis had called on him and stated that her son was also injured in rendering assistance, and asked if the Committee could see their way to compensate him for his injuries. A letter was also read from Mr. R. A. Niedermayer, solicitor for Mrs. Shadwell (the wife of one of the men killed) inquiring whether the Corporation could see their way clear to make some compensation to the widow. Mr. Brydges also reported that the cost of replacing the pillar would be about £25. The Committee resolved that, being under no legal liability in the matter, they regretted they could not see their way to pay any compensation in respect of the accident. With regard to the jury's recommendation that other switchboxes should be placed farther away from the side of the road, the Committee was advised that the switchbox in question was erected in accordance with the Board of Trade regulations and they awaited any revised instructions from that Board which might be issued.

The report of the Electrical Inspector to the Board of Trade (Mr. A. P. Trotter) on this accident is given on another page of this issue.

Elland.—The Electricity Committee has passed the following resolution as to errors in registering by electricity meters :—

If at any time it be ascertained that a meter has not registered the electricity consumed, the Council reserve the right to charge for any electricity in the same proportion, or as near as possible, to the consumption in the corresponding period of the previous year or on the consumption immediately before or after the period during which the meter was defective.

The Council were recommended to supply picture houses with current for kinema purposes at 2d. per unit, subject to any fluctuation which the Electricity Committee find it necessary to make from time to time, the present advance being 12½ per cent. The arrangement is to last for three years.

At the meeting of the Council last week Councillor SWIFT moved that the recommendation be referred back. Picture houses were luxuries, and therefore the Company ought to pay an advanced price.

Replying to the discussion, Councillor EASTWOOD said he regretted the electricity works had not been a greater success. From the two picture houses in the town the Council received about £300 per year, the loss of which would be serious to them. There would be just the same standing charges to meet if they were without those two customers. There were at least 110 matinées and that provided a portion for a day load. If they lost one of the picture houses they would probably lose both. The undertaking was becoming more and more successful, and he appealed to the members to help forward rather than retard that success. The price of gas would have been increased long since had it not been for electric lighting.

Only three persons voted for the amendment, and the recommendation was then approved.

Folkestone.—The charges for the supply of electrical energy are to be increased by 10 per cent. after the current quarter.

Hackney (London).—As from the meter readings for the March quarter the scale of charges for electric current will be increased by 17½ per cent.

Hastings.—The charges for electric current will be again increased by 10 per cent. as from March 31, making 20 per cent. increase since the outbreak of war.

Mirfield.—The Urban Council have applied to the Board of Trade to allow the use of overhead cables and the supply of energy at 400 volts under their provisional order of 1899.

Reigate.—The Council has increased the charge for current for heating from 1d. to 1¼d. per unit as from April 1 next.

Ripon.—A Committee has been appointed to inquire into and report on the terms and conditions under which a supply of electrical energy for lighting may be provided for the city by delegation of the Corporation's electric lighting powers to a suitable public company.

Stepney (London).—At the last meeting of the Council the Finance Committee reported having considered the Electricity Supply Committee's proposals as to the increasing load and the necessity of making provision for the winter of 1916-17, including the supply of electricity to Bethnal Green, Poplar and Shoreditch Councils.

It was necessary to provide at the earliest possible moment two additional boilers at the electricity works, and the committee have been in communication with Messrs. Babcock & Wilcox, who were prepared to supply the two boilers for the sum of £18,950. The Finance Committee approved an estimate of £19,000, which was adopted by the Council.

Swansea.—The new electrical showroom, which has been equipped in Wind-street, was opened on Friday last by Councillor Alex. Sinclair, chairman of the Electric Supply Committee.

The showroom has been equipped under the supervision of the borough electrical engineer, Mr. J. W. Burr.

For the opening ceremony, Messrs. Johnson & Burgess (Ltd.), a local firm of electrical suppliers, placed an electric saloon body car (claimed to be the first electric car in Wales) at the disposal of the mayor, the chairman and vice-chairman of the Electricity Committee, and drove them in it to the opening ceremony. In the course of his remarks, Col. A. Sinclair said the electric vehicle in which they had travelled was a very appropriate example of the advance made in the applications of electricity.

Wigan.—The recent failure of the electricity supply was discussed at the meeting of the Council last week.

Ald. FLETCHER, chairman of the Tramways Committee, said people had got the impression that his Committee was at fault. The Tramways Committee was not, however, responsible for the stoppage of the cars, as they had no control whatever over the electricity station. The estimated loss of receipts on the tramcars during the stoppage last month was £1,276. 19s. 10d., and, after deducting £204. 15s. 7d. for power expenses and £116. 8s. for wages, the net loss was £955. 18s. 3d. The bit of profit which the tramways had made had been wiped out through something over which they had no control. The Tramways Committee would run the cars if they could get the power.

Ald. J. T. GRIMSHAW, the ex-mayor and chairman of the Electric Light Committee, said his Committee had done all that was possible to avoid a stoppage, and, since the stoppage, to make good the repairs.

Councillor A. GUEST moved that a Special Committee be appointed to inquire fully into the cause of the disastrous breakdown at the electricity works last week, and to report thereon to the Council, and this was passed unanimously.

Wimbledon.—Having regard to the unsatisfactory manner in which the contract for the maintenance of the Gamewell fire alarm system has been recently carried out the Town Clerk suggested to the Postmaster-General that he should agree to the cancellation of the contract or the suspension thereof for, say, three years.

Should the Postmaster-General agree to the suggestion it is proposed to make arrangement with Mr. G. Longfield-Beasley for the maintenance of the system.

A Sub-committee of the Electric Lighting Committee has been appointed to consider what steps shall be taken to obtain the annual supplies required during the ensuring year.

TRACTION NOTES.

Aberdeen.—The question of purchasing the undertaking of the Aberdeen Surburban Tramways Co. was discussed at the meeting of the Tramways Committee last week, when it was agreed that it would be impossible to carry through the scheme at present, and to recommend the Council that the matter be deferred until after the war. A report on the matter has been supplied by Mr. J. Dalrymple, of Glasgow.

Birmingham.—Last week the chairman of the Tramways Committee (Mr. Harrison Barrow), in proposing the adoption of the minutes, said that the time for constructing the light railway to Quinton had been extended.

The recent accident on the tramway at Aston was exceedingly regrettable, and in the opinion of the Board of Trade Inspector it was due to temporary forgetfulness on the part of the motorman. At the outbreak of war they had 862 motormen, of whom 500 had enlisted ; they had 864 conductors, but 741 of them had gone (some of them to be motormen), and at present they had only 123 of the old conductors. The number of women conductors was 697, and on the whole they had done excellently. Their work had been particularly difficult owing to the great amount of overcrowding, and the consequence that they had not been able to put on the road all the cars they would have liked to deal with the enormous increase in the traffic. The Warwick-road route was ready for opening, but the terminus for the present would be Broad-road.

In the discussion which followed complaints were made of the inadequacy of the service, of overcrowding, &c., and the use of trailers was advocated.

In reply, Mr. HARRISON BARROW said that at present they could only get motor omnibuses by showing they were required for munition workers, and it was quite impossible to supply the needs of Quinton, but they hoped to be able very soon to construct the light railway to Quinton. As to trailers, he promised to furnish a statement on their adoption when next the Committee reported. He feared the difficulties at the termini would be very considerable.

Gateshead.—On Saturday last a tramcar accident occurred, resulting in four persons being killed and several being injured.

A tramcar was ascending Bensham Bank, when it became necessary to bring it to a standstill on account of another tram being delayed at a loop. Suddenly the upgoing car began to move backwards. The brakes were applied, but fa led to hold, and the car, having rapidly gathered speed, left the l nes at a turning in the road and fell over on its side. The four persons killed were pedestrians, who were struck by the car as it fell and crushed underneath it. With assistance the passengers, most of whom were bruised or cut, were removed from the wrecked car to receive medical treatment.

An inquest on the victims was held on Tuesday, when Leonard Jane, the motorman of the tramcar, admitted that he left his car to assist another driver who was in difficulties. He set the hand brake before leaving, but did not put on the slipper brake. He was 20 years of age and had been instructed in his duties. He considered the accident due to the extra weight of passengers who got on after he left the car, thus easing off the hand brake and setting the car off.

The jury returned a verdict of accidental death, finding that Jane had committed an error of judgment, which did not amount to culpable negligence.

L.C.C. Tramways.- It was reported to the L.C.C. on Tuesday that an arrangement had been made with Messrs. Dick, Kerr & Co. in regard to the contract for the reconstruction of the trackwork of the tramways in Burdett-road, &c.

The contract was for £60,566. 9s. 5d., and when the Treasury refused sanction for the work the contractors had incurred or were committed to certain expenditure, and it had been agreed that the Council should take over the materials already delivered in London and pay to the company about £6,875. The value of the materials taken over is about £6,350.

Women Tramway Conductors.—In reply to a question, Mr. Hume (chairman of the Highways Committee) stated that 192 women were now being employed as tramway conductors; they worked 8 hours and 24 minutes a day, and got 3 hours relief.

Rotherham.—Oldham Corporation has offered to sell a dozen single-deck bogey cars (seating 40 passengers) at £450 each, and the Tramways Committee proposes to purchase one and to ask the Oldham Corporation to keep the offer of the remaining cars open for a period to be agreed upon.

Women Tramcar Drivers.—The Glasgow Trades Council have adopted a resolution protesting against the employment of women tramcar drivers.

TELEGRAPH & TELEPHONE NOTES.

Deferred and Week-End Cablegrams.—The Pacific Cable Board announce that the deferred (L.C.O.) and week-end cable (T.W.T.) services between the United Kingdom and Australasia have been resumed.

Increased Telephone Charges.—The increased telephone charges are arousing opposition in business circles, especially in Scotland.

At a meeting of Glasgow traders and shopkeepers on the 3rd inst. a resolution was unanimously adopted calling upon the Government to withdraw the increased scale. It was held that the increase was inopportune and inadvisable. It was also decided to ask Glasgow Corporation to apply for a telephone license and re-start a service should the increased scale be enforced.

EMPIRE NOTES.

Australasian.—The town of Mt. Gambier (South Australia) is to be lighted electrically.

A contract has been signed by Mr. T. W. Bridger (representative of Bridger, Ltd.) for the installation work and its maintenance for 10 years, the Municipality having the right of purchase at the end of that period.

The determination of the Victorian Electrical Supply Board in respect to the wages to be paid to persons employed in the generation or distribution of electricity and the manufacture, repair, or maintenance of electrical appliances has been gazetted. The wages fixed are as follows: Night patrol man in the metropolitan district, 66s. per week of 48 hours; outside, 62s.; switchman in metropolitan district, 52s. 6d. per week; outside, 48s. 6d.; jointer of underground cables in metropolitan district, 63s.; outside, 59s.; station switchboard attendant, &c., in metropolitan district, 54s.; outside, 50s.; sub-station attendant in metropolitan district, 60s.; outside, 56s.; linesman, 60s. and 56s.; meter fixer, 56s. 6d. and 51s. 6d.; all others, 51s. and 48s.

The rates of pay fixed by the Commonwealth Arbitration Court in connection with the operation of the Adelaide and Launceston municipal electric tramway services are: *Adelaide*. Motormen, 9s. to 9s. 8d. per day; conductors, 8s. 4d. to 9s.; pitmen, 8s. 6d. to 9s. 6d.; signalmen, 9s. to 9s. 8d.; electrical fitters, 11s.; controller men, cleaners and labourers, 8s. 6d.; trimmers, trap gangers, fettlers, blacksmiths' strikers, mechanics' labourers, 9s.; leading cleaners, 9s. 6d.; overhead iremen and firemen, 10s.; car body builders, 11s.; blacksmiths, 11s. 6d.; carpenters, 11s. 8d.; mechanics, 9s. to 13s.; other labourers, 8s. *Launceston.*—Motormen, 8s. 4d.; conductors, 7s. 9d.; signalmen, 8s.; pitmen, 8s.; controller men, 8s.; car cleaners, 8s.; track cleaners, 8s.; labourers not otherwise specified, 8s.; electric fitters, 10s. 6d.; fitters, 10s.; car body builders, 10s.; carpenters, 10s.; painters, 10s.; blacksmith, 9s. 8d. and 10s.; blacksmiths' strikers, 8s.; firemen, 8s. and 9s. 6d.; engine drivers, 12s. and 12s. 6d.

The Caledonian Coal Co., Cessnock (N.S.W.), has agreed to extend the electric light cables to the town of Aberdare.

An electric generating plant to supply light in the town of Laura (S. Australia) has been provided by Mr. A. H. Forder. It consists of a 17 H.P. Blackstone oil engine coupled to a 10 kw. 230-volt generator.

An agreement has been entered into between Port Augusta (S. Australia) Council and Bridger (Ltd.), Adelaide, for the electric lighting of the town by the company, with the right to supply current for power also. The streets are to be lighted with eight 1,000 c.p. half-watt lamps, and 50 100 c.p. lamps. The plant will be large enough to supply in Davenport also and the district within 3 or 4 miles. The Corporation is to have the right to take over the scheme after 15 years.

West Guildford (W. Australia) Roads Board has made arrangements to purchase electric power in bulk from the Government power station at Perth.

Contending that Australian officers are capable of doing the work, the Professional Officers' Association of the Federal Service has made a strong protest to the Postmaster-General against further importation of electrical engineers. The Association admits that there is a shortage of engineers, but maintains that this is due to the failure of the department to grapple properly with the problem. A charge is made that last year two men were brought out from England and given higher salaries than Australian applicants in the same grade, and promised increments until the maximum of £504 was reached. The Postmaster-General has referred the matter to the Federal Service Commissioner and has suggested a way out of the difficulty.

"Tenders" (Melbourne and Sydney) says the Kilcoy (Queensland) Shire Council has decided to borrow £500 from the Government to instal electric lighting plant.

Hamilton (Queensland) Council has asked an electrical engineer to draw up a plan for lighting the town electrically.

Longreach (Queensland) Electric Lighting Co. has been formed to utilise the pressure from the local artesian bore to generate electricity to light the town.

Riccarton (New Zealand) Borough Council has decided to borrow £3,300 for electrical purposes, and £200 for wiring private consumers' premises.

The King Island Scheelite Co. is in the market for power plant (suction gas engine and producer, with electrical generator) and milling machinery. Mr. J. B. Lewis, Melbourne, is consulting engineer for the scheme.

Messrs. Norton Griffiths & Co. (Sydney) are in the market for a number of electric winches, to be used in connection with the construction of the Sydney underground railways.

The Quigley Prospecting Synd. Zeehan (Tasmania) have decided to instal a small electric winding plant at their mine. The local electrical undertaking has agreed to supply the current.

Canada.—Sir A. Beck has forwarded to the Board of Control at Ottawa a draft copy of by-laws in connection with the hydro-electric radial railway plan involving hundreds of miles of proposed railways in Ontario, with Toronto as the centre of the system.

The estimated cost of the railways is £2,750,000. Toronto's share of the outlay will be £850,000. Of eight radial lines two will most closely affect Toronto. An important clause of the proposed agreement between the city and the Hydro-electric Commission is that the Commission is to be furnished with a free right-of-way for the railway and power lines over any property of the city.

Sir A. Beck has also announced that reductions are to be made in electric lighting and power rates, that affect all classes of consumers and mean a saving of from 20 to 27 per cent. to the householders of Toronto. The reduction benefits domestic users chiefly, and particularly those who extend the use of electricity in the home above the normal consumption for lighting. It is stated that the houses where electric ranges are used and all cooking done by electricity are rapidly increasing.

FOREIGN NOTES.

Japan.—A report on the trade of Nagasaki for 1914 says total imports from the United Kingdom were valued at £419,089 (against £460,340 in 1913), from the whole of British Empire £500,977 (against £490,089), and the total from all other sources was £826,246 (against £1,157,220).

New Caledonia.—A consular report for 1914 states that the hydro-electric station at Tao is shut down owing to war conditions, and the hydro-electric works at Yate are in course of construction.

Paraguay.—The "Review of the River Plate" says the General

Electric Co. have applied for the concession for a public telephone service in Asunción.

Venezuela.—The Ministerio de Fomento has granted permission to Señor Néstor Maya to construct a telephone line (12½ miles in length) between the towns of Carayaca and Antímano (in the Federal District.)

MISCELLANEOUS NOTES.

B.E.A.M.A.—The following firms have been elected members of the B.E.A.M.A. :—

Messrs. Ferguson, Pailin & Co. and Mirrlees, Bickerton & Day (Ltd.).

The following firm has been elected a member of the Council for the session : Callender's Cable & Construction Co.

British Industries Fair, 1916.—This fair, which will be held in the buildings of the Victoria and Albert Museum, S. Kensington, London, S.W., will be open, to the trade alone, from Feb. 21 to March 3, inclusive.

The trades covered by the fair are : Toys and games, earthenware and china, glass, fancy goods, stationery and printing. Tickets of admission may be obtained by bona fide buyers either at the entrance to the fair, or on application to the Director, 32, Cheapside, E.C.

Callender's Hospital and Distress Fund.—The annual report of this Fund, which was approved at the general meeting on Jan. 31, shows that £284. 11s. has been voted to hospitals and other institutions, an increase of £1. 1s. on the previous year, and a record figure.

The amounts given to the various institutions varied from £73. 10s. to £3. 3s. The penny weekly subscriptions amounted to £269. 11s. 11d., against £281. 2s. 9d. in previous year. The Board resolved not to appeal to the donors, owing to the war necessitating so many calls. Gratuities to members amounted to £54. 7s. 10d. A large number of the members have joined the Colours, which accounts for the decrease in subscriptions.

Diesel Engine Accident.—An explosion occurred on Monday morning in the compressor of one of the Diesel engines in the generating station of the Smithfield Markets Electric Supply Co., Charterhouse-street, London.

The engine driver, Harry Baker, was uninjured, but his assistant, Edward Tyrell, was badly injured, and died a few hours after admission to St. Bartholomew's Hospital. The intermediate purge pot was destroyed, but otherwise there was no damage, and the supply of current was not interfered with.

Excess Profits Tax.—The office of the Board of Referees to consider appeals and applications in respect of the Excess Profits Tax is at 133, Strand, London, W.C.

The Chairman of the Board is Mr. H. E. Duke, K.C., M.P., and it will proceed to consider forthwith any appeals and applications which may be made to them through the Commissioners of Inland Revenue. Correspondence should be addressed to the Registrar, Board of Referees (Finance No. 2 Act, 1915), 133, Strand, London, W.C.

Fatality.—While charging a retort at the Pontymister Steel Works, near Risca (Mon.), with an electric charger, on Friday last, a man named Fredk. Wyndham Green received a fatal electric shock.

Inquest.—An inquest was held at Newcastle-on-Tyne last week on Samuel John Thomas, an electrician, who was killed at Messrs. Armstrong, Whitworth & Co.'s works.

Frederick G. Thomas, his brother and a foreman electric tester, stated that he and his brother went to the casting shop to test a fan motor which was controlled by a switch. Immediately above the switch was a way on which barrels conveyed coke to the furnaces, and when passing the switchboard there was less than 2 ft. clearance. His brother went straight to the switchboard and shortly afterwards he heard a shout and saw his brother lying against the switchboard. Witness knew his brother had had a shock and took measures to remove him. Artificial respiration was tried for some time, but he never recovered. On examining the switchboard witness found some wires had been bared, and witness thought his brother had been removing the tapes which covered them. He thought the accident might have happened through his brother pushing in the switch while pressing against the wall to allow the barrels to pass, and having hold of the wire with his left hand received an electric shock.

A verdict of "Accidental death" was returned.

Manslaughter Charge Against Tramcar Conductor.—At Dudley on Friday last Timothy Parkes, tramcar conductor, was charged with manslaughter.

Parkes was the conductor of the runaway tramcar which recently overturned, causing the deaths of two and injuries to 14 other passengers. At an inquest on one of the victims the jury returned a verdict that the overturning of the car was due to gross carelessness on the part of the conductor, and the Coroner thereupon committed him for trial at the Assizes on the charge of manslaughter.

Accused was remanded, bail being allowed.

Munitions Tribunal Case.—The engineer and manager of one of the metropolitan electricity works was recently summoned before the local Munitions Tribunal for the metropolitan district on a complaint made by a sub-station attendant.

Complainant alleged that consent to his leaving the electricity works had been unreasonably withheld on the ground that complainant was at present engaged on work that did not utilise his engineering skill and training as a skilled mechanic, and that he was only working 48 hours per week. After hearing the evidence, including that of the Borough Electrical Engineer and Manager and that of the engineer of neighbouring works as to the indispensability of sub-station attendants, the Tribunal unanimously decided not to grant the application for the release of the complainant.

Prohibition of Exports.—On Jan. 28 the Privy Council ordered that the exportation of (inter alia) files, pocket lamp cases and cases fitted with bulbs, but not containing batteries, be prohibited to all countries in Europe and on Mediterranean and Black Seas other than France, Russia (except through Baltic ports), Italy, Spain, and Portugal.

TENDERS INVITED.

Turbo-Alternators, Electric Generators, Water Turbine, &c.

Leigh (Lancs.) Council require tenders for a 2,000 kw. Turbo-Alternator, Surface Condenser, &c. Tenders by noon Feb. 18.

The New South Wales Government Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

The Town Clerk, Raetihi (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Wiring, Fittings, &c.

Bradford Guardians require tenders by 10 a.m. Feb. 14 for Wiring Installation, Telephones, Bells, &c., for the Union Hospital. Specifications from Mr. F. Holland, 22, Manor-row, Bradford.

St. Mary, Islington (London), Guardians require tenders for Alterations to Wiring, Supply of s.p. Motors, &c. Tenders by 4 p.m. Feb. 17 to the Clerk, St. John's-road, London, N.

Submarine Electric Cables.

Sydney (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

Electrical and Tramway Stores.

Marylebone (London) Electricity Department require tenders by noon Feb. 23 for six months' supply of Underground and House Cables, Box Compound, Insulating Materials, &c. Tender forms from the Electricity Dept., 20, York-place, W.

The Metropolitan Water Board want tenders by 11 a.m. March 7 for supply of Electric Lamps, &c. Forms of tender from the Chief Engineer, Savoy-street, London, W.C.

Hoylake and West Kirby Council require tenders by Feb. 22 for one year's supply of Metallic Filament Lamps. Specifications from the Engineer.

Bolton Electricity Committee require tenders by noon March 2 for one year's supply of Joint, Service and Fuse Boxes, Meters, Motors, Starting Switches, Transformers, &c. Specifications, &c., from the Borough Electrical Engineer.

Electrical and Tramway Stores

HAMMERSMITH (London) Borough Council invite tenders for the supply of various stores for the electric supply department for the year ending March 31, 1917. The articles include Small Engineers' Tools, Metal, Steam Tubes and Fittings (Screws, Bolts and Nuts), Steam Packing and Jointing, Oilmen's Goods, Electric Lighting Sundries, Insulated Wires, Joint and Fuse Boxes, Insulating Compound, &c. Forms of tender, &c., from the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, W., and tenders must be delivered at the Town Hall by 4 p.m., Feb. 16.

The Tramways Committee of MANCHESTER Corporation invite tenders for the supply of General Stores, including Motor and Controller parts, Resistances, Armature and Field Coils, Trolley Poles and Bases, Lightning Arresters, Lamps, Car Switches, Bells, Cells, Telephones, Carbon Brushes and Carbons, Overhead Equipment Material, Trolley Wheels, &c., Cable, Wire, Timber, Lubricants, Oils, Tools, Iron and Steel, Car Axles and Tyres, Castings, Fuel, &c. Schedules, from the General Manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by 10 a.m. Feb. 15.

PORTSMOUTH Tramways Committee require tenders by 10 a.m. Feb. 15 for six months' supply of Stores and Materials, including Tramway Tyres, Insulating Materials, Lamps, Overhead Line Materials, &c. Specification from the Engineer.

HALIFAX Corporation require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their electricity department, including Lighting Fittings and Electrical Accessories (Lamps, Switches, Tapes, &c.), v.r. Cables and Phosphor Bronze Wire, &c. Forms of tender from Foundry-street, Halifax.

HALIFAX Corporation also require tenders by Feb. 14 for 12 months' supply of Stores and Materials to their Tramways Department, including Lighting Fittings, Insulating Materials, v.r. Cable, Copper and Phosphor Bronze Wire, Trolley and Overhead Line Materials, Oils, Paints, &c Forms of tender from Tramways Engineer, Skircoat-road, Halifax.

Tenders are required by first post March 15 for one year's supply of Electrical Goods for the Cheshire County Asylum, MACCLESFIELD. Tender forms from the Clerk.

SALFORD Tramways Department require tenders for 12 months' supply of Miscellaneous Stores. Particulars from the Manager.

FINSBURY (London) Council require tenders by noon Feb. 14 for six or 12 months' supply of Electric Lamps, &c. Particulars and forms from the Chief Cleansing Inspector, 26, Wharf road, City road, N.

BELFAST Tramways & Electricity Committee require tenders by 10 a.m. Feb. 16 for supply of Electrical Accessories, Cables and Lamps. Forms of tender from the General Manager, Tramways Department.

The BEDWAS NAVIGATION COLLIERY Co. require tenders by 10 a.m. March 2, for 12 months' supply of Electrical Goods, Oils, &c. Forms of tender from the Secretary, Bedwas, Mon.

TENDERS RECEIVED AND ACCEPTED.

CAPE TOWN (SOUTH AFRICA).—In our last issue (p. 654) we announced than an order had been placed with S. Sykes & Co. for a rotary converter, at £3,050. We are now informed that this order is not for a rotary converter, but for one of the Peebles motor converters to be manufactured by Messrs. Bruce Peebles & Co., under the Peebles-La Cour patents.

The order has been secured for the firm by Messrs. S. Sykes & Co., of Johannesburg. Cape Town Corporation have already two 1,000 kw. Peebles motor converters, and the present order makes a third machine of that particular output.

GLASGOW.—The tenders of the British Westinghouse Co. have been accepted for the supply and erection of one 6,000-kw. turbo-alternator and condensing plant for Port Dundas generating station at £25,622; and that of Willans & Robinson for one 6,000-kw. turbo-alternator and condensing plant (with Dick-Kerr alternator) for St. Andrew's Cross station, at £25,480.

STEPNEY (LONDON).—The Council are recommended to accept the tender of Babcock & Wilcox for the supply of two water-tube boilers at £18,950.

LONDON COUNTY COUNCIL.—The Council have accepted the following tenders:—

Plant for Central Car Repair Depot.—B. R. Rowland & Co., two double-head grinding machines, £90; T. & R. Lees, coke-breaking machine, £73; Alldays & Onions Pneumatic Engineering Co., shafting, bearings, &c., £39. 12s.

Carbon Brushes.—Morgan Crucible Co. (Ltd.), £14. 10s. per 1,000; Le Carbone, £13. 10s. 10d. per 1,000.

Renewal of Cables of Electric Light at Blackwall Tunnel.—W. T. Henley's Telegraph Works Co., £100. 13s. 8d.

DOVER.—The Council have accepted the tender of the Cable Co. for the supply of cable at £3,395.

PRESTON.—Chamberlain & Hookham have secured the contract for the supply of meters for the coming year.

BATTERSEA (LONDON).—The Electricity Committee recommends the renewal for a further period of 12 months of the contract with Callender's Cable & Construction Co. for the supply of cables, &c.

HACKNEY (LONDON).—The Council is recommended to comply with the request of the British Insulated & Helsby Cables to vary their existing contract for the supply of armoured cables in accordance with a schedule submitted by the company.

MARYLEBONE (LONDON).—The Council are recommended to accept the tender of Ferranti Limited for 100 five ampere and 100 ten ampere meters.

WEST BROMWICH.—The Corporation have accepted the tender of the New Conveyor Co. for carrying out extensions of the coal conveyor.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1915 states that energy has been supplied to the Westminster Electric Supply Corporation, the St. James' & Pall Mall Electric Light and the Chelsea Electricity Supply Companies to the amount of 28,984,127 units. After making a full allowance for sinking fund and depreciation the net balance for the year 1915 is £1,175. 1d., and with £6,866 brought forward (as to £6. 7d. the amount to be carried forward is £7,156. 8d.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—The revenue for 1915 was £60,917. 1s. 9d., and the expenses were £37,775. 14s. 5d. After paying rent of Rochester Corporation, loss (£1,143. 13s.) and interest on debentures, &c. (£2,971. 6s. 8d.), transferring £6,000 to reserve for depreciation and £1,000 to maintenance reserve, and writing £907. 4s. 1d. off investments, and adding balance brought forward £1,167. 6s. 10d., the disposable balance is £15,772. 14s. 8d. Interim dividends at rate of 5 per cent. on the preference and at rate of 6 per cent. per annum on the ordinary share capital were paid for the half year ended June 30, and the directors recommend that dividends at the same rate be paid on the preference and ordinary capital for the half year ended Dec. 31, 1915. A sum of £342. 10s. 5d. has been paid to the directors (being 10 per cent. of net profits after payment of 5 per cent. dividend on the ordinary share capital) and £3,150. 4s. 3d. carried forward. There was an increase of £9,806 in the revenue, compared with 1914. The expenses have also heavily increased, due to war bonuses, &c., and to the greatly enhanced price of coal and all other materials. It has been impossible, due to shortage of labour and difficulty in obtaining materials, to maintain the track and rolling stock in the usual state of repair. These repairs can only be carried out when labour conditions have become more favourable, and £2,000 has been transferred to maintenance reserve account in order to make some provision for this expenditure.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—The annuity payable by the Anglo-Argentine Tramways Co. has been received and the net revenue for 1915 was £66,341. 0s. 1d. Interim dividends have been paid for the nine months ending Sept. 30, 1915, absorbing £46,500, leaving £19,841. 0s. 1d. The directors recommend that in addition to the interim dividends already distributed, a final dividend of 1s. 3d. per share (making 5 per cent. per annum, less tax) be paid for the year, absorbing £16,500, that £4,200 be transferred to general amortisation fund, the balance (£141. 0s. 1d.) being carried forward.

LANARKSHIRE TRAMWAYS CO.—The revenue for 1915 was £106,043. 19s. 5d., and the expenses were £66,091. 5s. After meeting contributions payable to local authorities, debenture interest, &c., transferring £11,000 to reserve for depreciation and writing off £1,266. 14s. 11d., the balance (with £919. 9s. 7d. brought forward) is £20,970. 17s. 5d. An interim dividend at rate of 5½ per cent. per annum was paid for the half-year ended June 30, and the directors recommend that the balance be disposed of by paying a dividend at rate of 6 per cent. per annum for the half-year ending Dec. 31, 1915 (making 5¾ per cent. for the year), and after paying 10 per cent. of net profits after payment of 5 per cent. dividend for the year, £958 has been carried forward. The revenue increased by £6,866, compared with 1914, and the expenses by £1,896.

LLANDUDNO & COLWYN BAY ELECTRIC RAILWAY (LTD.)—For year ended Nov. 30 the net profit was £5,414, and, with £562 brought in the total was £5,976. Part of this has been applied in providing £1,545 for sinking fund and £23 in writing off discount on debenture stock issued during year, and the directors recommend a dividend at rate of 4 per cent. per annum (less tax), carrying forward £432.

METROPOLITAN RAILWAY CO.—The report for 1915 states that the gross traffic receipts were £1,044,025 and expenditure was 637,335, leaving £406,690. Adding miscellaneous receipts, interest, &c. (£188,986) and balance forward (£11,458), and deducting interest, rentals and other fixed charges (£299,635) and dividends on preference stocks (£229,806), the available balance for dividend on ordinary stock was £77,693. The interim dividend at rate of 1 per cent. per annum on the ordinary stock for half-year ended June 30 absorbed £32,326, leaving £45,367, out of which the directors recommend payment of a dividend at rate of 1 per cent. per annum for half-year ended Dec. 31, 1915, making 1 per cent. for the year, leaving £13,041 to be carried forward. The amount transferred to the general renewals fund is £15,000. Notwithstanding the dislocation of business occasioned by the war, the traffic carried on the railway generally during last year was in excess of that carried in 1914, and also exceeded the traffic of 1913. On the Great Northern & City section the traffic has largely increased, in response, no doubt, to the improved train services introduced since that line was acquired.

NATIONAL ELECTRIC SUPPLY CO.(LTD.)—At the meeting on Wednesday it was announced that, including £1,310 brought forward, the profit for 1915 was £14,668. After placing £5,000 to reserve for depreciation, the directors recommend a further dividend of 4s. 6d. per share, making 7s. per share for the year (compared with 8s. for 1914), carrying forward £633.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors' report for the year 1915 states that the connections, which at the end of 1914 were 15,423 kw., have been increased during the year to 16,305 kw., and 10,674,609 units were supplied to consumers. The Central Electric Supply Co. has determined to pay no dividend on its shares in respect of the year 1915. The revenue derived from the sale of electricity has been again reduced by war conditions. The net profits for the year 1915 applicable to dividends on shares amount to £18,835. 12s. 2d., and with balance from 1914 (£2,416. 12s. 7d.), and £4,500 transferred from the contingency fund, the total is £25,752. 4s. 9d. An interim dividend was paid in August for half-year ended June 30 at rate of 7 per cent. on the preference and ordinary shares, and absorbed £10,500, leaving £15,252. 4s. 9d. to be dealt with. The directors now propose to pay a dividend at rate of 7 per cent. on the preference shares for the second half-year (£3,500), and on the ordinary shares for the second half-year of 4s. 6d. per share, making, with the interim dividend paid in August, a total distribution of 8 per cent. for the year (£9,000), leaving to be carried forward £2,752. 4s. 9d.

TYNESIDE TRAMWAYS & TRAMROADS CO.—At the half-yearly meeting on Tuesday it was agreed to pay the dividend on the 5 per cent. preference shares and a dividend at the rate of 3 per cent. per annum on the ordinary shares. The chairman (Dr. J. T. Merz) said the deficiency in the holiday traffic had been largely met by the receipts from general traffic. Owing to shortness of labour they had run fewer cars, but they had carried more passengers. The increase in expenditure was largely due to repairs and the upkeep of the line.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BROWN'S MOTOR ACCESSORIES (LTD.) (142,891).—Reg. Feb. 2, capital £6,000 in £1 shares, to take over the business of motor accessory dealers and electrical engineers carried on as Brown & Co. Private company. First directors are: H. Lodge and H. Bebington. Secretary (pro tem.): Mary C. Dodd. Reg. office: 56 and 58, Renshaw-street, Liverpool.

CROFT & PERKINS (LTD.) (142,893).—Reg. Feb. 2, capital £1,000 in £1 shares, to carry on the business of mechanical engineers, manufacturers of engines, pulleys, shafting and other machinery, tool makers, electrical engineers, manufacturers of motor cars, motors, &c., as a branch of Crofts (Engineers) (Ltd.) who are the controllers of the company. Private company. Reg. office: Empire Works, Thornbury, Bradford.

MORTGAGES AND CHARGES.

FOOTE & MILNE (LTD.)—Mortgage debenture dated Jan. 28, 1916, to secure £6,000, charged on company's undertaking and property, present and future. Holders: London County & Westminster Bank.

COLSTON ELECTRICAL WORKS (LTD.)—Mortgage on moneys payable to company by Bristol Corporation for installing electric lighting and electric bells at the Ham Green Sanatorium, Somerset, dated Dec. 25, 1916, to secure moneys due or to become due from company to Capital and Counties Bank.

CITY NOTES.

MEMORANDA (Feb. 9).—Bank rate 5 per cent. (since Aug. 8, 1914) Consols 58½. Consols Pay Day, March 1. Stocks and Shares Ticket Days, Feb. 23 and March 9. Pay Days, Feb. 24 and March 10. Price of silver, 27d.

ALDERSHOT GAS, WATER & DISTRICT LIGHTING CO.—With £16,311 brought forward, the accounts for the half-year to Dec. 31 show a gross profit of £28,938. The directors recommend dividends at rates of £5. 18s. and £4. 8s. per cent. per annum on the "A" and "B" stocks respectively, carrying forward £16,862.

MONTREAL TRAMWAYS CO.—A quarterly dividend of 2½ per cent. per annum has been declared.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—A dividend of 6d. per share has been declared on preference.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—The directors recommend a dividend of 2 per cent. for the year, carrying forward £1,300.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS (LTD.)—A dividend of 2½ per cent. has been declared on the first income bonds, carrying forward £651.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Feb. 8. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues. Feb. 8	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅝	7 5 5	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9⅜	4 15 8	Feb, Aug
10	6%	Do. 6% Cum 2nd Pref.	10 7/16	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7 1/16	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	83½	4 15 9	Jan, July
5	2/3	Do. 4½% Pref.	3 1/16	6 9 9	..
5	5%	Do. Ord.	3 7/16	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	2 11/16	8 7 5	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅛	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	11 1/16	7 10 9	Feb, Aug
10	6/0	Do. 6% Pref.	10 5/16	5 10 4	Mar, July
St.	5%	Do. 5% Deb. St.	97½	5 2 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
10	7%	County of London Ord.	10 1/16	6 19 2	Mar, Sept
10	6%	Do. 6% Pref.	10	6 0 0	Feb, Aug
St.	4½%	Do. 1st Deb.	80½	5 4 1	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	9%	Kensington and Knightsbridge Ord.	6 1/16	7 5 5	Feb, Aug
St.	4%	†Do. Deb. St.	79½	5 0 11	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4 1/16	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2 3/16	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-'on-Tyne E.S.5%2dMt.Db.St.	100	5 0 0	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref	1 1/16	5 16 4	Apl, Oct
4	5%	South London E.S. Ord	3 1/16	6 10 7	Mar, Sept
5	10%	St. James' & Pall Mall Ord.	7 1/16	6 19 9	Feb, Aug
5	7%	Do. do. Pref.	5⅛	5 19 2	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1 1/16	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4 1/16	5 10 9	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82½	6 0 10	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	68½	5 16 9	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1890	62½	8 0 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1[illegible]	3 15 7	Jan, July
St.	4%	Do. 4% Pref.	62½	6 8 6	Mar, Sept,
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	24½	4 7 11	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13 8	Feb, Aug
St.	3½%	Do. 3½% A Debs	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St	4%	Do. 4% Debs.	70	5 14 3	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	70	5 14 3	Jan, July
St.	4%	Do. 4% Guar. Stock	67	5 19 5	Mar, Sept
10	..	Underground E. Rys. of London Shares.	1 1/16	..	..
1/0	..	Do. A Ord.	5/16	..	..
St.	6%	Do. 6% Inc. Debs.	106½	5 12 5	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Feb. 8.	Rate per cent. Yielded.	Dividend Due.
		Electric Railways and Tramways	—*cont.*	£ s. d.	
..	6%	Underground E. Rys. of London 6% Inc. Bds., with coup. 16	84	7 2 10	Mar, Sept
..	4½%	Do. 4½% Bds.	101½	4 8 8	Jan, July
5	..	Yorkshire W. Riding Ord.	⅞	..	March
5	6%	Do. Pref.	4½	7 1 2	Jan, July
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅝	5 5 5	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 8 11	Mar
100	5%	Do. Prior Lien Debs.	85½	5 12 8	Jan, July
1	6%	Do. 6% Pref.	⅝	6 17 2	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 1 7	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅛	5 17 1	Jan, July
1	6%	British L.M.Ericssion Mfg.Cm.6% Pref.	⅛	6 6 4	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅞	7 1 7	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 18 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	65½	6 2 2	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅛	6 12 7	Jan, July
5	2/6	Do. 5% Pref.	4½	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	20%	Castner Kellner	3⅞	6 9 4	May, Nov
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅜	7 13 7	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	71	5 12 8	Jan, July
..	10%	General Electric Ord.	10½	9 10 6	July
10	6%	Do. 6% Pref.	9⅞	6 7 2	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 6 9	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅞	9 4 5	Feb, Aug
10	5%	Do. Pref.	7⅛	6 7 0	Apl, Oct
100	4%	Do. 4% Debs.	99⅛	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	36½	6 12 5	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅛	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82⅛	4 16 8	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 9	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 17 6	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69⅛	5 14 11	Ja.Ap.Jly.O
10	5%	Cuba Submarine Ord.	7⅛	6 15 7	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	†Direct United States	6⅛	6 12 0	Ja.Ap.Jly.O
St.	7%	Eastern Tel. Co. Ord.	127	5 10 3	Ja.My.Jly.O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja.My.Jly.O
St.	4%	Do. 4% Debs.	75½	5 6 4	May, Nov
St.	4%	†Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12⅛	5 10 11	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. 4	34	6 9 5	Ja. My, Jly
25	13%	Indo-European	49	6 12 8	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜	5 4 3	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅛	3 13 11	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 9 10	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	76	5 5 3	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99⅛	4 10 3	May, Nov.
		Telephones.			
..	$2	†American Telephn. & Telgh. $100 Cap.	131½	6 1 8	Ja,Ap,Jn,O
..	5%	Cuban Telephn. Co. 5% Bds.	77	6 9 10	Jan, July
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
..	4½%	New York Telephone 4½% Bds.	101⅛	4 8 7	May, Nov
1	10%	*Oriental Telephone Ord.	1⅜	6 0 9	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	6	6 13 4	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅜	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	87½	5 2 10	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10⅜	5 18 8	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10⅜	5 18 8	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80⅛	6 4 7	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	67⅛	5 18 0	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	122½	4 18 0	Apl, Oct
		Colonial and Foreign Railways, Tramways, &c.			
St.	5%	Anglo Argentine Trams. 5% Debs.	79⅛	6 0 2	Jun, Dec
St.	4½%	Do. 4½% Debs	75	6 0 0	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 2	Jan, July
5	5½%	Do. 5½% 1st Pref.	4⅜	6 11 4	Jan, July
5	5½%	Do. 5½% 2nd Pref.	3⅛	8 0 0	Jan, July
100	$1	†Brazilian Traction Ord.	5⅛	7 17 8	Fb,M,Aug,N
100	$1½	Do. 6% Pref.	9⅞	6 13 4	Ja,Ap,Jly,O
5	8%	Brisbane Trams Ord.	6⅞	6 1 1	May
5	2/6	Do. 5% Cum. Pref.	4½	5 11 1	May, Nov
St.	4½%	British Columbia 4½% Con. Debs.	64½	6 11 10	..
5	9½%	Calcutta Elec. Trams. Ord.	9⅛	7 10 8	Mar, Sep
..	5%	Havana Elec. Ry. 5% Bds.	9⅛	5 10 11	Feb, Aug
5	6%	Madras Elec. Trams 6% Cum. Pref.	4½	6 2 4	..
100	5%	Manaos Trams 5% Debs.	62	8 1 3	Jan, July
..	..	Mexico Trams Common St.	42	..	Fb,M,Aug,N,
..	5%	Do. 5% Bds	46	10 17 5	Mar, Sep
St.	4½%	†Montreal Street Ry. 4½% Debs (1922)	94½	4 15 6	Feb, Aug
100	5%	Rio de Janeiro Tram, L. & P. 5) yr. Bds	75½	6 12 5	Jan, Dec
100	4½%	Toronto Railway Co 4½% Bds	94	4 17 0	Feb, Aug
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	6	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs	93	5 5 3	Jun, Dec
10	6/-	†Bombay E. S. & T 6% Pref.	10	6 0 0	..
St.	4½%	Do. 4½% Debs	87⅛	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6⅛	7 15 1	May, Nov
5	5%	Do. 5% Pref.	4½	5 11 11	Mar, Sept
..	7%	Canadian Gen. Elec. Common St.	113½	6 3 4	Ja,Ap,Jly,O
St.	5%	Melbourne Elec. Supply 5% 1st Mt Debs	94	5 6 3	Jne, Dec
St.	5%	Do. 5% Cons. Deb. St.	95	5 5 4	Apr, Oct
..	..	Mexican Light & Power Ord.	29⅛	..	Ja,Ap,Jly,O
..	..	Do. Pref.	37	..	May, Nov
5½	5%	Shawinigan Water & Power 5% Bds.	103½	4 16 4	Jan, July
..	6%	Do. Cap. Stock	136½	4 9 7	Ja,Ap,Jly,O
St.	4½%	Toronto Power 4½% Deb St.	96	4 13 9	Jan, July
St.	4½%	Do. 4½% Cons. Deb. St.	89½	5 12 0	Mar, Nov
1	..	Victoria Falls & Transvaal P. Co., 6% Pf	⅜	..	Jan, July
..	5½%	Do. 5½% 2nd Mort Debs.	93½	5 17 8	Jan, July

* And 13s% bonus. † Ex dividend or interest.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Feb. 8, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	15½d.
Solid Drawn Copper Tubes	17½d.
Brazed Copper Tubes	17½d.
Brazed Brass Tubes	17⅜d.
Brass Wire	15⅜d.
Copper Wire	15½d.
Rolled Brass	15½d.
Brass Sheets	15⅜d.

	per ton.
Copper Sheets	£136 0 0
Spelter	£89 0 0

	per ton.
English Lead	£33 0 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£92 10 0
Brazier Copper Scrap	£80 0 0
Clean Scrap Brass	£62 10 0
Old Lead	£26 0 0
Old Zinc	£60 0 0
Hollow Pewter	£115 0 0
Black Pewter	£75 0 0
Gun Metal	£75 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Feb. 8 the following approximate prices of Scrap Metals: —

	per ton.
Aluminium Cuttings	£130 0 0
Clean Mixed Brass	£67 0 0
Clean Copper	£90 0 0
Clean Copper Wire	£94 0 0
Brazier Copper	£84 0 0
Gun Metal	£80 0 0

	per ton.
Old Lead	£26 10 0
Tea Lead	£24 10 0
Old Zinc	£65 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£80 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £100; Blowpipe Solder, £110.

ELECTRIC TRAMWAY & RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount	Inc. or dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or dec (a)
		£	£		£	£
Aberdeen Corporation	Feb. 2	1,683	+ 174	25	63,622	+ 4,187
Anglo-Argentine	„ 4	49,591	— 704	5	245,662	— 7,395
Ashton-under-Lyne	Jan. 29	460	+ 79	44	20,971	+ 1,711
Ayr Corporation	Feb. 5	265	+ 39	38	14,385	+ 969
Birkenhead Corporation	Jan. 6	1,389	+ 183	45	61,711	— 5,546
Birmingham Corporation Trams	„ 29	15,616	+ 3,646	44	629,379	+ 95,660
Birmingham Corporation Buses &c	„ 29	801	+ 165	44	36,675	+ 19,051
Blackburn Corporation	Feb 2	1,091	+ 127	45	56,377	— 83
Blackpool Corporation	„ 3	1,090	+ 257	45	73,188	+ 2,653
Blackpool and Fleetwood	„ 5	370	+ 24	5	1,727	+ 135
Bolton Corporation	„ 6	2,575	+ 82	45	120,554	— 533
Bournemouth Trams	„ 2	1,869	+ 264	44	92,452	+ 5,130
Bournemouth Buses	„ 2	7	+ 2	44	965	— 84
Bradford Corporation	Jan. 29	6,261	+ 707	43	282,274	+ 11,964
Brighton Corporation	Feb. 6	882	+ 96	45§	49,405	+ 955
Bristol Trams Trams	„ 4	4,586	+ 451	5	23,191	+ 1,524
Bristol Trams Buses &c	„ 4	4,817	+ 516	5	24,067	+ 3,348
Burmah E. Trams & Ltg	„ 5	R3,512	+ R13	5	..	+ R6,791
Burnley Corporation	„ 5	1,659	+ 241	18	39,267	+ 3,564
Burton Corporation	„ 6	273	+ [illegible]	45	12,799	— 288
Bury Corporation	„ 6	1,232	+ 60	41§	60,297	+ 342
Calcutta Tramways Co.	„ 5	R68,107	+ R3,213	5	..	+ R20,748
Camborne-Redruth	„ 5	142	+ 23	5	726	+ 123
Cardiff Corporation	Jan. 29	2,715	+ 411	43	118,034	— 1,004
Cork Electric Trams Co.	..	..	..	..	..	..
Coventry Corporation	..	..	..	..	..	..
Croydon Corporation	..	..	..	..	..	..
*Derby Corporation	Feb. 5	1,062	+ 159	44¶	47,021	+ 2,187
Dover Corporation	Jan. 29	275	+ 49	43	13,479	+ 2,286
Dublin & Lucan Railway	Feb. 4	128	+ 10	5	586	+ 5
Dublin United	..	..	..	..	..	..
Dundee Corporation	„ 2	1,339	+ 160	38§	51,444	+ 3,058
East Ham Council	„ 5	11,172	— 76	44	58,018	+ 5,806
Exeter Corporation	„ 4	328	— 34	44	16,768	+ 959
Glasgow Corporation	„ 5	22,634	+ 2,613	36‡	781,826	+ 59,288
Glossop Trams	„ 5	134	+ 29	6	810	+ 170
Gloucester Corpn	„ 2	304	+ 26	44	14,618	+ 216
Halifax Corpn. Trams	„ 1	2,093	+ 196	44	97,320	+ 1,083
Halifax Corpn. Buses	„ 1	47	+ 5	44	2,137	- 15
Hastings Elec. Trams Co.	„ 4	728	+ 65	5	5,783	+ 326
Huddersfield Corpn	„ 5	2,645	+ 418	44	119,017	+ 16,246
Hull Corporation	„ 5	3,094	+ 128	44	137,841	— 1,118
Ilford District Council	„ 4	695	+ 43	44	28,833	+ 3,258
Ilkeston Corporation	„ 2	147	+ 39	44	5,936	+ 432
Darwen Corporation	„ 5	449	+ 151	43	24,186	+ 4,220
Isle of Thanet Co.	„ 5	224	+ 14	18¶	4,694	— 958
Kilmarnock Corporation	„ 5	165	+ 18	38	6,426	+ 264
Lanarkshire Trams Co.	„ 3	2,170	+ 522	5	10,811	+ 1,762
Lancashire United	„ 2	1,616	+ 157	5‡	7,830	+ 632
Leeds Corporation	..	..	..	..	..	..
Leicester Corporation	„ 5	3,072	+ 325	5	16,592	+ 2,176
Leith Corporation	„ 5	763	+ 124	38	29,366	+ 2,337
Lincoln Corporation	„ 5	130	+ 14	45	6,314	+ 742
Liverpool Corporation	„ 5	13,338	+ 699	5	70,521	— 5,975
Llandudno&Colwyn BayR	„ 4	190	+ 15	9	1,765	+ 131
London County Council	..	..	..	..	..	..
Lowestoft Corporation	„ 5	117	— 14	18	2,363	— 777
Maidstone Corporation	„ 3	180	+ 28	44	9,613	+ 461
Manchester Corporation	„ 5	17,153	+ 725	44	795,447	+ 29,015
Neath Corporation	„ 5	183	+ 42	44	8,708	+ 566
Newcastle-Tyne Corpn.	„ 5	5,958	+ 337	45	276,740	+ 28,673
Newport (Mon.) Corpn.	„ 5	848	+ 127	45	37,732	— 1,579
Northampton Corporation	„ 4	678	+ 75	44¶	32,188	+ 5,595
Nottingham Corporation	„ 3	3,565	+ 345	44	165,183	+ 12,913
Oldham Corporation	„ 6	2,148	+ 147	46	104,400	+ 5,338
Portsmouth Corporation	„ 5	2,182	+ 49	45	110,302	..
Preston Corporation	„ 2	992	+ 165	44••	232,806	+ 10,802
Rochdale	„ 5	1,597	+ 193	..	75,992	+ 4,174
Rotherham Corporation	„ 2	1,224	+ 289	44	52,190	+ 7,039
Salford Corporation	„ 7	4,934	+ 352	45‡	43,192	+ 2,491
Sheffield Corporation	„ 6	9,442	+ 1,593	44	11,939	+ 57,992
South Manchester Corp.	„ 2	1,389	+ 229	44	66,460	- 7,896
Southport Corporation	„ 2	574	+ 714	44	35,611	— 7,919
South Shields	Jan. 29	756	+ 118	43	34,623	+ 1,640
Stockport Hyde & Dist B	..	..	..	..	..	..
Sunderland Corporation	Feb. 6	1,481	+ 184	45	67,605	+ 2,034
Tynemouth District	„ 2	565	+ 97	14	7,963	+ 752
Wallasey Corporation	„ 2	183	- 31	44	8,728	- 808
Wigan Trams Co.	Jan. 26	509	+ 24	4	1,871	- 34
Wallasey Corporation	Feb. 5	1,141	+ 92	44‖	56,719	+ 1,383
Walsall Corporation	„ 5	986	+ 227	44	4,341	+ 1,200
Wednesbury Corporation	„ 5	769	+ 41	45	39,585	+ 3,771
Wellington Corporation	„ 3	486	+ 72	44	20,541	+ 1,279
West Ham Corporation	„ 3	2,979	+ 259	44	136,897	+ 11,862
Wigan Corporation	„ 4	1,443	+ 75	43	67,118	+ 2,816
Wolverhampton Corpn.	„ 2	1,097	+ 96	18	20,254	+ 2,004
Yorkshire W.R. Trams	„ 6	1,555	+ 31	6	9,809	+ 1,247

(a) These [illegible] are with the corresponding period last year. * Partly electrical. † [illegible] ‡ Minus 2 days. § Minus 3 days. ‖ Plus 3 days. ¶ Plus 2 days. •• Compared with one week more last year.

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CONTENTS OF THE CURRENT NUMBER.

NOTES..... 691
Arrangements for the Week.. 694
The Boiler of 1915. By Arthur D. Pratt. Illustrated 695
The Testing of Underground Cables with Continuous Current.—*Discussion* 698
The Signalling Range in Radiotelegraphy. By J. L. Hogan. Illustrated 699
Characteristics of Three-Phase Induction Motors on Single-Phase Circuits. By M. Rosenbaum, B.Sc., A.M.I.E.E. Illustrated 701
The Effect of the Power Factor on the Cost of Electric Energy. By R. Stöppler. Illustrated 704
Selenium Cells. By W. R. Cooper, M. A., B.Sc. Illustrated.—*Continued* 705
Use of Electricity in North American Cities 707
THE MODERN BOILER..... 708
REVIEWS..... 709
The Wireless Telegraphist's Pocket-book of Notes, Formulæ and Calculations [Fleming]: Reviewed by L. B. Turner.
Constant Voltage Transmission [Dwight].
The Practical Electrician's Pocket-book and Diary, 1916.
Mechanical World Electrical Pocket-book.
Mechanical World Pocket Diary and Year Book.
Penrose's Annual [Gamble].
The Organisation of Scientific Research. By J. A. Fleming, D.Sc., F.R.S. 710
The Contact System of the Southern Pacific Company, Portland Division. By Paul Lebenbaum 713
CORRESPONDENCE..... 714
The Double Dynamometer Wattmeter (F. M. Denton).
LEGAL INTELLIGENCE 714
The "Electrician" Commercial and Industrial Section .. 717-724

NOTES.

Electricity Supply Tables.

IN this issue of THE ELECTRICIAN we publish two of our Annual Tables of Electricity Undertakings. These refer to the British Isles, and are in the same abbreviated form as was adopted last year, as there is considerable difficulty at the present day in obtaining complete information. The Tables differ in one respect, in that they include on the present occasion details of the power companies in addition to undertakings supplying energy for both power and traction. In glancing through the pages there are two things that become noticeable. The first is the increasing number of undertakings which are supplied in bulk. These now number 81. The other feature is the rapidly-increasing number of small stations. As far as we have been able to obtain information, the stations having a plant capacity below 100 kw. now reach the considerable total of 76. We are glad to see that the small station is now recognised as a commercial possibility. Very naturally it is built on different lines from those of the larger undertakings. The distribution is generally by means of overhead wires, and the plant is of the simplest kind, preference being given to gas engines or oil engines as prime movers. In this connection it is interesting to note the large increase in the number of stations using gas or oil, which fact becomes evident from a column we have introduced descriptive of the type of plant that is used. From this it is seen that 87 stations are usiug gas plant and 54 are using oil engines. The advent of the small station means that the advantages of electric light and power on reasonable terms are being placed at the disposal of those residing in the smallest towns. For this purpose there is no doubt that gas-plant and oil-plant offer very considerable advantages. On the other hand, we could wish that such undertakings were supplied wholly from electric power companies. This obviously is the proper course of development, but unfortunately the progress of the power company in this country has been so hampered that it has been impossible to take adequate advantage of electricity supply on a large scale. We hope that the future will show a very large development in bulk supply, so that we may ultimately have the advantage of networks operating over very large areas.

Save Us From Our Friends.

WITH most of Prof. FLEMING's Paper on the Organisation of Research, which was read last week before the Society of Arts, we are in entire agreement. Although at the moment it is impossible for us to deal with the several matters on which we hold different views, we are of the opinion that the time is ripe for sounding a warning note to those who take part in discussions on the question of the future of British industry. Up to the present, with few exceptions, two classes of people have taken no part in the discussions. We refer to the business men themselves and to the representatives of labour—to those on whose shoulders will rest the responsibility of actually carrying out our *post bellum* commercial policy. It would be idle to say that discussion on any subject by learned men is futile, but such discussion carries greater weight when those who are affected by the proposals come forward and state their case. If these men do not come forward, the assumption is apt to be made that "Barkis is willin'," and conclusions based on wrong assumptions are of little value. The insistent clamour for State aid, in a hundred-and-one directions, for those who have built up the trade of Britain is comical. The clap-trap indulged in by a section of the non-technical Press, and in Parliament, concerning what the State should do in order to exalt British trade makes us turn to HERBERT SPENCER'S account of the results of experiments of this kind in the past. With these results before us we are led to express the pious wish that the State will not give such "help" as will in reality prove a millstone. We venture to think that before long the amateur political economist will discover a danger threatening the whole of Europe compared with which the so-called German menace to the trade of this country is trifling.

The Position at Dublin.

IN another column we give brief accounts of reports on the position of the electricity undertaking in Dublin. Owing, it seems, to the state of affairs being not altogether satisfactory, Mr. P. W. D'ALTON was called in to report. His report was duly presented, but an unusual feature is the fact that not only is there a report by Mr. D'ALTON, but there are also reports on Mr. D'ALTON by Mr. MARK RUDDLE, the city electrical engineer, and Mr. L. J. KETTLE, his deputy. Very naturally these reports are conflicting, and it is quite impossible for those outside the undertaking to decide which of the conflicting views

are correct. The most important point, in our opinion, is that mentioned by Mr. D'ALTON at the beginning of his report in regard to dual control, partly by the engineer, "who is not the manager," and partly by the secretary, "who in part manages." We very much doubt if an undertaking can be run properly and be successfully developed unless the management is placed in the hands of a single individual. The most desirable person for a position of this kind is what may be termed the "commercial engineer," that is, an engineer who has a sound knowledge of the engineering principles underlying the business as well as the economic principles, and who is willing to leave many of the details in the hands of others.

Continuous Current Testing of Underground Cables.

MR. O. L. RECORD'S Paper on this subject at a recent meeting of the Institution of Electrical Engineers gave rise to a useful practical discussion. We are glad to note that Mr. RECORD negatived the impression that British cable makers and users are in a state of friction. Our experience of the cable makers of this country is that they are progressive engineers, ever on the look out for improvements both in material and methods of manufacture; and, in addition, they leave no stone unturned in an endeavour to give every satisfaction to the user. In some respects they have reasonable grounds for complaint when consulting engineers call for tests which it is well-nigh impossible to carry out. The influence machine method described by Mr. E. A. WATSON is a novel one, and we notice that trouble was experienced owing to the disintegration of the ebonite plates. In our own work we have used for some years a 6 in. influence machine working in dry compressed air. Examination of the cylinders shows that no disintegration has taken place, and, as an indication of this, we may mention that during the week we have obtained sparks of as great a length as the diameter of the cylinders. The material of which the latter are made appears to be some form of bakelised paper or pertinax. Although the design of a satisfactory high-power 150,000-volt influence machine is much more difficult than the desigr of a laboratory apparatus, we venture to think that the disintegration of the plates is a fault which can be overcome without much difficulty.

The Special General Meeting of the I.E.E.

As announced elsewhere a meeting has been called for the purpose of considering an addition to Article 11 of the Articles of Association. In this addition it is stated that "Any member of any class who at any time during such war shall be a subject of such enemy country or State shall forthwith cease to be a member of the Institution." We gather that the resolution is intended to apply to all enemy aliens, whether in this country or abroad, but there is the further important question as to what the effect will be upon those who are naturalised. We are not at all clear as to the meaning of the resolution. If a subject of any country or State be naturalised in this country and not de naturalised in the country of his birth, is it the intention of the Council to deprive such men of the privileges of membership of the Institution? As probably no two lawyers would attach the same meaning to the statement to which we have referred, we think that the clause "and not being a naturalised British subject," or the equivalent, inserted after "State" would get rid of the ambiguity, provided it is the intention that the resolution shall not apply to those who have acquired the rights of British citizens.

Tariffs as Affected by Power-Factor

THE effect of the power factor on the economical utilisation of a distributing network is well known, and it has often been thought that some inducement should be offered to the consumer to keep his power-factor as high as possible. But there are some legal difficulties; neither is the matter quite simple from the technical point of view. Prof. ARNO proposed a system by which the consumer should be charged for so many "complex" units; in fact, the consumer was to pay for the power he had received as well as for a certain fraction of the power he had not received—*i.e.*, for a certain fraction of the wattless current. This plan has disadvantages, legal and technical; among the latter may be mentioned the fact that, as Prof. ARNO proposed to alter the meters in such a way that they registered the number of "complex" units directly, there was no possibility of telling the amount of power the consumer had actually received. We publish in our present issue an alternative suggestion, according to which it would be necessary to add a second meter to an installation. It remains to be seen whether this is likely to find general favour. To the technical man, it seems reasonable to differentiate between consumers according to their average power-factors; but the legal mind might think otherwise. Added to this is the thorny question of explaining to the consumer what is meant by power-factor and what a "complex" unit is.

Petroleum Production in 1915.—The "Gas Age" states that the marketed production of petroleum in the United States in 1914 was 267,762,535 barrels, and the estimated production in 1915, 267,400,000 barrels.

Long-Distance Telephony Record.—At the beginning of the week a new link was forged in the chain binding Eastern to Western Canada, when speech was transmitted from Montreal to Vancouver (B.C.), a distance of 4,300 miles.

Electric Steel Industry of U.S.A.—According to the "Iron Age," the United States now holds the foremost place in this industry, having 73 electric furnaces, compared with 53 in Germany. Previously Germany had 46 against 41 in the United States.

British Ores.—In view of inquiries as to the British resources in certain minerals of economic value, for the supply of which dependence has been placed on imports, the Geological Survey has arranged to issue a series of memoirs giving details of their characters, sources, uses and methods of preparation.

Grants for Research.—The Council of the Institution of Electrical Engineers have been informed by the Committee for Scientific and Industrial Research that a sum of £840 has been granted to the Institution for research on "Heating of Buried Cables," and £250 for research on "Properties of Insulating Oils."

Faraday House "Journal."—The Lent term number of this "Journal" has just been issued. An interesting article on "The Origin of the Scale of Fahrenheit's Thermometer" is contributed by Mr. G. Scott Ram. There are two biographical sketches, and the Presidential Addresses of Mr. C. P. Sparks and Mr. P. V. Hunter (both of whom are Old Faradians) are given. In addition there is a description of the Lake Coleridge Hydro-Electric Scheme. The frontispiece is a photograph of Mr. C. P. Sparks.

Skin Effect in Conductors.—A Paper read at the Panama Pacific Convention of the American Institution of Electrical Engineers, by Messrs. A. E. Kennelly, F. A. Laws and P. H. Pierce, on "Experimental Researches on Skin Effect in Conductors," contains results of about a hundred series of tests. These tests cover a range of frequency up to 5,000 cycles per second on the impedance of long lengths of parallel conductors of different metals, sizes, and forms of cross-section. The theory of the effect in solid rods and indefinitely wide flat strips is given in a new and simplified form. For a thin strip of width w with ohmic resistance R at a frequency f, the following value for R' is deduced from experimental results when f varies between 1,000 and 5,000 cycles per second:—

$$R' = 0{\cdot}308 R f^{0{\cdot}21} w^{0{\cdot}103}.$$

Theory of Impulse Currents.—In a Paper read before the American Institute of Electrical Engineers, Dr. C. P. Steinmetz dealt with this question in an interesting manner. Starting from the integration of the general differential equation for the electric circuit, various special cases are discussed. For instance, considering the case for continuous-current in a circuit with distributed resistance and leakage, it is shown that complete reflection occurs at the end of the circuit, partial reflection at a transition point, and that a surge resistance exists. The equations for impulse currents are given in exponential, hyperbolic or trigonometrical functions. The Paper forms a compendium on current flow under different conditions.

The "Journal" of the Institute of Metals.—The subjects dealt with in the "Journal" that has just been published are of a very varied character, ranging from steam turbine blading to the detection of internal blowholes in metal castings by means of X-rays. A Paper dealing with the constitution of brasses containing small percentages of tin cannot fail to be of great interest to brass founders, whilst another describing a new thermostat for moderate and high temperatures, will appeal to the scientists in the works laboratory. Other Papers deal with such subjects as corrosion and the structure of alloys as affected by mechanical strain and other causes. The volume also includes a valuable contribution on the "Conduction of Electricity through Metals," by Sir J. J. Thomson, O.M., F.R.S.

Chicago, Milwaukee & St. Paul Railroad.—The officials and directors of the Chicago, Milwaukee & St. Paul Railway Co. recently toured the completed section of the 400-mile electrified district. Three special cars were drawn by one of the 260-ton 3,000-volt locomotives. Speed tests up to 70 miles an hour were carried out, as well as tonnage tests, 2,500 tons being hauled at 16 miles per hour. It is expected that the trans-continental all-steel trains will be operated electrically shortly. Although the cost of the work has been about £4,000,000, the saving effected by increased fuel economy, haulage, better speed schedules and upkeep will allow of a dividend of 20 per cent. per annum on the capital. Very successful tests were made on the regenerative braking appliances of the electric locomotives.

Artists' Rifles, O.T.C.—One remarkable effect of the Earl of Derby's Recruiting Scheme has been that a large number of professional men from the technical trades, including architects, engineers and surveyors, having realised that they must no longer delay offering their services to the country, have applied to the Artists' Rifles, O.T.C., for direct enlistment. Moreover, of those who have attested under the scheme, many have applied for and obtained transfer from Army Reserve B, in which Derby recruits are placed, to some Regular or Territorial Unit. This course is favoured by men whose education and position render them eligible for commissions. The corps has a special class for training members who desire to obtain commissions in the Royal Engineers and Pioneer Battalions, and for testing candidates for such commissions. The address of the headquarters is: 28th Battalion, the London Regiment (Artists' Rifles), Dukes-road, Euston-road, W.C.

Mixed Turbine Plant at a German Colliery.—The "Colliery Guardian" refers to a plant at the Neu-Iserlohn Mine of the Harpener Bergbau Akt. Ges. Owing to increased demands for power, the Company resolved to put down another 1,000 kw. plant.

The total supply of exhaust steam after deducting all losses was 23,700 lb. per hour, which, with a steam consumption of 35·5 lb. per hour, is equivalent to about 700 kw. Hence to get 1,000 kw. additional, enough steam at high pressure must be supplied for 300 kw. The mixed turbine plant only costs in capital £2,515 more than a high-pressure plant and boilers. The working costs are as follows, allowing a 16-hour day and a 300-day year: High-pressure plant £4,810 per annum, mixed-pressure plant £2,540 per annum. Consequently a turbine of the mixed-pressure Zoelly type was installed of 1,500 H.P. at 3,100 revs. per min. It has four rotors of 39·37 in. in diameter both in the high and low-pressure parts. The generator is three phase at 1,550 k.v.a. cos =0·8, and connected to the shaft by means of a star coupling. The voltage is 2,100 and frequency 50 cycles per second. The cooling air is filtered, and 490,000 cubic ft. are used per hour. The accumulator for regulating the supply of exhaust steam for the turbine has a capacity of 10,590 cubic ft. of exhaust steam. The steam consumption on test was per kilowatt-hour 35 lb. on exhaust and 18·54 high pressure. The steam pressure (absolute) was, in exhaust, 14·7 lb., high pressure 114 lb. at the stop valve. Consequently instead of paying £200 a month for electrical energy this sum is saved, and electrical energy to the extent of £150 per month is sold, without extra steam consumption.

The Institution and the Forces.—In the "Journal" of the I.E.E. for February we notice the following rewards for service in the field:—

Victoria Cross.—Lieut.-Com. E. G. Robinson, R.N.

Companion of the Bath.—Lieut.-Col. J. C. Chambers, West Riding Divisional A.S.C.; Brig.-General A. M. Stuart, Director of Works.

Distinguished Service Order.—Major F. J. Chapple, North Midland R.G.A.; Major S. H. Cowan, R.E.; Capt. A. E. Davidson, R.E.; Capt. H. M. Leaf, R.M.L.I.

Military Cross.—2nd Lieut. C. H. Goulden, R.G.A.; Lieut. H. R. L. Groom, Royal Warwickshire Regt.; Lieut. H. J. Gwyther, Manchester Regt.; Capt. H. P. T. Lefroy, R.E.; Lieut. I. W. Massie, R.E.; Lieut. A. Podmore, R.E.; 2nd Lieut. O. W. Sherwell, R.F.A.; Lieut. A. R. Tabor, R.F.A.; 2nd Lieut. G. W. Williamson, 3rd Manchester Regt.

Distinguished Service Cross.—Lieut. E. G. Boissier, R.N.D.

Distinguished Conduct Medal.—Private A. M. Doig, 1/6th Manchester Regt.; Private P. J. Wood, 18th London Regt.; Corporal C. W. Saunders, New Zealand Engineers.

Distinguished Service Medal.—Sapper J. H. Murray, Divisional Engineers, R.N.D.

Mentioned in Dispatches.—Lieut. C. R. Bicknell, R.G.A.; Capt. W. Casson, London Regt.; Commander W. H. Cottrell, R.N.V.R.; Sapper E. L. Damant, Divisional Engineers, R.N.D.; Lieut. H. L. Downes, Liverpool Regt.; Lieut. C. H. W. Edmonds, R.E.; Petty Officer C. S. Hann, Hawke Batt., R.N.D.; Lieut. L. V. Hart, R.E.; Major F. A. Iles, R.E.; Major G. S. Knox, R.E.; Capt. H. P. T. Lefroy, R.E.; Capt. G. T. W. Olver, R.E.; Capt. T. V. Smith, R.F.C.; Major G. H. Spittle, Divisional Engineers, R.N.D.; Brig.-General A. M. Stuart, C.B. Director of Works; Lieut. H. R. Tuppen, A.S.C.; 2nd Lieut. R. A. Williams, R.E.

Employment of Women on Munitions of War.—A book issued recently by the Ministry of Munitions on this question was prepared by an engineer who visited the various works in different parts of the country. The book is well illustrated, and the Minister of Munitions hopes it will act as an incentive and guide in many factories where employers and employed are sceptical as to the possibilities of the policy of dilution.

A point of great importance not always realised is the extent to which skilled engineers and engineering resources in this country are necessarily at the call of the Admiralty. This has compelled the Ministry of Munitions to find its labour in quarters hitherto unutilised for the class of work involved. The further employment of women is a matter of vital necessity owing to the demand to staff new factories, and without this labour the nation cannot make full use of the resources provided for munitions work. At the same time there is, not unnaturally, a certain amount of prejudice against the employment of women on work generally reserved for men. The introduction of large numbers of female workers meets with much opposition, and the support of public opinion is necessary to overcome this. In numerous cases the Trades Unionists have assisted greatly in the introduction of women labour, but a great deal still remains to be done. It should also be remembered that after the war all trade union restrictions will be restored, and this is embodied in an Act of Parliament. With reference to the work on 18 lb. shells, women are capable of running two lathes, and time-keeping is excellent. In small detail work women have attained extraordinary efficiency. Besides work on shell bodies, they are doing planing and shaping, grinding, milling and drilling. With regard to shell fuses, women appear to be peculiarly suited to the work, and the majority of successful fuse-making factories are manned by women. Regarding the training of munition workers, these are mostly given a short training in some of the various technical schools, and their employment causes no dislocation of other trades.

OBITUARY.

HERBERT KINGSFORD.—The death has occurred at Bournemouth of Mr. Herbert Kingsford, late chief of staff of the Central and South American and Mexican Telegraph Companies. Mr. Kingsford began his career with the Telegraph Construction and Maintenance Co., and took part in some of the Atlantic cable-laying expeditions of the "Great Eastern." He afterwards joined the Commercial Cable Co. and sailed in the ill-fated "Minia," but was a great many years in Peru with the companies first named. Mr. Kingsford was patentee of the bell-ringing grapnel now used by most of the cable-laying companies. He was a great traveller and had a wonderful collection of curious and humorous stories from all parts of the globe.

Sir C. RIVERS-WILSON.—The death of Sir Chas. Rivers-Wilson, G.C.M.G., took place on the 9th inst. He was born in 1831 and became a clerk in the Treasury in 1856. Subsequently he became Comptroller-General of the National Debt Office and one of the British Government Administrators of the Suez Canal Company. In 1895 he resigned in order to become president of the Grand Trunk

Railway Company of Canada. For some time he also acted as chairman of the British Electric Traction Company.

JOHN WOOD.—We regret to record the death of Mr. John Wood, which occurred on the 14th inst. at his residence, "St. Monicas," Mayow-road, Forest Hill. The deceased gentleman, who was in his 65th year, was the son of Mr. John Wood, for many years connected with the Russian Steam Navigation Co. In his earlier years he was closely interested in the shipping world. He was senior partner in the firm of Mosses & Mitchell, of Chiswell Works, Golden-lane, E.C., manufacturers and merchants, also director of several London firms, and will, therefore, be missed in City circles as one who was a staunch friend.

PERSONAL.

It is announced that Mr. J. G. Balsillie is retiring from his position of wireless telegraph expert to the Australian Commonwealth Government, and Eng. Lieut. F. G. Cresswell will occupy the post temporarily. Mr. Balsillie, whose term of service expired in September, 1914, but was extended, will remain in Australia for some time.

Sir Charles A. Parsons, K.C.B., F.R.S., has been appointed a member of the Advisory Council by the Privy Council Committee for Scientific and Industrial Research.

Owing to the pressure of special war work, Prof. B. Hopkinson, F.R.S., has resigned his seat on the Advisory Council for Scientific and Industrial Research.

During the week an announcement appeared to the effect that Principal Laurie, of the Heriot-Watt College, Edinburgh, has been appointed chairman of the Chemical Inventions Committee of the Advisory Panel of Scientific Experts, in succession to the late Prof. V. B. Lewes.

We understand that Mr. C. H. Smith, engineer's secretary, Corporation of Liverpool Electric supply department, has just completed 30 years' service with the undertaking. He has served in a commercial capacity under three chiefs, Mr. A. Bromley Holmes, Mr. A. Clough, and the present chief, Mr. Harold Dickenson. This is probably a record for electricity supply for so young a man, Mr. Smith being now only 44 years of age. He is a member of the City of Liverpool Volunteer Guard, and finds time for drilling and shooting, in spite of the fact that out of 40 of the office staff 23 have joined the Forces.

ROYAL ENGINEERS (T.F.).—The following notices have appeared in the "London Gazette":—

Tyne Electrical Engineers.—Gunner C. Graham (R.F.A.) to be Second Lieutenant (on probation). The surname of Second Lieut. C. B. S. Mecklam is as now described, and not as previously announced.

APPOINTMENTS VACANT AND FILLED.

An electrician is required for Gold Coast Government waterworks Salary £300, rising to £350 per annum. Applications to Messrs. Hunter, Duff & Middleton, 17, Victoria-street, London, S.W.

Walthamstow Council require a switchboard attendant. Wages 35s. rising to £2 weekly. Applications to Mr. G. R. Spurr, Priory-avenue, Walthamstow.

Mr. W. P. Thomas, of the Llanelly & District Electric Lighting & Traction Co., has been appointed junior engineer in charge at Newport (Mon.), at £117 per annum.

INSTITUTIONS AND SOCIETIES.

Institute of Radio Engineers.—A meeting of the Institute was held on Wednesday evening, Feb. 2nd, in Columbia University, Morningside Heights, New York. A Paper on "The Magnetic Amplifier for Radio-Telephony," by Messrs E. F. W. Alexanderson and S. P. Nixdorff, was presented. A magnetic amplifying device was described for permitting the control of radio frequency currents by varying the saturation of an iron core inductance. The control of the output of a 75 kw. alternator for radio-telephony was then fully illustrated by wiring diagrams and oscillograms. The Paper marked a distinct advance in the development of radio telephony.

Mining Institute of Scotland.—At the meeting held in Edinburgh, on Saturday last, Mr. Sam Mavor, Glasgow, replied to the discussion on his Paper on "Compressed Air for Coal Cutters." In the course of his reply he made an interesting statement as to the future of rock drills. The complaint that a satisfactory electric rock drill had not been produced was a valid one, but it was not relevant to the problem of raising the efficiency of the compressed-air system. Hitherto the compressed-air rock drill, despite its low-power efficiency, yielded in practice the highest commercial efficiency, and it, therefore, had held the field against all competitors, including drills on the internal combustion principle. He (Mr. Mavor) however, believed that the days of the compressed air rock drill were numbered. He had seen in operation a rock drill, constructed in accordance with an entirely novel system of power transmission, which absorbed only one-fifth of the power required by a compressed-air drill, and could be used in association with any electric plant. This system had features which differentiated it from all other attempts to compete with the compressed-air drill, and he believed it was destined to revolutionise not only rock drilling in coal and metalliferous mining, but in all branches of civil engineering and quarrying that were based upon rock drilling. He was not permitted at this moment to refer more particularly to the new system, but in the near future important developments in this direction would be unfolded.

Junior Institution of Engineers.—The present session has been notable for the high quality of the Papers submitted for discussion. Amongst these may be mentioned Mr. Rawlinson's Paper upon cast-iron foundry practice; the chairman's (Mr. W. A. Tookey) Paper on modernisation of power plant in factories, which has been extensively quoted and favourably commented upon by the majority of technical journals of varying interests; and the Paper upon business in engineering, by Mr. F. G. Hatch. The future session's programme includes a lecture by Prof. H. E. Armstrong, F.R.S., on Chemistry and Engineering, on Feb. 29; the use of Alternating Currents in Factories, by Mr. G. H. Ayres, in March; a Paper upon Electricity in Factories, by Mr. R. Rankin, M.I.E.E., in April; and, finally, one by Mr. H. N. Munro, in May. On Feb. 26, at the King's Hall, Holborn Restaurant, the J.I.E. have arranged to hold a Bohemain concert in aid of the British Red Cross Society in general and the City of London Red Cross Hospital in particular. Sir Boverton Redwood, Bart. (past president), will preside, and he will be supported by the Rt. Hon. the Lord Mayor of London.

Institution of Electrical Engineers.—A Special General Meeting will be held on Wednesday, the 1st prox., at 5 o'clock, for the purpose of considering, and, if thought fit, of passing a Resolution dealing with the modification of the articles of association. Notice is also given that, should this resolution be passed by the requisite majority, a further Special General Meeting will be held on Thursday, the 16th prox., at 7:50 p.m., when the said Resolution will be submitted for confirmation as a special resolution.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, Feb. 18th (to-day).

ROYAL INSTITUTION.

5:30 p.m. Meeting at Albemarle-street, W. Discourse on "Polarised Light and its Applications to Engineering," by Prof. E. G. Coker, M.A., D.Sc.

TUESDAY, Feb 22nd.

MANCHESTER SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at Engineers' Club, 17, Albert-square. Paper by Mr. E. V. Pannell on "Continuous Current Railway Motors."

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. Meeting at Society of Arts, Adelphi, W.C. Discussion on "Some Future Possibilities in the Design of Instruments for Measuring Illumination with Special Reference to Photometers Depending on Physical and Chemical Methods."

WEDNESDAY, Feb. 23rd.

BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at The University, Edmund-street, Birmingham. Lecture on "Terrestrial Magnetism," by C. Chree, D.Sc., F.R.S.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Commanding Officer: Lieut.-Col. C. B. CLAY, V.D.

Orders for week commencing February 21, 1916.

Drills: 6:25 to 7:25 7:25 to 8:25 p.m.

Monday, February 21st.—Sections 1 and 2, Technical: Sections 3 and 4, lashings and trestle bridging. Signalling Class and Recruits.

Tuesday, February 22nd.—School of Arms, 6 to 7 p.m.

Thursday, February 24th.—Shooting for Sections 1 and 2 and Signalling Class.

Friday, February 25th.—Sections 3 and 4, Technical: Sections 1 and 2, lashings and trestle bridging. Signalling Class and Recruits.

Saturday, February 26th.—Uniform Parade, 2:45 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 45, Regency-street, S.W. Sections for Shooting Parade at Miniature Ranges. Unless otherwise ordered, all parades at Chester House. Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate Hill as soon aspossible. Payment for uniforms to be made to the Adjutant.

THE BOILER OF 1915.*

BY ARTHUR D. PRATT.

Summary.—Some modern types of boilers, and the reasons for their economy are dealt with. Furnace design is discussed and methods of handling central station loads are compared. The questions of superheating and heat transfer in boilers are considered.

To treat the subject of modern boiler design in full would necessitate the illustrating of the various types of boilers built by different manufacturers. Should this be attempted, in order that there might be no partiality, it would be difficult to say where to stop, and the number of illustrations necessary would far exceed the prescribed limits. Further, the number of radical changes in actual boiler design that could be shown would, as has been stated, be negligible. Therefore but a few of the most modern designs are shown. It is evident upon inspection that these illustrations, while they represent some advance in the art, are in reality but slight modifications of designs that have been manufactured and used for years. Fig. 1 shows a boiler that is coming into general favour in England and on the Continent. The marine type of drum, namely, a cross drum, is used. The distinctive feature of this boiler is the inclusion of an economiser as an integral part of the unit. Fig. 2 represents an essentially different design from Fig. 1, though it is simply the combination of two partial units of a well-known boiler type. The distinctive feature here is the form and size of furnace made possible by the boiler design, and the very good performance of these boilers, to which reference will be made later, is directly attributable to the furnace. Units of this class have been built in sizes above 2,300† nominal rated horse-power.

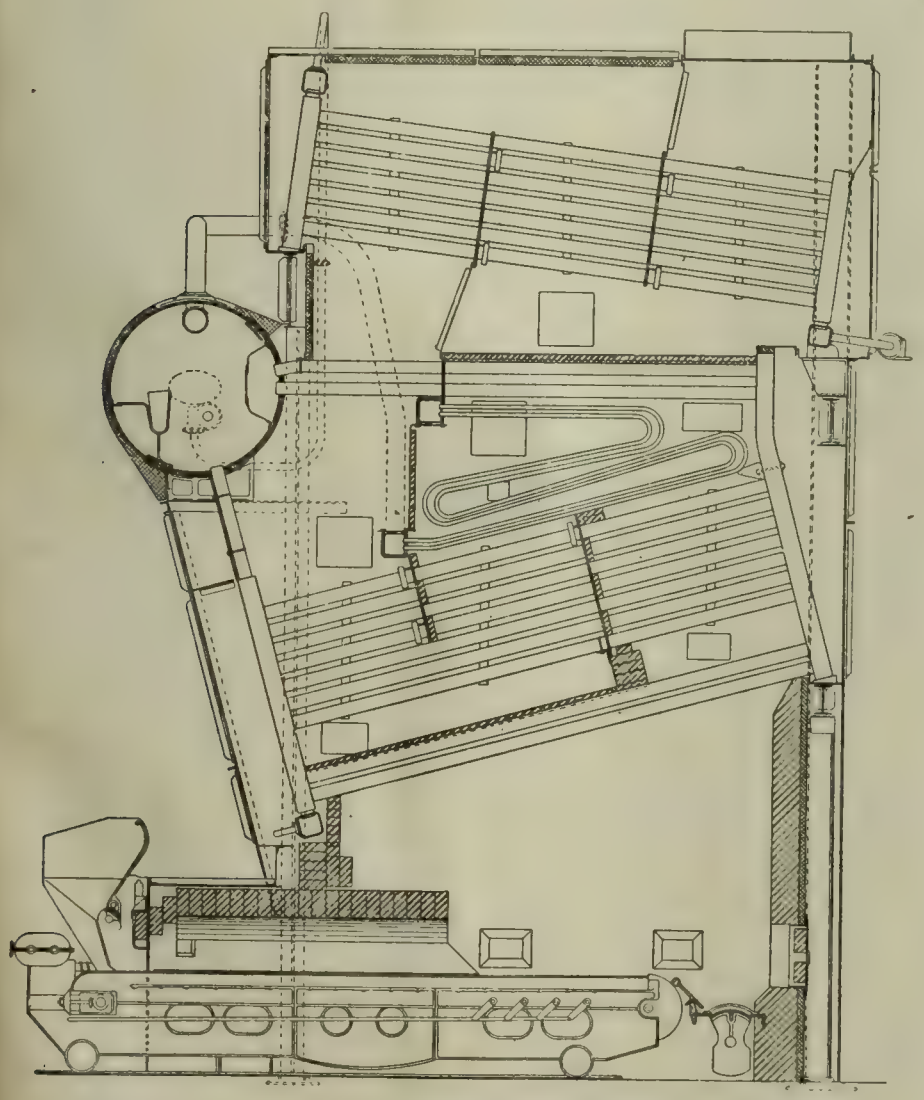


FIG. 1.—MODERN TYPE OF WATER-TUBE BOILER WITH INTEGRAL SUPERHEATER AND ECONOMISER.

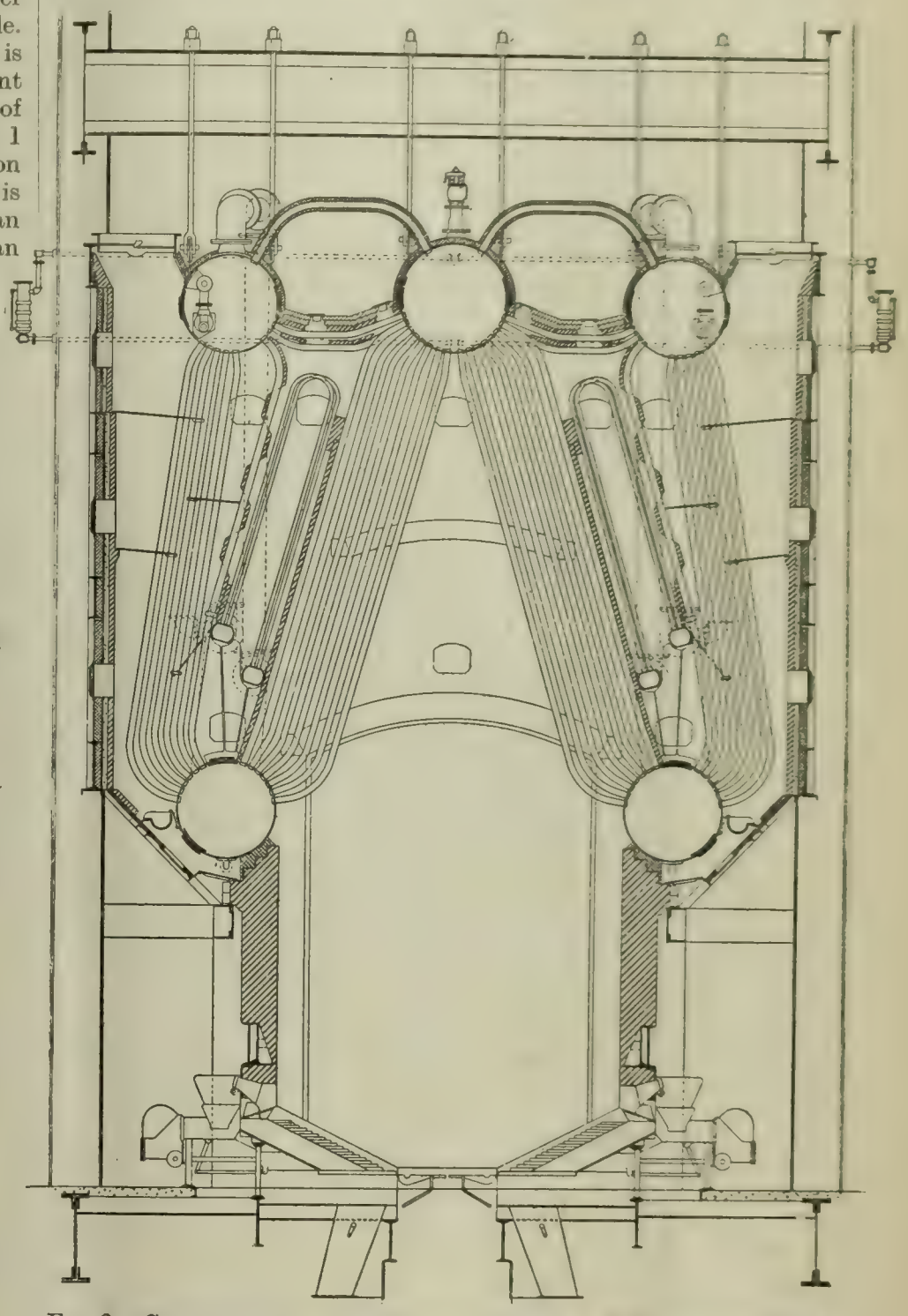


FIG. 2.—COMBINATION OF TWO PARTIAL UNITS OF A WELL-KNOWN TYPE OF BOILER.

The factors that have brought about increases in efficiency and capacity are so closely correlated that it is difficult to discuss them separately. Regardless of this, an endeavour will be made to divide the factors, up to a certain point, considering the efficiency aspect first.

The factor having the greatest bearing on modern high efficiency is unquestionably the improvement in furnace design. The heating surface of the properly designed steam boiler of to-day possesses the inherent ability to absorb heat economically. Under such conditions the question of boiler efficiency becomes in reality a question of economical combustion.

Improvements in furnace form and mechanical improvements have come together; that is, as some change has been made in the mechanical construction tending toward the betterment of fuel feeding, air admission, or the like, some modification of furnace form has been found advisable to meet the new conditions of combustion. The two factors are, therefore, very closely related.

The features bringing about the possible added efficiency may be summed up as follows:

Truly Mechanical Features.—1. A continuous and automatic fuel feed obviates the necessity of frequent openings of any fire doors. In this way the great quantities of air admitted over the fire at every firing interval in hand-fired practice are absent, and there is no deleterious effect on the boiler efficiency due to such air admission and no sudden cooling of the furnace.

2. The progressive movement of the fuel over the grates. The mechanical improvement here has in reality only to do with the actual movement of the fuel in different stages of its combustion, but closely related to this movement is the mechanical design of the apparatus which admits the proper amount of air during the progressive combustion, the combustion—assuming proper air admission—being taken care of by proper furnace form. This feature of proper air admission is unquestionably one of the most important factors in the bringing about of high efficiencies, and primarily depends upon

* Abstract of a Paper read before the International Engineering Congress at San Francisco.

† The figures for rated horse-power given herein are based on 10 sq. ft. of heating surface per horse-power. All figures for capacity generated are on the basis recommended in the boiler code of the American Society of Mechanical Engineers, namely, 1 H.P. equals 34·5 lb. of water evaporated from and at 212°F. per hour.

stoker rather than furnace design. The advantages of burning coal, or in fact any fuel, with the minimum amount of air is too thoroughly understood to need discussion here. When it is considered that with the modern stoker it is now possible, under test conditions, to reduce the ratio of air actually supplied to that theoretically required to 1·2 to 1, the greatly increased efficiencies possible are obvious. These figures, of course, represent test conditions, but numerous plants are operating with a ratio of 1·4 or 1·5 to 1 where previously ratios of 2 to 1 or 3 to 1 were common in hand-fired plants.

3. The quick and automatic removal of the ash and refuse, which for many years has been a distinctive feature of the chain-grate stoker, has reached a stage of perfection in other stokers in line with the improvements in the mechanical features of the stokers.

The purely mechanical features of modern stokers leading to high efficiencies may be summed up as the perfection of the automatic features which comprise the entire automatic feeding of the fuel, its automatic movement through a properly designed furnace, and the automatic and continuous discharge of ash and refuse.

The Factor of Furnace Design.—The underlying principles of furnace form or design that have aided in bringing about the modern efficient furnace may be broadly summed up as follows: A form such that the volatile gases are driven from the coal before combustion proper takes place, and such as to permit the air supply, properly admitted by reason of mechanical construction, to be so mingled with the volatile gases that the mixture is completely consumed before the boiler surfaces are encountered. Such a proper combustion of the volatile constituent of the coal almost automatically ensures the proper combustion of the remaining combustible, assuming, of course, the proper mechanical air admission for different stages of combustion throughout the furnace. Further, such a proper combustion ensures a high furnace temperature which, assuming the proper draft conditions and correctly designed gas passage areas from the furnace, is the ultimate indication of high furnace efficiency.

In the foregoing, the added efficiencies that have been brought about by mechanical improvements in stokers and improvements in the design of furnaces are the actual thermal efficiencies of the combined boiler and stoker units. In the sense of the broad plant efficiency—the cost per unit of power—there are a number of factors that have had a direct bearing. Some of these factors are the results of mechanical or furnace form improvements, and others are entirely apart from the combined unit as a piece of operating apparatus. These features may be enumerated as follows:

1. The labour-saving possible. An enormous saving has been accomplished in stoker-fired plants by the intelligent use of properly designed coal and ash-handling machinery.

2. Low operating cost. This is a result of improvements in the mechanical design of the stoker. Enormous quantities of fuel are fed to furnaces to-day with a cost for the actual manipulation of the stokers that is practically negligible as compared with hand firing.

3. Low maintenance cost. This is a result of both mechanical and furnace design improvement. In mechanical construction the better stokers have to-day reached a stage where replacements are reduced to a minimum, and this under the most severe conditions of service. The design of the modern furnace is such that the heat generated is properly distributed to the boiler and not concentrated to reduce the life of the stoker moving parts.

4. The human factor plays its part in the better class of labour that is gradually being employed in the boiler room. This applies not only to the actual boiler operators but to the engineers supervising the boiler-room operation.

5. Smokeless or, rather, more nearly smokeless combustion resulting from stoker and furnace improvements may perhaps be looked upon as an incidental result. Such improvements, with the end in view of increased efficiency, have naturally had a tendency to reduce smoke, and conversely the efforts toward smokeless combustion, frequently under compulsion, has unquestionably done much to improve furnace design, for the more nearly smokeless combustion is accomplished assuming that the smokelessness is not the result of great quantities of excess air, the better such combustion will be. Regardless of whether smokelessness is considered a cause or an effect, it has certainly had a bearing on the broad plant economy. With the absence of smoke and dust comes a lessening of wear and tear on machinery, an absence of damage to surrounding property, and a freedom from embarrassment from local authorities.

Another factor affecting the higher thermal efficiency now being secured, which is entirely apart from the boiler and furnace, is the use of steel boiler casing. This construction is coming more and more into use in the larger central stations. It is rather difficult to state accurately the added efficiency due to the use of such a casing. The ordinarily accepted advantage of a boiler casing is the reduction of radiation losses. Where a steel casing is properly insulated the saving in efficiency is made up not only of decreased radiation but also, as compared with the ordinary brick setting which has been in use for some time, the loss due to air infiltration through the unavoidable cracks. A steel casing alone, set over the boiler brick setting, while it would effectually prevent air leakage, would in no way reduce radiation losses, and the saving so effected would probably not warrant the cost of such an uninsulated casing. Where proper insulation is used between the brickwork and the steel casing, however, the saving unquestionably warrants the expense. Considering both radiation and air leakage, a properly insulated steel casing will show a saving of from $\frac{3}{4}$ to 1 per cent. over the average new brick setting. Such a casing will remain equally effective over long periods, and its saving, as compared with a brick setting that has been in service, say, a year, would probably amount to 3 per cent. In modern power plant practice, because of the severity of service, brick settings deteriorate rapidly, and the cost of keeping such settings tight is considerable. Since the properly constructed steel casing preserves its insulating qualities for long periods and prevents air leakage indefinitely, the cost of upkeep of the brick setting should be credited to the steel casing in the consideration of the broad plant economy. On such a basis the modern tendency toward the use of this construction is readily understandable.

Consider now the tendency, particularly in the United States, toward the increase in capacity demanded from a given heating surface. It is not many years ago that all boilers were rated, first, on 13 sq. ft., and then on $11\frac{1}{2}$ sq. ft. of heating surface per nominal horse-power, and when a boiler developed its rated capacity, even on this basis, it was considered that all was being done that could be expected. Boiler manufacturers next rated their product on 10 sq. ft. of heating surface per nominal horse-power, and in stationary boiler work this basis is used to-day. Such a rating is equivalent to an evaporation of 3·45 lb. of water from and at 212°F. per hour per square foot of surface. In view of the evaporation per square foot of heating surface that is being secured in daily practice in thousands of plants throughout the country, there is apparently cause for the widespread agitation against such an irrational method of rating the power of boilers.

The inherent ability of a given amount of heating surface to absorb heat has been present since the boilers have been constructed along the lines of modern design. The difficulty has been the supplying of sufficient heat to the heating surface. It has long been appreciated that the capacity of a given amount of heating surface—that is, its ability to absorb heat—was limited with certain restrictions, only by the amount of fuel that could be burned under such heating surface.

The amount of grate surface that can be placed under a given heating surface is limited by certain features of practicability of handling, of first cost, and of upkeep cost. With such limitations, capacity became a question of combustion rates. The possibility of the modern combustion rates has come only with a more thorough understanding of the relation of air supply to combustion. The high combustion rates necessary for the capacities carried in modern practice are made possible by the great improvements in the mechanical means of feeding fuel to the fire, the methods of introducing air for combustion, and the radical changes in the design of combustion chambers beneath the boiler, all of which factors have been discussed in the consideration of modern increased efficiencies. The high rates of combustion made possible by stoker installations are attained without an appreciable loss in boiler and furnace efficiency, and, due to the proper relation of grate and furnace to the boiler heating surface, efficiencies are common in modern practice at rates of evaporation of 7 lb. per square foot of heating surface per hour that were formerly not considered possible at rates of 3·5 lb. The ability of the modern stoker to burn coal economically at high combustion rates necessitates a low percentage of unburned carbon in the ash. When stokers were first introduced it was no unusual thing for the ash discharged to show at least 40 or 60 per cent. of unburned carbon. In power plant practice to-day many properly operated stokers are showing less than 20 to 30 per cent. unburned carbon in the ash at high rates of combustion, a figure which compares favourably with the best class of hand firing at combustion rates such as to give only low capacities from a boiler.

The references that have been made to capacity have been in connection with stoker-fired coal furnaces. Higher capacities are being secured, too, in hand-fired furnaces, but the cause here is almost entirely the improvement in furnace design, as the ability to shovel coal by hand has not increased appreciably. Hand-fired capacities are limited by the ability of the fireman, draught and the like, and it is rarely that capacities of over 150 per cent. are secured for any but peaks of short duration.

While an endeavour has been made to separate the consideration of efficiency and capacity, it has been clearly indicated that the

factors leading to present-day overloads and modern increased efficiencies are practically the same.

The same improvements in boiler furnace practice, mechanical and of form, which have made possible both greater capacities and high efficiencies, have enabled the modern boiler to meet three constantly recurring conditions in plant operation with infinitely better results, from the standpoint of broad economy, than formerly.

First, the ability of a boiler to be placed on the line quickly, either from a condition of bank or from a cold boiler. Second, the ability of a boiler or boiler plant to handle widely varying and rapidly fluctuating loads without appreciable variation in efficiency. Third, the ability of a boiler to carry continuous high overloads without an excessive drop in efficiency. The author discusses each of these conditions and gives numerous examples of which may be mentioned Fig. 3, which shows the ability of the modern boiler to carry high overloads. From this chart, between 8 a.m. and 11.30 the boiler is developing 3,240 H.P., or 137 per cent. of its rated capacity. From 12 o'clock until 1 o'clock the load increases to 5,076 H.P., or 214 per cent. of the boiler's rated capacity. Between 1 o'clock and 4.30 the boiler is delivering an average of 5,300 H.P., or 224 per cent. of its rated capacity, and during this period the efficiency was over 70 per cent.

In view of the possible overloads, as indicated by the above figures, the question arises as to the capacity at which a boiler plant should be run to show the highest operating efficiency. The governing factors here are so numerous that only the very most general statement may be made. The ability of individual units to be operated at very high capacities over periods of peak load has been shown, and in speaking of practicable operating capacities it is intended to consider the average load advisable.

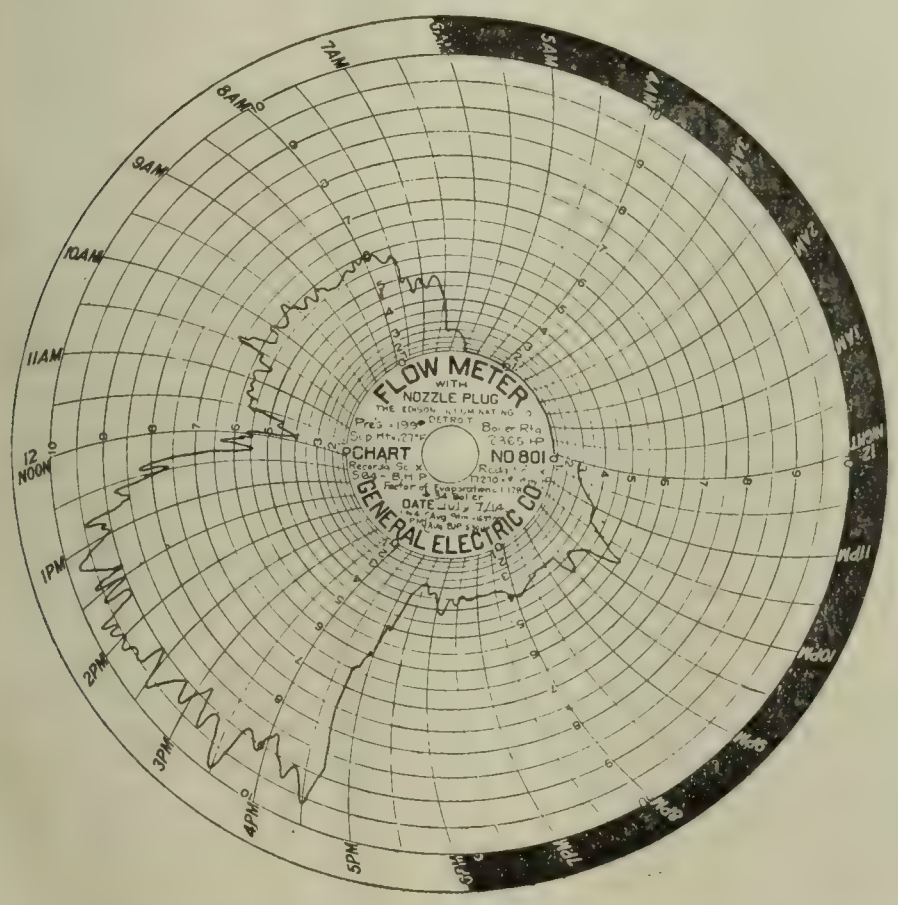


FIG. 3.—CHART SHOWING ABILITY OF A MODERN BOILER TO CARRY HIGH OVERLOADS.

Primarily, the controlling factor in a boiler plant—that is, the number of boiler units that must be installed, regardless of the nature of the load—is the ability to carry the maximum load that may be thrown on the plant under any conditions.

The concensus of engineering opinion respecting the best operating capacities for boilers is somewhat as follows: For a constant 24-hour load the operating capacity, to give the highest over-all plant economy, is between 125 and 150 per cent. of the boiler's normal rating. For the more or less constant 10 or 12-hour a day load, where the boilers are placed on bank at night, the point of maximum economy will be somewhat higher, probably between 150 and 175 per cent. of the boiler's rated capacity. The third class of load is the variable 24-hour load found in central station work. Here, even more than with the other classes of loads, the statement as to the economical point of operation must be general, due to the variation in handling, with differences in fuel, labour, type of stoker, flexibility of operation of the boiler and furnace, and other factors.

Modern methods of handling loads of this description, to give the best operating results under different conditions of installation are as follows:—

1. The load on the plant at any time is carried by the minimum number of boilers that will supply the power necessary, operating these boilers at capacities of 150 to 200 per cent. of their normal rating. There is, perhaps, an increasing tendency toward the higher figure. Such boilers as are in service are operated continuously at these capacities, the variation in load being cared for by varying the number of boilers on the line starting up boilers from a banked condition during peak load periods and banking them after such periods. This is, perhaps, at present the most general method of central station operation.

2. The variation in the load on the plant is handled by varying the capacities at which a given number of boilers are run. At low plant loads the boilers are operated somewhat below their normal rating, and during peak loads at their maximum capacity. The ability of the modern boiler to operate over wide ranges of capacities without appreciable loss in efficiency has made such a method practicable.

3. The third method of handling the modern central station load is, perhaps, only practicable in large stations or groups of inter-connected stations. Under this method the plant is divided into two parts. What may be considered the constant load of the system is carried by one portion of the plant operating at its point of maximum economy. Due to the possibility of very high over-all efficiencies at high boiler capacities where the load is constant, where the grate and combustion chamber are designed for a point of maximum economy at such capacities, and where there are installed economisers and such apparatus as will tend to increase the efficiency, the capacity at which this portion of the plant is to-day operated will be considerably above the 150 per cent. given as the point of highest economy for the steady 24-hour load for boilers without economisers.

The variable portion of the load on a plant so operated is carried by the second division of the plant under either of the methods of operation just given.

It may not be out of place again to point out the very general nature of these statements as to the economical load for any plant, and to emphasise the fact that each individual set of plant operating conditions must be considered by itself.

Apart from the question of furnace and stoker design, there are three factors that have an important bearing on the determination of the point of maximum continuous overload. These are feed water, furnace brickwork and draught.

In the foregoing discussion of efficiency and capacity and the factors bringing about the modern increases in both, the fuel considered has been in all cases coal. Greater capacities and higher efficiencies, however, are by no means limited to this class of fuel. Strides in furnace design for all classes have been as great as for coal, and furnace design to-day may be considered as much a specialisation as any of the highly specialised branches of engineering.

The author next deals at some length with boilers designed for burning oil-fuel, wood refuse, green bagasse and for utilising waste heat. Striking examples are given of the economy of the latter.

Improvements in modern recording apparatus have led to reliability and accuracy, and are of great service in attaining proper operating results. Records of water evaporated and the fuel consumption are of primary importance. Other records of temperature, gas analyses, draught and the like, serve as a check on the fuel consumption. They permit an intelligent study of the distribution of losses and afford a means of remedying such losses where improvement is possible.

The boilers of the modern power plant are almost universally equipped with integral superheaters. Superheaters as now offered have been in common use in stationary boilers for some 20 years, and during that time, as in the case of the modern boiler, there have been no radical changes in design. The superheaters introduced during the period 1895-1900 do not, however, represent the first use of superheated steam, and the modern superheater is essentially different from the apparatus first used for the purpose. The operation of all integral superheaters as offered to-day is alike, and different superheaters differ in constructional details rather than in essentials of design.

Experience has shown that for efficient operation the modern superheater must meet certain requirements that may be summed up as follows: (*a*) Superheaters must be located in the direct path of the gases as they sweep over the boiler-heating surface—that is, the gases utilised for the generation of steam must also be utilised to superheat that steam. (*b*) The location must be such that the full superheating surface is presented for contact with the gases, but the arrangement of surface must cause no undue amount of frictional resistance to the gases in their passage. (*c*) The surface should

offer the least opportunity for the adhesion of soot and dust. (*d*) all parts of the superheater should be readily accessible for inspection and repair and the design should be such as to allow freedom of expansion without affecting the boiler proper or the setting. (*e*) All superheaters should be equipped with safety valves set somewhat lower than the boiler valves. This is necessary in order to ensure a flow of steam through the superheaters when the load is suddenly taken from the boiler.

Practically all of the modern superheaters meet these requirements to a greater or less degree. In performing their function they interfere in no way with the operation of the boiler, and their upkeep cost is negligible. The efficiency of a boiler equipped with an integral superheater is, without question, greater than the efficiency of a boiler in which no superheater is installed, but the added efficiency due to the superheater is difficult to determine.

For some years after the re-introduction of the use of superheated steam there was a tendency on the part of steam users to demand degrees of superheat as high as could be obtained from integral superheaters. Operating difficulties have been gradually overcome, and under the improved modern plant conditions, there seems to be, within the past two years, a strong tendency on the part of engineers toward the use of degrees of superheat considerably in excess of 150° F.

The author refers briefly to the heat transfer in steam boilers, and gives accounts of three Papers that have been accepted as the most authoritative. In closing, reference is made to a comprehensive set of experiments, carried out under the direction of the engineering department of the Babcock & Wilcox Company, on "Heat Transfer Rates."

THE TESTING OF UNDERGROUND CABLES WITH CONTINUOUS-CURRENT.*

The following is a report of the discussion which took place on Mr. O. L. Record's Paper on the above subject at the meeting of the Institution of Electrical Engineers on Feb. 10th :—

Mr. B. Welbourn said, on rising, that he had just heard that the eldest and youngest sons of the President (Mr. C. P. Sparks) had been awarded the Military Cross for valour in the field.

Referring to the Paper, Mr. Welbourn said he regretted that the work of others in the same field, Mr. Watson, for example, was not referred to. There was nothing new in the use of continuous current for testing cable networks. He used it 15 years ago, and it was only dropped because of the rate of increase in the use of alternating-current networks, and because continuous-current machines giving 2,000 volts were of too flimsy construction. Dr. Lichtenstein established some relationship between continuous-current and alternating-current pressures. The author had not made it clear that one should differentiate between the tests on cables. Tests at the works on alternating-current cables should be alternating-current tests and the cables should be tested for dielectric hysteresis, but after laying it was necessary to ascertain that the cables had not been mishandled, the joints should be tested and that was where the continuous current test might find great application. There were now 33,000-volt cables and he thought they would have 50,000-volt three-core cables before long. To test such a cable 30 miles in length at 100,000 volts was an impossibility commercially. Therefore, the question of continuous-current pressure had to be considered. The main thing was to satisfy the users of the cables that the continuous-current test was practicable. The author had to test for 14 minutes before he got a clean burn out. He had seen a 130,000 volt direct-current cable discharged at the end and the spark was terrific. If the insulation was punctured he believed the discharge would occur through the puncture and a clean burn out would result. With the direct-current test one had a ready means of dealing with dampness, it shortened the period when the breakdown should come and a greater length of cable could be tested at one time than by the alternating-current method. The author did not mention the length of cable connected to the apparatus when he obtained his quantity tests from oscillograph records. In his remarks about cable makers the author must have had in mind French manufacturers. Sir John Snell's book on power distribution had an exactly similar curve to that shown in the Paper. It was prepared by himself (Mr. Welbourn) and his colleagues in conjunction with Mr. Bernard Price 10 years ago on the first 20,000 volt cable constructed in this country. He rather disagreed with the author where he said dielectric fatigue occurred. His experience was that if 50,000 volt pressure were applied to a 20,000 volt cable it would break it down after a time and it could be foretold within a quarter of an hour when the breakdown would occur.

Mr. A. P. Trotter said it had been the nominal custom to test for half an hour. In the old days it was usual to begin with double the working pressure. As the extra high pressure came along it was double voltage up to 10,000 volts and the working pressure plus 10,000 volts for anything higher than that, because in those days one could readily find the apparatus to do it. But the half hour nominal time brought in difficulties, and that question wanted consideration. Mr. Evershed gave in his Paper a time curve similar to that of the present Paper and he pointed out that if you were well over the knee of the curve you had only to apply it to different abscissæ and you were miles away from it; you got an entirely new knee. The actions which went on in a cable under stress were the subject of a good deal of scientific work and he fancied practical men were rather divided about the application of those scientific principles. The author said there was no definite relation between the resistance and the dielectric stress, but subsequently he seemed to assume that there was a relationship, which, however, he could not find in the Paper. He supposed the 40,000-volt tests in the Paper on 12 miles of cable referred to 20,000-volt cables. If cables could be treated in smaller sections the difficulties decreased. He would like to hear what practical users had to say. One had hoped that the work of Evershed and Addenbrook and the test suggested by Mr. Rayner of putting a small testing continuous-current superimposed on the alternating-current and watching the fall of the resistance, would have resulted in one's being able to predict more quickly what was going to happen to the cable and thus shorten the period of testing. It was open to doubt whether the half-hour was really wanted. Major Cardew thought it should not be diminished. The working pressure plus 10,000 volts allowed no margin of safety. Ordinary surges beyond that might occur any day.

Mr. F. C. Raphael said Evershed's Paper and the discussion upon it contained a great deal of matter on the action of the breakdown test. He gathered that the author thought it advisable for the cable user not to repeat the alternating-current test if it could be avoided, but he admitted that the cable maker was more or less convinced that the direct-current test was not of much use. He (Mr. Raphael) thought there was a distinct objection on the part of the cable makers to repeating the alternating-current breakdown test, and rightly so, because of the difficulties involved in it. There were so many possibilities of setting up resonance effects during the test, that it was not advisable to put it in the hands of people not used to making such tests. There must be an alternating-current test of the dielectric. The fact that they got ratios varying from 3 to 4 and wider limits showed that different qualities of insulation would break down under different conditions. In the case of the fault Mr. Record had produced by flattening the cable, if the fault had been produced by making a pinhole and allowing water to be absorbed until the resistance dropped to a megohm the cable would not have been broken down with continuous-current. He had broken down hundreds of faults with a couple of transformers with their secondaries in series. In his own experience there was no need to test very long cables joined up—they could be divided into sections. The satisfactory testing of a cable after laying was not hopeless. He thought the best solution was Mr. Beaver's proposal to use a cable with a metal sheath a little way under the lead and separated by a thin layer of insulation. If the lead were affected or the cable flattened that insulation would break down. That naturally increased the cost of the cable. It was possible that there might be a saving of money by employing zinc for the sheath. Mr. Record's apparatus would come in frequently for testing cables when alternating-current apparatus was not available and before Mr. Beaver's sheath method was universally used.

Mr. E. A. Watson then described a development of the influence machine principle which he and his firm had worked upon, which had not been published and which was not completely successful. It was an attempt to test a large cable at 150,000 volts with direct-current with such a machine. With the aerial influence machine the output was limited by the dielectric strength of the air in which it worked. If the dielectric strength were doubled the output was also doubled. The dielectric strength was about proportionate to the air pressure if the machine was run in compressed air. The next thing was to try and do away with all the different brushes by connecting the active material—the sectors—on each plate together by axial rods passing through the machine. It was designed for ½ kw. at 150,000 volts and it had 30 rotor plates of 12½ in. diameter. The sectors were sheet brass vulcanised into ebonite and the collector was of hardened steel rods screwed into the ebonite discs and joined to the sectors by axial rods through the machine. The stator consisted of a number of steel plates with cast-iron distance pieces holding them apart. The machine was excited by a small exciter at the end of the main machine and this exciter was connected to a needle-point gap outside. By varying the gap the excitation was controlled. They had runs of 130,000 volts for half-an-hour or so. The machine broke down by the general disintegration of the ebonite. He thought it failed because they neglected precautions which had not been necessary with small power machines. The collectors on the rotor were too few and their size too large. They induced oscillations and surging in the voltage, and there was sparking at the brushes setting up oscillatory currents. The breakdown occurred, although the factor-of-safety was nominally about 20 to 1. He thought another attempt would be more successful.

Mr. J. Warren said in a system where the trunk mains were run at 60,000 volts and the distributing mains at 6,000 it would be desirable to have apparatus which could be utilised for testing the high-pressure cables. This required a simple means of controlling and varying the pressure. Would the transformer of reasonable size for testing the trunk mains be suitable, generally speaking, for testing the distribution cables, the latter having lower insulation resistance. If the apparatus could be used for testing single-core cables it should be equipped with auxiliary condensers, in order to utilise it to its full extent, and avoid having to use an alternating current transformer. It was most probable higher transmission pressures would be used in future on single than on multi-core

* An abstract of this Paper was published in our issue of the 11th inst.

cables, and single-core cables should receive every attention in connection with such apparatus. The apparatus enabled tests to be carried out as the work proceeded, so that any defects in jointing might be rectified. A system when completed should be tested with such apparatus to provide a sufficient factor-of-safety to stand pressure rises. He did not think periodic testing necessary. An independent supply given by a small generator driven by, say, a small petrol motor would be of great value as it would enable the system to be tested independently of the main power station. The use of the apparatus would appear to be complicated owing to the actual direct-current pressure being variable and depending on the length of cable and the actual test pressure. The author referred to a test on 20 yds. of cable with an artificially produced fault. Was he convinced that it would efficiently burn out in a cable 20 miles long. Would the apparatus enable the faults to be localised easily. With regard to a practical length of section on extra-high-tension mains, on a system in which he was interested it had been settled that a good working section for cables of 30,000 volts would be from 2 to 4 miles. This required a transformer with a capacity of the order of 500 k.v.a. and in that connection the apparatus would appear to be of some use.

Mr. H. M. SAYERS said the testing of cables by continuous-current was a reversion to the oldest methods as was the use of continuous current many times the working pressure. Submarine cables were subjected to 300 Daniells=about 300 volts. An advantage of continuous-current testing was that the actual dielectric resistance of the cable could be measured. With regard to the relation of the dielectric resistance and the breakdown pressure, this was important to the man responsible for the maintenance of cables as the variation of the resistance indicated a developing fault. A particular cable, as long as it was sound, gave an insulation resistance showing a little variation evidently dependent on the surrounding earth temperature, but if it dropped from 10 megohms to 1 megohm it was evident that there was a fault somewhere. One wanted to find the fault before the cable was broken down. The usefulness of the insulated sheath for detecting faults had often been demonstrated to him when testing single-phase cables with an earthed outer. The earthed outer acted as the sheath described by Mr. Raphael. The earthed outer showed a drop of resistance due to a lead fault long before the cable was in any danger. By means of this drop of resistance he had found it possible to localise and remove faults which would in time have led to a breakdown. That method, which depended on the use of fairly high battery pressures, was better than the use of extra-high pressure which broke down a cable and rendered it useless. He had found it advantageous to use a separate engine for alternating-current testing, running it at as low a speed and frequency as would give the required pressure.

Mr. P. ROSLING said the breakdown test had a relation to the temperature. The half-hour test brought in the temperature question. By keeping on the current for half-an-hour a temperature might be caused which would not arise in practice from surges. He took it the difference of testing cables by bringing the voltage up and by raising it minute by minute was partly caused by the increase of temperature, as well as by the fatigue caused by the constant time the current was on. It seemed to him a direct-current test would point out any likely danger from slight moisture by collecting the molecules together better than an alternating-current. The large plant required for alternating-current testing was due to the consulting engineers, who specified that the length between sub-stations must be tested in one piece. They wanted 200 tons of 40,000 volt cable tested at one time. It should be in four or more sections, and the joints could be tested by seeing they were made properly. Instead of using a 2,000 k.v.a. transformer, a 500 k.v.a. might then be used.

The PRESIDENT said the Paper referred to Continental work, and did not refer to a great deal of work in this country. There were statements in the Paper that almost implied that British methods were very curious. The statements regarding the opposition of cable makers to the repetition of tests looked as though cable makers and supply undertakings were in a state of friction, but nothing of the kind occurred. If a cable was to be alternating, the test had to be alternating-current. After the cable was laid the joints wanted testing. The cable was built with a large factor-of-safety. Working with comparatively moderate pressures there had been little difficulty in testing cables in sections with alternating current. He welcomed the Paper for showing how to use direct-current, not to test the cable but the joints. From the statements made, to which he had referred, it seemed that people had to go through some system of dry nursing their system. They had not to keep on testing them, they were not unstable ; the cables supplied by British manufacturers, in his experience, were reliable. If a fault took place it was usually at a joint, and after it was repaired the cable went on working again for years. It was a pity that it was implied in the Paper that there were all these difficulties.

The AUTHOR, in reply to the discussion, said he was sorry members had read into the Paper reflections on British cable makers which were not intended. It might have been better if he had entitled the Paper a "Discourse on the Delon Apparatus." If he had said he had in mind cables of 30,000 and 40,000 and higher voltages it would have put a different complexion on things. He agreed that the test in the factory should be alternating-current and the apparatus was only for the test after laying. He had not the oscillograph records which had been asked for. The tests were made on a number of lengths of cables of different capacities, and the maximum value was what he had stated. With regard to the objection of cable makers to repeated tests, with 30,000 or 40,000-volt cables there was not the same margin of safety as with cables for lower voltages, and precautions had to be taken. Mr. Welbourn said the curve shown was not quite true. It depended whether a high voltage was applied for a short time or a lower voltage for a longer time. He did not quite remember making the statement that there was no relation between resistance and dielectric strength. Mr. Evershed's Paper only dealt with the first part of the curve, but when one came to the breakdown he was more concerned with the second part. He did not think there would be any difficulty in breaking down with the apparatus a voltage such as Mr. Raphael had suggested. He agreed that Mr. Beaver's shield was a good thing and was all that was necessary for testing after laying if people were willing to use it. The transformer had been fixed at 3 kw., but it could be made of greater capacity to suit the trunk mains. The difficulty as regarded single-core cable could be got over by using auxiliary condensers. He thought the larger single-core cables in the future would be mostly direct-current and the test after laying would probably be with 50 per cent. and not double working pressure. The apparatus could be made for stationary purposes up to 350,000 volts. With regard to Mr. Warren's suggestion about a separate generator, the Paper described the apparatus used by Siemens-Schuckert. It had a petrol generating set used in connection with a contact maker. Mr. Rosling mentioned the breakdown test pressure depending on the temperature. If the temperature varied due to the losses he agreed with him, but if the temperature were altered independently the breakdown pressure only varied slightly.

A vote of thanks to the Author closed the proceedings.

THE SIGNALLING RANGE IN RADIOTELEGRAPHY.*

BY J. L. HOGAN.

The several series of long-distance transmission tests carried on jointly by Dr. L. W. Austin and the National Electric Signalling Co.† included measurements of the effect on signalling range of antenna height, antenna current and wave-length. Heights from 37 ft. to 130 ft., sending currents from 7 to 30 amperes and wave-lengths from 300 to 3,750 metres, were observed at distances up to 1,000 nautical miles. Correlation of the data thus secured led to the expression

$$I_r = \frac{4{\cdot}25 I_s h_1 h_2}{\lambda d} \epsilon^{-0{\cdot}0015 d/\sqrt{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I_s and I_r are sending and receiving antenna currents in amperes, h_1 and h_2 effective heights at sending and receiving antennæ in kilometres, λ and d the wave-length and signalling distance in kilometres. As is easily seen, the expression may be used to compute the antenna currents or heights necessary to produce a required signal strength at any given distance under normal daylight conditions. With average 500-cycle spark senders and good crystal receivers, about 10 micro-amperes receiving current are necessary for barely audible signals.

Later tests‡ over greater distances extended the observations to antenna heights of 450 ft., sending currents of 110 amperes, and distances of 2,300 nautical miles. None of the data then obtained indicated need of altering the functional relation of the several quantities given in equation (1), though it was found that with the rectifying heterodyne receiver only 5 micro-amperes receiving antenna current gave signals of unit audibility, even with spark transmitters.

The expression (1) above has therefore been fairly well verified by application to many instances of radio transmission. It is probably the most nearly accurate equation for computations of the sort necessary if signalling distances and intensities are to be predetermined rather than estimated. For rapid numerical work it is desirable to state the various quantities in the units which are most convenient for their measurement ; for instance, if sending current is in amperes, receiving current in micro-amperes, antenna heights in feet, wave-lengths in metres and distance in kilometres, the equation becomes

$$I_r = \frac{392 I_s h_1 h_2}{\lambda d} \epsilon^{-0{\cdot}0474 d/\sqrt{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Or if, the other units remaining as just stated, distance is expressed in nautical miles, the coefficient of I_s should be 212 and the exponential coefficient 0·0877.

Simple algebraic solution of the equation is possible for all quantities except λ and d. These cannot be determined explicity by the common methods, since they occur both linearly and exponentially. By solving for I_r/I_s and determining a maximum by differentiation

* From the "Electrical World."

† "Some Quantitative Experiments in Long-distance Radiotelegraphy," by L. W. Austin, "Bulletin" Bureau of Standards, Vol. VII., No. 3, 1911, p. 315.

‡ "Quantitative Results of Recent Radiotelegraphic Tests between Arlington, Va., and U.S.S. Salem," by John L. Hogan, jr., "Electrical World," June 21 1913, p. 1361.

with respect to λ, it is possible to secure an expression for the optimum wave-length for a given set of transmission conditions. This is perhaps too extended an application of the original relations. A graphic method of solving for d was given by the author in the Paper above referred to.

to intersection of dashed curve for received antenna current desired.

3. From intersection proceed vertically to intersection with solid curve for assumed wave-length.

4. Proceed to right horizontally from this second intersection and read required value of d on right-hand ordinate scale.

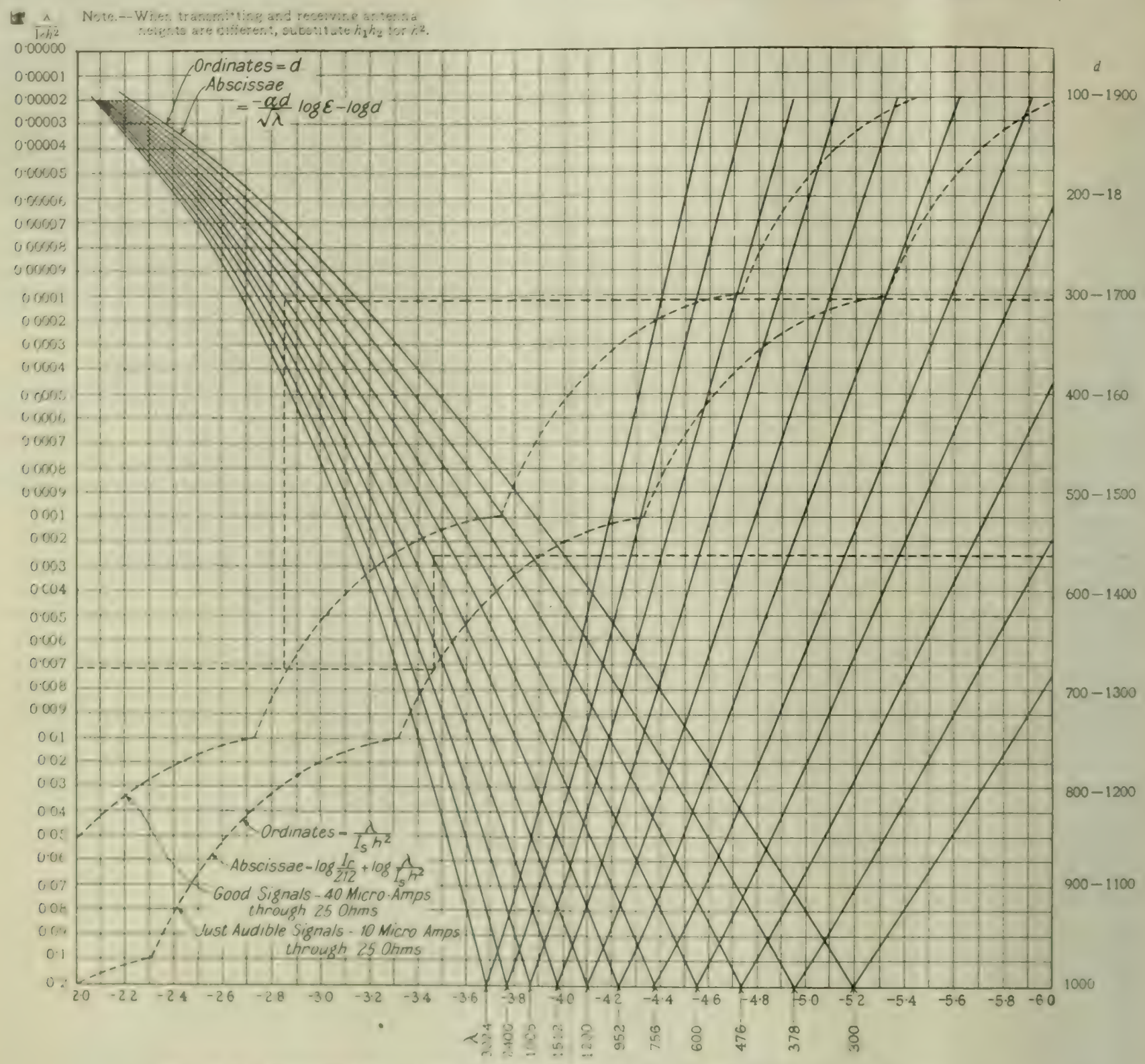


Chart for Computing Signalling Range for various Antenna Heights and Wave-lengths.

The ingenious logarithmic method of solving for d described below is the basis of a series of curves used at the United States Navy Yard, Puget Sound, Washington. Equation (2) is divided algebraically:

$$\frac{I_r \lambda}{2121 h_1 h_2} = \frac{\varepsilon^{-\frac{0.0877d}{\sqrt{\lambda}}}}{d} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and stated in logarithmic form:

$$\log_{10} \frac{I_r}{212} + \log_{10} \frac{\lambda}{I_s h_1 h_2} = \frac{-0.0877d}{\sqrt{\lambda}} \log_{10} e - \log_{10} d \quad . \quad . \quad . \quad (4)$$

A pair of curves for $I_r = 10\mu a$ (barely audible signals) and $I_r = 40\mu a$ ("good" signals) are plotted with ordinates $\lambda / I_s h_1 h_2$ and abscissæ

$$\log_{10} \frac{I_r}{212} + \log_{10} \frac{\lambda}{I_s h_1 h_2}.$$

For each of a number of wave-lengths (those shown above are United States Navy standards) additional curves are then plotted over the same abscissæ equated through expression (4) to

$$\frac{-0.0877d}{\sqrt{\lambda}} \log_{10} e - \log_{10} d$$

and with d as ordinates. By the use of these curves it is simple to solve direct for d by the process which follows.

1. Compute $\lambda / I_s h_1 h_2$.

2. Locate on left-hand ordinate scale and follow in horizontally

The example $I_r = 10\mu$ amperes, $h_1 = h_2 = 115$ ft., $\lambda = 952$ metres, is shown by dotted lines for $I_r = 10\mu a$ and $I_r = 40\mu a$, the signalling distances being respectively 565 miles and 305 miles.

When computing night-time signalling, or for distances less than 100 miles, the absorption term is ignored and the equation becomes

$$d = \frac{2121 h_1 h_2}{I_r \lambda} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from The Electrician Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 4s. and 9 per cent. for books published net. Add 10 per cent. for abroad or for foreign books.]

"Canadian Institute, General Index to Publications, 1852-1912." Compiled and Edited by J. Patterson, M.A. (Toronto: University Press.) Pp. 516. $5.00.

"L'Annuaire du Bureau des Longitudes pour L'An. 1914." (Paris: Gauthier-Villars et Cie.) Pp. vi. + 502. 1 fr. 50 c., net.

"The Process Year Book, Penrose's Annual, 1916." Vol. XXI. Edited by W. Gamble. (London: Percy Lund, Humphries & Co.) Pp. 112.

"Experimental Wireless Stations." By Philip E. Edelman. 3rd edition. (Minneapolis, U.S.A.: Philip E. Edelman.) Pp. 272. $1.50.

CHARACTERISTICS OF THREE-PHASE INDUCTION MOTORS ON SINGLE-PHASE CIRCUITS.

BY M. ROSENBAUM, B.SC., A.M.I.E.E.

Summary.—The author discusses a method by which three-phase motors can be employed with considerable advantage on single-phase circuits.

In many districts, due to the preponderance of lighting load during the initial stages of development, the only available supply is single-phase alternating current. As is well known, single-phase supply is not very suitable for motive power, as, with the ordinary induction motor not only are the capital costs per brake horse-power high, but the torque and starting conditions are very unsatisfactory. These advantages have of late years been somewhat modified, due to the advent of single-phase commutator motors ; but even these are far from satisfactory. Some supply companies who are in the unhappy position of possessing single-phase supply are fully alive to the disadvantages attendant thereon, and, owing to the large increase of their motive-power load, contemplate the ultimate conversion to a three-phase supply. For this reason these power companies have to consider the interests of their consumers who, with ordinary single-phase motors, would find that partial scrapping of the plant would be necessary when the change of system takes place.

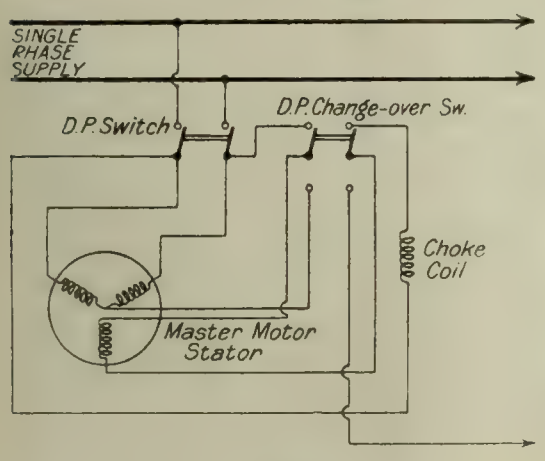


Fig. 1.

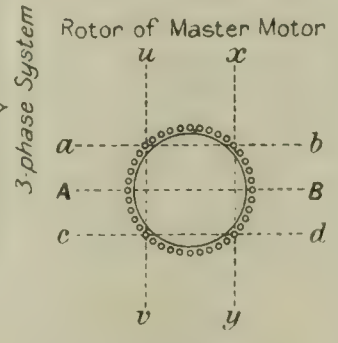


Fig. 2.

The object of this article is to discuss the method by means of which three-phase motors can, with decided advantages, be employed on single-phase circuits, and thus the purchase of new plant by the consumer would be unnecessary should conversion of the system take place.

A three-phase induction motor, when employed as a pure single-phase machine using one of the phases for starting purposes, develops only about 60 per cent. of the output of the same machine running on a three-phase supply, so that the capital costs of the consumer is about 66 per cent. higher per brake horse-power for a single-phase supply than for a three-phase supply.

The method investigated hereafter not only increases the output of this three-phase machine on a single-phase supply, but also has the advantage that practically the whole plant, inclusive of the starting gear, becomes serviceable should the supply be converted to the more economical three-phase system. Furthermore, the starting conditions become more satisfactory.

This method consists in the artificial production of a slightly unsymmetrical and unbalanced three-phase circuit by the employment of what is termed a master motor, this master motor being a three-phase machine acting as a transformer, and converting the single-phase supply to a three-phase system. This master motor can at the same time be usefully employed to drive machinery ; but just as in the case of a synchronous motor, which can be employed usefully and also to improve the power factor of a system, so here there is a limit to the output in each case, and the greater demand there is on it as a transformer the less power there is available for direct driving of machines.

A master-motor is essential for the initial production of this artificial three-phase system but once several single-phase motors are connected to this system each and every one serves as a transformer, and no one machine need be directly employed for the transformation, the transformer action taking place with those machines which are only lightly loaded directly, and supplying those machines which are fully loaded. For this reason, once the system is started, no one machine need necessarily be employed as a master motor, since each and every one can be made to serve in this capacity. It is, however, usual to employ a particular machine for this purpose, of a size sufficient for the needs of the network which, practically, can be assumed to be fully loaded.

The master motor consists of an ordinary three-phase machine, the stator of which is shown in Fig. 1. This machine is started up as a single-phase induction motor from the single-phase supply. The third phase completes the three-phase supply. The production of the three-phase supply can be simply explained as follows : Fig. 2 represents the rotor of this master motor, which can be divided into two stationary zones of conductors at right angles, and bounded by *ab*, *cd* and *uv*, *xy* respectively. The flux due to the single-phase current in windings 1 and 2 of Fig. 1 will be a pure single-phase alternating one along the axis A-B at right angles to the third phase. This flux along A-B is shown in Fig. 2, and has two effects as the rotor revolves.

On the conductors in zone *uv*, *xy* a transformer action takes place, and thus the E.M.F. induced is proportional to the product frequency of the single-phase supply $\times$ flux. This E.M.F. lags 90 deg. behind the flux. The belt between *ab* and

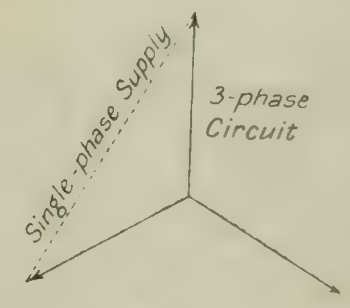


Fig. 3.

cd is subjected to a rotational effect, and the E.M.F. induced is proportional to $n \times N$, where n is the speed of rotation and N is the flux, this E.M.F. being in phase with the flux producing it. At synchronous speed n becomes equal to the frequency of the circuit. Thus these two stationary zones will have E.M.F.s induced in them at right angles to one another, and thus the current flowing will also be 90 deg. out of phase, since the internal characteristics of the rotor for these two zones will be the same. These currents give rise to a rotating magnetic field which, cutting the stator circuit, produces the three-phase supply necessary.

The effect of the speed of the rotor falling below synchronous speed will still be to produce this two-phase rotating field ; but an inverse field will also be set up, this inverse field increasing as the speed falls, the transformer field predominating as the speed drops, until at rest the latter alone exists.

The E.M.F. induced in the stator, which governs the amount of out-of-balance of the three-phase supply, will depend on the value and position of the crests on the rotating field wave, this latter depending on the speed of the master motor and the relative values ot the inductance and resistance of the rotor circuit—*i.e.*, the phase angle of the rotor currents. In general, due to the relatively small drops in the rotor and stator circuits, and the small leakage, these induced E.M.F.s in the stator windings will approach the theoretical maximum value, as shown in Fig. 3.

Relationship Between Size of Master Motor and Starting Torque of Motor Coupled to Artificial Three-phase System.—Fig. 4 shows the relationship between the starting torque of a motor as a

three-phase and single-phase machine with three different master motors, viz. :—

(*a*) 500 volts, 1,500 revs. per min., synchronous speed and 31 H.P. as three-phase.
(*b*) 500 volts, 1,500 revs. per min., 20 H.P.
(*c*) 500 volts, 1,500 revs. per min., 15 H.P.

The motor was capable of giving 15 H.P. as a three-phase machine and 8 H.P. as a single-phase machine. The full-load torque of the motor under test is given by a horizontal line. Comparison is obtained by comparing the torque developed with the same rotor resistance in the motor under test, with the three different master motors and with the motor on a pure

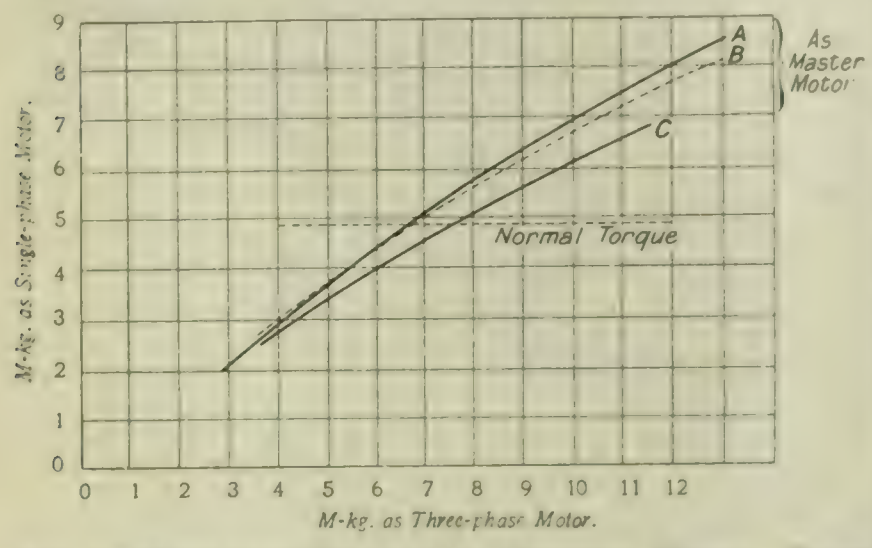


FIG. 4.—THREE-PHASE/SINGLE-PHASE INDUCTION MOTORS. CURVES SHOWING RELATION BETWEEN STARTING TORQUE OF INDUCTION MOTOR AS THREE-PHASE MACHINE AND AS SINGLE-PHASE MACHINE WITH DIFFERENT MASTER MOTORS.

three-phase circuit. It will be observed that the larger the master motor the more satisfactory the starting conditions become. A value of about 1 to 1·3 times the power of the largest machine on the system would be a practical value to take.

Fig. 5 shows the single-phase power taken from the system with various starting torques and two different master motors as before, which includes the power taken by the master motor in addition to the power taken by the motor under test, the motor being started up by means of a resistance inserted in the

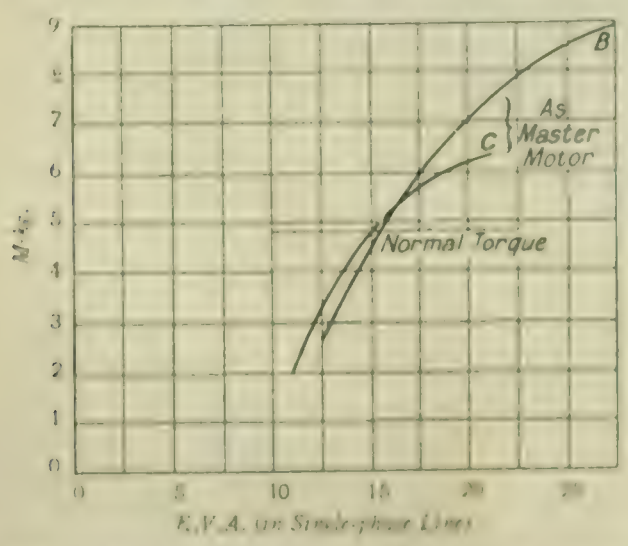


FIG. 5.—THREE-PHASE SINGLE-PHASE INDUCTION MOTORS. CURVES SHOWING RELATION BETWEEN STARTING TORQUE AND SINGLE-PHASE INPUT OF INDUCTION MOTOR AS SINGLE-PHASE MACHINE WITH DIFFERENT MASTER MOTORS.

rotor circuit, which again shows the advantages of a large master motor where a fairly high starting torque is required.

Relationship Between Output of Motor as a Single-phase Machine and When Used in Conjunction with a Master Motor.—Particulars of motors :—

Single-phase motor ... 500 volts, 1,500 revs. per min., 8 H.P. as single-phase, 15 H.P. as three-phase, 50 frequency.
Master motor ..... 500 volts, 1,500 revs. per min., 31 H.P. as three-phase motor, 50 frequency.

Fig. 6 shows the relationship between torque and speed under the following conditions :—

Curve *a*.—Pure single-phase machine ... Rotor short-circuited.
Curve *b*.—Motor run in conjunction with master motor ..... Rotor short-circuited.
Curve *c*.—Ditto ..... Resistance 0·11 ohm per phase inserted in rotor circuit.
Curve *d*.—Ditto ..... Resistance 0·185 ohm per phase inserted.

The torque at the various speeds was ascertained by braking the motor, the voltage of the system being reduced to 300 volts with a frequency 49·5 cycles per second. These curves give the relationship between the starting torque and the maximum torque under the various conditions. The single-phase motor develops 8 H.P. at 500 volts 1,450 revs. per min, and a torque of 3·94 m. kgs. when running as a single-phase machine. At 300 volts, the horse-power and torque will be reduced to an amount in proportion to the square of the voltage, and, therefore, develops only 2·88 H.P. at 1,450 revs. per min., and a torque of 1·42 m. kgs.

Comparing curves *a* and *b* at the speed corresponding to full-load torque, *i.e.*, the full-load speed, it will be observed that

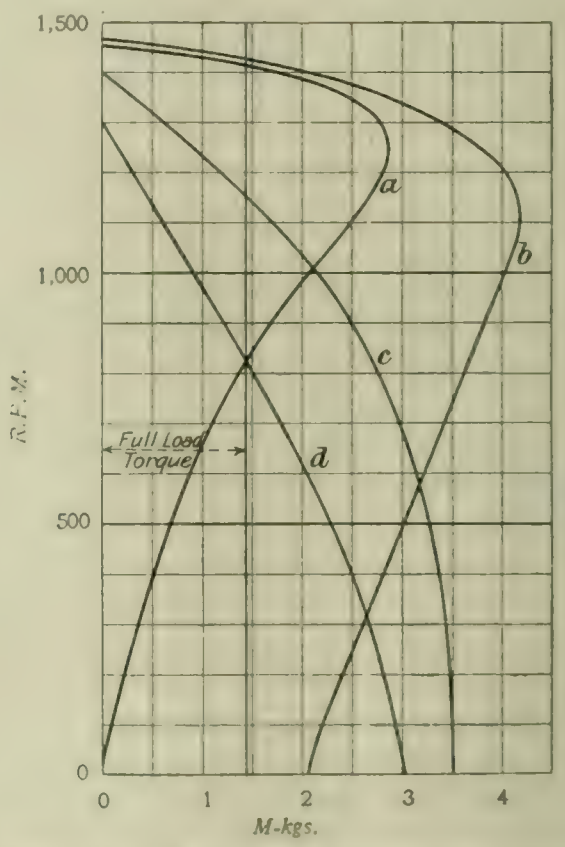


FIG. 6.—THREE-PHASE MOTORS ON SINGLE-PHASE SUPPLY. TORQUE CURVES, 300 VOLTS, 49·5 ∼.

	Condition.	Rotor resistance.
Curve *a*:	Pure S.P. Machine	Short circuited.
Curve *b*:	Motor run in conjunction with Master Motor	"
Curve *c*:	" " "	Resistance 0·11 Ω/phase.
Curve *d*:	" " "	Resistance 0·185 Ω/phase.

the torques are 1·42 and 2 m.-kgs. respectively. In other words, the full-load of the motor when used in conjunction with the master motor becomes $\frac{2}{1{\cdot}42} \times 8 = 11{\cdot}3$ H.P., *i.e.*, the output is increased 42 per cent., while the maximum torque is three times the normal full-load torque as a pure single-phase machine. The following are the results obtained :—

	Three-phase motor.	Single-phase with master motor	Pure single-phase.
Full load ...	15 H.P.	11·3 H.P.	8 H.P.
"	100 per cent.	76 per cent.	60 per cent.

Load Curves.—Fig. 7 gives the diagram of connections for the load tests discussed hereafter, while Fig. 8 gives the results obtained. It will be observed that the voltage between phases and the currents per phase are not equal, due to the different drops in the phases of the motors, and to the inverse rotating field as the speed of the master motor falls. Fig. 9 gives the supply characteristics, the efficiency curve given therein being

the efficiency of transformation of the master motor, namely, the ratio

$$\frac{\text{Watts input into motor}}{\text{Watts taken from single-phase supply}}.$$

Conclusions.—(1) With the use of a master motor, started up as an ordinary single-phase machine, and which artificially produces a three-phase system, the output of a single-phase induction motor can be appreciably increased and its starting

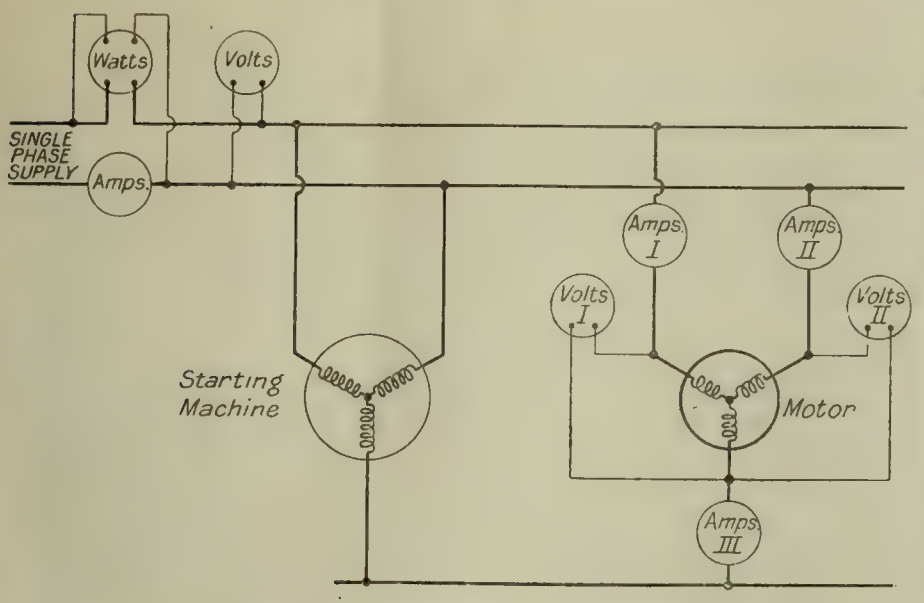


FIG. 7.—ARRANGEMENT OF MOTORS.

torque improved. This method commends itself in the case of factories with a single-phase supply and having several motors connected thereto.

(2) Should a change of system to three-phase be contemplated this method involves no scrapping of plant, as the whole of the plant excepting the single-phase master motor starter, can be utilised.

(3) The larger the master motor the more favourable the conditions become. Once the system is started, however, all

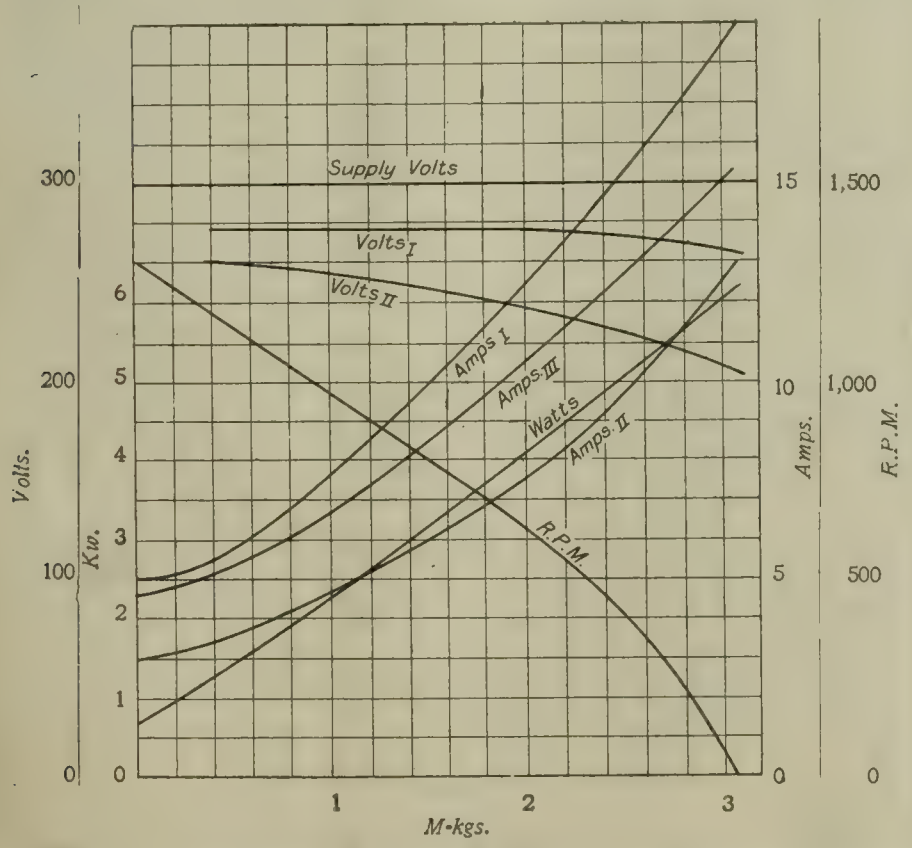


FIG. 8.—THREE-PHASE MOTORS ON SINGLE-PHASE SUPPLY. MOTOR LOAD CURVES.

Motor run in conjunction with Master Motor. Resistance in Rotor Circuit 0·185 Ω per phase, 300 volts 49·5 ∾.

the motors on the system can be made artificially to produce the three-phase system and thus act as transformers, the extent to which this can be obtained depending on the actual load on each machine. In certain cases the master motor can also be utilised for motive power.

Costs.—The following example may be taken of a factory requiring the following motor outputs :—

10	5 B.H.P.	3	20 B.H.P
5	10 B.H.P.	1	30 B.H.P.

The total requirements being 190 B.H.P.

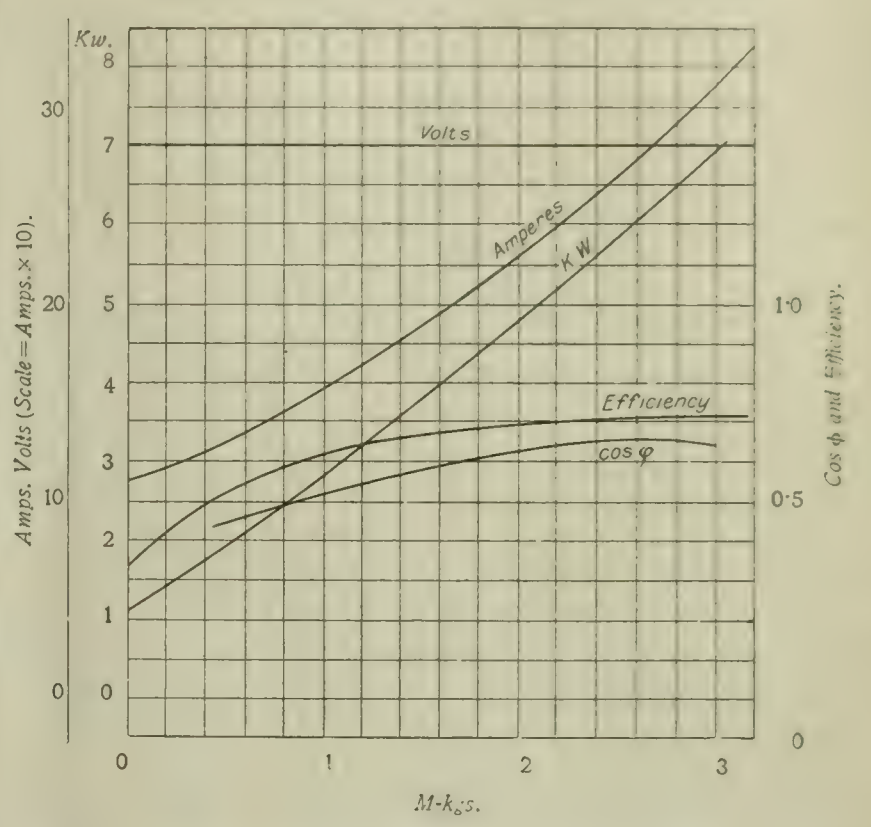


FIG. 9.—THREE-PHASE MOTORS ON SINGLE-PHASE SUPPLY. SUPPLY CHARACTERISTICS. CONDITIONS AS IN FIG. 8.

Comparative costs are given for the two following cases :—

A. Pure single-phase machines.

B. Three-phase machines with master motor, assuming the three-phase machines give 75 per cent. of its three-phase output on the single-phase circuit, and assuming a master motor 1·3 times the size of the largest motor.

Case A.	£1,050
,, B.	875

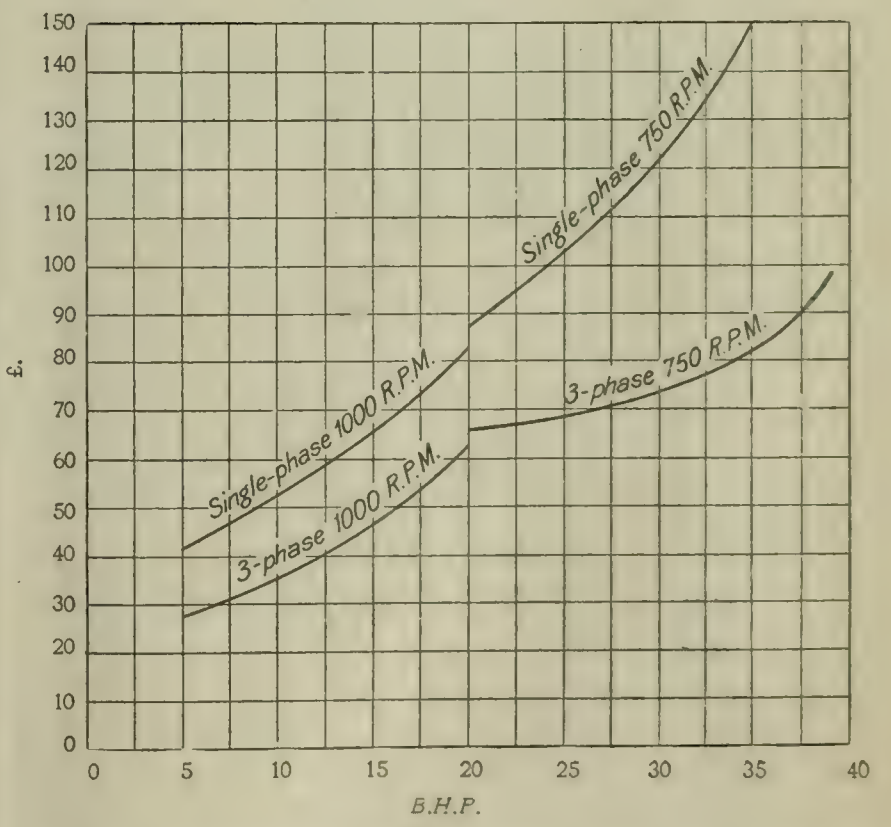


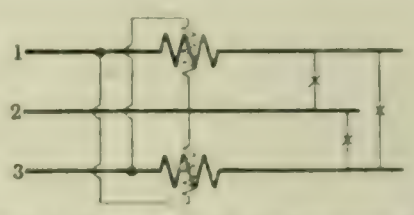
FIG. 10.—COMPARATIVE COSTS OF SINGLE-PHASE AND THREE-PHASE SQUIRREL-CAGE MOTORS WITH STARTERS.

These figures are based on the curves shown in Fig. 10, giving the comparative costs of single- and three-phase machines with starters, the voltage being in the neighbourhood of 500 volts. From such a curve as shown in Fig. 10 it will be possible to compare the two systems for any particular case.

THE EFFECT OF THE POWER FACTOR ON THE COST OF ELECTRIC ENERGY.*

BY R. STÖPPLER.

Prof Arno has introduced the question of complex metering as a result of his elaborate investigations into the working results of different companies. His idea is that the consumer ought to meet the charge for the power actually consumed and metered, and he ought, in addition, to pay a certain fraction of the difference between the amount consumed and the *apparent* amount consumed, which is the product of volts and amperes with a power-factor of unity. This fraction would vary according to the circumstances, and may be anything between a quarter and a half. Let us take it as one-third. Then a little calculation will show that the consumer will pay for two-thirds of the power actually supplied, together with one-third of the power apparently supplied. Prof. Arno's method of using the meters is described in the Swiss patents Nos. 55,774 and 55,973, and is somewhat as follows: † A Ferraris system of meter is used. He proposes to displace the driving active field, due to the volts, with respect to the driving active field due to the current by a certain angle in a backward direction; this angle would be greater than 90 deg., and its precise value would depend on the variations of the phase displacement with which the meter was expected to deal. It would thus be likely to have values between 100 deg. and 114 deg. This meter would then give the reading of the amount of power for which the consumer has to pay directly. If the load is free from induction, the results are exactly the same as those given by a power meter; if it is inductive, a higher reading is given. But there are objections to this method. The readings are not given in the lawful unit, the watt, but in a complex unit, which is difficult to explain. In some countries such proceedings are illegal. These meters give no idea of the power actually taken from the mains, which is a disadvantage from the management point of view; in fact, it is difficult to tell how the network is working unless the power put into and



Connections for a Meter on a Polyphase Network with Unequally Loaded Phases.

taken out of the network is known. And apart from the question of explaining the system to the consumer, there may be many cases in which it would be still more difficult to justify the results. Thus, a man might obviously reduce his intake, and yet find that owing to a change in the power-factor, his bills remained the same as before. Further, if a meter had been adjusted so as to read according to a certain fraction, say, one-third of the apparent power, it could not easily be changed so as to allow for one-quarter, even if the conditions demanded such an alteration. Once the fraction or angle of displacement has been fixed it cannot be altered. If the character of the load were to change in the process of time, and motors were gradually added to a lighting load, or a predominantly lighting load, a meter which read properly for power factors between 1 and 0·8 would be wrong for conditions where the power-factor varied from 0·9 to 0·5, as might well be the case with a motor load. Neither is the "complex" meter so good as the ordinary type in respect of the magnitude of the torque, the no load current and simple means of calibration.

Some notes on an improvement of this plan may be of interest. Practically the simplest plan seems to be to have two pieces of apparatus, which may be called meters, in series; the one measures the true watts, taking into account the power factor in the usual way, while the other measures the wattless input. Thus, the squares of the two readings, if added together, would give the square of the apparent input—*i.e.*, the square of the volts multiplied by the amperes. Now it is not possible merely by what may be called the fractional method to get the figure we desire—*i.e.*, the amount of "complex" power for which the consumer ought to pay. But by the aid of curves such as the author gives in his Paper it is possible by simple inspection to determine this. Thus, the curves may be dealt with somewhat on the plan shown in the following table, where the consumer is supposed to pay for the power which he actually

Table I.—*Showing the Method of Obtaining the Amount of "Complex" Power from Readings on the Wattmeter and the Wattless Meter.*

A	B	C	D	E	F
φ	$e \cdot i$.	$e \cdot i \cdot \sin \varphi$.	$e \cdot i \cdot \cos \varphi$.	$\frac{2}{3} \cdot e \cdot i \cdot \cos \varphi + \frac{1}{3} e \cdot i$	Coefficient E/D
0 deg	1	0	1	1	1
20 ,,	1	0·34	0·94	0·96	1·02
40 ,,	1	0·64	0·76	0·84	1·10
60 ,,	1	0·86	0·50	0·67	1·33
80 ,,	1	0·98	0·17	0·45	2·65
90 ,,	1	1·00	0	0·33	...

takes, together with an amount corresponding to one-third of the difference between the apparent power and the actual power; or, in other words, he pays for two-thirds of the actual power, together with one-third of the apparent power. The first column shows the phase-displacement; the apparent power is supposed to be unity; the readings in the two meters are given in the next two columns; the next column gives the amount of "complex" power for which the consumer actually pays, while the last column gives the ratio of this to the actual power. The consumer thus sees that it is to his interest to keep the reading in the wattless meter as low as possible.

In order to find the average phase-displacement, the ratio of the readings in the two meters is taken, and this gives the tangent of the angle. Thus, if the power meter reads 915, and the wattless meter 200, the tangent of the angle of the phase-displacement is 3·5. This gives a power-factor of 0·27, and a phase-displacement of 74 deg.; the coefficient, according to the curves, or by interpolation from Table I., is 1·88. According to Prof. Arno's method, the consumer would pay for 1,720 "complex" watts—*i.e.*, the product of 915 and 1·88. The calculations would probably only have to be done in the case of some of the larger consumers, and a graphical system might be considered a simplification.

It now remains to consider in addition to the already existing wattmeters on networks, how a supplementary meter could be added to give the desired figures. The simplest case is to take a polyphase net-work with three equally-loaded phases; the normal alternate-current meters are here employed, in which there is a phase-displacement between the magnetic fields due to volts and amperes of 90 deg. Then, if we put a current-coil in series with one of the conductors, and the pressure-coil is connected across between the other two, we get the driving active fields in phase, so long as the polyphase installation is free from induction, and the meter registers at a speed proportional to the wattless input. It is not difficult to see that the magnetic field due to the pressure coil is in phase with that due to the current coil, so long as the load is inductionless. But there are, of course, the same objections to this plan as there are to a watt-hour meter for polyphase current with equally loaded arms. It is better, therefore, to use an arrangement as shown in the accompanying diagram. Here a current-coil in conductor 1 works with a volt-coil, connected between conductors 2 and 3, while a current-coil in conductor 3 works with a volt-coil, connected between the conductors 1 and 2. The driving active field due to the pressure in the first of the above-mentioned volt-coils lags by 60 deg., so that it leads by 30 deg. in front of the corresponding current-coil in conductor 1. On the other hand, the driving active field of the second pressure-coil lags by 120 deg. behind the voltage which produces it, and leads in front of the field due to the current in conductor 3 by 30 deg. Such a meter can be very easily calibrated, has a high torque, and small losses in the pressure and current coils. The figures, which are shown on such an apparatus, are directly proportional to the wattless input at all loads and phase-displacements. The author describes another arrangement that may be used on polyphase circuits with a neutral return conductor. His Paper also includes some clock diagrams, which show the cyclic relations to one another of the various voltages, currents and fields.

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 39, 1915.

† See THE ELECTRICIAN, Vol. LXXII., page 731.

Portable Variometer for Magnetic Surveying.—Mr. G. W. Walker read a Paper before the Royal Society recently, in which a portable magnetic variometer for measuring horizontal force in a magnetic survey was described. The results obtained with it are discussed and compared with those of a Kew unifilar instrument. The operation of measuring force is reduced to a single reading of the instrument, together with a temperature reading at a definite time. The normal error does not exceed 5 per cent.

SELENIUM CELLS.*

BY W. R. COOPER. M.A., B.SC.

(*Continued from p.* 679.)

Summary.—A general account is given of the properties of the various varieties of selenium, this being followed by a discussion of the effects of light, the dependence of sensitiveness on wave length and the measurement of sensitiveness. In the latter part of the article is given some account of the theories which have been put forward to account for these facts. In conclusion some details of construction are given, and applications are briefly described.

Dependence on Wave-length.—It was very soon discovered that, generally speaking, the part of the spectrum including the yellow-red rays is more effective in its photo-electric effect on selenium than any other. The curve reproduced in Fig. 7, and which are due to A. H.

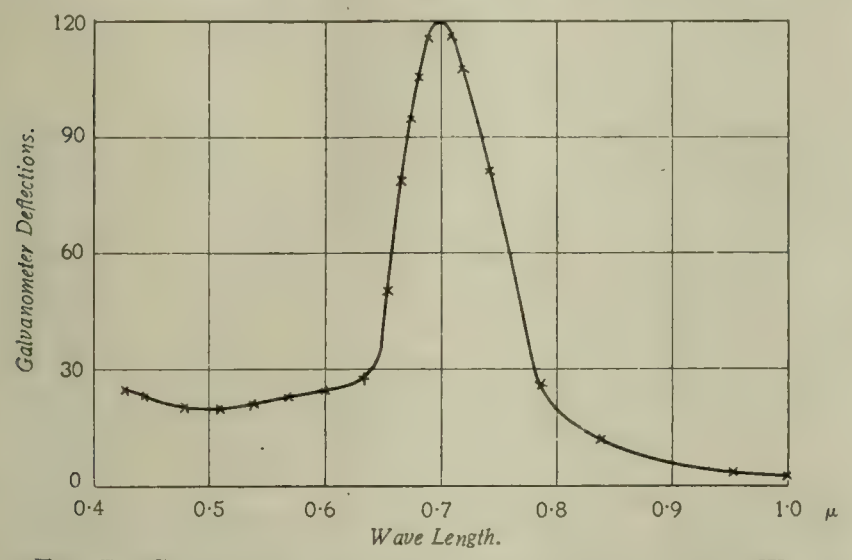


FIG. 7.—CURVES SHOWING VARIATION OF EFFECT WITH WAVE-LENGTH (PFUND).

Pfund,† are typical. From these curves it is seen that the maximum is very marked for wave-lengths of about 0·7μ, and do not vary much for the different illuminations examined. In making such an investigation it is necessary to be sure that the same energy is received at all observation points in the spectrum. This is ensured by first receiving

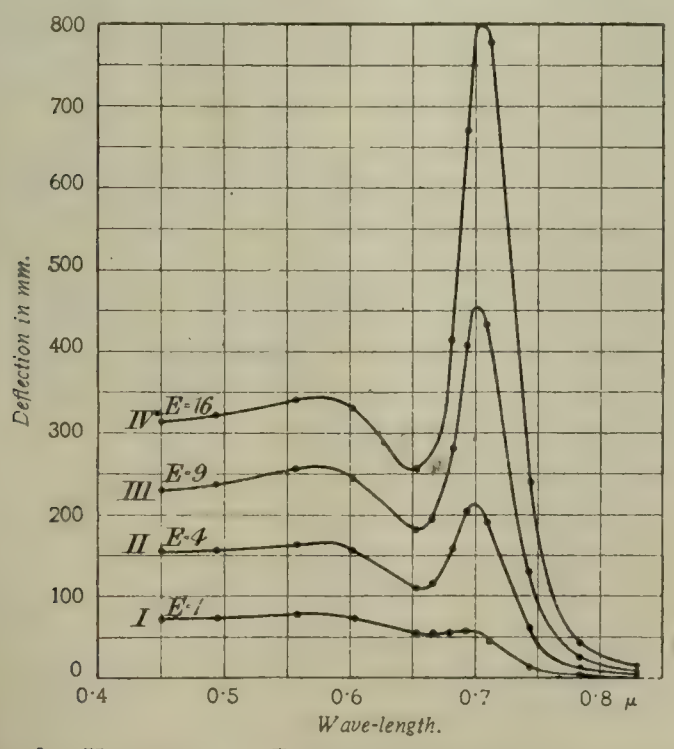


FIG. 8.—VARIATION OF POSITION OF MAXIMUM WITH INTENSITY OF ILLUMINATION (PFUND).

the illumination at each point on a thermopile and varying the illumination until the same deflection is obtained for each point.

Later investigations, however, have shown that the above statement must be accepted with considerable reservations.

* From a forthcoming edition of "Primary Batteries." (Copyright.)
† *Physical Review*, Vol. XXVIII., p. 324, 1909.

The same author* has shown that under feeble illuminations a maximum may occur in the greenish-yellow. This is seen from the curves in Fig. 1. Here the ordinates show the galvanometer deflections obtained for each of four illuminations, which were in the ratio 1 : 4 : 9 : 16. For the lowest illumination (Curve I.) the maximum is in the greenish yellow, but when the illumination is increased four times the maximum shifts to the red. It is noticeable that all the curves show two maxima. This is a feature which is very generally found.

E. O. Dieterich† has shown that the position of the maximum depends upon the temperature at which the selenium is annealed. If the temperature is high the maximum sensitiveness is in the blue, but if the temperature is lower the maximum tends to shift to the red. Some curves illustrating this fact are given in Fig. 9. In the view of Dieterich, there are two types of crystal, one sensitive to red and the other to blue rays. If the temperature is too high for the formation of crystals which are sensitive

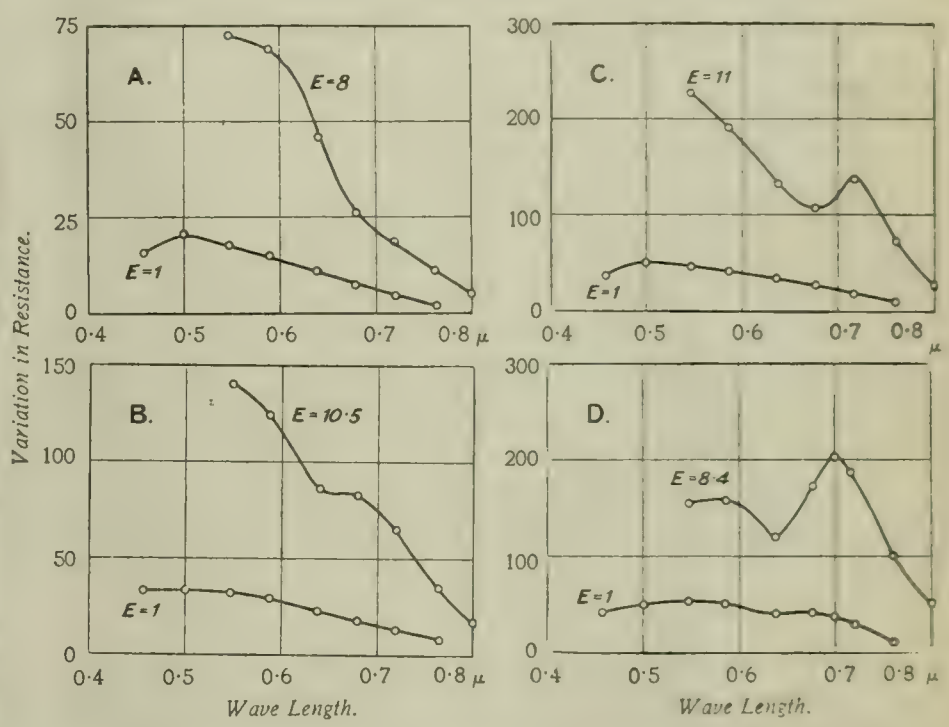


FIG. 9.—CURVES SHOWING VARIATION OF POSITION OF MAXIMUM WITH TEMPERATURE OF ANNEALING (DIETERICH).

Applied pressure, 16 volts; exposure, 0·4 second.

A. Resistance heated at 210°C. for four hours immediately after making.
B. Resistance heated at 210°C. for one hour and then at 200°C. for four hours.
C. Resistance heated at 210°C. for 30 minutes and then at 190°C. for six hours.
D. Resistance heated at 210°C. for 30 minutes and then at average temperature of 170°C.

to red, the maximum is in the blue. Various mixtures of the crystals would lead to the maximum being at some intermediate point.

It is natural to suppose that these differences of sensitiveness with wave-length might be accompanied by differences in absorption and reflection of corresponding wave-lengths by the selenium. Thus, if the light effect is due to penetration of the light, we should expect that when selenium is sensitive to, say, blue light it would show a maximum of absorption and a minimum of reflection for light of that wave-length. A. H. Pfund,‡ however, did not find any corresponding maximum and minimum in the absorption and reflection curves respectively corresponding with the maximum in the light sensibility curve. Absorption was found to be more marked in the blue and fell off towards the red, irrespective of sensitiveness.

* *Physical Review*, Vol. XXXIV., p. 370, 1912; *The Electrician*, Vol. LXX., p. 337, 1912.
† *Physical Review*, Vol. IV., p. 467, 1914.
‡ *Physical Review*, Vol. XXVIII., p. 324, 1909.

In all these properties there is liable to be a variation from cell to cell, as might be anticipated, owing to differences in the details of preparation.

Law of Variation of Light Effect.—The following formula has been given by E. Ruhmer * :—

$$R_d/R_l=(l/d)^n,$$

in which R_d and R_l are the value of the resistance under the smaller and brighter illuminations d and l respectively. The value of n was found to vary between 0·25 and 0·35.

Roughly, the variation in resistance when a steady condition has been reached varies as the square root of the illumination, but when the illumination is either very short or very feeble it is directly as the illumination.

G. Athanasiadis† prefers the more exact statement that

$$i=G(G-a)b,$$

in which i is the illumination, G is the conductance and a, b are constants.

P. J. Nicholson‡ found that the change in conductivity varied as a power of the illumination, or as I^n, the value of n varying from 1 to ½ according to the conditions, being ½ for long exposures.

In all such formulæ it is evidently necessary to define the experimental conditions rather carefully. This fact is

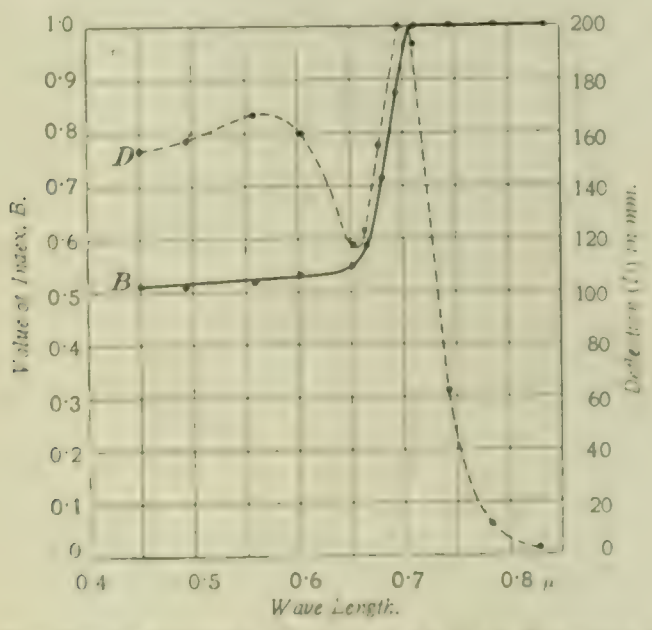


Fig. 10.—Curve showing Variation in B in Formula D = KE^B with Wave-length.

Illumination, 2·1 metre candles; exposure, 12½ seconds.

brought out by the curves in Fig. 10, which are due to Pfund.§ Here the law is expressed in the form D = KE^B, in which D is the deflection of the galvanometer, K is a constant, E is the energy received per unit area (in this case 2·1 metre-candles) and B is a number. With equal energy in different parts of the spectrum, curve D shows the deflections obtained, and curve B gives the corresponding values of B if this simple formula is to hold. It appears that B is about ½ for wave-lengths shorter than 0·65μ and 1 for wave-lengths greater than 0·7μ. Consequently the exponent must vary with the quality of the light.

Sensitiveness.—The sensitiveness of a selenium resistance to light may be expressed in the form

$$(R_d-R_l)\div R_d,$$

or

$$(G_l-G_d)\div G_d,$$

in which, for a given illumination, R_d and R_l are the values of the resistance when the selenium is in the dark and is illuminated respectively, and G_d, G_l are the corresponding conductances.

The sensitiveness falls off at very low temperatures. For example, Pochettino* mentions a case in which the resistance fell from 31,000 to 18,000 ohms at ordinary temperatures and from 2,600 to 1,900 ohms at the temperature of boiling liquid air; that is, the sensitiveness fell from 0·42 to 0·27. On the other hand, the sensitiveness decreases with rise of temperature at ordinary temperatures, and is stated by Pochettino† to be a maximum at −40°C.

L. S. McDowell‡ states that changes due to light take place more slowly at low temperatures, but that the final

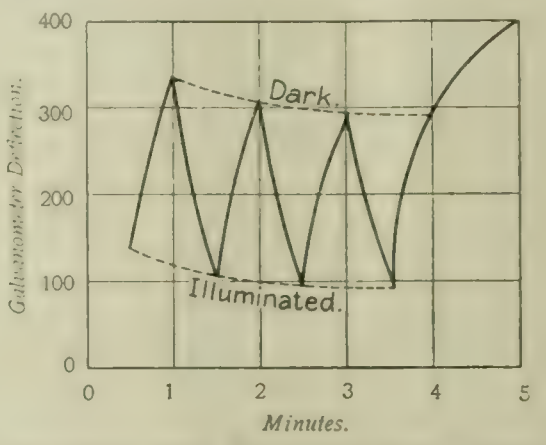


Fig. 11.—Galvanometer Deflection with Alternate Periods of Darkness and Illumination.

change carried to the point of saturation is enormously greater. The sensitiveness is also much greater at low temperatures.

It is sometimes said that the sensitiveness, expressed as the ratio of the conductivity in the light to that in the dark, varies from, say, 5 up to 20, and even 200. This basis gives information in a form in which it is often desired, but such figures do not convey a true meaning unless they are obtained under definite conditions. Unfortunately, high sensitiveness is only obtained along with high resistance; in fact, the lower the resistance the lower the sensitiveness,

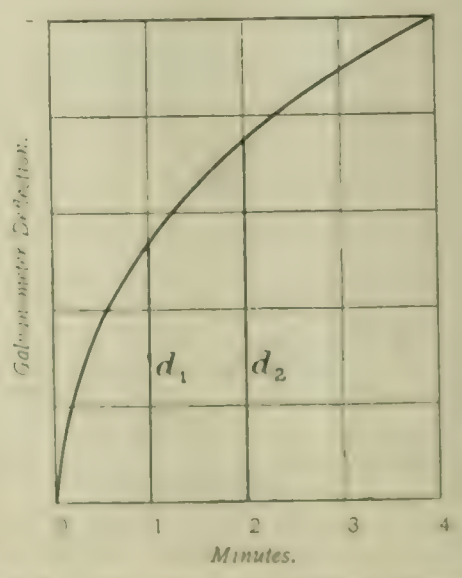


Fig. 12.—Calculation of Total Recovery.

which fact limits the usefulness of selenium for many purposes. When, for instance, the action required is the working of a relay, it is not so important to know the "sensitiveness" of the Se as it is to know the additional current it will yield under a given illumination, or what may be called its "efficiency."

Standard Tests.—There are so many possible variables

* *Elektrotechnische Zeitschrift*, Vol. XXV., p. 1021, 1904; *Science Abstracts*, 1905, No. 808.

† *Annalen der Physik*, Vol. XXV., p. 92, 1908; *Science Abstracts*, 1908, No. 671.

‡ *Physical Review*, Vol. III., p. 1, 1914.

§ *Physical Review*, Vol. XXXIV., p. 370, 1912. *Ib.* *Proceedings*, Vol. LXX., p. 337, 1912.

* *Atti*, Accademia dei Lincei, Vol. XI., p. 286, 1902; *Science Abstracts*, 1902, No. 1,888.

† *Nuovo Cimento*, Vol. VI., p. 147, 1911; *Science Abstracts*, 1911, No. 926.

‡ *Physical Review*, Vol. XXXI., p. 524, 1910.

in estimating this efficiency that E. E. Fournier d'Albe* has suggested the following standard conditions for testing :

(*a*) *Quality of Light.*—Complete radiation from a standard pentane lamp.

(*b*) *Illumination.*—To be 1 lux—*i.e.*, 1 metre-candle.

(*c*) *Applied Pressure.*—To be 1 volt.

(*d*) *Temperature.*—To be 15°C.

(*e*) *History.*—If the variation of conductivity is determined from the total recovery it will vary according to the previous immediate history of the selenium. In order to avoid this, the selenium is exposed alternately to light and darkness for one minute in each period until the galvanometer shows steady deflections for the light and dark conditions. Curves similar to those in Fig. 11 are thus obtained.

(*f*) *Measurement.*—Two Galvanometer readings are taken at two successive minutes during recovery. Taking the initial reading (the last one under illumination) as zero, the variation in the reading after one minute in the dark as d_1, and the variation after two minutes as d_2 (*see* Fig. 12), then the total variation from the light condition up to complete recovery may be calculated from the formula

$$\text{Total variation in conductance} = \frac{d_1 d_2}{2d_1 - d_2}.$$

The efficiency may be stated in micro-mhos per lumen,† or (with a pressure of 1 volt), in micro-amperes per lumen, or micro-amperes per square centimetre of sensitive surface divided by 0·0001.

The above conditions are laid down more particularly for feeble illuminations ; for other classes of work it might be desirable to modify them. The efficiency so obtained refers to exposures for one minute. If the selenium is to be used for shorter or longer intervals of exposure, the time interval in the measurements would be correspondingly altered.

* *Proceedings*, Royal Society, Vol. LXXXIX., p. 75, 1913.

† A light source of 1 c.p. gives a flux of 4π, or 12·566 lumens.

The efficiencies observed may be as high as, say, 25,000 micromhos per lumen for very feeble illumination, falling to, say, 5,000 or even a few hundred micromhos per lumen.

Similarly, the efficiency of a selenium cell would be defined as the E.M.F. in volts generated per lumen when the illumination on the plate is 1 lux (1 metre-candle). In the case of the cells used by G. M. Minchin for the selenium photometry of stars the efficiency was 1,270 volts per lumen.

Fournier d'Albe* states that selenium as a detector of light is at least 100,000 times as sensitive as a potassium photo-electric cell. Compared with the eye, selenium has the advantage of being more sensitive when the light is diffused.

Depth of Penetration.—There has been some discussion as to the depth to which the light penetrates the selenium. F. C. Brown† has shown that the effect of light is not restricted merely to the part that is illuminated ; the effect is also observed at some distance. He concluded that the depth of effective penetration was about 0·014 mm. On the other hand, W. S. Gripenberg‡ is of the opinion that the action extends deeply into the interior.

Electric Waves.—It is worth while to note that a variation in the resistance of selenium occurs when it is exposed to electric oscillations. Interesting work in this direction has been done by Louise S. McDowell.§ It appears that the effect is somewhat erratic ; it may be immediate or it may be deferred, depending on the state of the selenium. Possibly the effect may be akin to the well-known coherer action that is produced on metallic powders by electric waves.

In this connection it may be mentioned that Fritts‖ has found an increase in the sensitiveness of selenium to be caused by transmitting alternating currents through it, but the effect is liable to be transient.

(*To be concluded.*)

* *Loc. cit.*

† *Physical Review*, Vol. V. (2nd series), p. 167, 1915; and Vol. XXXIV., p. 201, 1912.

‡ *Physikalische Zeitschrift*, Vol. XV., p. 462, 1914.

§ *Loc. cit.*

‖ *Electrical Review* (*Telegraph Journal*), Vol. XVI., p. 208, 1885.

USE OF ELECTRICITY IN NORTH AMERICAN CITIES.*

An interesting Table showing the per-capita consumption of electric power in 20 large cities in Canada and the United States, has been made by Mr. H. E. M. Kensit, of the Dominion Water Power Branch, in connection with a study of power questions in Western Canada.

The high per-capita figures for power consumption in Winnipeg are due to the low cost of electricity and the high cost of coal and gas. The quoted figures are given as only approximate, although believed to be substantially correct. Care was taken to cover all sources of public electric supply for each city, including street and elevated railways. In each case the load and output for the city and district are taken, but the population shown in the accompanying Table is the estimated 1914 figure within the city limits.

Electric Central Station Loads in American and Canadian Cities, 1914.

—	Estimated Population, 1914.	Connected load, kw.		Peak load, kw.		Output, kw.-hour generated.	
		Total.	Per capita.	Total.	Per capita.	Total.	Per capita.
Atlanta, Ga.	199,740	88,000	0·440	44,320	0·222	145,684,803	730
Buffalo, N.Y.	457,900	137,872	0·310	67,424	0·147	302,220,107	660
Chicago, Ill.	2,436,000	852,000	0·350	344,500	0·142	1,280,962,600	527
Columbus, Ohio	213,900	49,309	0·230	19,471	0·091	70,283,250	329
Detroit, Mich.	583,000	...	...	87,800	0·150	329,395,900	565
Louisville, Ky.	232,350	97,000	0·417	28,200	0·122	100,692,219	433
Milwaukee, Wis.	420,000	...	...	46,924	0·112	170,889,000	406
Minneapolis and St. Paul	601,900	144,778	0·240	91,655	0·152	270,168,475	450
Nashville and Chattanooga	179,590	60,843	0·338	20,200	0·113	71,401,500	398
Philadelphia	1,671,000	202,086	0·121	82,078	0·490	275,711,745	165
Pittsburgh	572,700	...	...	71,000	0·124	316,500,000	553
Portland, Ore.	314,000	...	...	47,775	0·152	199,166,000	634
Providence, R. I.	249,000	82,060	0·330	39,700	0·160	113,286,600	455
Rochester, N. Y.	248,000	68,177	0·274	29,813	0·120	123,850,785	500
St. Louis, Mo.	740,400	...	...	92,176	0·125	319,151,753	430
Toledo, Ohio	187,250	60,315	0·322	23,965	0·128	91,996,426	491
Montreal, Que.	570,500	222,000	0·384	65,000	0·113	300,000,000	520
Toronto, Ont.	468,000	178,677	0·382	64,064	0·137	250,240,500	535
Vancouver, B. C.	186,400	61,290	0·330	34,300	0·184	124,884,565	668
Winnipeg, Man.	226,000	136,000	0·600	43,300	0·191	167,765,000	740

* From "Engineering News," slightly abbreviated.

The Electrician.

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THE MODERN BOILER.

The Paper, of which an abstract is given elsewhere, that was read by Mr. A. D. PRATT before the International Engineering Congress at San Francisco, deals with many matters of interest to the boiler maker and user. We think that the author, speaking as a boiler maker, is a little too modest when he states that steam generating apparatus, as it is in general use to-day, represents nothing essentially new. He warns us, however, not to confuse changes making for safety in operation with changes of design. Although the design of the representative boilers in use at the present time is not radically different from the design of those that have been offered for twenty years past, it is nevertheless well known that during this period the development of the art of steam generation has been phenomenal. Much of the development is due to improvements in detail, and these have had a profound effect on design. The last quarter of a century has seen the birth of the science of steam generation.

Little more than five-and-twenty years ago steam users were content to get what steam they could from a ton of coal ; nowadays the losses are so easily determined that makers and users can study and measure each loss separately, and by modifying detail, exactly where modification is needed, they strive to minimise each of the several losses. Had we to accept the view that modern steam generating plant represents nothing essentially new, we should be equally prepared to admit that modern dynamo-electric machinery represents nothing essentially new. We neither accept the one nor admit the other, except in the light that there is nothing new under the sun. In this light the idea underlying the water-tube boiler dates back to an earlier

period than the dawn of the Christian era, for excellent specimens are in existence which prove conclusively that the Pompeiians were familiar with the principle. One would no more think of giving credit to the Pompeiians for the water-tube boiler—which it is thought was used by them for the making of hot drinks—than one would think of attributing the steam turbine to HERO.

It is well within the last twenty years that the water-tube boiler has come into its own. A perusal of the discussion on the report of the committee, appointed by the Lords Commissioners of the Admiralty, to consider certain questions respecting modern types of boilers for naval purposes makes it perfectly clear not only that the advantages of the water-tube boiler were not well-established in 1901, but also that many engineers had hazy notions as to the form such a boiler should take. The effect of this discussion was to direct attention to the natural laws underlying the generation of steam, and knowledge of these laws made it clear that they could be utilised to the best advantage in boilers of the water-tube type.

At the present time every effort is made to secure higher efficiencies and to obtain greater capacities from a given heating surface. We agree with Mr. PRATT that improvements in furnace design and mechanical improvements in stoking apparatus are factors having an important bearing on high efficiency. An equally important factor is the use of recording apparatus for showing water evaporated, fuel consumption, temperature, gas analyses and draught. Furthermore, the present position is largely due to the practical application of the science of steam generation, of which we have spoken, and to the employment of highly skilled labour in the boiler room. Higher efficiencies and greater capacities are not limited to coal-fired boilers, and in the Paper reference is made to the results obtained with other fuels such as oil, wood and sugar-mill refuse, blast-furnace gas and waste-heat Several striking examples in this country illustrate the commercial efficiency of waste-heat plant. At one waste-heat station there are seven boilers evaporating in all 101,000 lb. per hour at 200 lb. to 235 lb. pressure and 180°F. to 200°F. superheat, the boilers being fired by the waste-heat and spare gas from 176 coke ovens. Of the total units generated at this station, the colliery company utilise $7\frac{1}{2}$-million and have a surplus of $18\frac{1}{2}$-million disposable by co-operation with the supply company. The system is one we should like to see very much extended in the future.

Of the four tons of coal consumed per head of the population in the United Kingdom relatively little has been done towards the development of plant for the recovery of the by-products. The problem is a fascinating one, but there is no prospect of an immediate commercial solution. Mr. S. E. FEDDEN, in his I.M.E.A. Paper on "Design and Operation of Modern Boiler House Plant," in 1914 dealt with the percentage of the total plant in an electric power station which could be economically operated by means of the fuel obtained from by-product plant. Other things being satisfactory he suggested that it might be economical to provide by-product plant for about 8 per cent. of the total plant of a power station, and found that this plant should be run at practically 80 per cent. load-factor to make it a paying proposition.

During the last decade considerable progress has been made in obtaining greater capacity from boiler heating surface. As evidence of this progress Mr. PRATT states that last year boilers rated at 6,100 H.P. were installed for supplying steam to a 30,000 kw. set, whereas in 1903 it was customary to provide 4,000 rated horse-power for a unit whose maximum output was 7,500 kw. Although we are still profoundly ignorant of the laws underlying the transmission of heat from a hot gas to a metallic surface here also there are signs of useful practical work being done. In this connection reference is made by Mr. PRATT to the work of Dr. W. NUSSELT, Mr. H. P. JORDAN and Messrs. H. KREISINGER and W. T. RAY, and those interested in the subject will do well carefully to study the results, given in the original Paper, of a comprehensive set of experiments on heat transfer rates. As yet little progress has been made in the utilisation of radiant heat, but good work is being done, and boiler makers and users are beginning to interest themselves in the matter. The further development of the steam turbine will accelerate the progress of boiler design and construction, and the adoption of higher pressures and of higher degrees of superheat are being considered. These, if adopted, will tend to modify the designs of existing boilers and will, in all likelihood, lead to the introduction of new types.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

The Wireless Telegraphist's Pocket-book of Notes, Formulæ and Calculations. By J. A. FLEMING, F.R.S. (London: Wireless Press.) Pp. xii.+347. 6s. net.

Most engineers' pocket-books contain a necessarily more or less arbitrary mixture of *potted* theory, brief descriptions of apparatus, and many tables of physical and mathematical quantities. According to the author's Foreword, the present work is "merely a *memoria technica* of formulæ, data and useful tables required in practical calculations connected with radiotelegraphy"; but the book is thus very inaccurately defined. It is mainly a theoretical textbook of wireless telegraphy, in a condensed form, suited to those who are not reading the subject for the first time. We say *mainly* for two reasons: those parts of the book which fall under this description occupy some 200 of its 340 pages, and they are, in our opinion, by far the most valuable feature of the work.

Most of the mathematical sections, pure and applied, are excellent. They will be very helpful to the wireless engineer who desires to refresh his ideas on the theory of radiation, or who cannot solve a differential equation as rapidly as he once could.

A few points, however, call for criticism. Surely in high-class teaching the practice is peculiar, even in this country, of using the decrement per *half* period, which the author calls the decrement and writes δ. At any rate, it is to be hoped so, for this nomenclature seems confusing and illogical. Almost on the same page in this book one finds worked out, or cited, formulæ for the *whole* period and this queer *half* decrement. A similar lapse in logical form occurs in the author's use of the "oscillation constant." It seems unnecessary to give the product $\sqrt{CL}$ a special name at all, but at any rate the quantity should not be measured in a mixture of electrostatic and electromagnetic units.

An extraordinary theoretical mistake occurs on p. 197. To find the number of useful periods of a Hertz oscillator, although the decrement has already been calculated, and the problem therefore solved, the author calculates the initial energy and the energy radiated during the first period. The latter proving to be nearly half the former, it is stated that "hence all the stored energy is radiated in about two complete oscillations."

We think the theory of the Poulsen arc might have been more amply given; arc transmitters are disposed of in three pages, and without a single diagram.

As a laboratory manual the book is far less satisfactory. Diagrams are lacking. The Stefan formula for inductance of single-layer coils is too cumbersome for practical use, and

could advantageously be replaced by newer formulæ and tables ("Wireless World," 1915. Esau, "Jahrb. d. t. dr. Teleg.," 1912). No mention whatever is made of the Audion, or the Rotary Tikker which has quite replaced the vibrating type; nor is the shunted-buzzer method of exciting oscillations, so useful in laboratory work, described. One resents the presence of the Fleming cymometer as the frontispiece in a work, professedly not historical, when diagrams of modern practical apparatus are sadly wanting. It is curious that in the several diagrams of, and references to, the valve detector no polarising P.D. is provided.

The style and contents of the mathematical portions of the book are what one might expect from a writer of the author's high standing. It is hard to believe that the last 50 or 60 pages of the text are the by same pen. Both by style and matter they appear to be addressed to a lower class of reader. They embrace two chapters on transmitters and receivers, and an elementary chapter of "Practical Information for Wireless Operators."

The book ends with a number of useful tables of mathematical functions and physcial constants. But since it cannot be regarded as a comprehensive work, and the tables can easily be found elsewhere, their inclusion is of no great importance.

The book is well printed and is suitably shaped and bound for the pocket; but the misprints are rather numerous and the index very incomplete.

If the volume ended after the first 200 odd pages and bore another title it would deserve almost unmixed praise.

L. B. TURNER.

Constant Voltage Transmission. By H. B. DWIGHT. (London: Chapman & Hall.) Pp. vii. + 115. 5s. 6d. net.

This little book deals with the advantages of synchronous motors for the regulation of voltage of transmission lines as distinct from their more usual employment in the raising of power factor. The action is, of course, the same, the power factor being what is primarily altered by the alteration of the field current, but the immediate aim in this instance is to maintain the voltage at the receiver end of the line at a constant value. For this purpose the field current is continually varied as may be necessary, either by hand or automatically, preference being given to the latter method. There are many advantages in the adoption of this system of regulation. The load may be increased two or more times as fluctuations in voltage with load are eliminated; and the conductors used on transmission lines may be larger and they may be spaced farther apart, as there is not the same objection to reactance as in the case of variable voltage. Incidentally, it is an advantage that the method can be tried little by little, more synchronous machines being installed as the results are found to be satisfactory. On the other hand, there are certain disadvantages, but on the whole these are unimportant except in the case of short high voltage lines, where the cost becomes increased by this method of regulation. The system is being used satisfactorily on some of the long transmission lines in the United States, such, for example, as the 140-mile line of the Utah Power & Light Co.

A great part of the book is somewhat popular in character, but at the end the author gives estimates of costs for four lines showing how the advantage increases with the length of line. He also gives in detail methods of calculation and various formulæ used in transmission problems, which should be distinctly useful to engineers interested in this subject.

The Practical Electrician's Pocket Book and Diary, 1916. (London: S. Rentell & Co.) Pp. 177. 1s. and 1s. 6d.

This handy electrical compendium is in its 17th edition and new sections have been added on electric pumping plant, electric drills, blowers and lifting magnets, mining telephones and shaft signals and bells and indicators. Acting on a suggestion from Mr. A. H. Seabrook, the publishers have included a chapter on accumulator road traction. The latter is a concise survey of the present position of the electric battery vehicle, and has been compiled by Mr. R. J. Mitchell. It should prove valuable in acquainting electrical contractors with the growing importance of the battery vehicle. In the list of company and municipal electricity undertakings a special designation has been adopted for those stations which furnish electrical energy for battery charging in accordance with the rates fixed by the Electric Vehicle Committee. The towns where battery vehicles are in use are also indicated. The other matter in the book maintains the high standard of excellence of previous editions. Its claim to the title of a "practical" pocket book is fully justified.

Mechanical World Electrical Pocket Book. (Manchester: Emmott & Co.) Pp. 240. 6d.

This popular pocket book contains the usual sections giving general data and information on dynamos and motors, instruments, cables and conductors, telephones, &c. A new chapter on earthing, a subject which is in need of ventilation, has been added, and the section on batteries now includes particulars of the alkaline cell. Other new features are notes on half-watt lighting and the efficiency of direct-current dynamos and motors.

Mechanical World Pocket Diary and Year Book. (Manchester: Emmott & Co.) Pp. 330. 6d.

This widely read pocket book, now in its 29th year of issue, has a number of new features, notably a section dealing fully with the Diesel engine, its design, thermal efficiency and practical operation. The section on steam boilers has been re-written and information added regarding boiler scantlings, boiler mountings, &c. New tables are also included which deal with Lancashire and Cornish boilers, the dimensions of locomotive boilers, steel plates, friction clutches, circle spacing tables, &c. The standing matter has been revised and brought up to date where necessary.

Penrose's Annual. Edited by W. GAMBLE. (London: Percy Lund, Humphries & Co.) Pp. 112. Price 5s.

The 21st issue of this well-known annual, dealing with process work, is of a high standard, containing many beautiful examples of the engraver's art both in the older monochrome processes and by colour printing. There are a number of short articles, which are mostly beyond our province, but we notice one by Mr. Harold Holt, suggesting that electrolytic etching might well be substituted for the ordinary acid etching of zinc blocks. The suggestion seems worth consideration, if for no other reason than that it allows the automatic recovery of zinc which is otherwise wasted. Another article, by Mr. G. E. Dunton, refers to the value of technical education and describes what is being done in New York to turn out young "comps." properly equipped for their work. The get-up of the volume leaves nothing to be desired.

THE ORGANISATION OF SCIENTIFIC RESEARCH.*

BY J. A. FLEMING, D.SC., F.R.S.

Summary.—The author deals with the methods of scientific research, with the means of conducting such research, and outlines a suitable training for the men engaged in scientific and industrial research.

In the last 40 years there has been a slowly progressive enlargement in the provision made within the British Empire for conducting and encouraging scientific research, though by no means proportional to the necessity for it.

Amongst the indirect results of the appalling war, we may hope that there will be some increased appreciation in the minds of the politicians who govern us of the enormous influence of scientific research and discovery, even in its most abstruse forms, on the prosperity and safety of the Empire.

The public is too prone to judge of the success or value of scientific work by the degree to which it can be immediately applied in what are called useful purposes. They require to be instructed that we cannot produce merely the knowledge which is instantly utilisable in common life. Practical invention is much affected by other factors, such as our patent laws, fiscal policy and wise or unwise commercial legislation. These will require thoughtful revision in view of coming competition.

* Abstract of a lecture delivered at the Royal Society of Arts on the 9th inst.

The question obviously divides itself into the three sections: (1) Methods, (2) Means and (3) Men.

I. Methods of Scientific Research.

The great bulk of all our scientific discovery and research in the past has been due to individual labour and initiative; much of it a labour of love, unrecognised at the time. Men of great genius have opened up new lines of thought or pursued private researches often with very inadequate appliances. In fact, the greater part of past British scientific research may be said to have been amateur work, not in the sense that it was lacking in the highest qualities, but only in the sense that it was pursued for the sheer pleasure and interest of it by private individuals. The author refers to the necessity for co-operation in scientific work, and states this is already being done by the British Association and Faraday Society to some extent. Also scientific societies should at the beginning of each session direct attention to important matters.

The White Paper, which was issued last July by the Board of Education, signed by Mr. Arthur Henderson, seems intended to bring into existence some machinery for effecting this desired end. So far as the "Scheme for the Organisation and Development of Scientific and Industrial Research," outlined in this White Paper, is formulated in detail, it appears to consist in the establishment of (i.) a committee of the Privy Council, which will be responsible for any expenditure voted by Parliament for scientific and industrial research; and (ii.) a small advisory council, composed mainly of scientific men and men actually engaged in industries dependent upon scientific research.

The primary functions of the Advisory Council are stated to be to advise on :—

1. Proposals for instituting specific researches.
2. Proposals for developing or establishing special institutions for the study of problems affecting particular industries.
3. The establishment and award of research studentships and fellowships.

The White Paper tells us that it is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned on which it would be desirable to enlist the services of persons actually engaged in science, trades or manufactures.

It is clearly impossible for any single board composed of a few men, however eminent, to deal in any reasonable time with all the research problems awaiting solution in physics, inorganic, organic and technical chemistry, metallurgy, engineering, electrotechnics, bacteriology, agriculture, &c., and the questions concerned in the recovery of our trade in dyes, drugs, glass, ceramic ware, ferro-alloys and scientific apparatus.

Hence separate bodies of experts will unquestionably be required to deal with the different subjects in order to bring to bear upon them the proper technical knowledge and to guide research on the right lines.

But now, if this is the case, the question at once arises: Why is it necessary to create new machinery for dealing with these matters?

The proposition I submit for your consideration is that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. The essential matter is that this organisation of scientific research should not become bureaucratic or academic, but should be conducted by bodies representative of the best technical and scientific opinion, and be closely in touch with the members of each of the several scientific and technical societies.

If public funds are to be administered, then it might be proper that certain of the members on each board should be appointed by the Government Department concerned, say, by the Education Department; but my contention is that the organisation work should be the work of scientific men as a whole and not any small section of them, or be carried out by Departmental officials over their heads.

Suppose, then, we assume that we have created permanent advisory committees for the different branches of pure and applied science, the duty of which should be the organisation of research in the irrespective departments. Their first work should be to draw up as comprehensive a report as possible, pointing out the general needs of each department of knowledge and the most necessary directions of research.

The first report would, no doubt, have to be concerned chiefly with the deficiencies in the appliances and means of correcting it, such as laboratories and apparatus. Also with the number, and supply, of men available for or actually engaged on research work. Subsequent reports would then be properly occupied with the more detailed discussion of the problems awaiting investigation and particular suggestions for directions of research. These advisory boards would have then to be supplemented by some means for carrying out their suggestions into practice.

The author next deals with the position of the scientific man employed in a works, and with the difficulties which arise, such as patent rights, and expresses the view that some scheme of profit-sharing is undoubtedly the fairest, and the best to couple together the interests of all parties. He dismisses the idea of the State rewarding a scientific man by a pecuniary prize owing to the difficulties which arise.

Who, for instance, could have set a value on Faraday's discovery of induced currents or magneto-electric induction, when in 10 days of unintermitting work at the Royal Institution in the autumn of 1831 he gathered in new knowledge of surpassing importance to mankind? These facts had no apparent value at the time, yet their application has brought wealth in untold millions into the exchequer of nations.

I remember speaking, shortly after Clerk Maxwell's death in 1879, with an eminent Cambridge mathematician concerning Maxwell's great Paper published in 1865 "On the Dynamical Theory of the Electromagnetic Field." He told me in all seriousness that the impression produced on his mind by this great Paper was, that it was one of the most exalted productions of the human intellect. Yet it was 20 years, and long after Maxwell's death, before this Paper brought forth its fruit in Hertz's work, and 35 years before we saw the final outcome of it in the achievements of wireless telegraphy.

I believe the only practical method of assisting scientific research is by a well-devised system of research scholarships and fellowships renewable annually or at longer intervals, and in any case held subject to productive work.

If we combine such a system with the above suggested advisory boards, there is a possibility of creating a workable system for the endowment and encouragement of scientific investigation which will be kept in close contact with practical necessities as well as with the most fertile regions of scientific thought. The important question is, then, the ways and means.

Deferring for a moment the consideration of the training of the men necessary for conducting research, we may consider in the next place :

II. Provision of Means for Conducting Scientific Research.

By this is meant the materials and apparatus required. In early days these were simple and comparatively inexpensive. Much great work has been done with simple apparatus. Nevertheless, our modern scientific research requires, for the most part, costly appliances.

One rather startling experience at the outset of this great war was the discovery of the extent to which we had become dependent on Germany and Austria for these implements of research. We found that our sources of supply of chemical glass such as flasks, beakers, tubes, graduated vessels, and more complicated pieces of analytical apparatus was cut off. Also porcelain crucibles, basins, tubes and retorts, filter papers, and large numbers of research chemicals were not produced in England of the requisite quality. Amongst pharmaceutical chemicals, a very large number have been unobtainable, or obtainable with difficulty, since the war—such as salicylates, salvarsan, veronal and phenacetin.

This partial famine in essential scientific materials and apparatus is not due to any real want of scientific ability on the part of British inventors or manufacturers. It is due to causes which are very deep-seated. For one thing, our easy-going national temperament has found it less trouble to buy from abroad than make for ourselves. Labour difficulties, our fiscal policy and other causes have rendered it difficult to compete with German prices.

Above all, the mistakes and ignorance of politicians who allowed themselves and others to believe that there was no real danger of a rupture of peace, and that Germany's tremendous preparations for war had no other object than defence against sudden attack by jealous neighbours, acted like an opiate on our spirit of commercial enterprise and dulled our instinct of self-preservation.

Meanwhile it is to be hoped we are now awake to facts, and that our scientific men, manufacturers and statesmen will unite in remedying the present serious condition of affairs.

Now the question is—are we going back, when peace returns, to the old easy-going habits of importing German-made scientific apparatus? Surely the answer is No! a thousand times No! But unless we wish Germany's crime-stained hands to take back in commerce what she has lost in war we have to create and maintain an entire scientific and economic independence of our own. For this purpose we need, for one thing, a properly-complete Scientific Intelligence Department. The different agencies, committees and institutions which have been endeavouring to supply scientific information as to manufactures should have as their resultant a single organisation, the function of

which should be to collect and distribute all possible information concerning the mode of manufacture and cost of production and information concerning the patent position, if any, of all the appliances and materials used in scientific research. Such a scientific intelligence and information bureau might need subsidising at the start, but it might be possible later on to make it self-supporting by the subscriptions of firms and persons who desired information on particular matters. Just as one can pay a fee to a patent agent to conduct a search for anticipations on some particular subject, so this information bureau should have as its object to collect and supply to its subscribers all possible information concerning the manufacture or supply of the materials and implements of scientific research.

There are already the beginnings of such a scheme in the information published by the Institute of Chemistry on reagents for analytical purposes prepared by a special committee appointed by the Institute and by the Society of Public Analysts and other Analytical Chemists. There is also an association called the British Laboratory Ware Association, formed by various firms to stimulate the production in this country of various laboratory requisites hitherto mainly produced in Germany.

The means that shall be taken to prevent this nascent national production of the materials of research from being killed by subsequent German competition is a question to which our political economists and statesmen must address themselves very seriously. It is only a small part of the great problem of our *post bellum* commercial policy in relation to the British Empire and our Allies, but the consideration of it lies beyond our present purpose.

We have then to consider :

III. Training of Men Necessary for Conducting Research.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can hardly be doubted that much can be done to foster and assist research and invention.

The nation must be educated to see that the men with high scientific and inventive ability, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality.

The great outstanding fact in modern life is the degree to which the energies and materials of Nature are employed to overcome the difficulties created by the increase and concentration of population. Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind. Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it.

The Public Schools and Law Courts are then dealt with. The destruction of the madder and indigo industries by German synthetic research is referred to as showing the effect of science on industry of a country, and it is urged that we ought to create a very much closer union between industry and science.

To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of man more useful in the factory. For this reason I am an advocate of the so called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches, but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student apprentice, so as to turn out all round men and not unpractical theorists or unscientific practists. We have to improve in many ways our college teaching, so as to expend to better advantage the available time, and place more stress on ability to use information than to store it. One result of the war and of the economic pressure which will follow, will no doubt be to diminish the time given to amusements and games at both schools and colleges.

DISCUSSION.

Mr. J. S. Swinburne, F.R.S., said that the first thing a traveller should do on setting out on a journey was to settle where he wanted to get to. Here there were two or three objects in view. The recovery of England and the Allies; further suppression of Germany; or to manufacture everything ourselves. The science of economics had been more neglected than "science" in England. Economics was far more important for the nation and the public. He did not see how a discovery made in this country and published would help us if other nations could copy it. There was a confusion between scientific research, industrial research and invention. After contrasting the different way of viewing things in this country and in other countries, he expressed agreement with the author that any kind of research in the hands of the Government was useless. A Committee was quite useless—ordinary Committees were bad enough, but Government Committees were infinitely worse. He did not consider the author's suggestions about research practicable—research was dull work. He thought that students should be trained in economics, next the State must not lay its deadening hand on industrial advance, the student should be trained in principles at college, and do their research work in the works. The Patent Laws should be revised, not by politicians and lawyers, but by the people concerned.

Sir W. Tilden, F.R.S., said that half the members of the House of Commons should have been as well educated in science as the other half were in the old classical manner. Mr. Haldane once stated that when his party got into power a substantial proportion of scientists would be put in every office in Whitehall, but he (Sir W. Tilden) did not see much change. In Germany students were taken into works and paid a living wage. In this country students asked "What will it lead to?" when offered a research scholarship. He would like to hear the views of some big manufacturers on this question.

Dr. W. H. Eccles thought many scientific men would agree as to the possibility of organisation of industrial research. Collaboration was difficult in the fine arts, such as painting, or literary work. Though such a scheme might work for industrial research it might be harmful from a purely scientific point of view. These two sides had to be borne in mind.

Prof. A. Bone, F.R.S., was apprehensive of any research work getting into the hands of Committees. He saw danger in specious schemes of scientific socialism.

Prof. H. E. Armstrong, F.R.S., preferred to follow Mr. Swinburne's views. He said we must not blame the public and politicians for their ignorance, because we ourselves were the authors of this ignorance. He did not believe any improvement would be seen in Parliament after the war for one, two or three generations. Unless the scheme of British education was absolutely reformed he did not believe this country would make any progress. After referring to the different kinds of research he said that he believed our disease was brought on by the teaching in our schools, the only solution of which was to crucify or get rid of the headmasters in some way.

Mr. Walter F. Reid desired to emphasise the point that inventors were treated very badly in this country. He knew this as Chairman of the Institute of Inventors. The inventor ought to be encouraged instead of discouraged as at present.

Mr. J. W. Lovibond, speaking as a free lance in research, referred to errors in text-books on light and said he held that aeroplanes could be rendered less discernible by scientific colouration, but scientific men seemed to think it so difficult as not to be worth a trial.

Mr. L. Gaster wished to emphasise the point that if a Government Department was approached with a definite scheme, it was taken up practically. He referred to the Home Office and illumination of streets.

The Chairman (Dr. Dugald Clerk, F.R.S.), in proposing a vote of thanks, said he agreed both with the author and Mr. Swinburne regarding the necessity of studying economics. He thought scientific men were over-rating the danger of foreign competition. The efforts of British people were more successful than that of any other people, except America, the average income per head being £53 per annum. Competition was not a thing to be frightened of. England and France, besides being the chief scientific nations, were also the chief industrial ones. There was no "war on industry," and if any person fancied they could send things to a country without getting goods back, the sooner they went to school and learned economics the better.

British Science Guild. The "Journal" of the Guild for January contains copies of the memorial on "Universities and War Economy," the report of the Microscope Committee and a list of the Universities, Education Committees and schools where only British made glassware will be used for three years after the war, providing the price is satisfactory. There are Papers on "Organisation and Education," and "Science and War," together with a Paper on the "Introduction of the Metric System" by R. A. Gregory. There is also a copy of a letter written by the President, Sir William Mather, to the Prime Minister, on "The Mobilisation of Science."

THE CONTACT SYSTEM OF THE SOUTHERN PACIFIC COMPANY, PORTLAND DIVISION.*

BY PAUL LEBENBAUM.

Summary.—The Paper describes in detail the overhead contact system of the electrified lines of the Southern Pacific Company, Portland Division, which operates at a potential of 1,550 volts. The design and materials of construction and the cost per mile of material and labour are given.

The electrified lines of the Southern Pacific Company, Portland Division, extend from Portland to Whiteson, a distance via Forest Grove of 54·0 miles and via Newberg of 45·2 miles, with a line from Cook to Beaverton 7·4 miles long. All these had been operated by steam for many years. At Hillsboro, Forest Grove and Newberg, detours from the main line permitting electric trains to pass through the centre of these three more important towns were constructed; inclusive of detours, the total length of main line single track is 104·0 miles, with approximately 16 miles of electrified second track and sidings.

Except for 3 miles of 600-volt trolley in Portland, the operating potential is 1,550 volts. Construction was actively undertaken in July, 1912, and the lines were put into operation in January, 1914.

The electrification work was carried on during the operation of the road by steam, resulting in much "lost time" due to the distance between sidings and the lack of frequent telegraph stations.

In general, side-bracket type of catenary construction is employed, the poles being placed on the outer side of curves. High-tension transmission lines (13,200-volt) are carried on the same poles as the contact system between Oswego and Dundee and between Oswego and Forest Grove, via Beaverton, their total length being 47 miles. In order to maintain the transmission line on one side of the track, cross-span construction is used where the poles come on the inside of curves.

The standard pole spacing on tangents is 150 ft. Over 25 per cent. of the main line mileage is curved track, the portion between Sherwood and Springbrook being exceedingly crooked; on this account, as well as on account of siding and cross-span construction, 5,666 poles were used, or an average of 54 poles per mile. Construction was further made more difficult by the presence of 25,204 ft. of trestle, of such height as to make support of the pole on the trestle a necessity.

In the following, the costs due to the presence of a high-tension line on the poles supporting the contact system have been eliminated as not being relevant.

Poles.—All poles are nominal 9 in. diam. top, cedar, purchased under specifications that required a top circumference between $27\frac{1}{4}$ in. and $32\frac{1}{4}$ in., and subject to inspection at destination; it was found that, unless some limitations were placed on contractors, the term "9 in. top" was very flexible. The standard pole length for catenary construction is 35 ft.; for transmission and catenary, 40 ft.; local conditions, such as crossing of telephone and telegraph lines by the transmission line, increased these lengths. The cost of the poles at the hole varied from £1. 15s. for a 35 ft. pole to £2. 8s. for a 55 ft. pole.

All poles were given two thorough brush treatments with carbolineum avenarius, from a point 18 in. above the ground to within 3 ft. of the butt. The preservative was applied by means of burlap fastened to the ends of long mop handles and was kept hot by steam coils placed on the bottom of the shallow tank over which the poles were rolled. Steam was furnished from a locomotive and approximately one gallon of preservative (including losses due to leakage from barrels and evaporation) was used per pole.

Contact System.—The details of the materials used in the support of the contact system were developed by the Southern Pacific Company on its 1,200-volt suburban system at Oakland, Cal., some slight modifications being made to meet local conditions. Pole and line material is galvanised or Sherardised, all bolts and nuts being given the latter treatment. The increased cost of galvanised material was deemed to be warranted on account of increased life and decreased up-keep in a region where rains, winter and summer, are of frequent occurrence.

The messenger cable is $\frac{7}{16}$ in. high-strength (crucible) steel strand (15,000 lb. breaking strength), strung at a tension of approximately 2,200 lb. at 70°F. The tension in the 4/0 grooved copper trolley wire is 2,000 lb. A construction train was used to erect the messenger and trolley wires and to clip in the hangers. As first installed the locknut was omitted. The threads on the rods, due to the vibration of the line, began to strip, and the locknut was added to overcome this trouble, which it has done. The standard 150 ft. span weighs 1·152 lb. per foot.

A mechanical clamp holds the messenger in the groove of the insulator, and prevents slipping in the event of line trouble. The contact system is further anchored every half-mile on tangents, and against a curve at each end thereof, so as to take the strain out of the curve. Steady-braces were installed every half-mile, after the system was placed in operation, they being found a necessity; on curves, the pull-offs have a steadying effect.

The line is sectionalised at all junction points, at sub-stations, and where the voltage changes from 1,550 to 600, a sectionalising insulator being used. On account of the hard spot introduced in the line by this device, a section break, consisting of two parallel wires suitably insulated from each other, is being developed.

The cost of a mile of tangent construction was £300 for material, labour £440. To this must be added the usual percentages for engineering, superintendence and contingencies. Curves and sidings for the division under consideration increased these costs about 20 per cent., so that the cost of the average mile of main line track (excluding the section between Sherwood and Springbrook, where excessive curvature greatly increased construction costs) was £510. This figure makes no allowance for construction on trestles, which is deemed a very local condition, and is, therefore, not included.

Men lived in outfit cars, rental of which is included in all labour costs; gasoline section cars or work trains were used to transport the crews to and from work, the average run being not more than 3 miles.

In analysing costs of material, attention is called to the fact that freight is an important item, especially on steel products, for Pacific Coast conditions. Feeder supports, but no feeder, are included in the above costs. This item will vary with sub-station spacing, line voltage and traffic conditions.

Curve Construction.—Flexibility is extremely desirable in a contact system from which the current is taken by roller pantagraphs, on account of the inertia of the collector, and at no place in the line is this more evident than at curves. As first constructed, pull-offs of $\frac{5}{16}$ in. steel strand (3,800 lb. breaking strength) were used between the backbone and the catenary system, and a maximum deviation on curves of 6 in. from centre line of track was allowed. It was found that a pull-off of this size was too stiff, especially on the lighter curves (up to 6 deg.), and $\frac{1}{4}$ in. strand (2,300 lb. breaking strength) is being substituted.

Maintenance.—The system was placed in operation on January 18, 1914. The following figures on maintenance apply only to the period from October 1, 1914, to March 31, 1915; the contact system being almost new: Material £160, labour £1,464; total £1,624.

In addition to maintaining the contact system, the crew handles all repairs to the 13,200-volt transmission line and 2·5 miles of 60,000-volt transmission line, about 6 per cent. labour in addition to that shown in the above tabulation being chargeable to this item.

Petrol section motor cars, equipped with towers, are used for maintenance, the crew, where possible, taking regular trains to get to and from work. Because of the short period under operation, it is hardly possible to analyse the work done in maintaining the lines, say, as between hangers, messenger, trolley, feeders or special devices, such as crossings, section, insulators, steady-braces, &c.

As an indication of the use made of the contact system, the following figures are given:—

Average train miles per day	1,460
Average motor-car miles per day	3,041
Average trail-car miles per day	560
Weight of motor car, tons	53
Weight of trail car, tons	35
Schedule speed, miles per hour	20
Average running current per motor car	200

Current Collectors.—In closing, a few words may be of interest as regards the results being obtained with the current collectors. An improved system of lubrication was devised by Mr. E. Sears, superintendent of electrical equipment; this, together with the substitution of roller bearings for the graphite bushings originally furnished, has made possible the costs per 1,000 motor-car miles for the period January 1, 1915, to April 14, 1915 of £14. "Welsh" oil, at 7d. per gallon, is used for lubrication.

Collectors are made of 5 in. (outside diameter) steel tubing with $\frac{7}{32}$ in. wall, and operate at a pressure against the wire of from 30 lb. to 35 lb. The wear on the trolley wire to date has been inappreciable.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

CORRESPONDENCE.

THE DOUBLE DYNAMOMETER WATTMETER.

TO THE EDITORS OF THE ELECTRICIAN.

I should like to express my appreciation of Dr. Drysdale's valuable articles appearing in recent issues (January 14th, 21st and 28th) of THE ELECTRICIAN, on the double dynamometer wattmeter. They come appropriately at the moment when the country is slowly and only too reluctantly becoming awake to the need of preparation for the resumption of the commercial war with Germany which is temporarily suspended by the naval and military war.

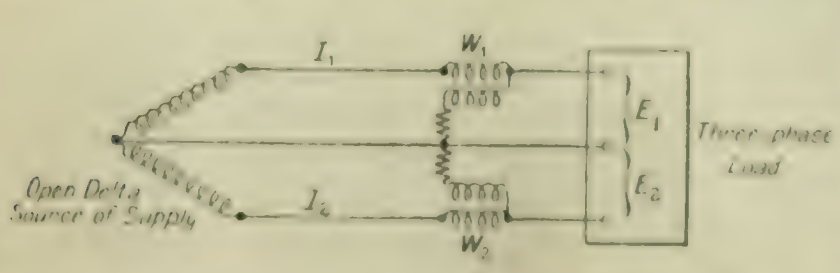
Great Britain's position in the production of electrical instruments is not one to be proud of. It is true that Great Britain was the birthplace of electrical measuring instruments, and is second to no country in contribution to the development of the science of electrical measurement, but her production of instruments is, in quantity, and too often also in quality, quite unworthy of her talents.

In spite of the good work which continues to be done by the select few amongst our manufacturers, much of the design of electrical instruments is based upon rule of thumb, whilst the methods of manufacture are antiquated, are inadequate to successful production in quantity, and fail to possess any compensating quality of precision.

To my mind these things hang closely together with the fact that technically-trained men are neither sought after nor appreciated. I do not say they are not *asked for*. They *are* asked for, but so small is the accompanying persuasion, in terms of immediate salary and future prospects, that the asking is usually futile.

Referring now to Dr. Drysdale's article, I have read with interest the ingenious treatment on p. 524 (January 14th) of the theory of the double wattmeter for three-phase power, and should like to draw attention to another method (which, though not a proof, may readily be developed into one) for demonstrating to the practical engineer, whose theory has become rusty, that the sum of the readings of two wattmeters may be made a measure of any three-phase load.

Every engineer knows that when supplying a three-phase load by means of *delta connected* transformers, the removal of one of the transformers of the delta is permissible, provided the load is not too great. In other words any three-phase load, balanced or unbalanced, and of whatever power factor, may be supplied from an open delta source. It is obvious that the *output* from such a source is given by the sum of two wattmeter readings, one looking after each arm of the open delta, thus:



and, of course, the output of the source of supply is the input to the load.

This method of demonstration serves not only to satisfy the practical man as to the correctness of the two wattmeter method, but also to remind him of the wiring.

I am greatly struck by the neat proof given on p. 559 (January 21st) of Dr. Weston's method of compensating for the effect of mutual interference between the component systems of a double dynamometer wattmeter. In spite of Dr. Drysdale's explanation I did not realise, on first reading the proof, that the symbols E and I meant *instantaneous* values, and that, therefore, the proof applies not only to the continuous-current case, but is quite general provided the coefficients of mutual interference are equal. It seems to me especially appropriate to emphasise the general nature of the proof because of the peculiarly interesting way in which the compensation operates in the case of three-phase loads.

In a balanced three-phase load of power factor unity, the average value of the interference torque when the ordinary uncompensated two wattmeter connection is used is zero, because E_1 and E_2 are as vectors at right angles respectively to I_2 and I_1. The introduction of Dr. Weston's compensation has a two-fold effect; it brings each pressure-coil current more nearly into phase with the line current (in the same wattmeter), and simultaneously disturbs the quadrature relationship between E_1 and I_2, and E_2 and I_1. The first effect tends to increase the wattmeter reading whilst the second effect tends to an exactly equal degree, to reduce it. The compensation device may be thought of as introducing an interference torque and simultaneously neutralising it.

Under no condition of load can the compensation device lead to error, but care should be taken to remember that when taking a reading upon one only of the wattmeters the pressure circuit of the other wattmeter should be opened.

In conclusion, may I say that I look forward with much interest to the multiple range alternating-current *ammeter* which Dr. Drysdale's Paper seems to foreshadow.

London, Feb. 6. F. M. DENTON.

LEGAL INTELLIGENCE.

Allen West & Co. v. British Westinghouse Co.

ALLEGED INFRINGEMENT ACTION FAILS.

On the 10th inst. Mr. Justice Astbury heard this action by plaintiffs for an injunction for alleged infringement of a registered design.

PLAINTIFFS said they were the registered proprietors of the copyright in a design of controller fingers for electrical machinery, and defendants had, without their licence or written consent, infringed the copyright, and as an instance of the infringement plaintiffs referred to the supply by defendants to the Admiralty of controller fingers for use on machinery installed in a boiler shop in a dockyard in the latter part of 1914 or the beginning of 1915. Defendants denied the alleged infringement and said the design was invalid, and it was not new or original at the date of registration. They also pleaded prior publication and prior common general knowledge; they said the design had been published in this country prior to plaintiffs' registration by the publication of a drawing by Robert Friedrich Baerlocker, of the Westinghouse Works at Trafford Park, defendants' engineer in 1909, and by publication of the drawing by defendants to their workmen in the ordinary course of their trading between March, 1909, and March, 1910. Defendants also said the design of plaintiffs had been anticipated by the manufacture and sale by defendants to the Cargo Fleet Iron Co. in 1910 of 17 controllers with controller fingers. Defendants had a motion to expunge plaintiffs' design from the register of designs.

Mr. Colefax, K.C., and Mr. C. Terrell appeared for plaintiffs and Mr. Walter, K.C., and Mr. J. H. Gray for defendants.

Mr. COLEFAX said the action dealt with controller fingers which were used in electrical appliances in conjunction with a disc, part of the conducting surface of which was cut away, and the idea was that one was able to put in more or less resistance. The infringement and the registered design were the same, except in one respect, namely, that where the spring went in, defendants had dispensed with a shoulder or a thickening of the metal. The explanation for that was that the Admiralty requested a certain number of manufacturers to tender, and ultimately the Admiralty adopted as their approved pattern the registered design in that case. Defendants accepted an order from the Admiralty to supply the approved Admiralty pattern, and in fulfilling that order they sent the infringing articles on which plaintiffs relied in the case. Therefore, it was not remarkable that the infringing article fitted almost precisely on the registered design. The commercial value of the registered design consisted in the very considerable economy of space by using that particular shape which plaintiffs had made the subject of their registration as contrasted for example with the alleged prior use and design.

Mr. WM. DENNETT said, from the point of view of economy of space in the composition of the controllers according to the registered design, he saw no difference between the fingers of plaintiffs and those of defendants.

Capt. WEST said he attributed the success of their particular finger to the shape of the article, and, in particular, its economy of space.

Mr. J. H. GRAY submitted on behalf of defendants that the design in question was wholly wanting in subject matter, and, in the second place, that whatever construction was put upon the design, there had been no infringement.

Mr. JAMES SWINBURNE said he could find no economy of space in plaintiffs' design over defendants'.

Mr. W. BENNETT said the alleged infringing article was supplied in 1910 by defendant company to the Cargo Fleet Iron Co., and that the article was working satisfactorily, was proved by the fact that they had received repeat orders from the same company. The spring finger was the standard adopted by the British Westinghouse Co.

His LORDSHIP said the question was whether the registered design was an original design or merely a workshop alteration, such as a competent workman would make in a particular article.

Capt. WEST, recalled, said the problem of the economy of space in the design was a very difficult one to solve, and it took him and several workmen several months to solve.

Cross-examined, Mr. Baerlocher, who was previously in defendants' employment and afterwards with plaintiffs, had a voice in the designing of the finger in question.

His LORDSHIP gave judgment, and said it was most important to bear in mind that the patent laws were not intended and should not be allowed to paralyse or impede the natural growth and development of manufacture, which they were intended to benefit. He thought that the present case rested upon the question whether the difference in the registered design of the right-angled support finger was or was not sufficient to make it an original design within the meaning of the Act, or whether on the contrary it was not an ordinary and natural alteration of the shape of a known article for fitting it into a case or apparatus in which it was desired that it should work. He thought that the pattern of the finger in the anticipation could, if it was reasonably adjusted, be made to fit into a space as small for all practical purposes as the finger shown in the original design. The alteration was not sufficient subject matter for a registered design, and the design in question was therefore not valid. He gave judgment for defendants in the action and motion, with costs.

A stay of execution was granted.

Motor Purchase Dispute.

Last week before his Honour Sir W. Lucius Selfe, in the West London County Court, the Electric Generator Co. sued Mr. H. Jackson, engineer, for £11. 10s., balance of hire of an electric motor, and £6 for a starter.

It was stated that in October, 1914, defendant went to plaintiff's works and hired a motor, the price of which was £11. 10s., at £3. 15s. a quarter, with the option of purchase. He also had a starter, the price of which was £6. One quarter's hire (£3. 15s.) had been paid in advance, and plaintiffs also claimed 5s. for the carriage of the motor and starter to defendant's premises.

Defendant admitted the hire of the motor, but said that he was to have the option of purchase any time up to the end of the first year. In November, 1914, he saw Mr. Hunter, the managing director of the plaintiff company, and arranged with him to purchase the motor which suited his requirements—he was working on some patents for electrical machinery. He did not buy the starter, it was brought by Mr. Hunter to start the motor at first, and had not been used since. He was to be allowed half the first quarter's hire off the price if he purchased the motor.

After hearing the evidence, his Honour gave judgment for plaintiffs for £10. 3s., and costs (deducting half the first quarter's hire), payable in two monthly instalments.

Munitions Case.

The General Munitions Tribunal for the London and S.E. Division has given its decision on a complaint by Messrs. Evershed & Vignoles (Ltd.), against Messrs. Wm. Cubitt & Co. (branch of Holland, Hannan & Cubitt).

In giving his decision the chairman (Sir ROBT. WALLACE, K.C.) said that they had heard very fully the question of all the different cases which had come before them. The first question which arose was not the question of leaving the service, but whether under sec. 7 an offence had been committed by respondents. In their opinion it had been quite clearly established that the complainants came within the terms of the Act of Parliament and that the workmen were engaged in war work, that they left without the consent of their employers and that they had not obtained from the legal tribunal a certificate of discharge and that they had all been taken into the employment of respondents. It was quite clear that an offence had been committed. It was suggested before the tribunal determined what penalty should be imposed, that an application for leaving certificates by the workmen should be made to the tribunal, and that course was allowed to be adopted. The penalty depended largely on the conduct of the parties. Having heard all the witnesses called by respondents and the men, they did not want to hear any evidence on behalf of Messrs. Evershed & Vignoles. As regards two of the applications for leaving certificates, those were now unnecessary, the workmen having left complainants over six weeks ago. As to the other two, it was four weeks since they left Evershed & Vignoles, and only two weeks remained before certificates would be unnecessary. They did not take the view that certificates of discharge were unreasonably withheld. At the suggestion of the tribunal Messrs. Evershed & Vignoles left the matter of those two workmen in the hands of the tribunal and they did not ask that they should be ordered to return to their employment. They made no formal order in the matter, leaving Messrs. Evershed & Vignoles, as a matter of favour, to grant the certificates of discharge in those two cases. The taking on of the four workmen was a deliberate offence against the Act and not done in ignorance. The manager of Wm. Cubitt & Co admitted that when the first man applied for work questions were asked and he was informed that no leaving certificates had been obtained; he was also informed that they had been engaged on war work. There was no doubt that Welsh, who was formerly in Messrs. Evershed & Vignoles' employment, was the medium through whom those men were engaged. It was a very bad case indeed and they fined respondents £15 in each case, with 10 guineas costs.

Breaches of Colliery Regulations.

At Hamilton last week Robt. Hutchison and Andrew Shaw were charged with contravening the Mines Act. The charge, which arose out of a fatal accident in Bordykes Colliery, Blantyre, on Aug. 17 last, was that a fall of stones, blaes and debris having taken place in one of the seams on Aug. 16, and an unarmoured electric cable having been brought down and covered by the debris, the accused negligently and wilfully asked and allowed several workmen to clear and red the fall while the electric current was still on the cable, whereby the lives of the men were endangered and one was killed by making contact with the cable. They were further charged with having failed to report the fall.

The defence was that the firemen had conformed to a practice general in most of the Lanarkshire collieries—viz., that when a live cable was brought down by a fall and covered the current was not switched off if the firemen, as they were in this case, were satisfied that the cable was uninjured, and that a fall was not reported so long as it did not release noxious gases or impair the ventilation and general safety of the mine. Both the accused declared that they were satisfied that none of these things was affected by the fall, and that having warned the workmen that the cable was "live" there should have been no real danger in clearing the debris.

Sheriff SHENNAN, who deferred judgment, gave his decision on Wednesday last. He found in regard to Hutchison that so far as the cable was concerned no blame attached to him, and that the course he adopted was not dangerous so long as the workmen observed reasonable precautions. The plan adopted was to clear away the debris from the side of the road furthest away from the cable. As that was done the soft material kept falling away towards that side, and by the time the men came very near the cable it should have been possible to lift it by hand and replace it, so as to hang it on the side of the road. Hutchison warned the men that the current was on so that they might exercise caution. That could not be urged against him as proving that there was danger. There were many unavoidable dangers in coal mining, and it was part of the duty of a careful fireman to keep on warning the men to be cautious. The Sheriff, however, considered that Hutchison, through a misunderstanding of his duty, had failed to comply with the statutory requirements in regard to the state of the roof where the fall took place. He ought to have mentioned in his report that the roof was defective there. He found this part of the charge proved, but dismissed respondent with an admonition. He found the charges against Shaw not proven.

At Pontypridd on the 8th inst. Jas. Steele, manager of the Duffryn-Llantwit Colliery, appeared to six summonses, charging him with failing to appoint in writing an electrician and with other breaches of the Home Office Electrical Regulations of the Coal Mines Act, 1911.

It was stated that in June last the electrician was killed by electric shock at the colliery, and the two inspectors who afterwards visited the place called the attention of the manager to numerous breaches of the regulations. They visited the colliery again in November, and found that most of the breaches had not been put right.

For defendant, it was said that the sole reason for the technical breaches of the regulations was that the manager had been unable to get an electrician.

The STIPENDIARY said the summons for not appointing an electrician would be adjourned for three months, so that steps could be taken to get a competent man. In the case of failing to provide efficient means for indicating any defect in the insulation system a fine of £1 was imposed, as there had been delay in fixing the instrument purchased for that purpose. The other summonses were dismissed.

E. Price v. Hammersmith (London) Borough Council.

On Monday last Mr. Justice Rowlatt gave judgment in this case, in which plaintiff sought to recover damages in respect of a fire that occurred at his premises through (as he alleged) the fault of defendants' electrical installation.

In giving judgment his LORDSHIP said that plaintiff sought to recover damages in respect of a fire that broke out in a laundry, and defendants were sued as the corporation which supplied the laundry with electricity. It appeared that the fire broke out in the sorting room of the laundry, where the service main (which belonged to defendants and for which they were responsible) entered the fuse box and meters, which were connected at a point where plaintiff's own wires began, and for which defendants were not responsible. The first question was whether the fire broke out in the service main belonging to defendants, on defendants' side of the fuse box. On that question, and on that alone, he had been addressed by counsel. Defendant's current came from their electricity station through that service main, which entered the sorting room of the laundry under the wall, where it was bent from a horizontal into a vertical direction.

It then went up inside of the wall, to which it was attached by staples, for 2 ft. or 3 ft., and then just under the fuse box it turned again to a horizontal position and entered the fuse box by a hole in the side of it. The conductors were attached to two terminals of the fuse box. One wire went through the meter and through the house. When the fire happened the position was as follows: The fuse box with its sealing chamber and the meter had both fallen to the ground, and had been separated from each other, and the meter was separated from the service main. The fuse box had one of its fuses—that carrying the current—intact, and the other was broken but was not fused. The wire which carried the current had been released from the fastening in the fuse box. That wire showed some slight sign of fusing. The facts as to the commencement of the fire were as follows: Plaintiff went round his premises at 8, 9 and between 10 and 10:30. Two carmen left at about 10:15, and about five minutes after that plaintiff heard the crash of breaking glass, and about 10:37 the fire seemed to plaintiff to be "roaring." The sorting room contained combustible articles and material, and the question was whether those articles took fire and burned the cable, or whether the cable took fire itself. Interesting theoretical evidence and opinions had been put forward. Plaintiff had given an interesting and clear theory as to the fire, but it was necessary to be careful in dealing with purely theoretical suggestions. The cable itself was a good cable; there was evidence that it had been tested and that there was nothing wrong with it or with the system under which it was installed, and there was no defect to which that fire could be traced. There was no evidence given as to external injury. He thought it had not been made out that plaintiff's fire commenced in defendants' service mains. He did not think plaintiff had proved his case. It was a fire which must remain, in his judgment, one of unknown and mysterious origin. It had not been shown to him how it happened. He knew quite well, where there was apparently no external cause of a fire and there was electricity in the place, and the service main was found to be burned, that one was apt to say that it must have been the electric current which started that; but that was only guessing, and he did not think that he was entitled to adopt that intellectual process. Plaintiff had not reasonably convinced him by the evidence that that fire was caused by the electrical main, and he could not say how the fire began. Under those circumstances the onus was on plaintiff, and he must say that he had not proved his case, and therefore there must be judgment for defendants, with costs.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

4,471 Maiser & Martin. [illegible]

23,938 B.T.-H. Co. (G.E. Co.) Permanent [illegible]

A method of [illegible]

24,099 Marconi's Wireless Telegraph Co. & Franklin. [illegible]

The object of the invention is to provide a system of [illegible]

24,659 Stirk. [illegible]

1915 Specifications.

270 Bowke. [illegible]

324 Pilkington. [illegible]

482 Mellett & Mellett. [illegible]

677 Pritchard. [illegible]

1,091 Siemens Telegraph & Electric Co. & Ward-Mellor. [illegible]

Adjacent [illegible]

1,212 Pritchard. [illegible]

1,234 Cauderay. [illegible]

1,234 Hodgkinson. [illegible]

1,264 "Vulcan" Maschinenfabrik Aktien. [illegible]

2,546 Bagge & Mayhew. [illegible]

4,149 W. R. Sykes Interrupter Co. & Taylor. [illegible]

4,911 B.T.-H. Co. (G.E. Co.) [illegible]

An electromagnetic [illegible]

5,883 Wade. [illegible]

6,032 Davis. [illegible]

8,524 Dennis. [illegible]

10,423 Smith & Sons & Shackleton. [illegible]

10,901 Jones. [illegible]

11,314 Johnson, Fraser & Canadian Telegraph Co. [illegible]

11,999 Allgemeine Elektricitäts-Ges. [illegible]

12,143 Graham. [illegible]

12,248 Heins. Starting system for internal-combustion engines. (10/10/14.)

12,924 Pate & Wood. Electric heating apparatus.

15,369 Graham. Telephonic receivers.

APPLICATIONS FOR PATENTS

*Note.—The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

December 31, 1915.

18,189 Amphlett. Alternating-current electro-magnets.

18,203 Lenz. Switch for eliminating dead end effects in wireless receiving apparatus.

18,212 Colley. Improvements in signalling, also applicable for other purposes.

18,215 Thomas & Stait-Gardner. Trucks for railway or tramway vehicles.

18,222 Haddan. (Soc. Française des Electrodes, France.) Method for connecting carbon electrodes to one another.*

January 3, 1916.

9 Leake. Railway signalling.

16 Berry. Electric switches and fuse switches.

19 Robinson. Apparatus for undercutting the insulation between the commutator segments of electrical motors and dynamos.

43 [illegible]-Coles. Electrolytic process for the manufacture of metallic wire and strip.

54 Ferranti (Ltd.). Electrical range-finders.

54 Rey. Electrical range-finders.

54 Testard. Electrical range-finders.

58 Larsen. Apparatus for utilising the energy of tides and waves.

58 Petersen. Apparatus for utilising the energy of tides and waves.

70 Hamilton. Electric controller.

88 Salto. Apparatus for concentrating and projecting radiant energy.

January 4, 1916.

139 Smith. Transmitters, microphones, relays, &c., for telephonic and similar purposes.,

142 Rabady. Railway signal-operating mechanism.

January 5, 1916.

149 Huntington. Suspenders for electric cables, &c.

155 Pulford. Electrical signalling apparatus.

177 Westercamp. Arc lamps.

184 Wechsler. Electric incandescent lamps, filaments therefor and manufacture thereof.

199 Westinghouse Machine Co. Power developing and transmitting apparatus.

203 Modi. Casings for electric wires.

January 6, 1916.

224 Firth. Driving and controlling dynamo-electric generators.

224 Rhodes. Driving and controlling dynamo-electric generators.

229 Roberts. Apparatus for operating railway and tramway signals, points, &c.

229 Railway Signal Co. Apparatus for operating railway and tramway signals, points, &c.

235 Mizen. Guide for connecting trolley wheels to overhead wires.

241 Thomas Transmission (Ltd.). Power transmission on rail and road trains, &c.

245, 246, 247 Wright. Receivers for wireless signals.

245, 246, 247 Marconi's Wireless Telegraph Co. Receivers for wireless signals.

250 Schaanning. Fuses for protecting electric circuits.

Jaunary 7, 1916.

269 Tregoning. Extra-high tension isolating-link phase indicator.

288 Woods. Electric lighting means.

309 B.T.-H. Co. (G.E. Co., U.S.) Apparatus and process for separating argon.

334 Schor. Order telegraphs, &c.

339 Arbib. Radiotelegraphy apparatus.

339 Mellersh-Jackson. (Arbib.) Radiotelegraphy apparatus.

346 Marino. Electrolytic deposition of a cobalt-silver alloy.

January 8, 1916.

358 Wrigley. Electric lighting system or circuits.

372 Constantinesco. Transmission of energy.

376 Bottomley. Damping devices for oscillating bodies.

395 Edison & Swan United Electric Light Co. & Lovelace. Electric indicators.

January 10, 1916.

417 International Electric Co. & Le Noir. Telephone transmitters or microphones.

422 Davidson. Production of X-rays.

January 11, 1916.

425 Taylor. (Burgess.) Electrical heating apparatus.

436 Salt. Magneto-ignition devices.

440 Vernon-Ward. Means for applying electrical treatment.

455 Podmore. Apparatus for the external shaping of clay in the manufacture of telegraph insulators, &c.

465 Whitaker. Electric rotary converters.

465 B.T.-H. Co. Electric rotary converters.

469 Bachelet. Electro-magnetic therapeutic apparatus.

471 Franklin. Electrical condensers.

471 Marconi's Wireless Telegraph Co. Electrical condensers.

477 Codd. Ignition devices for internal-combustion engines.

484, 488 Krupp Akt.-Ges. Grusonwerk, F. Magnetic separators.

[illegible] Krupp Akt.-Ges. Grusonwerk, F. [illegible] magnetic material.

492 Harrison. Electric arc lamps.

494 Kilroy. Telegraphs.

January 12, 1916.

503 Boothroyd. Cable clamps for electric wiring installations.

[illegible] Dalley & [illegible] Co. [illegible] installations.

[illegible]

January 13, 1916.

[illegible] & Helsby Cables Ltd.) & Welburn. [illegible]

[illegible] & Helsby Cables Ltd.). Electric street pillar boxes, &c.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

January 14, 1916.

[illegible]

[illegible] & Tate. [illegible]

January 15, 1916.

[illegible] Thames Works. [illegible]

[illegible] & Sankey. [illegible]

[illegible] & Whitaker. [illegible]

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	717	Electric Pumps for Ship's Fire Duty. Illustrated	135
Imports and Exports of Electrical Manufactures	718	The New Premier Electric Suction Cleaner. Illus.	136
Business Notices	718	Railway Electrification Cables. Illustrated	140
Electricity Supply	718		
Lighting and Power Notes	720	Tenders Invited	721
Traction Notes	720	Tenders Received & Accepted	721
Empire Notes	720	Companies' Meetings and Reports	722
Miscellaneous Notes	720	City Notes	723
The Round Table	133	Electrical Companies' Share List	724
"Lektrik" Switches. Illustrated	134		

COMMERCIAL TOPICS.

Municipal Councils and Alien Enemy Goods. The Association of Municipal Electrical Engineers recommends that, as a means of avoiding the possibility of purchasing articles of alien enemy manufacture, the Government should compile and publish an authoritative list of the firms concerned in the supply of these goods.

* * * *

Trading with the Enemy. In connection with the administration of the Trading with the Enemy (Amendment) Act of 1916 the Board of Trade have appointed Mr. Ernest R. Moon, C.B., K.C. (chairman), the Hon. John D. Fitzgerald, K.C., Sir Geo. Croydon Marks, M.P., and Mr. Gershom Stewart, M.P., to be a committee to advise them on matters arising under the Trading with the Enemy (Amendment) Act,1916. The secretary to the committee is Mr. W. P. Bowyer. All communications should be addressed to the Board of Trade, 38-39, Parliament-street, London, S.W.

The only comment we have to make upon the composition of the above Committee is that it seems to be scarcely representative of the trade and commerce of this country. Sir Geo. Croydon Marks is an authority on patent law, and Mr. Stewart has been in business in the Far East, but why must 50 per cent. of the Committee be lawyers, even though they happen to be eminent representatives of the Parliamentary Bar?

* * * *

Electric Power as a Factor in Capturing Trade. Mr. E. W. Lloyd, of the Commonwealth Edison Co. (of Chicago), and President of the National Electric Light Association (of New York), recently expressed the opinion that if the United States was going permanently to acquire some of the choicest manufacturing monopolies of Europe, electricity would be the factor which would bring this result about. The following is an abstract of Mr. Lloyd's views:—

There is no indication (said Mr. Lloyd) that the electric power business has reached the saturation point in any American city. The companies managed by modern electric light and power men with modern methods cannot help but increase their business. In every line of manufacturing electricity is impressing itself more and more strongly and especially so since the European war has thrown into our hands opportunities for electrical manufacturing in which Germany, France and England formerly held the balance of power. Better steel is wanted and the demand for lighter parts has necessiated the use of electrically manufactured steel in increasingly large quantities. In a recent tour of the country I noted the great growth in the electrolytic production of metals, particularly zinc and copper. I feel quite certain in saying that there will be a remendous increase in the demand for central station power in the near future. Already the demand for manufacturing is such that individual consumers using 25,000,000 kw.-hours of current annually are quite common. The manufacture of chemicals by electric power is already being done in this country, although but little is yet being said in regard to it, but plans based on production of these chemicals on a large scale are rapidly being matured. Norway is utilising large amounts of water-power in the electrochemical industries and Germany is now using electric current to obtain a supply of nitrates. The United States Government is being urged to utilise our available water-power in the manufacture of nitrates as one phase of its programme of preparedness.

Land Settlement for Soldiers and Sailors. It may be a little early to discuss the problems arising out of the various proposals which are now being put forward for the settlement of partially disabled soldiers and sailors upon the land in these islands. Electrical engineers in this country have had few opportunities of bringing within the reach of the agriculturist many comparatively inexpensive time and labour saving contrivances and many comfort-giving appliances of an electrical nature. The distribution of electric power on the countryside has failed to make any progress or is confined to comparatively limited suburban areas. The advantages of the electric service from centralised power stations has not yet been placed within the reach of country dwellers. We hope that the small isolated plant which is now becoming standardised, and therefore available at small cost, will not be lost sight of under this new scheme which the Government is fostering. The Home Office, the Board of Trade and the Board of Agriculture, in consultation with the War Office and the Admiralty, have this matter of land settlement in hand, and there must be a number of officials towhom the advantages of labour-saving appliances are well-known. Not a few of our disabled fighting men will be engineers or mechanics who have had some experience or direct knowledge of modern machinery or appliances. While in the abstract they may disapprove of the idea of being settled on the land, they are more likely to take kindly to the project if there is a prospect of the introduction of machinery to do a lot of the drudgery and also to furnish light and, perhaps, heat under hygienic sanitary and safe conditions.

* * * *

The War and Labour Saving Devices. The war is already responsible for many changes in our national affairs. It is likely to bring about a complete revolution in our methods of living and in the conduct of home affairs generally. We have on previous occasions emphasised the necessity for giving the utmost prominence in the public mind to the value of the electric service in minimising many distasteful domestic operations which in pre-war days were entrusted to highly paid labour. This class of labour has almost disappeared, and it is doubtful whether it will be capable of recruitment again after the war. An importance, which may almost be said to have become national, therefore attaches to domestic electrical appliances which previous to the war were regarded as luxuries. We have in mind particularly the domestic electric vacuum cleaner. On another page we describe and illustrate in some detail one of these patterns of cleaner, which seems to us to remove one of the chief objections to this class of electrical appliance. The makers have succeeded in fitting an interchangeable motor fan which can, if required, be replaced should the user move into a district having a voltage differing from that in which he previously resided. This is a great step forward. Coupled with it must be considered the comparatively low price, in this case a matter of seven guineas, at which the machine is offered. In the present state of the domestic labour market such a figure is not an expenditure, but an investment, and if the public can be made to realise this they will become possessed of an extremely valuable aid to the solution of the domestic problem. The cleaning of carpets, hangings, upholstery and other household fabrics is closely allied with the portable suction cleaner. We should very much like to see a campaign instituted by the Development Committee of the I.M.E.A. to bring these important facts to the notice of a waiting public.

* * * *

Trade after the War. There was an important discussion on the question of trade after the war at the annual meeting of members of the Manchester Chamber of Commerce on Monday. The report of the directors expressed the view "that the Manchester Chamber of Commerce adheres to the policy of Free Trade—not a doctrinaire Free Trade, but Free Trade for the purpose of admitting imports at the lowest possible cost, especially raw materials and semi-manufactured articles, which are practically the raw materials of various trades, and resists proposals

for protective tariffs, seeing that these tend to bolster up artificially inefficient industry at the expense of the community."

The President of the Chamber (Mr. R. Norton Barclay), who moved the adoption of the report, pointed out the dangers of a tariff war. He advocated the abolition of the advantages which German shipping lines had hitherto enjoyed, the need for more effective enforcement of the compulsory working of patents, restrictions on the establishment of German concerns in Great Britain and her oversea Dominions, and reforms in the Consular Service. He also thought there should be an extension of banking facilities, and he emphasised the necessity for improvement in scientific and technical training and methods and their adaptation to commercial ends. The amount of money we had devoted to scientific education, compared with Germany, was perfectly ridiculous. He trusted that means would be found, by securing greater unification of the interests of capital and labour, to ensure our making the fullest use of our producing power after the war. That, in conjunction with a like energy in the scientific direction of industry, would secure for our nation a future greater than our past.

Mr. H. DERWENT SIMPSON moved an amendment that the memorandum on trade after the war be referred back for further consideration. The memorandum meant that there was to be Free Trade with Germany after the war, but it would take years and years for us to overtake Germany in the matter of technical education, and in the meantime Free Trade would reign supreme and we should be in a worse position than ever.

Mr. B. LOVE-CORTOM (Electromotors, Ltd.) seconded the amendment and spoke as a manufacturer. He represented the electrical industry, and he held that the trade after the war really affected it. He had exercised the right of a member of the Chamber to inspect the minutes of the board meetings, and he found that the Special Committee on Trade after the War evidently comprised 12 Manchester members, three Bolton members, two Bury and two Oldham members, and one Blackburn member. The Committee met on Jan. 17 and appointed a sub-committee to draft proposals on the lines suggested by one director for submission to a subsequent meeting of the Special Committee. He would like to know how many directors were present at the meeting which adopted the memorandum and whether all the trade sections were represented.

On a vote the amendment was carried by a large majority, and a poll which was demanded will take place next week.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 7, 1916, *to* Feb. 12, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

EXPORTS.

JAPAN.—Various: Unenumerated, £31.

FRANCE.—*Pauer:* Elec. machinery, £341. *Paris:* Unenumerated, £150. *Bordeaux:* Unenumerated, £29. *Boulogne:* Unenumerated, £65.
PORTUGAL.—Unenumerated, £95.
CHILI.—Elec. machinery, £1,286.

FOREIGN GOODS (duty paid and free).

Amsterdam: Unenumerated, £48. *Adelaide:* Elec. lamps, £44. *Alexandria:* Unenumerated £93. *Bombay:* Unenumerated, £194. *Bordeaux:* Unenumerated, £38 *Cape Town:* Unenumerated, £655. *Durban:* Unenumerated, £30. *Paris:* Unenumerated, £170. *Petrograd:* Unenumerated, £486. *Port Elizabeth:* Unenumerated, £13. *Perth:* Unenumerated, £595. *Sydney:* Unenumerated, £376.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICE.

The Electrical Supplies Co. notify that, in order to meet the increasing demands of their customers in Manchester and district, they have opened a Manchester office and stores at No. 40, Victoria-buildings, Victoria-street (telephone, City 5794). Mr. R. L. Bateson will act as manager of this branch depot, where the company will hold stocks of all the standard electrical supplies.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aberdeen.—The Electricity Committee have approved a report by the city electrical engineer (Mr. J. Alex. Bell) recommending extensions of plant at the sub-stations, including the purchase of a 500 kw. Peebles-Lacour converter at a cost of £1,800.

Accrington.—The borough electrical engineer (Mr. H. Gray) has been authorised to prepare a scheme for dealing with necessary extensions at the electricity and destructor works.

The proposal includes the erection of a new chimney and flues and the provision of a new water-tube boiler for the destructor and will cost between £5,000 and £6,000.

Barrow.—The Corporation have applied to the L.G. Board for sanction to borrow £10,300 for extensions of plant and cables.

Lincoln.—The Council have applied for power to supply electric current to premises at Foss Bank by overhead cables.

Luton.—Sanction has been received to a loan of £30,327 for extensions of the electric supply undertaking.

Manchester.—The Corporation are recommended to provide additional plant at the distributing stations, and to make arrangements for letting electric motors on hire. The estimated cost of the proposals is put at £40,000, and application is to be made for permission to borrow this amount.

Newport (Mon.).—The L. G. Board has sanctioned the borrowing of £780 for the partial construction of a sub-station at Mill Parade.

The cost of the temporary structure (£170) has been excluded, but the Board has also sanctioned a loan of £3,004 for mains and of £500 for services. With regard to the proposed loan for the provision of power to works at Maesglas, the Board asks to be furnished with details showing how the revised estimate of £3,872 is made up.

The contract for the supply of cables having expired, the electrical engineer (Mr. A. Nichols Moore) proposes, for the present, to order supplies as required.

St. Helens.—It is proposed to lay another high-tension feeder to the Sherdley district.

Salford.—The Corporation have applied for sanction to borrow £13,000 for additional plant and the extension of the high-tension switch house at Pendleton works.

Sheffield.—At last week's meeting of the Council it was decided to sanction the expenditure of a further £10,000 on the electric supply department. The expenditure is required in order to meet the increasing demand for power.

Stafford.—The Council have applied for sanction to a further loan of £12,000 for extensions of the electric supply undertaking in order to meet the increasing demand for electrical energy by power users.

GENERAL.

Barnes.—The Electricity Committee is to make temporary arrangements to give a supply of electrical energy to the houses on the Vine Cottage Estate as soon as they are ready for occupation.

The contract for the maintenance of the storage battery at the electricity works by the Tudor Accumulator Co. having expired, the Committee has adjourned consideration of the question of a further contract with the firm, the engineer, in the meantime, to make other inquiries.

Bradford.—At the meeting of the Corporation last week the report of the Special Committee on Economy in Expenditure recommended

that in preparing the estimates of expenditure for the ensuing financial year each committee should be asked to bear in mind the urgent need for the strictest possible economy.

Mr. LUND moved, as an amendment, that the following words be added: "That for the period of the war no new services or extensions or developments of existing services be undertaken except such as are necessitated by the war; that for the same period no advance in salary shall be granted to persons in receipt of £250 or over, with the exception of those working under scale."

Ald. G. H. ROBINSON, who opposed the amendment, said that to pass it would prevent the Electricity Committee from carrying out necessary extensions—extensions which would probably mean increased revenue and which every business man would consider justified in spite of the war.

On a division it was lost by 38 votes to 21.

A Sub-committee of the Guardians has been deputed to inquire as to the advisability of installing electric supply at the Bowling Park Colony.

Brighton.—The Lighting Committee have issued a further report on the proposals to increase the charges for electrical energy.

The committee are of opinion that their previous recommendations should be adopted with the addition of an increase in the charge made for electricity supplied for power purposes, and they recommend accordingly. The proposed charges for lighting and traction were given in our issue for Jan. 21. It is proposed to increase the flat rate for electricity supplied for power from 1¼d. to 1½d. per unit for the first 2,000 units consumed per annum, the charge after the first 2,000 units being 1¼d. per unit.

Notice is to be given to all consumers who are supplied with electricity at different premises which are charged together as one supply, that each supply will be charged for separately in future.

Except as provided in the recommendations the whole of the existing charges for the supply of electricity for lighting and power will be abolished. The increase in the charges is intended to be temporary, and is stated to be due to the increased price of coal and other consequences of the war, and will be revised after the conclusion of the war.

The committee have further considered the resolution with respect to provision for payment to the electricity fund from the district fund of a sum of £2,000 for interest and sinking fund charges in respect of capital expended for the supply of electricity for street lighting expenses. They report that they are advised by the engineer (Mr. John Christie) that the proportion of generating plant, including land, buildings, trunk mains and machinery required for street lighting purposes in respect of which debt charges are still running is estimated at £25,000. Also that, on the distribution system in the Brighton area, there are 2,000 services for supplying incandescent street lamps and 17 miles of arc cable, together involving a cost of at least £15,000, but that the loans in respect of those items have now been practically wiped out. With regard to the £25,000 for plant above referred to, Mr. Christie reports that the electricity undertaking is at the cost of all the standing charges without having any revenue in return for the expenditure, and he estimates that 5 per cent. on that account for interest, sinking fund, depreciation, &c., would be a proper contribution to be made by the district fund. The Lighting Committee, therefore, recommend that, for the financial year commencing April 1, 1916, a contribution be made by the district fund to the electricity fund of £1,250 per annum to cover the loan charges and standing charges above mentioned, credit being given against such contribution for all current taken for street lighting purposes.

Dublin.—A report on the municipal electricity supply undertaking has recently been prepared by Mr. P. W. d'Alton.

In his report Mr. d'Alton states that the administration of the undertaking is unduly complicated as a result of, at least in part, dual control by an engineer, who is not a manager, and a secretary, who in part manages. The placing of more responsibility upon the engineer for the number and qualifications of people employed and for such work as the extension of the load and its measurement would, in his opinion, increase the efficiency of the system and reduce its cost of operation. The charges for energy, while not unreasonable for public lighting, are unduly high for private supply, as was clearly evidenced by the bad load factor. The number of engineers paid out of revenue was small, and could not be reduced. Considerable reductions in the number of workmen employed at the Pigeon House were possible, and would follow upon the greater use of modern machinery and selection by the power house superintendent. The wages charged under the head of distribution were not capable of reduction. Those paid under the department of public lighting, although they did not bulk large, appeared to be out of proportion, the salary and the wages amounting to £2,064, or over 16 per cent. of the gross revenue received for that service. Mr. d'Alton considers that the cost of the secretarial department is high, and he believes that a general gain in economy would follow were canvassers and meter-readers placed on the engineering staff. The salaries and wages paid otherwise than from revenue appear to be unduly heavy. The system of coal supply wants careful overhauling. At present the supply seems to have become a monopoly; methods should be adopted in future to secure competition for so extensive a contract as that of the electricity department. It would be imperative that further capital must be expended at the generating station to provide for the demands of the winter 1917-18, and a scheme of extension must be prepared, and estimates invited and considered during the coming year. The returns of the units generated at the power house were unreliable on account of the condition of the wattmeters, as proved by Mr. Tatlow's tests which were attached to the report. Those meters were in a generally defective and dirty condition, which showed that even if they had been cleaned by the station staff periodically, the periods were too infrequent for the needs of the situation. Mr. d'Alton thinks some of the engines are obsolete and extravagant. The [illegible] Westgarth turbine should be in part reconstructed, in order to bring it up to an efficiency more in consonance with modern practice. The [illegible] turbines were excellent, but it would be necessary to keep close observation upon their steam consumption. It would be necessary to augment the plant in the near future. The station condensers had for long been seriously ineffective, and must be put right. The older section of the boiler house ought not to be worked, as it now was on the daily load. The practice of using obsolete plant for the majority of the working hours of the station, and reserving modern and efficient machinery for intermittent peak and emergency loads was to be deprecated as most extravagant. It was desirable, in the best interests of the Corporation, that the new part of the station, so admirably begun in both engine and boiler-rooms, should be extended as soon as conditions permit.

In a report by Mr. Fred Allan, secretary of the Electricity Supply Committee, it is pointed out that Mr. d'Alton did not visit the sales office. He "does not think it a serious proposition to report on a recommendation that his department should be wiped out altogether," and he should have wished to give Mr. d'Alton some facts as to local circumstances and difficulties, and to explain a number of points as to the work of the committee, the extent of the "commercial management," canvassing, &c. No alterations in rates had been made without careful and prolonged consultation between the committee and Mr. Ruddle and himself. The committee had always weighed up every consideration—economic, engineering and municipal. Whenever possible, and so far as possible, the rates had been brought down and restrictions removed. Mr. Allan states he could have shown Mr. d'Alton, had he been given opportunity, that the rates charged were not excessive for Dublin, and that those who changed from gas to electricity for either light or power had in every case saved money. So long as they could sell a better article at less cost the Electricity Supply Committee had always held they should not throw a burden on the rates. He denies that the cost of the secretarial department is high.

In a report by Mr. Mark Ruddle, city electrical engineer, it is stated that various criticisms were made by Mr. d'Alton upon the several sections of the undertaking, based in some cases upon insufficient examination and want of full consideration of the difficulties. He drew attention to the relative incomes derived from the units sold for power and lighting purposes. During the year ended March, 1915, the 3,844,800 units sold for power produced an income of £20,024, while the 4,261,200 units sold for private lighting produced £72,300. That was to say, that of the total units sold for private lighting and power, 53 per cent. sold for lighting produced 78 per cent. and 47 per cent. sold for power produced 22 per cent. of the total income. Those relative figures had an important bearing upon the financial position when considering the heavy annual capital charges which had to be provided for. He did not agree that the rates were unduly high for private supply. On the contrary, considering the price of gas and the relatively higher price of fuel in Dublin, he considered that they compared well with the charges elsewhere.

Mr. Laurence J. Kettle, deputy city electrical engineer, has also prepared a report, in which he dealt in detail with the points concerning the generating station. He claimed credit for the saving he effected in the coal consumption, and said the saving was a far larger percentage than any which would be effected by any new plant operating under similar conditions of load factor, &c. Mr. d'Alton was very strong upon the point that during 1912-13 they should have run the new Oerlikon 3,000kw. engine practically the whole year, but that could not have been done. It would have been sheer lunacy to have gambled with the safety of the supply in the irresponsible manner suggested. He denied that the proposed method of running would have shown the extraordinary saving set out. He would go further, and say quite definitely that it would not have shown any saving, but would have involved them in unnecessary danger without any compensating advantage. Mr. Kettle also dealt in detail with the criticisms directed against the machinery used in the generating station.

The reports are to be considered at the next meeting of the Electricity Supply Committee.

At last week's meeting of the City Council Ald. THOS. KELLY drew attention to the above reports. He said the special Investigation Committee had appointed an expert to examine and report, and it was understood that that report, and the reply of the officials to it, would be regarded as strictly confidential until the Committee had fully dealt with the subject. He was surprised to find the report and the reply of the two engineers and the secretary of the Committee published in one of the evening papers. It should not have been given to the Press until the members of the Committee had had an opportunity of considering it.

Mr. J. J. O'NEILL, chairman of the Electricity Supply Committee, repudiated the publication, and he denounced it as unfair to the Council.

It was resolved to refer the matter to the Electricity Supply Committee for investigation and report.

Horrabridge.—The inauguration of electricity supply took place on 27th ult.

Hindley.—At the meeting of the Council last week the chairman (Mr. H. J. Bourchier) explained that representatives of Wigan Corporation and the Lancashire Electric Power Co. had interviewed the surveyor with a view to giving a connection for the supply of electricity by the Lancashire company to Wigan Corporation tramways, and it was decided to approve the action of the chairman of the Council and the chairman of the Electricity Committee in allowing a connection to be made.

Shoreditch (London).—The Lighting Committee recommends an increase in the price of current for all purposes by 15 per cent. as from the date of the March readings.

Walsall.—The electrical engineer (Mr. H. A. Howie) has been authorised to negotiate a working arrangement with motor manufacturers whereby they will supply motors on a three or five years' hire-purchase basis through the sales department, but without any liability by the department.

LIGHTING & POWER NOTES.

Electric Driving in Mills.—At the recent meeting of the Ripponden Commercial Co., of Halifax, the chairman (Mr. J. Pickles) said that a serious drawback had been their steam engines, which had cost £700 in repairs, besides the expenses involved in assistance, making the total about £1,000. Further, their production had been seriously handicapped, losing them perhaps £1,000.

But for those drawbacks, he said, they would have had more profit. They hoped that the new electric driving plant, nearly ready for installation (one room at a time so as to avoid delays), would reduce the cost by from 50 to 60 tons of coal weekly, or a few thousands a year, with the possibility of better running. They had, therefore, much better prospects than 12 months ago.

In reply to a question he said that the Fine Spinners' Association, of Lancashire, the largest spinners in the country, perhaps in the world, had already seven mills electrically driven, and they were shortly to increase the number. It was on their recommendation that they had taken the step to adopt electric driving. They had also the guarantee of the makers. They would have a motor for each room.

Electric Power for Oil Wells.—A company has recently been formed in the United States for the purpose of supplying electric power for pumping wells in the Cushing (Okla.) field.

The new company proposes to instal electric pumps at the wells, and furnish the current from a central station, thus doing away with much of the present obsolete oil or gas-driven pumps. Contracts have already been signed with more than 500 wells, and the erection of the generating station and distributing lines will begin this month.

Electric Power in Yorkshire Collieries.—The first sod of an accommodation shaft was recently cut at the Thorncliffe collieries.

Before the first sod was cut by Miss Newton the general manager of the collieries (Mr. W. Hay) explained the importance of the undertaking, which he said would mean an immense saving in the time taken by the miners to reach the workings, and consequently increased earnings would be a result. A novelty in connection with the scheme was an electric winder, the first in the district, which was supplied by the British Westinghouse Co., the current being conveyed by overhead wires from an exhaust steam turbine at Rockingham Colliery. The exhaust steam from the engines at Rockingham Colliery would be utilised to work the turbine which would generate electric power to 3,000 volts.

TRACTION NOTES.

Aberdeen. The Corporation have agreed to defer the question of the purchase of the undertaking of the Aberdeen Suburban Tramways Co. until after the war.

North London Railway.—We are informed that the work of electrifying the North London Railway to Richmond is in hand, but at present, owing to inevitable delays on the part of contractors in the delivery of electrical equipment and rolling stock consequent on the war, it is not possible to say when it will be ready for running electric trains over the railway to and from Richmond.

Women Tramcar Conductors.—There are now about 200 women conductors in the service of the London County Council.

Women conductors work on an average eight hours and 23 minutes a day, and they are paid at the same rate as men.

Several additional provincial tramway undertakings now employ women, and Nottingham Corporation have 70 women in their service.

EMPIRE NOTES.

Australasia.—The latest report on the progress of the East West Railway shows that up to Dec. 1 the rails had been laid for 742 miles—411 miles on the western side and 331 miles on the eastern side, leaving the gap between the two ends a little over 200 miles. On the eastern section the earthworks have been completed for 753 miles and the telegraph line for 73 miles. About 1,000 men are employed.

The "Commonwealth Engineer" says Mr. W. Corin, electrical engineer of the Public Works Department, Sydney, recently visited Ipswich (Queensland) to report on the possibilities of a power scheme for the district.

A proposal was made at the last meeting of Prahran (Victoria) Council that a contract be entered into with Melbourne Electric Supply Co. for the whole of the street lighting of the city, at £4. 6s. per lamp per annum. There are at present over 100 lamps lit by electricity and over 500 by gas. The last electric contract was £4. 13s. 6d.; gas, £4. 16s. 6d. The electric company agreed to reduce the price to £4. 8s. 6d. per lamp, and the gas company came down to £4. 14s. per lamp. Later the electric company agreed to light the whole city at £4. 6s., and the gas company brought down its tender to £4. 5s. The gas company's tender for five years was accepted, after which the matter was referred back to Committee.

Ohakune (N.Z.) Council, who installed a hydro-electric plant in 1915, consisting of two 110 H.P. Boving turbines direct coupled to 60 kw. Westinghouse alternators, is considering the installation of an auxiliary set. Three-phase current is generated at 2,300 volts and is distributed at 400 and 230 volts. The electrical engineer is Mr. J. W. Downie.

The Electrical Association of Australia has approved (with some minor modifications) the amended general conditions of contract based on the conditions of the British Institution of Electrical Engineers. The Australian conditions are being submitted to the various purchasing bodies in the electrical industry.

Canadian Exhibition.—The Canadian National Exhibition will be held in Toronto during the last week of August and the first week of September.

This exhibition has been held annually for some years. It usually attracts an attendance of about 900,000 people. Communications with regard to space, &c., should be addressed to Dr. Orr, manager, Canadian National Exhibition, Williams Building, King-street East, Toronto.

MISCELLANEOUS NOTES.

Colonial Preference for British Goods.—The New South Wales Government has decided that in the purchase of supplies for the public service a 10 per cent. preference shall be extended to local British or Empire manufactures as against those of other countries.

Controlled Works.—An order has been issued declaring 116 additional establishments controlled establishments under the Munitions Act, making a total of 2,834.

Exports Prohibited.—By a fresh Order in Council the exportation of carbon electrodes for electric furnaces and of petroleum coke is prohibited to all destinations.

Inquests.—An inquest was held at Sheffield on Monday on a boy named Cyril H. Roper (16 years of age), who died under remarkable circumstances.

The evidence showed that the lad and two others were in the bathroom at Roper's home, Roper being in the bath. The two others were trying to fix a blind, when the blind fell, knocking down an electric lamp, which fell, with the electric light wire attached, into the water. Deceased received a severe shock, and screamed for help. His brother, who tried to get him out of the bath, failed to do so, and also received a shock. The boys' father hearing the shouts rushed to the room and got the lad out, but, despite medical aid he died. The voltage of the current was 200, and a witness said that the shock was received from the water through the body and the taps at the end of the bath, which it appeared deceased clutched.

A verdict of accidental death was returned.

An inquest was held last week into the death of Fredk. W. Green, an electric chargeman, who was killed at the Pontymister Steel Works, Risca, on the 2nd inst.

James Watkins, steel smelter, said he was in charge of the D furnace on the day of the accident. Something happened to the machine, and witness saw a large flash close to deceased's seat. Green was about to turn round the machine when the flash occurred; in fact, he had turned it half way. He could not say whether he caught hold of a handle or not. He called for assistance to take the man from the machine; he could not say whether first aid was tried on the man before he was taken away.

Wm. John Parfitt stated that when last he saw deceased he was picking up a box of shearings which was left on the ram of the charger. He regarded the blowing off of a fuse as a safeguard; he thought an electric shock was the cause of death.

Medical evidence was to the effect that two men had tried artificial respiration. There were no marks of burning, except on the right hand, and no signs of violence on the body. Death was instantaneous, and was due to an electric shock. It was impossible to dogmatise on the current required to kill a man, but it must have been a severe shock in that case, and artificial respiration was absolutely useless in that instance.

Benjamin Thomas, electrician, stated that two sets of fuses were blown. The switch and two controllers were in position, but two fuse-box doors were open. He tested the machine, but did not find any leakage. He could not say how deceased met his death. Green might have put the switch in the machine with the two controllers on, and this would cause two sets of fuses to be blown; or he might have sat down on his seat, put his hand backwards, and come in contact with the fuseholes. The latter theory was consistent with the condition of the hand. Deceased was a careful, experienced workman. Porcelain protectors were wanting

on the fuses. He did not think the vibration of the machine caused the fuse doors to fly open. The voltage of the current was 500. He had had no previous experience of electric machines before he was employed at Pontymister. He was aware that Acts of Parliament laid down the importance of the protection of fuses. Notices were exhibited in the works. He could not say which of the fuse doors was loose. One driver after the accident refused to go on the machine with broken insulators unless he was provided with indiarubber gloves and boots, and the management had now provided those.

The jury returned a verdict that deceased was accidentally killed by an electric shock while in the discharge of his duty.

Unemployment Insurance.—The following decisions have recently been given by the Umpire under the Unemployment Insurance portions of the National Insurance Act, 1911 to 1915 :—

Contributions are payable in respect of workmen engaged in turning, machining or finishing moulds or patterns of iron or steel for use in connection with the shaping of rubber, vulcanite, ebonite, &c. This decision reverses decision B 932, given in August, 1912, in so far as the two may conflict.)

Contributions are not payable in respect of workmen engaged in the manufacture of permanent magnets for electrical instruments and for magnetos.

War Trade Licences and Exports.—The director of the War Trade Department notifies that where a license is granted for the export of prohibited or restricted goods the license does nor relieve the owner of the goods or the consignor or other person to whom the license is granted from any responsibility for any breach of law or regulations.

It is, therefore, incumbent on persons before applying for licenses or exporting goods to take all reasonable steps to satisfy themselves that the ultimate destination and intended use of the goods are unobjectionable. Failure to do so may involve serious consequences, and will certainly entail most careful consideration of any further applications for export licenses. Applications will not in future be considered unless they bear the signature of the applicant, or in the case of a firm, the signature of a partner, or, in the case of a company, the signature of a director or the secretary.

Will.—The late Mr. Herbert Arnaud Taylor, of Messrs. Clarke, Forde, Taylor & Erskine-Murray, left £42,529, with net personalty £42,287.

TENDERS INVITED.

Wiring, &c.

Firms in the NORTHERN COMMAND who are desirous of undertaking large or small electric wiring contracts should apply to be placed on the local list of contractors for such work. Communications to the Commanding Royal Engineer, 12, Wenlock-terrace, York. *See an advertisement.*

SWANSEA Education Committee require tenders by noon March 6 for Wiring Brynmil Infants' School and Cwmbwrla Girls' and Infants' School. Specifications from Clerk, 9, Grove-place, Swansea.

Electrical and Tramway Stores.

BIRKENHEAD Corporation require tenders by March 9 for supply and laying of Cable, and two Rotary Converters, with Switchgear. Specifications from Borough Electrical Engineer.

MARYLEBONE (London) Electricity Department require tenders by noon Feb. 23 for six months' supply of Underground and House Cables, Box Compound, Insulating Materials, &c. Tender forms from the Electricity Dept., 20, York-place, W.

The METROPOLITAN WATER BOARD want tenders by 11 a.m. March 7 for supply of Electric Lamps, &c. Forms of tender from the Chief Engineer, Savoy-street, London, W.C.

BOLTON Electricity Committee require tenders by noon March 2 for one year's supply of Joint, Service and Fuse Boxes, Meters, Motors, Starting Switches, Transformers, &c. Specifications, &c., from the Borough Electrical Engineer.

Tenders are required by first post March 15 for one year's supply of Electrical Goods for the Cheshire County Asylum, MACCLESFIELD. Tender forms from the Clerk.

The BEDWAS NAVIGATION COLLIERY Co. require tenders by 10 a.m. March 2, for 12 monhs' supply of Electrical Goods, Oils, &c. Forms of tender from the Secretary, Bedwas, Mon.

DUNDEE Tramways Committee require tenders by Feb. 28 for one year's supply of Armature Coils, Commutators, Carbon Brushes, Lamps, Switches, &c. Specif cation fromGen. Manager.

The POWELL DUFFRYN STEAM COAL Co. require tenders by 10 a.m. March 8 for supply of Electrical Goods, Rubber, Asbestos, Steel, Steam Tubes and Fittings, &c. Forms of tender, &c., from the Stores Manager, Aberaman Office, near Aberdare.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. March 7 for supply of White Paper Tape for Wheatstone receivers and transmitters for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specification, &c., from the Deputy P.M.-G., Melbourne.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmasters-General.

Tramcars and Parts.

DUNEDIN (N.Z.) City Council require tenders by 5 p.m. May 17 for six Electric Tramcars and sections of Cars (Bodies, Electrical Equipments and Trucks). Specifications, &c., from the Town Hall, Dunedin.

Turbo-Alternator, Hydro-electric Set, &c.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

Submarine Electric Cables.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

Oil (or Gas) Engine, Generator, Accumulators, &c.

The Deputy Postmaster-General, Brisbane, requires tenders by noon Feb. 28 for the supply of an Oil or Gas Engine, Generator, Accumulators, Power Board, Distribution and Fuse Cases and Test Table Tablet (schedule 370) for Townsville Post Office, for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specifications from Deputy Postmaster-General, Brisbane.

TENDERS RECEIVED AND ACCEPTED.

WALSALL.—The tender of Bellis & Morcom has been accepted by the Electricity Committee to supply a 3,750 kw. turbo-alternator (in place of one commandeered by the Government) for £13,227.

SLOUGH.—Messrs. Chamberlain & Hookham have received the contract for electricity meters for the coming year.

DERBY.—The Council have placed an order with the British Electric Transformer Co. for a transformer, at £110.

BRISTOL.—The Docks Committee have accepted the tender of W. T. Henley's Telegraph Works Co. for some 7/20 S.W.G. armoured cable, that of Callender's Cable & Construction Co. for v.i.r. cable, that of Simplex Conduits (Ltd.) for conduit and fittings, and that of Dorman & Smith for fittings, &c.

HANTS.—The tender of Hill, Upton & Co. (at £2,598. 18s. 10d.) has been accepted by Hants County Council for the provision of telephones, fire alarms, tell-tale clocks and bells at Park Prewett Asylum.

BERMONDSEY (LONDON).—The following tenders have been accepted by the Electricity Committee :—

Babcock & Wilcox, worm wheels, dumping bars and c.s. noses; Glenboig Union Fireclay Co., 3,000 firebricks and 1 ton fireclay in bags ; Jas. Howden & Co., pair crank pin brasses ; Wightman & Co., 600 sheets.

The Committee proposes to renew for a further period of 10 years, upon the same terms, the agreement with the Tudor Accumulator Co. for the maintenance of the storage battery.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

St. James' & Pall Mall Electric Light Co. (Ltd.)

The ordinary general meeting was held on Tuesday, under the presidency of Mr. WALTER LEAF.

The MANAGING DIRECTOR AND SECRETARY (Mr. Frederic J. Walker) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: When we met a year ago, I do not suppose that any of us really believed that in February, 1916, we should be meeting again not only under the shadow of war, but with the end not yet in sight. But now we have to recognise the fact, and we can only foresee that our own industry has yet to suffer for an indefinite time under conditions which are wholly adverse to us and bring no war profits of any sort. You may remember that last year, assuming a condition of affairs similar to that then prevailing, we estimated that there would be in 1915 an additional loss in profits, as compared with 1914, of £9,000. With this in view, we set aside £4,500 out of revenue, to be used this year for the equalisation of dividends. We did this in the hope that we should be enabled thereby to maintain the dividend of 10 per cent. Unfortunately, conditions have been worse than we anticipated. Our estimate of revenue was almost exactly correct. But the rise in expenses, mainly in the cost of coal, was greater than we foresaw. We have also had to spare a much larger proportion of our men for active service than we then supposed; the half of their wages which we continue to pay them, together with the war bonus which, in consideration of the increased cost of living, we feel bound to give those who have stayed to serve us and their country at home, now amounts, as our accounts show, to no less a sum than £2,287, or considerably more than 1 per cent. on your ordinary capital. The upshot is that, while our revenue has been what we expected, our expenses have exceeded the estimate by about £5,000. The loss of profit due to the war is, therefore, about £12,000 additional to the loss realised in 1914. After bringing in the £4,500 set aside for the purpose last year there is sufficient to pay a dividend of 8 per cent. for the year, but not more. The increased expenditure shows itself mainly in the accounts of the Central Company, on which we rely more and more for our supply of current. The cost of the unit for electricity purchased has risen materially; and it has been thought desirable by the two companies concerned that, in order to keep down the cost to the lowest point possible, the Central Company should not declare a dividend for 1915. We shall therefore, be that amount short in the revenue of the St. James' Company next year.

We have further had to carry out some very important renovations of plant at the Grove-road Works of the Central Company, and we have added a large new turbo-generator with its attendant boiler plant, which was urgently needed to cope with the work. In addition to this the difficulties of coal supply have made it important for our safety that we should have a large reserve of coal on hand there. These two causes have involved considerable capital expenditure, which must be provided by the two companies for a time, till it can be made up out of the large provision for depreciation which we are setting aside annually out of the Central Company's revenue. It is for this purpose that we are proposing to you the resolution extending the borrowing powers of the Board.

In view of the possibility of damage by hostile aircraft—a risk against which we have, of course, insured our stations—we, through the Central Company, have entered into an arrangement with our neighbours, the Borough of St. Marylebone, whose station is near ours on the Regent's Canal, for a system of mutual support. This will be of substantial assistance in the case of damage to either undertaking; but it is confined to that contingency. I should like to take this opportunity of bearing my testimony to the good feeling and harmony which characterise the working of the Central Company and of thanking our good friends and partners the Westminster Company for the [illegible] we [illegible] the very backbone of our system. Of our staff 64 have joined the Colours. We have to lament the loss of six who have been killed, while several others have been wounded. One Company has been accepted as an electrical unit, and have thus a very special claim for consideration in the rolling up of our men who have been attested under the Derby Scheme. In recognition of this a number of our skilled men have been authorised to receive the War Service Badge, issued by the Ministry of Munitions, as men employed for the proper conduct of the business in the public interest. We regard this as a responsibility rather than a privilege, and have been glad to release for service every available man, and we have to thank the men whom we have kept for their loyalty, very often under difficult circumstances and great pressure. We have also, in our small way, been able to find them something to do in connection with [illegible] which has constantly continued since the early part of last year in preventing [illegible] and recently turning to account in one or other of the operations of their manufacture. We are glad to think that the work on our hands has turned out has received very high praise, and that we are for this reason kept constantly employed. The small profit we have earned by this work we have handed over as a bonus to the men who have done it, as recognition of their good service to their country.

The investments of the Company amount at cost to just over £55,000. A note is appended in the balance-sheet to say that at the prices ruling on Dec. 31 they stood at £45,716. Some of them are taken at the only quoted price of that date, the minimum price. We must, of course, recognise that they could not now be realised except at a value considerably below this. Now, I wish to point out that these investments are savings of the business, and not ear-marked for any special purpose. We are at liberty to use them, if necessary, for any of the purposes of our business. But, at the same time, we do not see any likelihood that we shall need to realise them; and unless some need not at present foreseen presents itself, it is our intention to hold them until the liquidation of the business, whether at the termination of our Order in 1931 or earlier. If at that time there is a depreciation, it will be a capital depreciation, and will have to be met out of the capital reserve fund. It is not a depreciation which we are in any way called upon to make good out of revenue. If it should be necessary to realise any of them at a loss before 1931, we should regard this in the same way as a loss chargeable, not to revenue, but to capital reserve. We, therefore, propose, and your auditors agree with us, that the proper course is to carry them in our balance-sheet at cost, calling attention in a note to their present value where ascertainable.

With regard to the future I shall make no prophecy of any sort. We are entirely dependent upon the course of the war. If the war stopped to-morrow I have no doubt that we should soon step back into our previous prosperity; but so long as the war continues there is no obvious reason why profits should improve. The best point at the moment is that our revenue showed somewhat unexpected elasticity in the second half of 1915, and for the five months where comparison with war times was possible it made a marked recovery. This is a real growth, due to the extension of the use of electrical energy for power and heating. It is also partly due to a somewhat increased scale of charges to customers. This increase has been well received by them, and we shall profit by it more in 1916 than we did in 1915. But increase of price is not a resource on which we can depend to any large extent; there comes a point at which any increase of charge will simply mean that the demand is cut down. It is only to the expansion of demand for heating and power that we can look to make up to some extent the inevitable loss in the shop-lighting, which has always been the backbone of our supply. For our Company, as for the country, the first essential is that we should strain every nerve to win the war; until we have done that we must be content to bear the ills of war with patience and courage, and we may perhaps console ourselves with the thought that there are worse things to be borne than a dividend of 8 per cent. I beg to move the adoption of the report and accounts, and the declaration of the dividends recommended.

Mr. MARLBOROUGH R. PRYOR seconded the resolution, which was carried unanimously.

The retiring directors, Mr. Marlborough R. Pryor and the Right Hon. Gerald W. Balfour, and the auditors were re-elected.

The CHAIRMAN then moved the following resolution: "That the amount which the Directors are authorised to borrow (without the further sanction of the Company in General Meeting) be increased from an amount equal to one-half the nominal capital of the Company for the time being to £50,000 in excess of that amount."

He said that the Central Company has had the following large items of capital expense during the year: (1) A renewal and extension of the main switchboard; and (2) the substitution of a large 6,000-kw. turbo-generator, with its attendant boiler plant in place of one of the old 1,500 reciprocating engines. The orders for those were given before the war, and the fresh plant was absolutely necessary, in view of the continually increasing use which both the Westminster Company and themselves were making of the Central plant. In addition the great difficulty which was at one time experienced in getting deliveries of coal had rendered it imperative to increase the reserve stock stored on the Central Company's premises at Grove-road. That had involved a lock-up of more than £10,000. Arrangements had been made to finance the Central Company's extensions by setting aside annually a very large sum to depreciation account. On an average of years that would be sufficient; but for this year, owing to the accumulation of these large extensions, it had been necessary for the two parent companies to find additional capital. That they had done for the present by jointly guaranteeing a bank loan; but the Central Board, in consultation with the parent companies, preferred the system of loans from the two companies to the Central Company. Their borrowing powers to the extent of half their capital had already been exhausted by the debenture issue, and their bankers therefore asked that they should obtain consent to an extension of their powers for another £50,000.

Mr. S. K. GEORGE seconded the motion, which was carried unanimously, and a vote of thanks to the Chairman, the Directors, and the staff for their services in the past year, brought the proceedings to a close.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.).—During 1915 99 additional consumers were connected and the number of units supplied was 1,067,081, an increase of 55,246 units over 1914. The total profit for the year was £9,159 5s. 10d. which, with £2,646 15s. 2d. brought forward, makes £12,006 4s. After deducting debenture and other interest

(£1,792. 15s. 4d.) and placing £3,000 to depreciation, there remains £7,213. 8s. 8d. An interim dividend of 2 per cent. (absorbing £1,783. 19s. 7d.) has been paid and the directors recommend payment of a further dividend of 3 per cent., making 5 per cent, for the year. This will absorb £2,675. 19s. 5d., leaving £2,753. 9s. 8d. to carry forward.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.)—The net profit for 1915 was £3,638, against £2,964 in 1914 and £2,569 in 1913. After payment of directors' remuneration the balance brought forward was £602, and the disposable balance is £4,240. The directors recommend payment of a dividend (tax free) for the year 1915 at the rate of 6 per cent. per annum on the ordinary shares (£2,208) and the increase of the reserve fund to £4,000 by adding £1,000, leaving £1,031 to carry forward. In view of the increased expenditure, the lighting restrictions and other difficulties occasioned by the war, the directors consider that the results of the year's working are very satisfactory. The stong position of the company is due largely to their close association with the Yorkshire Electric Power Co. and to the benefits of the agreements for bulk supply and management made with that company. Due to these, the difficulties of the past year have been met in a manner and at a cost which would not have been possible if separate generating stations and a separate organisation had been established. Applications were made in 1914 for provisional orders for Selby and district and Stanley, and these orders have been granted and confirmed by Parliament.

ELECTRICAL & INDUSTRIAL INVESTMENT CO. (LTD.)—At the meeting on Wednesday the report for the year ended Dec. 31 stated that the investments of the company have been written down to correspond with the reduction of capital. The revenue account shows a profit, after payment of management expenses and interest on debenture stocks, of £11,500, and with balance (£10,377) brought forward the total available is £21,877. The directors recommend payment of the dividend for the year on the 6 per cent. cumulative preference and a dividend of 5 per cent. on the preferred ordinary shares for the year, carrying forward £10,877.

LIVERPOOL OVERHEAD RAILWAY CO.—The gross receipts for the year 1915 amount to £95,231. 11s. 10d. and working expenses (including appropriation to reserve funds) to £64,435. 3s. 10d. The total number of passengers carried was 15,082,502, against 13,361,944 in 1914. The railway has continued to be worked during the year under the agreement concluded with the Government on the outbreak of the war. After deducting working expenses and appropriation to reserve funds (£64,435. 3s. 10d.) and paying interest on debenture stock (£6,755. 4s.) and adding £7,012. 16s. 10d. brought forward, the amount available for dividend is £31,054. 0s. 10d. Interim dividend has been paid for the half-year ended June 30 on the 5 per cent. preference shares and at rate of 2½ per cent. on the ordinary shares, leaving £20,838. 10s. 10d. Out of this balance the directors recommend the declaration of dividends, for the half-year ending Dec. 31, at rates of 5 per cent. per annum on the preference shares, and 4 per cent. per annum (making 3¼ per cent. for the year) on the ordinary shares, leaving £6,873. 0s. 10d. to be carried forward.

MACKAY COMPANIES.—The annual report of the Mackay Companies states that the annual receipts have been satisfactory, but points out that the extraordinary weather conditions of the past year caused considerable additional expense in the maintenance of the cable and telegraph systems. Apparently there was some serious disturbance in the bed of the Atlantic ocean, particularly in the zone where nearly all of the transatlantic cables of the different cable companies are laid, and the continued severity of the storms and their uninterrupted violence rendered repairs slow and very expensive. Extraordinary storms in the United States also had a similar effect on the land wires. As to the possibility of an increase in the dividend on the common shares, the report says that, "In view of the uncertainty of the future, this is deemed inadvisable. The war may terminate at any time, and upon its termination it is impossible to say whether the present high tide of prosperity in the United States will continue. It is difficult to see how this country can keep up with the present degree of prosperity when practically all other countries will be adjusting and paying debts, with further heavy taxes to be imposed. An individual labouring under heavy obligations restricts his business operations and consumption, and the same would seem to apply to a nation. A merchant has little trade when his chief customers are economising to pay debts. We are aware that others entertain a different view, and believe that this country can prosper irrespective of the desperate financial condition of the other great nations of the world. The experience, however, of the whole world for a few years after the Boer war would indicate that where even a single great nation is depressed by financial losses and disturbances due to war this affects the commerce and prosperity of all nations. Accordingly your trustees do not believe that any policy of higher dividends and exploitation should be adopted at present. Developments in wireless telegraphy and experiments in wireless telephony continue, and are scientific achievements of incalculable value for the protection and direction of ships and for the changing conditions of the battlefield or other places where poles, wires or cables cannot well be erected or maintained, but nothing has caused your trustees to change or modify their opinion that, as commercial propositions, wireless telegraphy and wireless telephony are and will continue to be negligible. Their limited capacity and the difficulty and expense of operation, measured by the results obtained, will prevent them from ever becoming serious competitors of our ocean cable or land-line systems."

At the annual meeting, held on Tuesday, the 15th inst., the following trustees were re-elected : Sir Thomas Skinner, Bart., of London, England; Sir Edmund B. Osler, of Toronto ; Henry V. Meredith, president of the Bank of Montreal, Montreal ; Clarence H. Mackay, William W. Cook, Geo. G. Ward, Edward C. Platt, Geo. Clapperton and Milton W. Blackmar.

METROPOLITAN RAILWAY CO.—At the meeting last week Lord Aberconway said that the total net income had been £595,675, against £598,286 in 1914. In July an interim dividend of 1 per cent. per annum had been paid, and they proposed to pay a dividend at the same rate for the second half of the year. The Government did not guarantee the railway companies their 1913 dividends ; what they did guarantee was the same net receipts from traffic. Although important new works were now earning revenue of which the Government got the benefit, the company had been left to bear the interest on the new capital. Their capital had been increased by £125,582. They had a number of improvement works in contemplation. The traffic generally for 1915 showed a satisfactory increase ; the introduction of the escalator at Baker-street connecting their station with that of the Bakerloo Tube had increased the exchange traffic between their line and the Tube system, and the traffic on the Great Northern and City line had responded quickly to the improvements they had made in the service on that section.

PAISLEY DISTRICT TRAMWAYS CO.—The revenue for 1915 was £68,079. 0s. 3d., and expenditure £45,737. 1s. 7d. After meeting debenture interest, income tax and debenture sinking fund (£1,500) and adding balance brought forward (£3,200. 9s. 8d.), the amount available is £19,477. 17s. 3d. Of this amount £6,500 has been placed to general sreserve, £3,750 has been paid for the cumulative preference dividend and £1,000 has been placed to preference share sinking fund for the half-year ended June 30, 1915, and the directors recommend payment of the preference dividend for the half-year ended Dec. 31, 1915, and the placing of £1,000 to preference share sinking fund for the half-year, leaving £3,477. 17s. 3d. to be carried forward. The year's taaffic receipts increased by £6, 141, but the expenses also largely increased, due to the war bonus granted to the staff, which was lately increased to 5s. per week, to the great increase in the price of coal, and to the increase in the price of all materials. Owing to the scarcity of labour the company have been unable to undertake the whole of the maintenance of the track and rolling stock which would have fallen to have been executed in ordinary course. These repairs are only postponed, but the directors have carried to general reserve £2,000 more than the usual amount in order to make some provision for this expenditure.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1915 was £4,249. 18s. 6d. (compared with £4,576) and net profit £2,816 (against £3,139). A sum of £400 has again been placed to debenture stock redemption fund and £1,250 to depreciation account. The available balance, including £1,330 brought in, is £2,496, which the directors propose to deal with by paying 2 per cent. per annum on the ordinary shares (£1,200) and carrying forward £1,296. The output of current has been well maintained notwithstanding the adverse conditions, but costs of production have generally increased. A settlement of matters in dispute in connection with the existing oil plant has been effected on favourable terms, and the cost has been charged to capital account. Another oil generating set of improved design, to replace the last remaining steam set, is in hand.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The total power of the lamps, motors and apparatus connected to the company's mains, which on Dec. 31, 1914, was the equivalent of about 41,201 kw., had increased by Dec. 31, 1915, to the equivalent of about 42,355 kw. The directors have set aside £2,500 out of the profits of the year, and that sum, together with the £500 received for the founders' shares which were cancelled in 1897, has been added to reserve fund. These sums are more than sufficient to cover the loss on the investments realised during the year. An interim dividend at rate of 6 per cent. per annum on the ordinary shares and the dividend on the 4½ per cent. preference shares for the half-year ending June 30, 1915, has been distributed. After allowing for depreciation, sinking fund and other charges, the net balance is £35,893. 7s. 2d., from which must be deducted the second half-year's dividend on the preference shares, which absorbed £12,375, leaving £23,518. 7s. 2d. Out of this the board recommend payment of a dividend at the rate of 8 per cent. per annum (less tax) for the past half-year, making 7 per cent. for the year, carrying forward a balance of £1,518. 7s. 2d.

CITY NOTES.

MEMORANDA (Feb. 16).—**Bank rate 5 per cent. (since Aug. 8, 1914). Consols** 58¼. **Consols Pay Day, March 1. Stocks and Shares Ticket Days, Feb. 23 and March 9. Pay Days, Feb. 24 and March 10. Price of silver,** 26 15/16d.

CENTRAL LONDON RAILWAY CO.—The following dividends have been declared : On the undivided ordinary stock for six months of 1½ per cent., making for the year 3 per cent. (against 2⅝ per cent.), on the deferred 2 per cent. for the year (against 1¼ per cent.), carrying forward £15,685 against £15,413.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors recommend a dividend for the half-year to Dec. 31, 1915, at rate of 4 per cent. per annum on the ordinary share capital, making 4 per cent. for 1915, after paying debenture interest and placing £14,720 to depreciation fund, £704 to debenture premium redemption fund, writing off £1,089 from cost of extinction of founders' shares and £1,000 off cost of investments ; carrying forward about £3,260, subject to audit. The dividend will be payable on and after 15th prox.

CITY & SOUTH LONDON RAILWAY CO.—A dividend of 2½ per cent. has been declared on the 5 per cent. preference stocks for the six months ended Dec. 31, making 5 per cent. for the year.

LONDON ELECTRIC RAILWAY CO.—The directors recommend a further dividend of ¾ per cent. on ordinary (making 1½per cent. for 1915), carrying forward £12,808.

LONDON ELECTRIC WIRE CO. & SMITH'S (LTD.)—A dividend of 7½ per cent. and a bonus of 2s. 6d. per share have been declared on the ordinary shares, making 12½ per cent. for the year; £50,000 has been placed to reserve and £28,559 carried forward.

MATHER & PLATT (LTD.)—A final dividend of 9½ per cent. actual, making 12½ for year, has been declared, the same as in 1914.

MERSEY RAILWAY CO.—The directors have declared a dividend of 4 per cent. on the 1866 debenture stock, 3 per cent. on the 1871 debenture stock, 3 per cent. on the 1882-83-85 debenture stocks and 1 per cent. on the "B" debenture stock, carrying forward £164.

METROPOLITAN DISTRICT RAILWAY CO.—A dividend on the 5 per cent. second preference stock for the six months ended Dec. 31 of 1½ per cent. has been declared, making 3 per cent. for the year (against 2 per cent.), carrying forward £13,952.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—A further dividend of 10 per cent., together with a bonus of 12s. per share, has been declared, the same as a year ago. The transfer books will be closed from 21st inst. to 2nd prox., inclusive, preparatory to payment of dividend.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Subject to the respective dividend announcements of its subsidiary companies the revenue of the Underground Co. will enable it to pay full interest to Dec. 31 on its 6 per cent. first cumulative income debenture stock and on its 6 per cent. income bonds, carrying forward about £38,500.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Feb. 15, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	16½d.
Solid Drawn Copper Tubes	18½d.
Brazed Copper Tubes	18½d.
Brazed Brass Tubes	18½d.
Brass Wire	15½d.
Copper Wire	17d.
Rolled Brass	15½d.
Brass Sheets	16½d.

	per ton.
Copper Sheets	£143 0 0
Spelter	£93 0 0
English Lead	£32 15 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£100 0 0
Braziery Copper Scrap	£90 0 0
Clean Scrap Brass	£66 0 0
Old Lead	£26 0 0
Old Zinc	£60 0 0
Hollow Pewter	£120 0 0
Black Pewter	£80 0 0
Gun Metal	£80 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Feb. 15 the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£130 0 0
Clean Mixed Brass	£70 0 0
Clean Copper	£94 0 0
Braziery Copper	£88 0 0
Gun Metal	£85 0 0
Old Lead	£27 0 0
Tea Lead	£25 0 0
Old Zinc	£68 0 0
Hollow Pewter	£120 0 0
Stereotype Plate Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £100; Blowpipe Solder, £110.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Feb. 15. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues., Feb. 15	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 7 7	Mar, Sept
10	4½%	†Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	†Do. 6% Cum 2nd Pref.	10⅞	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	84½	4 15 9	Jan, July
5	2/3	Do. 4½% Pref.	3⅞	6 9 9	..
5	5%	Do. Ord.	3⅞	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	2½	8 9 5	Jan, Dec
5	5%	Chelsea Elec. Supp. Co Ord.	4½	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	11⅜	7 11 2	Feb, Aug
10	6/0	Do. 6% Pref.	10½	5 10 4	Mar, July
St.	5%	Do. 5% Deb St.	97⅛	5 2 6	Jun, Dec
St	4½%	Do. 4½% Debs.	90½	5 12 11	Jun, Dec
10	7%	County of London Ord.	13⅛	6 19 2	Mar, Sept
10	6%	Do. 6% Pref.	10⅛	5 14 3	Feb, Aug
St	4½%	Do. 1st Deb.	90½	5 4 1	Jan, July
St	4½%	Do. 2nd Deb.	90	4 12 9	May, Nov
St.	4½%	Edmundsen's Elec. Supp. 4½% Debs.	75	6 0 0	Jan, July
5	9%	Kensington and Knightsbridge Ord.	6⅜	7 5 5	Feb, Aug
St	4%	†Do. Deb. St.	70½	5 0 11	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4⅛	7 3 3	..
St.	4%	Do. 4% Mort. Debs.	75½	5 4 6	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2⅛	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	85	5 11 6	Jan, July
St.	5%	Midland Elec. Corp. 1st Mort. Deb St	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E. L. 6% 2nd Deb.	99½	6 0 6	Mar, Sept
St	5%	Newcastle Low-Tension S. 5% 2nd Mt. Db St.	100	5 0 0	Mar, Sept
4	6%	North Metropolitan E. P. Supp. 6% Pref	1⅛	5 16 4	Apl, Oct
4	5%	South London E.S. Ord.	3⅛	6 10 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Feb. 15.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	10%	St. James' & Pall Mall Ord.	5⅞	8 10 3	Feb, Aug
5	7%	Do. do. Pref.	5⅞	5 19 2	Feb, Aug
St.	3½%	Do. do. Debs.	80	4 7 6	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅜	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	6	7 10 0	Mar, Sept
5	4½%	Do 4½% Cum. Pref.	4⅛	5 10 9	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82½	6 1 3	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75	8 0 0	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	69	5 15 11	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½	8 0 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1⅛	3 11 5	Jan, July
St.	4%	Do. 4% Pref.	63½	6 6 0	Mar, Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St	1%	Metropolitan Ry. Con. Ord.	24	4 3 4	Feb, Aug
St	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St	3½%	Do. 3½% Convertible Pref.	74½	4 13 ..	Feb, Aug
St	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St	..	Metropolitan Dist. Ry. Ord.	15	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	71	5 12 8	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	70	5 14 3	Jan, July
St.	4%	Do. 4% Guar. Stock	67⅞	£5 18 9	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅛	5 4 8	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	88½	5 12 8	Jan, July
1	6%	Do. 6% Pref.	8⅛	6 14 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10½	7 0 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅛	5 17 1	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm.6% Pref.	⅝	6 17 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅞	7 1 7	April
100	6%	Do. 6% Prior Lien Debs.	102½	5 17 8	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	61½	6 4 0	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11½	6 10 5	Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅝	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅜	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	71	5 12 8	Jan, July
50	10%	General Electric Ord.	10⅜	9 8 3	July
10	6%	Do. 6% Pref.	9⅞	6 5 6	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅜	7 5 5	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅜	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅞	9 4 5	Feb, Aug
10	5%	Do. Pref.	7⅛	6 7 0	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37½	6 9 4	Mar, July
100	4%	Do. 4% Debs.	93	4 5 0	Jan, July
1	7½%	Vickers Ord.	1⅜	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	82½	4 16 8	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 6	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅞	6 17 1	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69½	5 14 1	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 11 2	May, Nov
10	10%	Do. 10% Pref.	15½	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	†Direct United States	6⅛	6 12 0	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	126½	5 10 6	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77½	5 2 7	May, Nov
St.	4%	†Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12½	5 5 11	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. 4	34	6 9 5	Ja, My, Jly
25	13%	Indo-European	50½	6 8 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜	5 3 3	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅛	9 8 4	May, Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 5 11	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	78½	5 6 0	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99½	4 10 3	May, Nov.
		Telephones.			
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
1	10%	*Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅜	6 15 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	84½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10½	5 18 8	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	9½	6 1 6	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80½	6 4 7	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	67½	5 18 0	Ja,Ap, Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 1o 9	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs.	95	5 5 3	Jun, Dec
10	6%	†Bombay E. S. & T 6% Pref.	10	6 0 0	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	6½	7 15 1	May, Nov
5	5%	Do. 5% Pref.	4½	5 11 11	Mar, Sept

* And 13⅓% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 725
Arrangements for the Week .. 728
The Wave-Shapes Obtaining with Alternating-Current Generators Working Under Steady Short-Circuit Conditions. By A. E. Clayton. Illustrated 729
The Principles of Modern Printing Telegraphy.—*Discussion* 731
Top Contact Unprotected Conductor Rail for 600-Volt Traction Systems. By Charles H. Jones 733
Selenium Cells. By W. R. Cooper, M.A., B.Sc. Illustrated.—*Concluded* 735
The Effect of Electric Oscillations on the Magnetic Properties of Iron Investigated by the Campograph. By J. A. Fleming, M.A., D.Sc., F.R.S., and P. R. Coursey, B.Sc. Illustrated 738
Lord Kelvin and Terrestrial Magnetism. By C. Chree, Sc.D., F.R.S. 740
The Propagation of Electric Waves at the Surface of the Earth and the Ionised Layer of the Atmosphere. By Prof. H. Nagaoaka. Illustrated. 741
MORTGAGING THE FUTURE 742
Long-Distance Radio Transmission. By Louis Cohen .. 743
The Nominal Candle-Power of Incandescent Lamps. By Dr. Ernst Salomon 744
CORRESPONDENCE 745
"The Principles of Modern Printing Telegraphy" (Edward Raymond-Barker and H. H. Harrison).
The Organisation of Research (Hy. Tinsley).
City and Guilds Examination in "Wiremen's Work" (A. P. Lundberg & Sons).
Earthing (S. C. Rhodes).
Some Future Possibilities in the Design of Instruments for Measuring Illumination 746
Physical Society 747
LEGAL INTELLIGENCE 748
The "Electrician" Commercial and Industrial Section .. 749-758

NOTES.

The Kelvin Lecture.

THIS year the Kelvin Lecture was on a more purely scientific subject than has usually been the case, the subject being terrestrial magnetism, and the lecturer Dr. C. CHREE, the well-known Superintendent of the Kew Observatory. Lord KELVIN was not so closely identified with this branch of work as with some others, although he played an important part in the improvement of the mariner's compass. He also took a keen interest in ecrtain theoretical speculations. Thus he was somewhat averse to various theories which were put forward from time to time attributing magnetic storms on the earth to the direct magnetic action of the sun. It is characteristic of Lord KELVIN that he tested such matters by putting them into numerical form. Thus, in refuting the theory of the direct action of the sun, he calculated that the production of an ordinary magnetic storm would require the expenditure of 160 million million million million horse-power, so that in eight hours of a moderate magnetic storm as much work would be done by the sun in sending magnetic waves in all directions through space as it actually does in four months of its regular heat and light. Although it is still held that the sun may give rise to magnetic storms, the mechanism of the action is now supposed to be very different from that of direct magnetism. Of the many interesting magnetic changes that are continually in progress, the secular change in H is, perhaps, the one that has the greatest practical interest, and no doubt there will be much speculation in generations to come as to whether the phenomenon can be represented by a closed loop. In all terrestrial magnetic phenomena, a relation between the sun or sunspots appears to run as a continuous thread. It is difficult to prove any relation with certainty, and it is remarkable to see how contradictory may be the evidence put forward by leading men on a question of this kind. The general feeling is that there must be some such relation, though it is not every physicist who would have the patience of Dr. CHREE to investigate entries running into tens of thousands to prove what is true in a given contention. The suggestion made by Dr. CHREE that workers in radiotelegraphy should look out for similar periods as appear to exist in terrestrial magnetic phenomena should not be forgotten. Measurements of this kind might yield results which would help to clear up points, both in regard to terrestrial magnetism and electric waves.

The Candle-power of Incandescent Lamps.

THE term candle-power, when applied to incandescent lamps, has ceased during the last few years to have an exact signification. In the days of the carbon glow lamp the flux of light was fairly distributed over the lower hemisphere. The first type of lamp to disturb this state of things was the Nernst lamp, which showed great variations in the direction of the filament. Although this lamp may now be disregarded, other variations have been introduced. Thus the average metal filament lamp gives much more light in a horizontal direction than in a vertical direction. On the other hand, when we come to spiral filament lamps the flux is greater in a vertical direction than horizontally, because in the horizontal direction one part of the filament interferes with another. Thus the measurement of candle-power in a horizontal direction is unsatisfactory for different types of lamp. The mean hemispherical unit is rather better, but it cannot be said fully to meet the case commercially, because light thrown upwards may be almost as valuable as light thrown downwards, due to the fact that lamps are generally used with reflectors. The measurement of mean spherical candle-power gives a true figure, but is comparatively troublesome. It is obvious that the maker of one kind of lamp is not likely to agree to a proposition of another maker if the method of rating does not show his lamp off to advantage. Thus it is difficult to obtain anything like unanimity of opinion. Judging by an article by Dr. E. SALOMON, of which we give an abstract elsewhere, these difficulties are being felt materially by German makers, and conferences have therefore been held between representatives of the different firms. The outcome of these conferences appears to be that opinion is in favour of rating lamps purely by the watts. This solution has already found favour in this country, and probably it is the best course to adopt. The public has little idea of the meaning of candle-power and still less as to the variation of candle-power in different directions. On the other hand, it is scarcely likely that makers will entirely drop the use of the term candle-power when it suits their purpose. For example, if two makers each produce a 50-watt lamp, and

one lamp gives double the candle-power of the other, it is not likely that the maker of the more efficient lamp will hide his light under a bushel by calling it merely a 50-watt lamp. In some respects, therefore, the difficulty will not be solved simply by adopting watts as a basis.

Wiremen's Work.

A CORRESPONDENT raises the important question of the training of wiremen, and with much of the letter we are in entire agreement. That the average electrical contractor does not attach sufficient importance to the technical training of his apprentices is generally admitted, with the result that many of these men, even after serving their apprenticeship, cannot be said to know their trade. In this connection the Electrical Contractors' Association could well follow the example set by the several gas companies, and make a satisfactory technical and general education one of the strongest features of the apprenticeship course. With full knowledge of the conditions which obtain in many of our colleges and schools, we state emphatically that the fault, if fault there be, is not in the main due to them, nor is it due to the City and Guilds of London Institute. Much as we should like to see the wiring syllabus brought into line with modern requirements, we attach the greatest importance to the pioneer work carried out by the Institute. That one of our contemporaries should state that the City and Guilds of London Institute is really not very well known is contrary to fact, and we take this opportunity of recording our appreciation of the splendid work done, under the auspices of the Institute, in every branch of technology. Nowadays evening classes have to compete with kinema palaces, and, after a long day's work, it is not to be wondered at that the tired apprentice seeks recreation at the latter, in preference to further toil. But we admire the youth who, fighting against heavy odds, endeavours to improve his knowledge of his trade by attending the night school. The country stands in need of such men.

"The Central." The January number of this journal contains articles on "The Hardening and Annealing of Metals" by R. G. Parker, "The Photographic Industry," by F. F. Renwick, together with "Old Student Notes," and some reviews.

Thermo-Electromotive Force of Iron Alloys.—An interesting Paper was read recently before the American Electrochemical Society by T. S. Fuller on this question. The alloys were electrically annealed and are welded to form the couples, and measurements were made in millivolts against copper as a standard. For iron-nickel alloys with small percentages of silicon and carbon the E.M.F. varied from —0·64 with 17 per cent. Ni to — 2 with 96·3 per cent. Ni. For iron-chromium alloy + 1·2 with 10 per cent. Cr and 0·32 with 23·5 per cent. Cr. For iron-cobalt 10 per cent. Co gave —0·64, 30 per cent. —3·50. Other alloys tested were iron-nickel-chromium and iron-nickel-manganese. The difference of temperature of the junctions in all cases was 100° C.

A Thirty-two Element Synthesiser.—In the "Journal" of the Franklin Institute there is a striking Paper by D. C. Miller, D.Sc., dealing with harmonic analysis and synthesis. After referring to the work of Bashforth and of Kelvin, and to the remarkable tide-predicting machine with 38 elements of the United States Coast and Geodetic Survey (all described in the special publication No. 32 of the U.S. and Geodetic Survey), he deals with the Henrici analyser. The simple harmonic motion of each element in the new synthesiser consists of a pin-and-slot device, and is doubled in amount by a simple fusee chain passing round a pulley. The 32 elements are mounted on a cast-iron bedplate, and all the pulleys used are made of aluminium, and ball bearings are used in these and in the pin-carriage. Having the Fourier equation of the curve given in a single series of sines, the pin in each disc is then set to the amplitude and rotated till it has the correct phase. A 10 component curve can be synthesised in five minutes, and a curve drawn for 30 components in 12 minutes.

Christobal Coaling Plant.—The "Canal Record" referred recently to work at Panama in erecting the coal-handling machinery.

Following the preliminary tests on the first of the four unloader towers of the permanent coaling plant at Christobal, the main frames of all four reloader towers, on the opposite side of the plant from the unloaders, have been erected and the erection of the booms and machinery is in progress. The erection of the two stocking and reclaiming bridges, spanning the storage spaces, is practically completed. One of the bridges No. 1, was moved under its own power on Wednesday, January 5th. Forty-six of the 88 hopper cars which will carry the coal on the overhead viaduct have been practically completed. The troubles in sinking the final caissons for the foundation for the end wharf, at the north-end of the plant, have been overcome and the last section of floor for the wharf was poured on Saturday, January 8th. The surplus coal in the supply brought to the Isthmus for the Panama Railroad is being stored in the dry storage space. The wet storage is reserved for the United States Navy.

Institute of Industry.—The Institute of Industry has appointed a Special Committee to meet representatives of important trade interests. The Committee appointed is as follows: Mr. F. J. Nettlefold (chairman); Sir Clifford J. Cory, Bart., M.P. (Messrs. Cory Bros. & Co., Ltd.); Sir James Heath, Bart. (Messrs. R. Heath & Sons, Ltd.); Mr. Godfrey C. Isaacs, (managing director, Marconi Wireless Telegraph Co., Ltd.); and Mr. Frank Warner, (president, The Silk Association of Great Britain and Ireland)

The directors propose to take advantage of the suggestion put forward in this direction by Sir Edward Carson, and a number of business men have promised to subscribe the requisite funds to ensure success. It is gratifying to learn that developments of a far-reaching nature are now pending, and there has been a considerable increase in the membership of the Institute since the beginning of the year. The directors would be glad if British manufacturers and other gentlemen interested in the industrial welfare of the Empire would send in their applications for membership to the Secretary, Institute of Industry, Aldwych Site, Strand, W.C.

Calorising Metals.—Mr. W. E. Ruder in a recent Paper, read before the American Electrochemical Society, discusses methods of protecting metals working at high temperatures from oxidation. The process called "calorising" consists in producing a rich aluminium alloy upon the surface of metal requiring protection. The pieces to be protected are packed in a mixture of alumina and powdered aluminium with 1 per cent. of ammonium chloride. For copper and brass the mixture is low in aluminium and the firing temperature between 700° and 800°C. For steel and iron richer mixtures are used, and the temperature is 900° to 950°C. This process resembles the cementation one, and results in the formation of a skin of alloy. The results appear to show that the process protects metals from oxidation below 1,000°C. and above this temperature it increases the life considerably. It also protects copper from atmospheric corrosion. This process is being used to protect furnace parts, pyrometer tubes, annealing boxes and combustion tubes.

Alloys for Turbine Blading.—In the "Journal" of the Institute of Metals there is an interesting Paper by Mr. W. B. Parker on "Specifications for Alloys for High-speed Superheated Steam Turbine Blading." It is shown that the steam pressure in itself is not important, but temperature is probably the most serious item as regards turbine blades. With the increase of steam pressure to 400 lb. per square inch and added superheat, the steam temperature is 750°F. at the nozzle entrance. Consequently the first rows of blades have continuously to withstand successfully the high pressure at this temperature. At the exhaust again the blades have to withstand low temperature, about 80°F. to 100°F., and possibly wet steam. Again the velocity of the steam may be in the early stages, between 2,000 ft. and 1,200 ft. per second, and any erosion of the material produces a sand-blast action on the blades, owing to the velocity of particles of metal, as well as the steam itself. In addition there is water erosion which will

not vanish until the superheat is increased to about 1,000°F. In the Paper there are interesting photographs showing effects of erosion, and microstructure of alloys, and other useful information is given. Copper-aluminium-nickel alloys are highly spoken of both in the Paper and in the discussion which follows it. These alloys possess remarkable physical properties at ordinary temperatures, and the author considers that they foreshadow rivals to the special alloy steels now used for the most highly heated and stressed portions of the turbine blading.

"The Organisation of Scientific Research."—We give below an abstract of Dr. Fleming's written reply to the points raised in the discussion of his Paper on the above subject at the meeting held on the 9th inst. at the Royal Society of Arts. An abstract of the lecture, and a report of the discussion, appeared in our issue last week.

Dr. Fleming felt it was satisfactory to find there were several points on which there was general agreement. One of these was the necessity to distinguish between purely scientific research, technical research and useful inventions. Therefore, no nation could say it would foster one branch and leave the other alone. His contention was that the State should do this by putting funds for this purpose at the disposal of properly qualified scientific men. It was satisfactory to note that the opinion of most of those who took part in the discussion was against detailed control of research by Government Committees. One way of doing this was by the creation of Research Professorships, with no other obligations except to expound occasionally to public audiences the results of investigation. For younger men scholarships on the lines of the 1851 Exhibition Scholarships would prove a good investment. As regards industrial research he agreed with Mr. Swinburne, Sir William Tilden and Prof. H. E. Armstrong, that it must be left to the manufacturers to settle. As regards inventions, the chief benefit the State could confer was to leave the inventor alone. He agreed with Prof. Armstrong that our public school education must be reformed. It was not so much a question of giving more time to science and less to classics in schools so much as elevating the whole tone of the teaching. The absorbing interest in public schools hitherto had been the games, and the intellectual life was relegated to a second place. One thing was perfectly certain; we as a nation had to set to work to make and manufacture scores of hundreds of things we had previously bought from Germany and Austria, and that would compel national attention to scientific matters hitherto ignored.

Earth Resistance and Electrolysis.—Entitled "Earth Resistance and its Relation to Electrolysis of Underground Structures," a technologic Paper by Messrs. Burton McCollum and K. H. Logan was issued at the end of December by the Bureau of Standards.

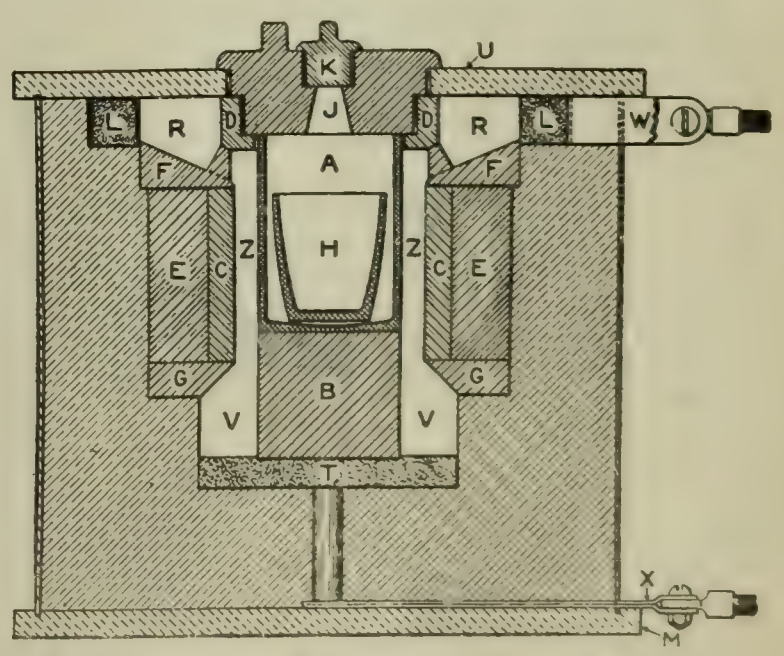
The authors show that the resistivity of the soil is of much importance with respect to electrolysis of these structures. Three methods of measuring the specific resistance of the soil, two of which do not require the removal of the soil from its original position, are described. Results of soil resistivity measurements by each method are compared, and it is shown that any of the described methods is satisfactory for practical purposes, although each has advantages over the others under certain conditions. The results of a large number of measurements of resistivity of soil samples are tabulated, and these show great variations, and indicate the desirability of a study of local soil conditions in connection with any complete electrolysis survey. The majority of soils tested show resistivities of between 1,000 and 5,000 ohms per centimetre cube. A number of factors have been found to influence the resistivity of the soil. Increasing the pressure on the sample under test tends slightly to increase the conductance, especially if the original pressure is low. Increase in moisture increases the conductance of the soil if the latter is not saturated with water. The amount and kind of soluble material in the soil affects its resistivity. The resistivity of soil is found to increase as its temperature falls, especially when the freezing point of the water is reached. The flow of current has been found to produce an apparent temporary increase in the resistivity in the neighbourhood of the electrodes. The relation of soil resistivity to electrolysis is considered from the standpoint of leakage from street railway lines, using the track as a return circuit. The importance of good rail bonding and of well-drained road-bed is pointed out. The relations of the various factors affecting leakage resistance—namely, character of the soil, pressure, moisture, freezing, polarisation and surface films to the electrolysis problem—are described, and it is shown that a knowledge of the resistivity of the soil is of importance in estimating the danger indicated by P.D. and potential gradient measurements. It is also shown that the moisture and temperature of the soil materially affect the amount of current escaping from a grounded track used as a return circuit, and that these factors must be given due consideration in the interpretation of data obtained during an electrolysis survey.

Proposed Standard Numerals.—Mr. A. P. Trotter has compiled some notes on "A Set of Proposed Standard Numerals for the Scales of Measuring Instruments," and now published in the "Journal" of the Institution of Electrical Engineers by request of the Meter Panel of the Engineering Standards Committee on Electrical Accessories. It appears that with some numerals, when the height is 10 units, if the width is made much less than 7 units the legibility suffers. The following table gives the dimensions of numerals suggested, all reduced to height equal to 10 units, compared with the systems of the India Office and that of Col. A. Strange:—

	India Office.	Col. A. Strange.	Proposed.
Width of line	0·8 to 1·7	0·86	1
2. Width of	4·5	7·2	7
Semi-ellipse major axis	...	...	7
,, minor axis	...	...	3
Radius of breast	...	...	5
3. Width of top	4·5	6·9	5
Ellipse major axis	...	...	7
,, minor axis	...	...	6
4. Width of	8·0	7·1	7
Centre of bar from base	2·8	3·5	3·5
Overhang of tail from centre of stem	3·0	2·15	2·5
5. Width of	6·5	7·8	7
Down stroke, over all	4·0	5·3	5
Width of top bar	4·0	6·0	5·5
6. Width of	6·5	7·8	7
Ellipse major axis	...	...	7
,, minor axis	...	...	6
Radius of tail	...	...	7
7. Width of	5·5	8·6	7
Radius of tail	...	...	30
8. Width of lower part	8·0	8·6	7
,, upper part	6·3	7·8	6
Centre of cross-bar from base	5·5	5·7	5·5
10. Width of	7·4	7·6	7

According to the usual practice, a 9 is simply the 6 reversed.

Experimental Electric Furnace for High Temperatures.—The electric furnace shown in section in the accompanying illustration was described in a recent number of "Metallurgical and Chemical Engineering." It was designed primarily for determining the fusion points of coal ash, metals and alloys, but it has also found application in other experimental work. Under normal heats the furnace reaches 1,600°C. in about one hour, and has a maximum temperature limit of 1,800°C. Referring to the illustration, Z represents the heating zone formed by two concentric cylinders A and B inside and C outside the zone. A special granular resistor material is used which is



HIGH-TEMPERATURE EXPERIMENTAL FURNACE.

placed in the chambers R, Z and V. The portions R and V have large area and lower resistance than V, consequently the heat is concentrated in the zone Z. Graphite electrodes are shown at L and T. These form contact with the granular resistor material. The resistor material is gradually replaced as it is used up. In a test, one of these furnaces was run continuously for a week on one charge of granular resistor material. The furnace operates with either alternating or continuous current up to 125 volts, and the size of the heating chamber is $2\frac{1}{2}$ in. diameter and $3\frac{3}{4}$ in. deep. All refractory parts are replaceable. The furnace is known as the "High Temp" and is sold by Messrs. Eimer & Amend, of New York.

OBITUARY.

R. H. Smith.—We regret to announce the death of Prof. Robert Henry Smith, M.A., A.M.I.C.E., M.I.Mech.E., M.I.E.E., which occurred suddenly on the 18th inst. Prof. Smith was the author of several engineering works, including the following: "Commercial Economy in Steam and Other Power Plants," "Tables of Multiplication, Division and Proportion for Quantities, Costs, &c.," "Measurement Conversion Tables (English and French)," "The Calculus for Engineers and Physicists," "Cutting Tools," "Electric Traction" and "Boilers, Economisers and Superheaters."

A. L. Sabine.—We regret to learn that Mr. A. L. Sabine, late secretary to Siemens Bros. & Co. (Ltd), died on the 20th inst. He was secretary from the registration of the Company in 1880 until 1910, when he retired after 50 years' service with the firm. The deceased, who was 75 years of age, was inte red at the Camberwell Cemetery, Honor Oak, yesterday (Thursday).

Killed in Action.—It is now announced that Sergt. J. D. Batty, who was formerly electrical engineer-in-charge of the municipal plant at Korumburra (Victoria), was killed at Gallipoli.

PERSONAL.

Royal Engineers (T.F.).—The following appointments have been made:—

London Electrical Engineers: Sec. Lieuts. (temporary Lieutenants) Thos. F. Middleton-Case, Geo. R. Madge and Maurice G. Bland to be temporary Captains. Sec. Lieuts. Harry G. G. Clarke, Cecil H. S. Evans, Wm. H. Mather, Geo. E. Owles, Ernest E. Levett and Thos. H. Gotch to be temporary Lieutenants. Lance Corp. Alan S. Gill to be Second Lieutenant (on probation).

Tyne Electrical Engineers: Temp. Sec. Lieut. J. L. Batey (from Northumberland Fusiliers) to be Second Lieutenant.

APPOINTMENTS VACANT AND FILLED.

The Electric Appliances Co. (Ltd.), 8, Fisher-street, Southampton-row, London, W.C., advertise for electricians accustomed to small armature work.

Mr. T. W. Hawthorn has been appointed electrical engineer at the Eaglehawk (Victoria) borough electricity works in place of Mr. S. W. Cooke, resigned.

INSTITUTIONS AND SOCIETIES.

Institution of Electrical Engineers (Scottish Section).—On the 8th inst. a meeting of this section was held at Edinburgh, when Mr. H. H. Harrison's Paper entitled, "The Principles of Modern Printing Telegraphy," was read. The following discussion took place:—

Mr. Turnbull asked if anything had been done to connect two typewriters together, so that an operator could work a typewriter with his vis-à-vis at the other end of the wire, and was the typewriter at the receiving end under such an operator's control.

Mr. McGregor said he agreed that for military reasons hand-working would be retained. In the "Scotsman" newspaper office they had had three wires, but with the Creed system one wire overtook the work, with a large resultant saving. The apparatus had cost some £2,000, but in a few years' time it would pay for itself. He did not see how the Morse system would overcome the typewriter printing from a commercial point of view. With regard to synchronisation of transmitters on circuit, he asked the author to state whether the reed with the phonic wheel, the motor-driven transmitter or the wave-driven transmitter gave the best speed.

Mr. Mavers asked what was the maximum phase to be allowed between distributors, and whether any regulation could be got with the use of a motor with a permanent field and secondary coils with definite regulation, so as to have a more definite voltage on the armature.

Mr. Dawkes said they in Edinburgh had had experience with the Murray and Creed types. The Murray-Baudot system had undoubtedly points to commend it.

Mr. Harrison, in reply, said the London and Manchester circuit had such an arrangement as was referred to in Mr. Turnbull's question, the receiving typewriter being controlled by the machine at the end from which the message comes. Usually 1½ deg. per revolution were allowed between distributors. The distributor was ¼ revolution per second, and the distributor rotated at 1 revolution per ¼ second, the distributor running 14,000 times faster than the minute hand of a clock. There must be synchronisation, and it was impossible to rely upon the constant speed of a motor. He commended the retention of Morse operators in connection with Creed and other similar installations. The motor-driven transmitter assumed a fairly large motor, and he thought that transmitters and reproducers on the Creed system could be driven on the phonic wheel.

Institution of Post Office Electrical Engineers.—On the 14th inst. Mr. J. Hedley read a Paper on "The Western Electric Company's Semi-Automatic Telephone System" before the London Centre. In this system the mental and physical labour of the operator is reduced to a minimum. The Paper deals in detail with the manual operations involved in working such systems. An account of the "Western Electric Machine Switching Telephone System" appeared in The Electrician, Vol. LXXIV., pages 390, 420, 453 and 494.

Royal Society.—Amongst the Papers read at yesterday's meeting we notice the following: "The Ignition of Gases by Impulsive Electrical Discharges," by Prof. W. M. Thornton; and "On Speed Effect and Recovery in Slow-speed Alternating Stress Tests," by Prof. B. Hopkinson, F.R.S.

Physical Society.—The meeting arranged for the 25th inst. will not take place.

Institute of Chemistry.—In the "Proceedings" for February, it is pointed out that the Institute has continued to render service to the Government in matters connected with the war. The inquiries dealt with included army chemical supplies, laboratory apparatus, inventions, materials of war, trading with the enemy and questions of contraband. So great was the demand for chemists that the Institute opened a register for chemists whether connected with the Institute or not, and this has been freely utilised by the authorities. The Glass Committee has also done much useful work as regards assisting British manufacturers to produce resistance glass for pharmaceutical purposes, for miners' lamps, X-ray bulbs and other glass not obtainable owing to the war.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, Feb. 26th.

Junior Institution of Engineers.

3 p.m. Bohemian Concert at Holborn Restaurant (King's Hall) in aid of the Red Cross Hospital.

Association of Mining Electrical Engineers.

3:30 p.m. Meeting at University College, Nottingham. Paper on "Static Transformers," by Mr. Chris. Jones.

TUESDAY, Feb. 29th.

Association of Supervising Electricians.

7:15 p.m. At St. Bride Institute, Bride-lane, E.C. Paper on "Illuminating Engineering," by Mr. Leon Gaster.

WEDNESDAY, March 1st.

Institution of Electrical Engineers.

5:p.m. At Victoria Embankment, W.C. Special General Meeting to consider an Extraordinary Resolution in regard to members who are subjects of enemy countries.

Institution of Electrical Engineers—Students' Section.

7:45 p.m. Meeting at Victoria Embankment. Paper on "Suggested Applications of Science in Warfare," by R. E. Dickinson, B.Sc.

FRIDAY, March 3rd.

Royal Institution.

5:30 p.m. Meeting at Albemarle-street, W. Discourse by Prof. S. P. Thompson, D.Sc., F.R.S., on "Corona and Other Forms of Electrical Discharge."

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lieut.-Col. C. B. Clay, V.D.

Orders for week commencing February 28, 1916:—

Drills: 6:25 p.m. to 7:25 p.m.; 7:25 p.m. to 8:25 p.m.

Monday, February 28th.—Sections 1 and 2, Technical; Sections 3 and 4, Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, February 29th.—School of Arms, 6 p.m. to 7 p.m.

Thursday, March 2nd.—Shooting for Sections 3 and 4.

Friday, March 3rd.—Sections 3 and 4, Technical; Sections 1 and 2, Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, March 4th.—Adjutant's Instruction Class at 2:30 p.m.

Sections for Technical parade at Headquarters, London Electrical Engineers, 46, Regent-street, W.

Sections for Shooting parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate-hill, as soon as possible.

THE WAVE-SHAPES OBTAINING WITH ALTERNATING-CURRENT GENERATORS WORKING UNDER STEADY SHORT-CIRCUIT CONDITIONS.*

BY A. E. CLAYTON.

Summary.—The Paper deals in detail with the action of single and polyphase alternators under short-circuit conditions. Both salient-pole and cylindrical field alternators are considered.

The author discusses the action of an ideal alternator under steady for the short-circuit conditions. He next deals with the wave shapes obtained with short-circuited alternators for the flux distribution. This is followed by a consideration of the wave form of the E.M.F. induced in the armature conductors and the resulting E.M.F. for a winding in slots displaced by various angles. Consideration of the current wave then follows, and the M.M.F. distribution waves for a machine with a cylindrical field and a table for the resulting E.M.F. for certain windings is given. Three-phase machines are then discussed as follows :—

Three-phase Machines.

The actions set up on short-circuit for three-phase machines may be taken, for approximate purposes, as being the same as those set up in the ideal polyphase alternator just considered. However, the ideal case assumes that the armature magnetomotive force is constant and of sinusoidal distribution, whereas with actual three-phase machines the magnetomotive force is neither constant nor sinusoidal, although the variations on either side of the mean sine curve are small.

Armature Magnetomotive Force.—The Paper considers in detail the variations in the armature magnetomotive force of a three-phase alternator, and then discusses the effect of these variations for both types of field construction.

(*a*) Salient-pole Machines.

Flux Distribution and Induced E.M.F.—Under the conditions assumed the flux distribution will vary periodically at six times

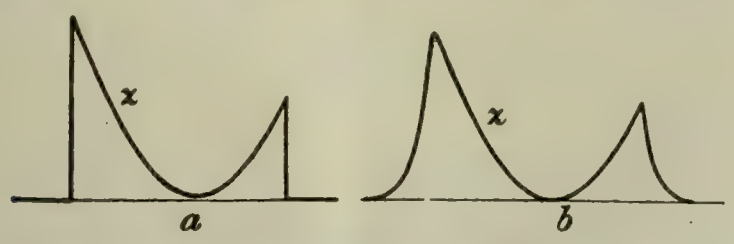


Fig. 1.—Effect of Armature Resistance and Fringing upon the Shape of the Resulting Induced E.M.F.

the main frequency, and the E.M.F. set up in the armature conductors will depend to a certain extent upon the position of the conductor. The E.M.F. induced in any particular conductor may be taken as being composed of two parts : (1) An E.M.F. of constant magnitude and wave-shape due to the mean value of the total resulting magnetomotive force ; and (2) an E.M.F. due to the additional magnetomotive force which alternates at six times the main frequency.

Assuming that the variations in the resulting magnetomotive force follow a sinusoidal law, the E.M.F. due to these variations will give rise to ripples in the wave of total E.M.F. set up in the conductor, the ripples being equivalent to the combined effects of harmonics of the (6−1)th and the (6+1)th orders—*i.e.*, the fifth and seventh. The amplitude of this ripple will not be the same for all the conductors, but will depend upon their position ; in no case, however, will the amplitude be large.

The eddy currents induced in the pole-shoes by this alternating component of the flux render the already small deviations between the general action of a three-phase alternator from that of the ideal polyphase machine practically negligible.

As a result, the total induced E.M.F. and current waves for three-phase star-connected alternators will not differ appreciably from those obtaining with the ideal polyphase machine having a winding of similar spread. For mesh-connected machines, the presence of the third harmonic in the current wave may cause slight differences from the ideal machine, but these will be trifling. The chief difference between the star and the mesh-connected machines will be that the third harmonic will be absent from the current for the star, and probably present for the mesh winding.

Effects of Armature Resistance and Fringing.—So far as resistance is concerned, the effect is simply to cause the lag of the current behind the induced E.M.F. to be less than one-quarter of a period, and as a result the armature magnetomotive force will not be in exact opposition to the main magnetomotive force. A slight dissymmetry in the wave-shape of the induced E.M.F. is thus produced. Neglecting the flux in the interpolar space, the wave-shape would then be as shown in Fig. 1*a* ; including the flux due to fringing, the induced E.M.F. will then be of the form shown in Fig. 1*b*. So far as the total E.M.F. is concerned, the effect of the pole fringe will be to round off all the sharp points in the curves.

(*b*) Cylindrical-field Machines.

As with salient-pole machines, the departures from the conditions obtaining with the ideal case are negligible for star-connected machines, for which the short-circuit current is practically a pure sine-wave. For mesh-connected machines the third and fifth harmonics may be pronounced in the wave of resulting E.M.F., depending upon the winding spread, and may be of importance in the current. The reactance and normal M.M.F. ratio for machines of this type are always small, and the higher harmonics prominent in consequence.

Effect of the Spacing of the Rotor Winding.—The actual M.M.F. distribution due to the exciting winding is stepped, and not a straight line, owing to the winding not being uniformly distributed over the wound portion but placed in slots. As a result of the main M.M.F. diagram being stepped, marked ripples are set up in the wave of E.M.F. induced in the armature conductors on short-circuit. The

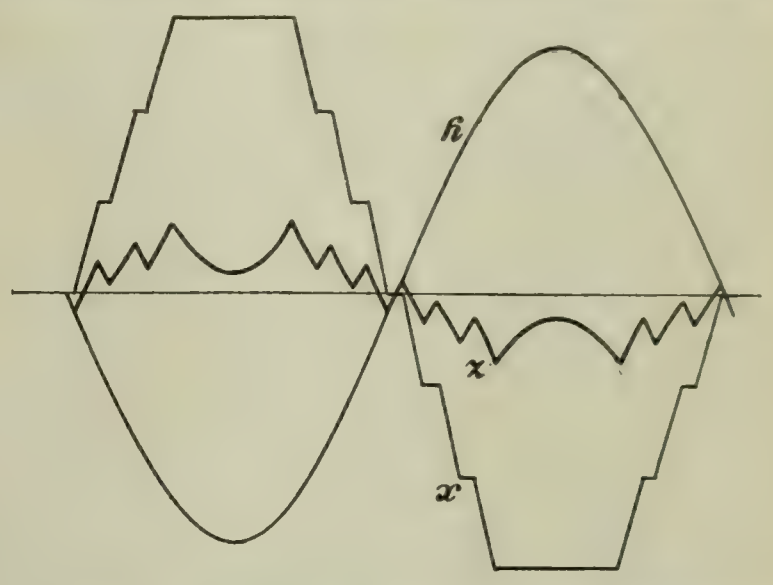


Fig. 2.—Effect of the Spacing of the Excitation Winding Upon the Shape of the Induced E.M.F. Wave.

ripples are very prominent owing to the great reduction which takes place in the fundamental harmonic of the main magnetomotive force on short-circuit, whereas the higher harmonics are not reduced to any appreciable extent. Fig. 2 illustrates the actual conditions that are likely to exist, neglecting the effect of armature resistance.

For clearness of construction Fig. 2 has been drawn for a smaller ratio of Y/X than is customary with cylindrical-field machines. Table I. has, therefore, been prepared showing the method of calculating the resulting E.M.F. wave. The second column gives the value x due to the sole action of the main magnetomotive force ; the third column gives the corresponding value of y due to the sole action of the sinusoidal armature magnetomotive force, and the fourth column shows the value z due to the combined effects of the two magnetomotive forces. The case taken is for $Y=1{\cdot}0$, and $X=1{\cdot}04$, the rotor winding being distributed in eight slots per pole, and two slots per pole being left vacant or the equivalent portion of the rotor not slotted. The importance of the higher harmonics in this case is very

Table I.—*Resulting Flux Distribution for a Cylindrical Rotor with* 10 *Slots per Pole, of which* 8 *are wound.*
$Y=1{\cdot}0$; $X=1{\cdot}04$.

Angle.	x.	y.	z.
0 deg.	0	0	0
4·5 ,,	0	−0·0785	−0·0785
13·5 ,,	0·26	−0·2334	0·0366
22·5 ,,	0·26	−0·3827	−0·1227
31·5 ,,	0·52	−0·5225	−0·0025
40·5 ,,	0·52	−0·6494	−0·1294
49·5 ,,	0·78	−0·7604	0·0196
58·5 ,,	0·78	−0·8526	−0·0726
67·5 ,,	1·04	−0·9239	0·1161
76·5 ,,	1·04	−0·9724	0·0676
85·5 ,,	1·04	−0·9969	0·0431
90·0 ,,	1·04	−1·0000	0·0400

* Abstracted from the "Journal" of the Institution of Electrical Engineers, Vol. LIV., No. 252.

marked, the ripples due to the spacing of the rotor winding being particularly prominent.

Secondary Effects Set Up in Three-phase Machines.—With three-phase alternators the actual variation in the total magnetic flux per pole is so small that no appreciable effect upon the exciting circuit takes place.

Experimental Results.

The oscillographic records given were taken during short-circuit tests at normal full-load current, and included in each case the wave-shape of :—

1. The E.M.F. induced in a search wire placed axially along the armature surface.
2. The armature current.
3. The exciting current.
4. The P.D. between the excitation slip-rings of the alternator.

The machines were all star-connected, and no tests for mesh-connected machines are at the author's disposal. In all cases the four records were taken on the same film by means of separate exposures The records simply give the wave-shapes and not the relative phases of the various functions. The wave shapes of the E.M.F.s and currents are numbered to correspond with the above list.

Remarks on the Experimental Results—Three-phase Alternators.

(*a*) Salient-pole Machines. (Fig. 3.)

1. *E.M.F. Induced in the Search Coil.*—Although the search wire was placed haphazard, the wave-shapes obtained are similar for the two machines. With machine A the wave-shape is exactly as predicted for the ideal polyphase machine ; whilst with the other machine the effect of the pulsations in the armature magnetomotive

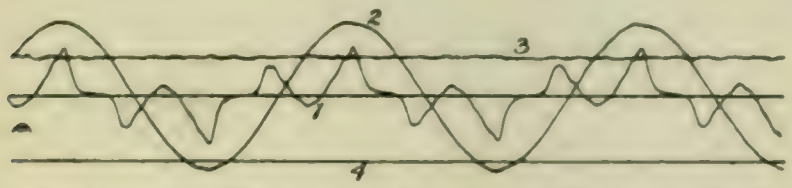


Fig. 3A.—Machine A.—Three-phase Short-circuit Curves.

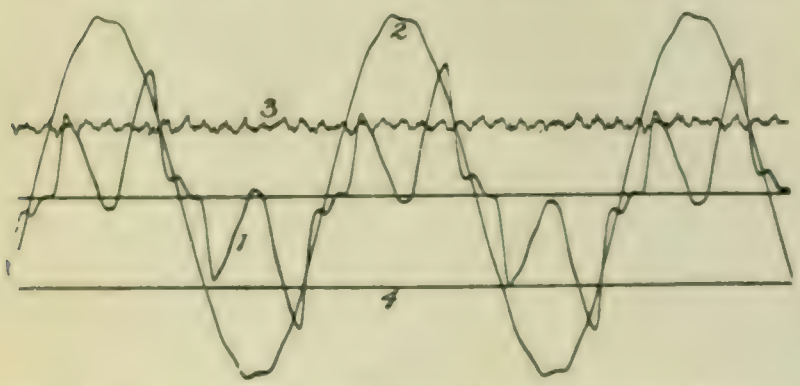


Fig. 3B.—Machine B.—Three-phase Short-circuit Curves.

force are discernible in the slight ripples set up in the E.M.F. when the conductor is situated in the interpolar space. Small ripples due to the effect of the stator teeth are also noticeable

The analyses of these E.M.F. waves are as follows :—

Machine A :

$$e = 100 \sin \theta + 131 \sin 3(\theta + 33^\circ) - 57 \sin 5(\theta - 19.5^\circ) - 47 \sin 7(\theta - 11.5^\circ) + \ldots\ldots$$

Machine B :

$$e = 100 \sin \theta + 78 \sin 3(\theta + 18.5^\circ) - 23 \sin 5(\theta - 11^\circ) - 63 \sin 7(\theta - 11^\circ) + \ldots\ldots$$

The machines had approximately the same designed M.M.F. ratio. Machine A had open slots, whereas B had semi-closed slots and fewer slots per pole than the other machines. As a result the reactance of machine B was greater than that of the other machine, and the effect of the armature currents is therefore less pronounced. This results in a considerable reduction in the importance of the third harmonic.

2. *Armature Current.*—Except for the presence of small ripples of a high order the current is in every case practically a pure sine curve.

3. *Pressure Between Excitation Slip-rings.*—No evidence of an E.M.F. of six times the normal frequency can be detected ; the fluctuations in the exciting pressure can in every case be attributed to the normal fluctuations in the voltage of the exciter.

4. *Exciting Current.*—The high frequency fluctuations present in the exciting pressure do not produce any appreciable effect upon the exciting current, which is quite constant for machines A and B.

Cylindrical Rotors. (Fig. 4.)

1. *Electromotive Force Induced in the Search Coil.*—The great effect of the armature magnetomotive force upon the flux is made obvious by the importance now gained by the ripples due to the spacing of the rotor winding. As already pointed out, the reactance of machines of this type is small, and the ratio of the normal excitation magnetomotive force to the normal armature magnetomotive force is low ; as a result the fundamental harmonic of the armature magnetomotive force is but slightly smaller than that of the main magnetomotive force. With both machines the wave-shapes are of the same type, and correspond exactly with the shape predicted. For machine E the position of the search wire is such that the wave is not quite symmetrical.

The relative amplitudes of the various harmonics for the two E.M.F. waves are as follows :—

Harmonic.	1	3	5	7	9
Machine E	100	163	45	26	22
Machine F	100	375	132	73	110

Machine F had a much smaller M.M.F. ratio than machine E, and in addition a smaller reactance.

The analysis of the curves shows the striking manner in which the importance of the higher harmonics is increased owing to the great reduction in the value of the fundamental.

The effect of the stator teeth can be detected, but is small.

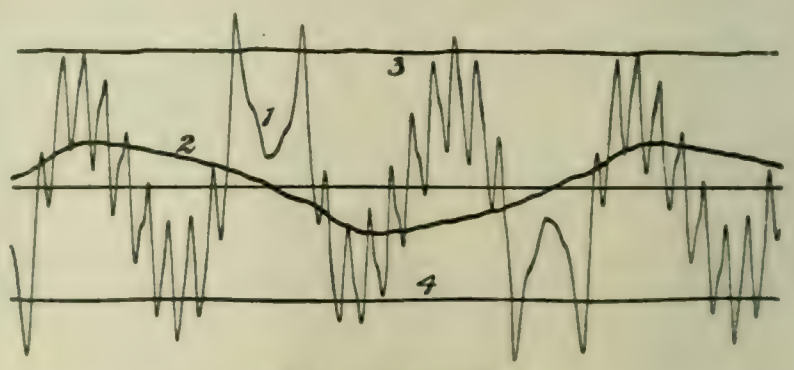


Fig. 4A.—Machine F.

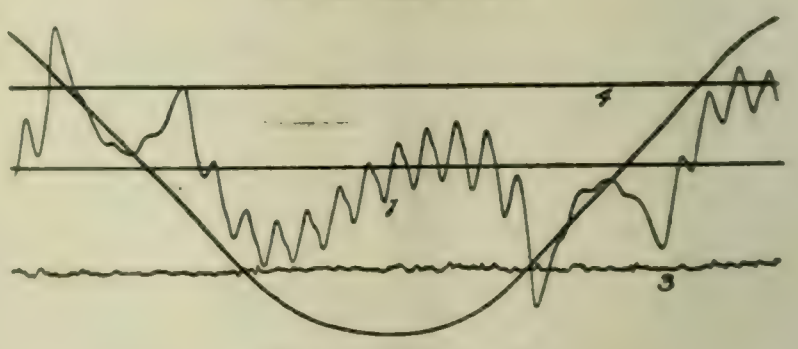


Fig. 4B.—Machine E.

Figs. 4A, 4B.—Short-circuit Waves on Three-phase Alternators with Cylindrical Rotors.

2. *Armature Current.*—Normally the current obtained for this type of machine under short-circuit conditions is similar to that obtained for machine E. The wave obtained for machine F is abnormal, containing a third harmonic, and it is probable that it is not the real current curve, but that there has been some error in making the test.

3. *and* 4. *Exciting Pressure and Current.*—These are both constant. The results obtained with both types of three-phase machines are in complete agreement with the predicted waves.

Single-phase Machines.

With single-phase alternators the armature magnetomotive force is alternating, and not rotating, so that the flux distribution on short-circuit is no longer constant. As a result of the periodic changes set up in the flux distribution under the poles, eddy currents may be set up in the pole-shoes and damping coils—if present—and the magnetomotive force due to these eddy currents will tend to limit the changes in the flux, and under favourable conditions will reduce them to a negligible quantity. In addition to these eddy currents, alternating E.M.F.s and currents may be induced in the main exciting winding, due in general to variations in the total value of the flux and not to local changes in its intensity.

These secondary effects will obviously have an effect upon the E.M.F. and current waves. With perfect damping the case will not differ appreciably from that of the ideal polyphase machine already considered. When the secondary effects, however, exert a negli-

gible damping influence the resulting magnetomotive force is simply due to the joint action of the main and armature magnetomotive forces, the main magnetomotive forces being constant.

The total E.M.F. induced in any conductor on the armature surface is thus composed of :—

1. A dynamic E.M.F. due to the rotation of the flux set up by the sole action of the main magnetomotive force ; and

2. A static E.M.F. due to the alternations of the flux set up by the sole action of the armature current.

Of these E.M.F.s the dynamic E.M.F. has the same value and wave-shape for all positions of the conductor, but its phase is entirely dependent upon the position. The static E.M.F., on the other hand,

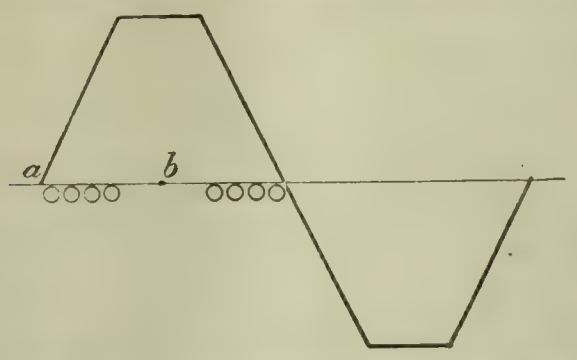


Fig. 5.—The M.M.F. Distribution Curve for a Single-phase Armature.

is in phase for all positions of the conductor, but varies in magnitude according to the position, being a maximum at such positions as *a*, and zero at *b* (Fig. 5). For a cylindrical-field system the wave-shape of the static E.M.F. is the same for all the conductors, but for a salient-pole machine it is somewhat dependent upon the situation of the conductor.

Neglecting the slight effect of armature resistance, the static and dynamic E.M.F.s are in exact opposition of phase for conductors situated as at *a*, and at quarter centres for those at *b*.



Fig. 6.—Calculated Induced E.M.F. in Four Search-Wires Placed at 30° for a Single-phase Alternator with a Cylindrical Rotor.

With salient-pole machines the motion of the poles causes periodic variations in the path of the armature flux, and complicates the problem to a certain extent. In the original Paper the cases of salient-pole and cylindrical-field machines are discussed at some length, and the wave shapes deduced are given in Figs. 6 and 7.

Secondary Effects.

As a result of the alternating armature magnetomotive force, induced E.M.F.s and currents of double frequency are set up in the pole-shoes, the poles and the main exciting winding, and that these currents give rise to a magnetomotive force tending to limit the pulsations of the armature flux. With perfect damping due to amortisseurs, the exciting winding would be screened from any changes of flux, and the conditions there obtaining would not differ largely from those which hold for polyphase machines. With normal single-phase machines amortisseurs are generally provided, but perfect damping is only possible with distributed amortisseurs, such as are formed by a squirrel-cage winding. In general, then, double-frequency currents are to be expected in the exciting windings. These currents react on the armature windings and give rise to an E.M.F. of triple frequency and independent of the spread of the stator

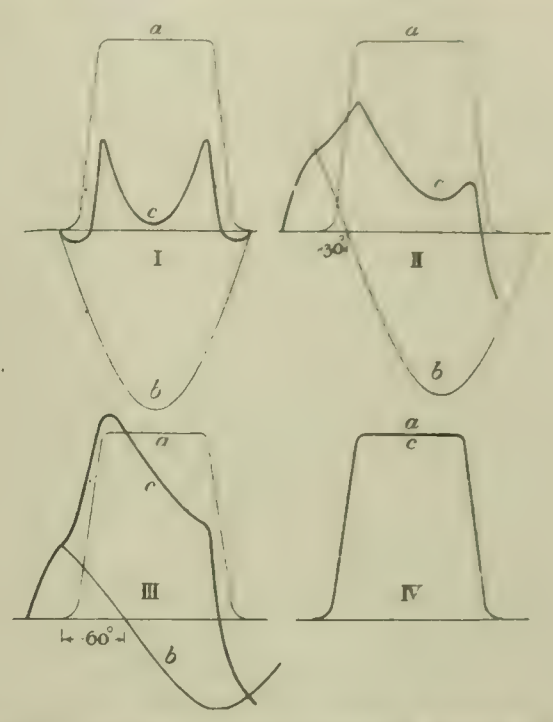


Fig. 7.—E.M.F.s Induced in Four Search Wires at 30° for a Single-phase Salient-pole Alternator on Short-circuit : Static E.M.F. Assumed Sinusoidal, Secondary Actions Neglected.

winding. As a result a third harmonic is to be expected in the current wave of single-phase machines on short-circuit, its magnitude, however, depending largely upon the extent of the damping action set up by the amortisseurs. The third harmonic in the current is to be expected further to give rise to an E.M.F. of quadruple frequency in the exciting winding, which, in turn, will give rise to a fifth harmonic in the armature current, and so on.

(To be concluded.)

THE PRINCIPLES OF MODERN PRINTING TELEGRAPHY

The following is a report of the discussion on Mr. H. H. Harrison's Paper at the Manchester meeting of the Institution of Electrical Engineers on the 25th ult. An abstract of this Paper appeared in our issues of January 28th and February 4th and 11th.

Mr. W. J. Medlyn said it was unfortunate that many inventors wasted much time and money on schemes which had already been tried. In view of the abundant practical information available on the subject of printing telegraphs, there was ample opportunity for inventors to become familiar with the principal pitfalls. Although printing telegraphy had reached the stage of successful commercial application, certain types were quite recent, and even the inventors of these types were agreed that further improvement was desirable as dictated by tests under working conditions. In Manchester the Murray and Western Electric Co.'s printing systems were used, whilst Liverpool used the Siemens and the Baudot systems. The Wheatstone automatic and the Creed re-perforator and printer were also used at both the above centres. Regarding the use of a reservoir for storing signal permutations in readiness for running through the transmitting apparatus automatically, had the revolving drum been found successful under working conditions; also how many words could be stored on a drum 6 in. in diameter ? On the Murray and Western Electric apparatus in Manchester operators had no difficulty in typing at the rate of about 50 words per minute, and thus keeping well ahead of the automatic transmitter running at 40 words per minute. The author had not dealt with any method of printing a message in duplicate. In Manchester, specially prepared ink rollers were used, the printed tape or page print was afterwards run through a copying machine in order to produce a duplicate for departmental purposes. The printing of a duplicate by the telegraph apparatus itself would, if possible, effect a considerable saving. Referring to the page-up

device mentioned in the Paper, it was not clear why it should be necessary to tell a distant transmitting operator when to signal for a fresh line. Surely the transmitting operator would control all such signals at her own end.

Mr. HARRISON said the word "distant" should be deleted.

Mr. MEDLYN, continuing, said the high-speed one-channel automatic printer appeared to have a disadvantage which the author had not mentioned—namely, the delay experienced in obtaining repetitions or correcting errors of transmission. In the ordinary multiplex system receiving and transmitting arms were paired together on the table with corresponding pairs at the distant end of the line, and as there was relatively little delay between the perforation of the slips and its passage through the transmitter at either end, questions relating to corrections could readily be dealt with. In the high-speed automatic system, however, questions had first to be perforated on one of the sets and then wait their turn for passing through the common transmitter. The required reply suffered delay at the distant end through the same reasons. The speaker laid special emphasis upon the importance of accessibility and interchangeability of parts which were liable to wear and get out of adjustment.

Mr. A. BROOKER considered that the author's Paper would become a standard work of reference and a starting point for newcomers. The printing telegraph practice of the future was apparently to be based chiefly upon the work of Hughes and Baudot. The speaker thought that the names of the clever mechanicians who made the ideas of Hughes and Baudot practicable should be placed on record. The valuable work of the Post Office engineers had to be recognised, particularly in duplexing printing telegraphs. In these days the duplexing of a Hughes instrument was no great achievement, because lines had been improved and balancing problems solved; but in the early days the task was difficult on account of the armature being released by a slight kick of the current, the slightest want of balance causing false letters to be printed. Duplexing by the ordinary differential system with a Hughes instrument would have been impossible without the introduction of the bridge duplex principle. It was not fully appreciated even now that a differentially wound instrument, although balanced to a steady current, was not necessarily so to transient currents; in fact, an instrument could hardly be made truly differential to transient currents of different duration and voltage. The Post Office engineers duplexed the Baudot, and, whilst this was a difficult problem, it was rendered easier by the experience in attempting to duplex the Delany multiplex. Speaking of the unfortunate Delany instrument, on which so much work was done without commercial success, it was gratifying to know that the work which had been considered as wasted had proved beneficial in other directions. The La Cour phonic wheel motor controlled by a vibrating reed seemed identical with that evolved from the crude Delany apparatus. The experience with the Delany multiplex had prejudiced people against the use of a printing telegraph multiplex system such as the Baudot. The chief reason for the failure of the Delany lay in the fact that the line was distributed between four or six operators at regular intervals, and these operators were called upon to send at irregular intervals signals of a definite length. This, of course, was theoretically impossible, and while in practice the signals got through fairly well, it was absolutely impossible to obtain perfect signals. The Baudot system had no such inherent defect, as the operator, instead of plunging in at any point with a signal whatever the position of the apparatus, would wait his time to launch the signal, and so get perfect results. The Baudot in some form was likely to survive. The speaker had always credited Baudot with the introduction of the cadence signal, and, if this was not so, the originator of such an important device should be mentioned. The author had issued a warning to inventors who tried to produce signals by varying current strength. This warning might be made more precise. Inventors believed that the failure was chiefly due to such systems having been tried on overhead lines with variable insulation, and they cheered themselves with the hope that ultimately all the telegraph lines would be underground paper-insulated cables. If the author held the opinion that, even with perfectly insulated lines, variable current methods were not going to succeed, it would be well if the warning was more definite and reasons given.

Mr. T. F. HERBERT said the author's Paper formed a fitting sequel to the two classical Papers read before the Institution by Mr. Donald Murray. Regarding the author's statement that the typewriter class of printer would survive, it would probably be remembered that Murray constructed a special typewriter with a very short type bar and ball bearings, with a view to increasing the rapidity of the machine. The final result was a speed of about 200 words per minute. The recent telegraph of Siemens claimed a rather higher speed with the aid of a type wheel. This result might be due to the use of condenser impulses to effect the printing, but the speaker was not convinced that the type bar would eventually survive the type wheel. The author had pointed out that, in the simpler forms of telegraph, the type wheel was distinctly to be preferred, and in designing his own machine he had adopted a type wheel. The author's machine was suitable for very long distances, but would probably be rendered more generally useful by the addition of the ordinary typewriter keyboard. There was a simple form of type-printing telegraph (constructed by Siemens) in extensive use in Germany, and it would be remembered that in this country the Stearn admittedly failed because it was badly constructed. Had the construction been better it would have been in extensive use to-day, and, as things stood, there was nothing to replace it for short distance work. The author had stated definitely that Morse must necessarily be retained for military purposes, but in the speaker's opinion some form of printing telegraph would have to be devised for use in such circumstances. It was vitally important in the case of army orders to have a definite record of the message as transmitted and received, and the transmission of important instructions by telephone was distinctly dangerous. Some form of robust type-printing telegraph would present many advantages. It was pleasing to note the author's agreement with Murray's view that the generation of corrections from the signals themselves was not worth carrying out, except on very long lines.

Mr. T. PLUMMER said that in Birmingham the duplicating of messages had been abandoned. Only one copy was prepared, which passed on to the public, but certain particulars embodying number of words, origin of message, time, &c., were recorded on a portion of the message form, which could be detached and retained. The old method of taking carbon copies had apparently been abandoned, in which case one of the great difficulties of inventors of printing telegraphs had been removed. Birmingham had two sextuple duplex Baudot sets working to London in place of four quadruplex, and four duplex sounder circuits. The Birmingham–London cable was underground paper insulated, and the four quadruplex sets were worked on loops—*i.e.*, without any earth connection—and on the top of the loops the four earthed duplex circuits were superimposed. This old arrangement gave 12 channels working in either direction between the two cities, and these 12 channels, which formerly took up eight wires, were now being provided by the two Baudot sextuple duplex sets taking up only four wires. The new arrangement released lines for extension to other towns. A trial was made recently to find what the Baudot sets could do, and the record, Birmingham to London, was 849 messages finished and disposed of in an hour. Since this traffic did not keep the instruments fully employed, the figure could not be taken as the maximum possible.

Mr. G. C. MARRIS considered the question of maintenance was a point for discussion as well as general principle. When contrasting the single-channel high-speed with the multiplex low-speed instrument a point to be borne in mind was the speed at which the printed tape could be gummed up to message forms and checked. Gummers and checkers all worked in one group with the high-speed insturment, and there was only one tape to be gummed. The work could, therefore, be easily distributed amongst the group, and the size of the group varied according to the speed. With a multiplex, however, one gummer was required for each channel. The transmitter also had to be considered, and the speed of the channel had to be adjusted to give both ends suitable loads. This, of course, was largely a traffic matter. Regarding the methods of power supply, the distributers of multiplex instruments could be satisfactorily driven by means of weights with motor re-winding, as in the case of the Baudot. Single-channel instruments required direct electrical drive with suitable steady voltage. Series resistances for cutting down voltage caused speed variations in spite of regulating devices. In view of the various reciprocating parts liable to breakage, the speaker was surprised to hear that the type-bar printer would most likely survive the type-wheel machine. An electrical combiner, consisting only of relays coupled with a rotating type wheel, offered the best solution of many mechanical difficulties. The whole question of the detailed design and inevitable repairs of the mechanical parts of printers required further attention, and it might seem that in their efforts to satisfy fundamental principles inventors and manufacturers had devoted insufficient attention to the choice of material. Regarding the use of perforated tape as a reservoir of signals, although this had been employed for many years, it was far from satisfactory. The difficulty in making punches to work rapidly and accurately was surprising, and worn punches and dies were often a source of stoppage. Paper of variable thickness also contributed to the faults. The author had referred to Col. Squiers' sine-wave method of telegraphy, and one could not refrain from speculating upon the possibilities of printing telegraphy if these methods of "wired wireless" could be successfully applied. All five printing signals might be sent simultaneously on one segment and suitably sorted out at the receiving end, using tuned circuits. If so, the speed of circuits would be enormously increased. Regarding the chain relay system, it would appear that the correct reception of a signal depended entirely upon the relays having the same speed of operation.

Mr. MOORE said the Paper disclosed a most encyclopædic knowledge, which could only be the result of years of unremitting study. The author would find his reward in the fact that his efforts had placed at the disposal of British manufacturers a mine of information.

Mr. F. D. LAWRIE said it was surprising to note that prior to 1900 only two systems of type-printing telegraphs had achieved permanent success. In the year 1872 the British Post Office first granted a licence to the Exchange Telegraph Co. to carry on their news distributing service by means of electrical type-printing machines, and that service had continued satisfactorily. In the speaker's opinion, a Paper dealing with the history and principles of type printing telegraphy would be incomplete without reference to the late Mr. Fredk. Higgins, of the Exchange Telegraph Co., whose pioneer work was invaluable. Joining the Society of Telegraph Engineers in 1873, Mr. Higgins read a Paper on type-printing telegraphs in 1877, and continued to exercise his great inventive ability until his death about three months ago. Regarding Fig. 9 in the Paper, it was stated that at the receiving end of the line the alternating currents passed through a polarised relay LR to earth. The system referred to was the nearest approach to that of the Exchange Telegraph Co., but in the latter case the relays were not situated at the receiving end, nor were they polarised. They were sufficiently sensitive, however, to respond to the current impulses at the rate of about 2,000 per minute. The author stated further that, in series with both the escapement magnets was a printing magnet PM, which was relatively slot acting and re-

affected by the stepping impulses. In the Exchange Telegraph Co.'s system the electromagnets EM were of the polarised pattern, whereas the pointing magnet PM was not polarised. This arrangement assisted in securing sluggishness of the printing lever, which was necessary on account of each current impulse being of such short duration (about 0·016 of a second), and the self-induction of the coils preventing the current rising to such a strength as to magnetise the core sufficiently to overcome the inertia of the printing lever before another impulse of opposite direction reversed the polarity. In practice it had been found that in a transmitter running at 100 revs. a minute the electromagnets had an "apparent" ohmic resistance of approximately nine times the actual ohmic resistance as measured by a Wheatstone bridge, consequently the operating current was only one-ninth of that under steady current conditions. It was interesting to know that one operator could actuate an unlimited number of receiving instruments; in fact, some years ago, the Exchange Telegraph Co. maintained about 700 financial recording instruments scattered throughout London, and all controlled by one operator stationed at the central office in Cornhill.

The AUTHOR, in reply to Mr. Medlyn, said that, in spite of the available information, a number of patent specifications still neglected fundamentals. Regarding the storage of letters, a 6 in. drum would store about 25 letters, and it was very desirable to keep all dimensions reasonably small and the parts light in order to avoid large inertia forces coming into play. The type of drum shown in the Paper under "Mechanical signal storage" was a modification of the storage transmitter by Murray, and had a capacity of about 120 letters. The type-bar translator was the only satisfactory translator which would make duplicates; but the one difficulty in making duplicates with printing telegraphy was that of feeding in blanks. The ingenious methods of controlling and rejecting the blank, as described at the end of the section of the Paper dealing with printing mechanism, had to be abandoned if more than one copy was required. The only practical way seemed to be to take press copies. The automatic suffered in the matter of delay in dealing with corrections. Needless to say, every effort was made to standardise parts as much as possible and secure ease of replacement and maintenance. The author agreed with Mr. Brookers' remarks concerning the work of Hughes and Baudot. Hughes showed excellence in the workmanship of his printer, while Baudot put forward the correct alphabet—namely, the equal letter alphabet. It was fair to state that Baudot founded the system of modern printing telegraphs. The cadence signal and the locked keyboard developed in two stages. The locked keyboard was first suggested by Whitehouse in 1854. He had no cadence signal, but presumably the noise inseparable from all ratchet mechanism itself formed the signal. The modern form of locked keyboard with a separate and distinct cadence signal was first described by Burnett in 1860. The work done connection with the Delany system had had a useful effect, especially in connection with phonic wheels. An objection to varying the current strength for signalling purposes, quite apart from its use on overhead lines, lay in the fact that, in order to produce a suitable alphabet, it required to be an unequal letter alphabet, which could not be multiplexed. Generally speaking it was better to keep away from a system depending on variable current strength. In reply to Mr. Marris, the type-bar translator of the future referred to multiplex high-capacity circuits. The modern typewriter was wonderfully robust and cheap, and, in the author's opinion, a type-bar translator would give excellent results when worked at 45 or 50 words per minute, or even higher. Regarding type wheels, the author did not think a shaft material could be produced which would stand a speed of 45 or 50 words per minute for any reasonable length of time without shearing. The wear on perforator punches was certainly very heavy, but there was no reason why the operating staff should not be trained to keep the punches in order. The prospect of printing telegraphs for military purposes was not good, and the author had recently reluctantly declined to consider such an apparatus. It was, however, interesting to note that in America artillery fire control was actually carried out by means of a rather primitive and simple form of printing telegraph, using only 16 letters. The pioneer work of Mr. Fredk. Higgins, referred to by Mr. Latimer, did not come within the scope of the present Paper, but the author expressed his admiration of the work of Mr. Higgins, and paid tribute to his exceptional mechanical genius.

TOP CONTACT UNPROTECTED CONDUCTOR RAIL FOR 600-VOLT TRACTION SYSTEMS.*

BY CHARLES H. JONES.

Summary.—The Paper deals with the various factors which enter into consideration in the design of a 600-volt contact rail system. The weight of rail to be used depends upon conditions met with in each case, but in general, a heavy rail is preferable from all points of view. The question of quality is rather indeterminate, but generally it is not advisable to use soft steel until the weight has been brought up to at least 80 lb. per yard; however, consideration should be given to it above this weight. Insulating and supporting is a mechanical problem which must be decided by local conditions.

The author deals with the various factors which enter into the construction, operation and maintenance of a top contact, unprotected third rail, located to one side and above the gauge line of the track rail, on a heavy 600-volt direct-current traction system using a gravity type collecting device.

Weight of Rail.—Rail weighing from 40 lb. to 150 lb. per yard has been used for this purpose. The lighter weights of rail, 3 lb. to 50 lb. were used almost exclusively on the oldest installations of this type of contact system and have been in service about 20 years. This light-weight rail is not as satisfactory as a heavy one, and in recent years has been practically abandoned for a heavier rail, except for yard purposes where it can still be used to good advantage, since high conductivity is not required, and its life in this class of service will be very long. In some instances a T-iron with its flat surface turned up has been used for contact rail in yards to good advantage. For main-line purposes the lighter rail requires closer maintenance, since it lacks the necessary rigidity, its light weight will limit its life, while the installation cost will almost equal that for a heavy rail. The later installations of contact rail systems have used rail varying from 80 lb. to 150 lb. per yard, the larger size being used on extremely heavy traction systems

The question of rail section is closely related to the matter of the weight of rail to be used and is dependent to a great extent upon the gauge of contact rail. For weight of rail up to and including 80 lb., A.S.C.E. section is a very satisfactory one to use providing conditions permit it. The distribution of metal is such that it can be easily supported, it is very rigid and is easily bonded and jointed. For a heavier rail it will be well to consider the advisability of using a special section which will throw more metal into the contact surface and thereby increase the life. The question of supporting this weight of rail is not as serious as with a lighter rail which is more easily distorted. On one system having 40 lb. rail that was installed in 1897 there is about two years of useful life remaining, on another having 48 lb. and 50 lb. rail, which was installed in 1895, there is about six or seven years of useful life. Another line having 80 lb. rail which was installed 12 years ago shows a very small amount of wear up to date. These figures will give some idea of the life that can be expected. The length of rail may vary from 30 ft. to 60 ft. and should be determined somewhat by the weight. A light rail up to and including 80 lb. may be satisfactorily handled in 60 ft. lengths, thus reducing the amount of bonding. For renewal or small repairs on this weight of rail 30 ft. lengths will be more easily handled and should be used, although it will be necessary to sacrifice the gain in bonding. For rail above 80 lb. in weight, 60 ft. lengths will be rather difficult to handle and better results can probably be obtained with 30 ft. lengths.

Quality of Rail.—The conductivity of the rail will vary inversely with the percentage of carbon or manganese allowed to remain in the finished rail. The ordinary run of Bessemer rail will have a conductivity of about one-tenth that of copper, while a rail with a low percentage of carbon will have a conductivity one-eighth that of copper or an increase of about 25 per cent. in conductivity. The price will increase from 18 per cent. to 20 per cent. on this quality of rail. Increasing the conductivity will make the rail considerably softer, thus requiring more careful handling to prevent it from being kinked during installation. It is very difficult to remove any kinks that may get in it, therefore the alignment may be affected. There is no appreciable difference in the rate of wear between the low carbon and ordinary steel in the class of service referred to in this Paper. If use is made of a rail weighing less than 80 lb. there is nothing to be gained, since increased conductivity can be gained by using a heavier weight of rail at a slight increase in cost and a greater increase in the advantage of a heavy rail. Above 80 lb. rail the question requires careful consideration, since the gain in conductivity will cost almost as much as equivalent conductivity obtained by adding to the copper in the feeding system paralleling the rail.

Insulating and Supporting.—The insulating of contact rail for a 600-volt system is more of a mechanical than an electrical problem, and the type of insulator to be used depends upon local conditions, such as the clearance between bottom of contact rail and the ground, or whether on the surface or on an elevated structure. Impregnated wood, porcelain, reconstructed granite and composition insulation have been used with varying results, depending upon the local conditions. Wherever there is any vibration, porcelain and reconstructed granite or insulators having any castings bolted together have not been satisfactory. The life of an insulator is from 10 to 12 years under ordinary conditions, although on one system a great many impregnated wood insulators have lasted from 15 to 20 years.

Bonding and Jointing.—In order to provide for carrying current across joints in the rail it is necessary to provide a low resistance path, since a joint plate does not give good electrical contact. This is done by placing a copper bond or bonds of capacity equal to that of the solid rail around each joint. This may be done in several ways. A concealed bond with either a pin or pressed terminal under the

* Abstract of a Paper read before the American Institute of Electrical Engineers.

plate is well protected, but cannot be readily inspected, and if it does fail and start to burn in the terminal the hole is usually burned so badly that a new bond cannot be put in the same place, therefore requiring a different type of bond for replacement. A long bond with pressed or pin terminal applied outside the plate is easily inspected, but the cost is very great and mechanical protection is poor. A short bond which may be soldered or welded to the base or ball of the rail is cheap and easily inspected, but is very difficult and expensive to renew under traffic. On an installation now under construction, a cast-copper weld is being made at the joints, in the extremely heavy rail that is being used, which will serve the double purpose of both bond and joint plate. For jointing the rail, both two and four-bolt plates have been used and from the results obtained it is thought advisable to use a four-bolt plate for all sizes of rail, since it holds the rail more firmly, requires less inspection and eliminates the possibility of having the bolt pulled out of the end of plate as sometimes occurs with a two-bolt plate on account of heavy strain due to contraction of rail. It will also help out the bonding due to holding the joint stiller and preventing slight motion of the bond which has a great deal to do with the breaking of bonds. Where foot bonds are used it will usually be necessary to notch out the bottom of the plate to allow clearance for the expanded bond terminal. Keeping the joints tight will do more toward maintaining the contact rail in good condition than any other maintenance operation.

Anchoring.—Due to changes of temperature the length of the rail will vary, and to control the variation in length it is necessary to provide some means of forcing this expansion to take place along proper lines. This is done by cutting the rail up into lengths of from 1,000 ft. to 1,200 ft. and anchoring it in the centre of these stretches so that when it expands and contracts it will take effect in predetermined locations. The method of anchoring will depend on local conditions. On surface track that is not provided with a wooden guard rail, the rail may be anchored by attaching several strain insulators of a substantial strength in multiple to an iron plate which in turn will be extended over and be bolted to several ties, the other end of these insulators to be fastened to the base of the contact rail. If a wooden guard rail is used an anchor block consisting of a piece of 6 in. by 8 in. oak 2 ft. long impregnated with a wood preservative may be attached to this guard rail, and the contact rail in turn is bolted to this block. If it is thought advisable, a set of porcelain insulators may be placed between this block and the guard rail. These openings between stretches of rail, commonly called expansion gaps, may be made in several ways. One of these is to use a plate with a slot in one end instead of a hole, using long bonds with a loop of slack in them to take care of the change in length. This is not very satisfactory on account of the ends of the rail wearing very rapidly at this joint, and pounding is soon caused by trolley collectors. The best method of providing the expansion gap is to end each run of rail with a suitable incline leaving a 3 ft. space between each stretch of rail. In a good many cases, especially on surface track, it will not be necessary to have an opening in the contact rail, due to street crossings, special work at cross-overs, &c., which will take the place of this expansion gap.

Special Work Required.—Several kinds of special devices are necessary to pick up collecting devices (otherwise called trolley shoes) from their free position to the elevation of the contact rail. The most common of these is the end inclined. This is made from a piece of steel rail having the web cut out and the ball bent down to meet the base and a countersunk head rivet driven in the end to keep the two parts together. This incline should have an angle just sufficient to pick up a shoe without causing it to jump, and, on the other hand, the incline should not be any longer than necessary, otherwise a heavy arc will be drawn at the trailing incline when a car leaves the end of the rail before it makes contact on the next stretch of rail. In some instances a very sharp angle incline has been used on the trailing end of a rail, but this is not satisfactory, since at any time it might be necessary to reverse traffic on a stretch of track and then the incline would be too short, causing shoes to jump, thus burning the rail or possibly breaking the shoe on the car. At cross overs where it is necessary to open the main contact rail and not leave a space greater than the distance from centre to centre of car trucks without contact rail it is necessary to place a piece of short rail that is set on the opposite side of the track starting at a point just back of the heel of the switch and extending to a point opposite the continuation of the main rail, which is just beyond the track frog on the track in question, so that a trolley shoe on a car going through the cross over will not strike the main rail. This rail is called a lap rail and in general is less than 100 ft. in length. A good method of providing inclines on this rail is to have the incline formed on the end of a full length of rail. Where a contact rail is normally placed on the outside of two adjacent tracks and a cross-over is located it is not necessary to have a lap rail, but some means must be provided for raising the trolley shoe of a car, going through the cross-over, up on to the approaching rail from the side. This may be done by one of two methods. One is to provide a side incline approach, which is nothing more than a straight switchpoint with a standard end incline formed on the end. This device is attached to the side of a main contact rail with the thin end of the point opposite the switch point in the track. The angle of the approach varies with the angle of the cross-over. Another method is to put in a drop centre rail in the main contact rails opposite the switch points. The bottom of inclines to the drop should be opposite the point of switch in track, the other end of the drop should be back far enough so that the trolley shoe on the car coming through the cross-over will not hit the side of the main rail. The amount of drop in rail should be sufficient so that a shoe hanging in its free position over the rail will not touch the rail in the drop. The drop rail method is the best, providing there is nothing to interfere with its use, such as lack of clearance between bottom of rail at drop and the ground, switch rods, &c.

In laying out a storage yard with a number of tracks coming off from one or more lead tracks, the contact rail lay-out requires careful consideration otherwise it may be found impossible to put in sufficient contact rail to provide for proper operation. It is desirable to have a continuous contact surface. This may be accomplished by using a side incline opposite each turn out switch point, or if the yard track centres are not too close, a drop centre rail may be used opposite each turn out switch point. This requires that the distance from heel of switch to point of switch on adjacent track should be greater than the distance centre-to-centre of trolley shoes on a car.

Method of Connecting at Crossings.—On surface track or elevated track on solid fill, where it is necessary for one reason or another to leave out a piece of contact rail, such as at an expansion gap or cross-over, it is necessary to make the circuit continuous by using an underground cable installed in one of the two following methods. First, using clay or fibre duct or iron pipe, pulling the cable into this and terminating at each end with a cable terminal for protection against breakdown and enclosing the device with some kind of insulating and weather protecting casing. Second, using a steel taped or wire-protected lead-covered and rubber-insulated cable, commonly called submarine cable, buried in the ground without using ducts and terminating it with a cable terminal similar to that described above. The connection between these cable terminals and the rail to be made with short cable jumpers having enough slack to take care of expansion and contraction of rail. This second method is considerably cheaper than the first and is very satisfactory where there is no possibility of having to dig up a paved street if trouble should occur in the cable.

Cost of Installation and Maintenance.—The cost of installation of contact rail will vary with the local conditions, such as weight of rail required, whether the work is to be done on surface, solid fill elevated track, or elevated track on steel structure. The amount of rail required will determine the price of rail to some extent and since this is the largest individual item entering into the cost of the installation, the cost of the job will depend on this and will vary considerably. The working conditions, such as outlined above, will determine the cost of labour. The estimated costs given herewith are based on the assumption that over 500 tons of rail will be required and the working conditions are the average that are met with on surface track.

Cost per mile of single track, using 80 lb. A.S.C.E. standard rail in 60 ft. length. 5,280 ft. 80 lb.—60 ft. steel—70·4 tons	£662 0
Labour	70 10
Total labour and material	£732 10
Engineering and supervision 10 per cent.	73 4
Total cost	£805 14
Cost per mile of single track using 50 lb. A.S.C.E. rail in 30 ft. lengths. 5,280 ft. 50 lb.—30 ft. Bessemer steel—44·0 tons	£502 0
Labour	95 12
Total labour and material	£597 12
Engineering and supervision 10 per cent.	59 14
Total cost	£657 6

The cost of maintaining contact rail will vary during the life of the installation from a very low figure during the first few years to a maximum during the rehabilitation period when the installation reaches a point where it must be practically renewed, or ties become rotted so that they will not hold the lag screws used to fasten down insulators. It will depend on the weight of rail used, condition of road bed and will also depend on the working conditions under which the necessary maintenance will have to be done. Where it is necessary to have traffic diverted from a track in order to do such

heavy maintenance as may require temporary openings or joints, &c., on a high-speed road the cost will go up very fast since the labour required to do this may even exceed the actual maintenance labour. With rail of 80 lb. or greater weight on a well ballasted roadbed the maintenance for five or six years will be practically nothing with the exception of periodic inspection, which should be made to detect any defects before they become serious, such as loosening up of the joint plates, replacing a defective insulator, shifting of alignment and breaking of bond. After this length of time the amount of maintenance will begin to increase due to wearing out of inclines, rusting out of joint bolts, &c. At an average cost of £16 per mile per year the contact rail can be kept in first-class condition and the insulation changed every 12 years, which is about the life under ordinary conditions. This, however, does not include complete renewal of rail, plates and bonds, such as will occur when the rail is completely worn out, but includes the usual maintenance of these items in order to keep them in good condition.

SELENIUM CELLS.*

BY W. R. COOPER, M.A., B.SC.

(*Concluded from p. 707.*)

Summary.—A general account is given of the properties of the various varieties of selenium, this being followed by a discussion of the effects of light, the dependence of sensitiveness on wave length and the measurement of sensitiveness. In the latter part of the article is given some account of the theories which have been put forward to account for these facts. In conclusion some details of construction are given, and applications are briefly described.

THEORIES.

The theories which have been advanced to account for the action of light upon selenium may be classed broadly as electrolytic, chemical (or physico-chemical) and electronic.

The difficulty in proposing any theory is that there are so many facts to be explained, many of them somewhat contradictory.

The electrolytic theory was proposed by Shelford Bidwell,† who considered that the action was due to selenides formed by the interaction of the selenium and the metal support. Bidwell showed that such a theory would account for the effect of annealing, the diminution of resistance with the applied voltage, the largeness of the resistance temperature coefficient, the observed reduction of resistance with time and certain other phenomena. This theory, however, is disproved by the fact that when carbon or graphite is used as a support, so that selenides cannot be formed, and the selenium is carefully purified, it is still sensitive to light. Also, pure selenium has been found to be more sensitive than the impure element.

In chemical theories it is assumed that the selenium consists of two or more allotropic modifications, one modification changing into another under the influence of light, and the reverse change taking place when the illumination is removed or reduced. R. Marc‡ has reached the conclusion that there are two allotropes, which he terms A and B. In heating up selenium the change from A to B takes place most readily at 200°C. The establishment of equilibrium is facilitated by the presence of metallic catalytic agents, such as silver and platinum. This point of view has also been studied by A. Pochettino.§

The physico-chemical theory is based upon the idea that the effects are due to crystalline structure, to orientation of the crystals or differences in pressure between their faces. Work in this direction has been carried out by E. O. Dieterich,* and by L. P. Sieg and F. C. Brown,† though the last named inclines to an electron theory. Sieg and Brown have shown that the sensitiveness of a selenium crystal varies on the application of mechanical pressure to the crystal, and that both the sensitiveness and the position of the maximum in regard to wave-length may vary according to the crystalline axis along which the incident beam passes.

That the pressure between the crystals may explain the phenomena to some extent is supported by the fact that electrical oscillations cause variations in the resistance (as already mentioned), and are, of course, of the same nature as light.

F. C. Brown‡ has also done interesting work in support of the view that selenium consists of three modifications in equilibrium, one of which is conducting. The effect of light is to change the quantities in equilibrium (and thus the conductivity), just as a change of pressure alters the proportions of steam and water in an enclosed vessel at a definite temperature.

Most recent investigators, however, have favoured the electron theory in some form or another, the view being that light acts simply by liberating electrons. C. Ries§ holds the opinion that light liberates from the atoms electrons of no great velocity; these do not emerge, but remain within the substance, and thus increase the conductivity. P. J. Nicholson‖ has explained most of the observed phenomena on an electron basis.

But a simple electron theory does not explain the increase of light sensitiveness by mechanical pressure and other pressure effects. F. C. Brown¶ has, therefore, suggested that a large proportion of the conducting electrons in the crystal are ordinarily fixed in the crystal structure in varying degrees of stability. The effect of light is to render some of these unstable or free.

E. E. Fournier d'Albe** has based an ionisation theory of the light action on the relatively simple laws observed when the electrodes are of carbon and the illumination is feeble. He assumes, as is usual in ionisation theories, that the rate of production of selenium ions is proportonal to the illumination, and that these tend to re-combine in proportion to the square of the number present. If N is the number of additional ions at any time, I the illumination and a a constant, then

$$dN/dt = I - aN^2.$$

A steady state is reached when $I = aN^2$, showing that the final change is proportional to the square root of the illumination, which is found to be the case. Integrating, we have

$$N = \sqrt{(I/a)} \tanh (t\sqrt{I}),$$

or

$$t = \frac{1}{2\sqrt{I}N_0} \log \frac{N_0 + N}{N_0 - N},$$

in which N_0 is the final addition of ions, or final increase in conductivity. The recovery curve is given simply by

$$dN/dt = -aN^2,$$

or

$$\frac{1}{N} - \frac{1}{N_1} = at,$$

in which N_1 is the additional conductivity at the moment of cutting off the light. If the galvanometer deflection at

* From a forthcoming edition of "Primary Batteries." (Copyright.)

† *Philosophical Magazine*, Vol. XX., p. 178, 1885.

‡ *Zeitschrift für Anorganische Chemie*, Vol. XLVIII., p. 393, 1906; *Science Abstracts*, 1906, No. 1111.

§ *Nuovo Cimento*, Vol. IV., p. 189, 1912; *Science Abstracts*, 1913, No. 233.

* *Physical Review*, Vol. IV. (2nd Series), p. 467, 1914.

† *Physical Review*, Vol. IV. (2nd Series), p. 507, 1914; and Vol. V. (2nd Series), p. 167, 1915.

‡ *Physical Review*, Vol. XXXIII., p. 1, 1911.

§ *Physikalische Zeitschrift*, Vol. XII., pp. 480 and 522, 1911; *Science Abstracts*, 1911, No. 1391.

‖ *Physical Review*, Vol. III., p. 1, 1914.

¶ *Physical Review*, Vol. V., p. 75, 1915.

** *Proceedings*, Royal Society, Vol. LXXXIX., p. 75, 1913.

this moment is called zero, and d_1, d_2 are two readings taken at equal time intervals after that moment, then

$$N_1 = \frac{d_1 d_2}{2d_1 - d_2}.$$

We have already referred to this formula, which gives the total recovery. That there should be any remaining conductivity in the dark is due to thermal agitation; complete re-combination of the ions would only take place at the absolute zero of temperature, and would take an infinite time.

The above ionisation theory does not account for the behaviour of selenium under strong illumination, which is probably complicated by heat effects.

Construction and Practical Applications.

Selenium Resistances.—Since the resistivity of selenium is high, it is desirable to adopt some form of construction in which the selenium bridge between the two electrodes is as short and as wide as possible. Further, the layer of selenium must be thin, because the light action takes place only near the surface, and therefore the resistance cannot be diminished by increasing the depth of the cross section; otherwise the sensitiveness is diminished. On the other hand, it seems undesirable to have extreme thinness.

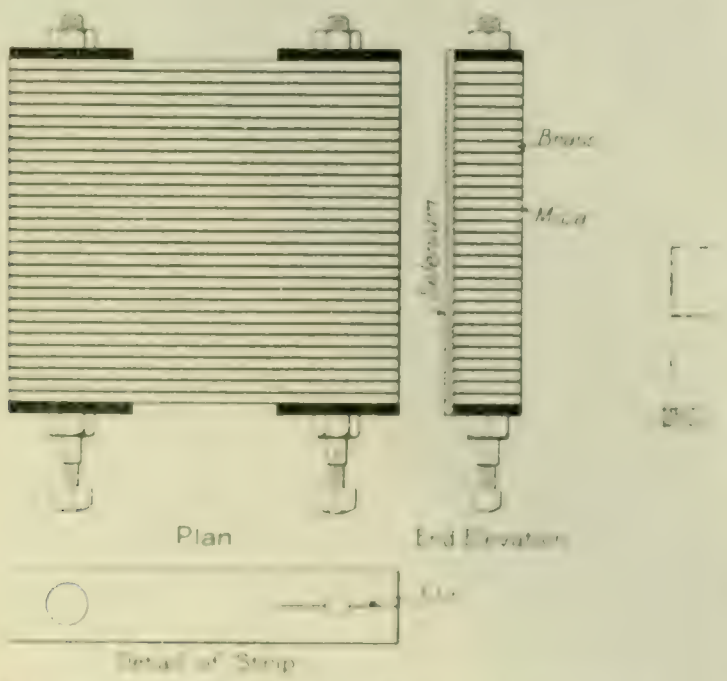


Fig. 13.—Details of Construction for Selenium Resistance.

Perhaps the simplest form of construction is that adopted by Pfund.* A piece of ground glass, say 1 cm. × 3 cm. × 0·1 cm. thick is used as the support. The glass is warmed so that a stick of selenium melts when rubbed on it, and a layer is thus obtained thin enough to appear red by transmitted light. The crystalline grey metallic variety forms at once. Around this is wound four strands of No. 30 S.W.G. copper wire. The ends of two of these (say Nos. 1 and 3) are then fixed, and the remaining two are removed. This leaves a spiral of two wires separated from each other.

The final step is to anneal the selenium so that it is in the required crystalline condition throughout. This is effected by placing the device in an air bath at 180° C. for about five minutes. The resistance is then about 20 megohms, and if it is exposed to the light of a 16 c.p. lamp at a distance of 30 cm. the resistance falls to about one-tenth of this value. Since moisture renders the conductor non-permanent, it should be covered with a piece of glass or mica, fixed with a little wax. Or Ruhmer's method may be followed, and the resistance sealed in a vacuum tube.

* *Physical Review*, Vol. XXVIII., p. 324, 1909.

A more complicated construction is adopted by F. Townsend.* and is shown in Fig. 13. A block is built up of alternate strips of brass and mica. The alternate plates of brass are connected together, one set to one terminal and one to the other. One face of the block is then coated with selenium.

At one time it was thought necessary to anneal for a long time and to cool down very slowly from the annealing temperature. This, however, does not seem to be the case.

The final value of the resistance depends upon the heat treatment that is given. This is shown by the figures in Table I., due to E. O. Dieterich.†

Table I. *Effect of Different Annealing Temperatures.*

No. of resistance.	Temp. of annealing.	Period of annealing.	Resistance, ohms.
23	210 C. 200 C.	6 hours	233,000
22	210 C.	4 ,,	358,000
28	210 C.	5 ,,	490,000
16	180 C.	3½ ,,	1,400,000
15	190 C.	2 ,,	3,690,000

The figures in Table II. show that if the cells are heated for only a short time at a high temperature and then annealed at a lower temperature the resistance is much less than if the short treatment at the higher temperature is omitted. Thus, Nos. 18 and 19 received the same treatment, except that No. 18 had a preliminary heating at a higher temperature for half an hour; yet its resistance was one-fortieth that of No. 19. When using a 16 c.p. lamp at a distance of 30 cm. the sensitiveness of the above varied from 5/1 up to 20/1.

Table II. *Effect of Different Annealing Temperatures.*

No. of resistance.	Temp. of annealing.	Period of annealing.	Resistance, ohms.
18	210 C. 180 C.	½ hour 9 ,,	976,000
19	180 C.	9 ,,	40,000,000
20	210°C. 180 C.	1 ,, 14 ,,	250,000
21	180 C.	14 ,,	9,500,000

Various metals can be used as electrodes, but copper has the objection that it oxidises when heated. Nickel is better in this respect, and is said to be as satisfactory as platinum.

E. Ruhmer‡ draws a distinction between hard and soft resistances, the difference being dependent on the allotropic modification of the selenium that is obtained. A "hard" resistance is obtained by rapid cooling after applying the selenium to the electrode, the resistance being agitated during cooling. A "soft" resistance is obtained by cooling the selenium slowly after applying it to the electrode; it is then heated for a time to 200°C. The soft resistances are of higher conductivity than the hard resistances, and are more sensitive to weak, but less sensitive to strong, illumination than hard resistances.

Selenium Cells.—Turning to selenium cells, we find that much less work has been done in this direction than on selenium resistances. This is probably due to the fact that a cell is less robust than a resistance. The internal resistance of such a cell is necessarily very high, and therefore the generation of a small E.M.F., such as 1 volt, loses a good deal of its effectiveness. With selenium resistances, on the other hand, the low value of the conductivity can be compensated considerably by applying a high voltage.

Selenium cells appear to have been first used by E.

* *The Electrician*, Vol. LIII., p. 987, 1904; *Electrical Review* (New York), Vol. XLV., p. 391, 1904.

† *Physical Review*, Vol. IV. (2nd series), p. 467, 1914.

‡ *Physikalische Zeitschrift*, Vol. III., p. 468, 1902; *Science Abstracts* 1903, No. 99.

Sabine.* He used selenium on platinum wire as one electrode and platinum foil as the other, the electrolyte being distilled water. In the dark the selenium was found to be electro-positive to the platinum (about 0·1 volt), whereas in the light it became electro-negative (about 0·05 volt). This effect diminished after a few minutes, but the selenium still remained electro negative until the light was cut off, when the original state was regained.

G. M. Minchin † used selenium cells in astronomical photometric measurements. As electrodes, or supports for the selenium, he found that platinum, silver, tin, zinc and bismuth gave considerable results; copper gave nearly a zero E.M.F.; and the best results were obtained with aluminium. Platinum was used for the other plate and methyl alcohol as the electrolyte except in the case of aluminium, when acetone was found to be the best. The E.M.F. was about 0·25 volt. The greatest sensitiveness was obtained in the yellow part of the spectrum, though the variation with wave-length was not nearly so marked as in the case of selenium resistances.

Recently experiments with selenium cells have been described by A. A. C. Swinton.‡ Copper was used as the support for the selenium, the uncovered parts being varnished with enamel. The other plate consisted of a metal or carbon having a hole cut in it of the same size as the layer of selenium on the copper. The cell was mounted in a glass vessel, with tap water as an electrolyte (since acid or alkali caused the selenium to strip), so that light could be projected through the inactive electrode on to the selenium. A zinc electrode was found to be electro-positive to the selenium, and it became still more electro-positive when the latter was illuminated. On the other hand, with carbon or copper, the selenium was the electro-positive element, becoming electro-negative on illumination. These results are similar to those of Sabine with platinum.

Applications.

The most serious practical application of selenium resistances has been in the telegraphic transmission of pictures. For this purpose, light is passed through the picture, which is kept moving; the transmitted light therefore varies with the shading of the picture, and as it is allowed to fall upon a selenium resistance, currents are transmitted over the telegraph line which vary according to the shading of the picture. At the receiving end this fluctuating current causes variations in a beam of light which falls upon a sensitive film moving in synchronism with the picture at the transmitting end.

In order that such a method should work at all quickly it is necessary to eliminate the lag to which the selenium resistances are subject, and to have a constant current as the result of a given illumination irrespective of the time of exposure. This has been ingeniously effected by A. Korn.§ by connecting two selenium resistances, as in Cardew's method of measuring resistances, as indicated in Fig. 14. Since the current through the galvanometer is the difference between the currents through the selenium resistances, it follows that if the resistances were precisely similar in their response to light no current would flow as the result of illumination. If, however, the resistances differ suitably in their sensitiveness and inertia, a given illumination will always cause the same effect. The result will be independent of previous illumination, because if one resistance tends to be, say, too low the other resistance will have the same tendency, and since the two effects are in opposition they tend to cancel. Actually the compensating resistance is illuminated slightly later than the one to be compensated, so that compensation does not come into play immediately on exposing the operating resistance. In actual working the place of the galvanometer is taken by the line and the receiving instrument.

Many attempts have been made to use selenium in photometric work, so as to eliminate the eye in such work and render the measurements less dependent on the skill of the observer. At the outset it must be recognised that selenium photometers can only be produced by calibration against lamps of known candle-power, and since the sensitiveness of selenium varies with the wave-length of the light, the indications obtained will depend on the quality of the light. Consequently such instruments can only be relied upon for comparing lamps of the same character as the standards with which they are calibrated.

A selenium photometer for industrial use has been described by T. Torda.* In this instrument the current through the selenium when in circuit with two dry cells is read on a milliammeter. Having read the current corresponding to the dark resistance a shutter is opened so as to expose the selenium to the source of light it is decided to measure, this being at a fixed distance. In order to have definite conditions, the shutter is controlled by clockwork, so that it remains open for only two seconds, and then remains closed

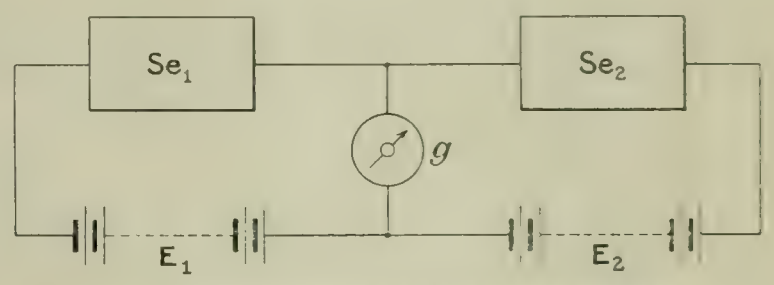


Fig. 14.—Compensation of Selenium Resistances.

for 40 seconds before a further observation can be made. In this way long exposures are avoided and a sufficient period of darkness is given to ensure a reasonable degree of complete recovery. The candle-power is read from a calibration curve.

The earliest practical application of selenium was made by Graham Bell † in his photophone, an instrument for telephonic transmission by means of light. In this device the voice was directed against the back of a mirror, and a beam of light reflected from the front of the mirror was directed on to a selenium resistance, in series with which was a telephone receiver and a battery. The effect of the voice was to cause variations in the beam of light, or to give what Bell termed an "undulating beam," to which the selenium responded, and thus the telephone reproduced the transmitted sounds.

An apparatus termed the optophone, depending upon selenium, has been devised by E. E. Fournier d'Albe ‡ to enable the blind to read ordinary type. In this apparatus a beam of light passes through a rotating wheel having holes perforated on a number of concentric circles. Thus, a number of intermittent beams are obtained, each having a different frequency. These beams are focussed on the paper in a space the size of a letter of the print to be read, and are diffusely reflected from the paper on to a selenium resist-

* *Nature*, Vol. XVII., p. 512, 1878.
† *Philosophical Magazine*, Vol. XXXI., p. 207, 1891.
‡ *Proceedings*, Physical Society of London, Vol. XXVII., p. 186, 1915.
§ *The Electrician*, Vol. LVIII., p. 577, 1907. *See* also T. Thorne Baker, *The Electrician*, Vol. LXIV., p. 1070, 1910.

* *The Electrician*, Vol. LVI., p. 1042, 1906.
† *American Journal of Science*, Vol. XX., p. 305, 1882.
‡ *The Electrician*, Vol. LXXII., p. 102, 1913; and *Proceedings*, Royal Society, Vol. XC., p. 373, 1914.

ance, in series with which is connected a battery and telephone relay, the latter being connected to an ordinary telephone receiver. If the paper is white a note is heard in the telephone corresponding to the resultant of all the beams, but if the paper bears a letter, a certain number of the beams are ineffective, being no longer reflected, and the note changes. Consequently, if a line of print is passed over the aperture where the beams are focussed the note varies with the letter, and with practice the print can be read by the sounds that are emitted.

Many proposals have been brought forward to work devices by relays actuated by light falling on selenium. Most of these have been rendered useless by the inconstancy of the selenium resistances used, and their high temperature coefficient of resistance. The most successful application so far has been to light buoys anchored in waters difficult of access, the light being automatically switched on at nightfall.

THE EFFECT OF ELECTRIC OSCILLATIONS ON THE MAGNETIC PROPERTIES OF IRON INVESTIGATED BY THE CAMPOGRAPH.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., AND P. R. COURSEY, B.SC.

Summary.—The authors discuss the effect of electric oscillations on the magnetic hysteresis of iron, whilst at the same time a slowly varying magnetic cyclical force acts on the iron.

The authors refer the reader to a previous Paper by Dr. Fleming,† in which an instrument was described. In the present Paper they apply an improved instrument to the study of hysteresis problems.

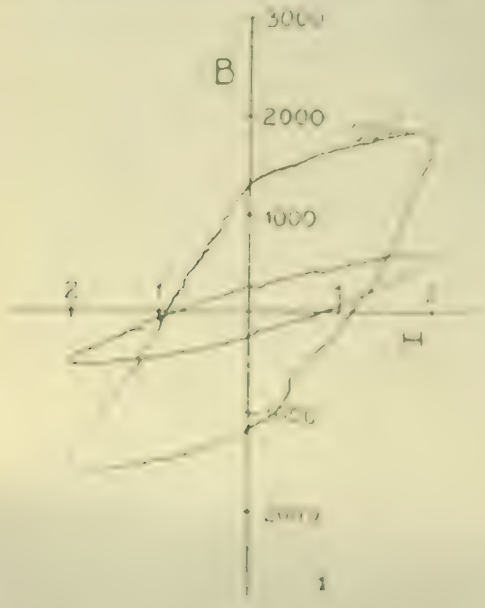


Fig. 1.

R.M.S. current = 70 to 1 amp.; frequency = 0·75 × 10⁶; spark frequency = 250 per second; decrement = 1·08.

Hysteresis loss per cm.³ per cycle: normal = 317 ergs; with oscillations = 462 ergs.

Maximum flux density: normal = 1,740; with oscillations = 1,750.

negatives, each taken in a very few minutes. Also at the same time alternating currents or high-frequency oscillations could be passed through the iron wire, or made to circulate round it, through an inner helix wound on the iron wire. This last coil had 800 turns of No. 26 S.W.G. copper wire, and the length of the helix was 46·5 cm.

The first group of observations were on the effect of damped electric oscillations of constant R.M.S. value (about 70 milliamperes) and constant oscillation frequency (about $0{\cdot}75\times10^6$) and spark frequency (about 250), but the maximum value of the slow cyclical magnetising force varying from about $H_{max.}=1$ to $H_{max.}=10$. This effect is different for small forces and large. If $H_{max.}$ lies between about 0·2 and 3 C.G.S. the effect of the oscillations is to produce a very marked increase in the hysteresis and a marked increase in the magnetic flux corresponding to the maximum force, with a maximum effect in the neighbourhood of H=0·5 to 0·7. If $H_{max.}$ lies between 3 and 6 then the effect is in the same direction but less marked. If, however, H_{max} is about 8 or 10 then the hysteresis loop becomes smaller by the corners being rounded off. These various effects are shown in Figs. 1 and 2. Hence for small slowly cyclical magnetising forces the effect of superimposing electric oscillations is greatly to increase the hysteresis loss and also the magnetic flux density corresponding to the maximum force. For large maximum cyclical forces the effect of the oscillations is to diminish the flux at or near the zero value of the magnetising force. Since the coil carrying the oscillations had 800 turns and a length of 46·5 cm. it will be seen that the turns per centimetre are 17·2, and hence the magnetising force for 70 milliamperes is H=1·5.

For the damped oscillations used in this set of experiments the ratio of the maximum value of the current in a train to the R.M.S. value was very nearly 100. Hence the magnetising force rose at some instants to nearly 150, but had an R.M.S. value of 1·5. It follows, therefore, that the oscillatory magnetic force carried up the flux density to saturation at certain instants 250 times a second. The explanation of the above effects may be as follows: Superimposed upon the slowly cyclical force we have a rapidly cyclical force of

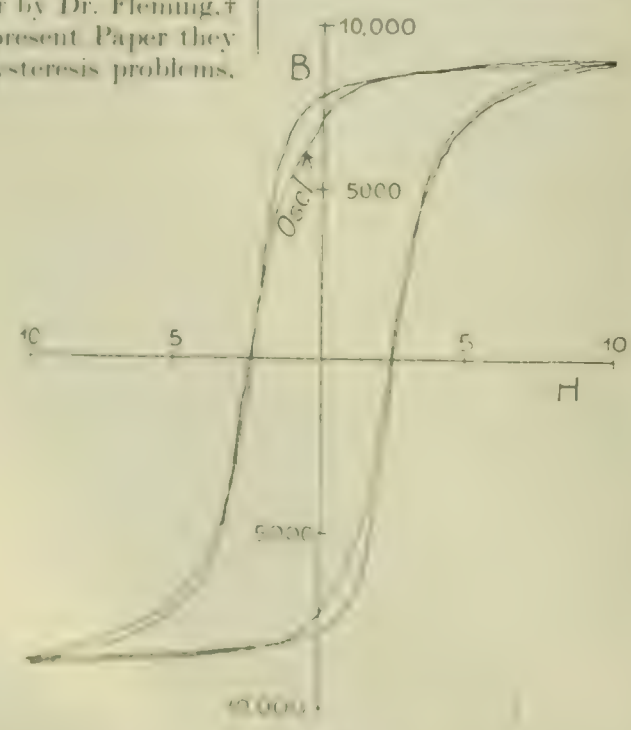


Fig. 2.

R.M.S. current = 70 to 1 amp.; frequency = 0·75 × 10⁶; spark frequency = 250 per second; decrement = 0·8.

Hysteresis loss per cm.³ per cycle: normal = 7,360 ergs; with oscillations = 6,770 ergs.

Maximum flux density: normal = 8,870; with oscillations = 8,230.

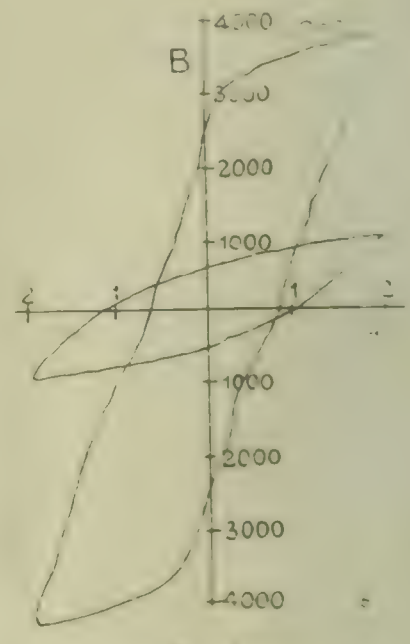


Fig. 3.

R.M.S. current = 60 to 10 amps.; frequency = 11,000; spark frequency = 250; decrement = 1·07.

Hysteresis loss per cm.³ per cycle: normal = 231 ergs; with oscillations = 556 ergs.

Maximum flux density: normal = 960; with oscillations = 4,050.

and continue as follows: A magnetising helix of 71,136 turns was constructed 1 metre in length and the iron wires employed were of 50 cm. in length and about 2 mm. in diameter. Hence the iron may be regarded as placed in a nearly uniform field. We refer also to the above mentioned Paper for details as to the mode of calibration of the campograph so as to determine the absolute value of the hysteresis from the photographic delineation of the curves.

The iron wire employed was placed in the long magnetising helix and fixed in position near the magnetometer and campograph. It was then easy to photograph a hysteresis loop for the iron by slowly varying in a cyclical manner a direct current through the magnetising helix. The illustrations in this Paper are reproduced from the actual very varying maximum. The effect of this is to shake up the magnetic molecules of the iron and to promote greater responsive magnetisation to the slow cyclical force at the extreme ends of the cycle, but this action also increases the retentivity and, therefore, the hysteresis. On the other hand, for large values of the slowly periodic force the effect of the oscillations is somewhat to reduce retentivity and so reduce the magnetisation at the moments of zero force and, therefore, to cut off the corners of the hysteresis loop.

In the second set of experiments the maximum value of the slowly cyclical force was kept constant at H = 2 and the oscillations at the constant frequency of $0{\cdot}75\times10^6$ and spark frequency at 250, but the R.M.S. value of the oscillations varied from 23 to 57 milliamperes, and hence their magnetic force in the same ratio. It was found that the effect of the oscillations was to increase the area of the hysteresis loop almost in a linear relation to the oscillatory currents and also to increase the maximum value of the flux density corresponding to maximum of the slowly cyclical force.

* Abstract of a Paper read before the Physical Society of London.

† "An Instrument for the Optical Delineation and Projection of Physical Curves," by J. A. Fleming. Proc. Phys. Soc. Lond., Vol. XXVII., p. 316, 1915.

In the third set of experiments the slowly varying magnetising force was kept within limits $H_{max.}=2$ and the oscillatory current kept of constant R.M.S. value (60 milliamperes), but its oscillation frequency varied from $0{\cdot}75\times10^6$ downwards. The spark frequency was kept at 250 for the high-frequency damped oscillations. In this case there was a very marked increase in both the area of the hysteresis curve and in the maximum value of the flux density (B) corresponding to the maximum slowly varying magnetising force.

The photograph in Fig. 3 shows the effect when the oscillation frequency was 11,000, the R.M.S. value of the oscillations being 60 milliamperes and the spark frequency 250. The same type of effect takes place if the oscillations are replaced by an undamped high-frequency current from an alternator. Fig. 4 shows the result when persistent oscillations of frequency 2,800 cycles were employed, and it was most marked when the frequency of the alternating current was reduced to 100 cycles.

In the fourth set of experiments the effect of sending damped or undamped oscillations of various strengths and frequencies along an iron wire on the magnetic hysteresis curve, due to slowly varying force, was investigated. In the first place the oscillations used were damped. The result was much the same as when the oscillations

The effect was next studied of sending a low frequency ($n=80$ ~) alternating current along the wire, whilst at the same time a slowly varying cyclical longitudinal magnetising force was applied to the wire. The result is shown in Fig. 6.

The authors applied similar methods to a study of the magnetisation curve and the variation of permeability with magnetising force. (*See* Fig. 7.)

Conclusions.—Broadly and generally, the effect is as follows: When the cyclical magnetic force has a small maximum (H = 1 about) the effect of either superimposed damped or undamped oscillations of high or low frequency is to increase the hysteresis loss and to promote or increase the magnetisation at the extreme ends of the cycle. If, however, the cyclical force has a larger maximum (H = 8 or more) then the general result is to diminish the hysteresis loss. Except in the case of strong currents (10 to 20 amperes) sent along the wire the general effect of either longitudinal or circular alternating magnetising force, damped or undamped, is to increase the magnetisation at the ends of the cycle.

Experiment shows that mechanical shocks or vibrations act very much in the same manner. In all cases it is found that the increase of hysteresis loss, and of apparent permeability at the extreme end

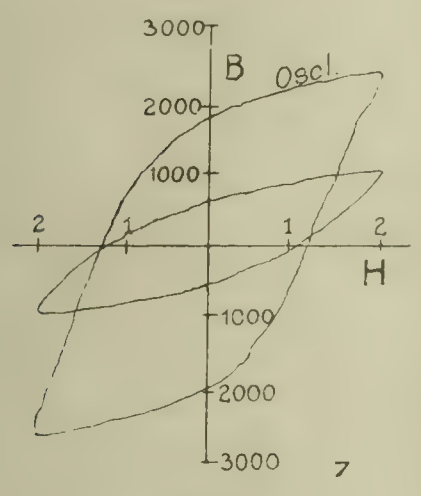


FIG. 4.

R.M.S. current = 60×10^{-3} amp.; frequency = 2,800; decrement = 0.
Hysteresis loss per cm.³ per cycle; normal = 263 ergs; with oscillations = 760 ergs.
Maximum flux density; normal = 965; with oscillations = 2,480.

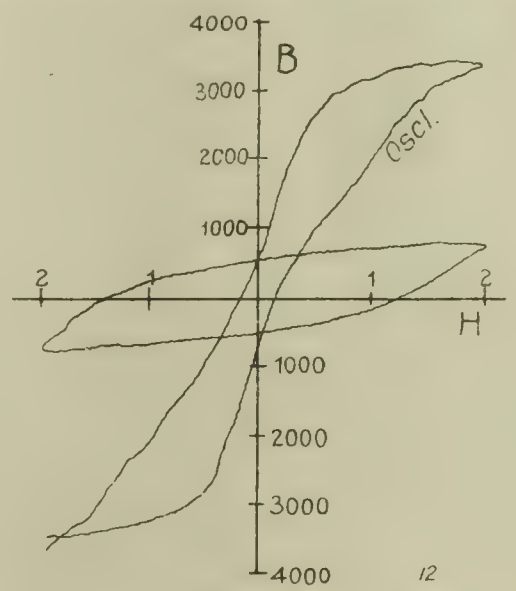


FIG. 5.

R.M.S. current = 9·5 amps. along the wire; frequency = 186,000; decrement = 0·209; spark frequency = abt. 200.
Hysteresis loss in ergs per cm.³ per cycle: normal = 250; with oscillations = 282.
Maximum flux density: normal = 778; with oscillations = 3,460.

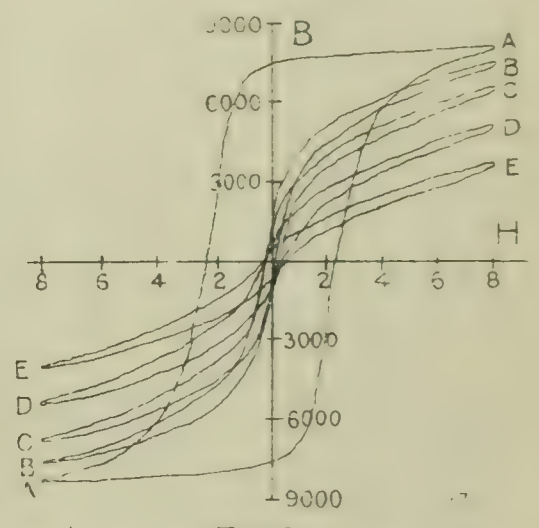


FIG. 6.

Current along iron wire.	Frequency = 80 ~ ; decrement = 0.		
Curve.	Current.	Loss in egrs.	$B_{max.}$
A	0	6,650	8.220
B	4·5	753	7.650
C	7·0	615	6.750
D	12·0	684	5.250
E	20·0	615	3.920

passed round the wire—viz., for small maximum value of H the hysteresis loop was increased and for values of $H_{max.}=8$ or 10 the area was diminished by the shoulders of the curve being rounded off.

In another set of experiments the oscillatory current was carried up to 20 amperes, at an oscillation frequency of 477,000 and decrement of 0·156. When the slowly varying magnetic force had a maximum value of about 3 to 4 or more the effect of the oscillations in this case was to close up or diminish the area of the hysteresis loop by an amount depending on the current strength, but at the same time it increased the maximum value of the flux density very greatly for small maximum values of the slowly varying cyclical magnetising force. (*See* Fig. 5.)

There is, therefore, a double action. The hysteresis is diminished, but the magnetisation is increased at the extreme ends of the cyclical curve, except when the current is very large, when the extreme magnetisation is diminished. This diminution of the hysteresis is also found when a strong continuous current is sent along the wire. It is not an effect due to heat.* This was proved by sending along the iron wire a current of hot air, and no sensible diminution in area of the hysteresis loop was found.

It is clear, however, that this diminution of the hysteresis is the result of the strong circular magnetisation produced by the current, whether direct or alternating, flowing along the wire.

When the longitudinal cyclical force has a small maximum value H = 1 the effect of sending strong oscillatory currents along the wire is to produce a remarkable increase in the maximum flux density at the extreme ends of the cycle. It also increases the area of the loop. The superimposed oscillations then promote magnetisation by shaking up the magnetic molecules both when the electric oscillations flow along the wire and when they flow round it through an insulated helix.

* In the Paper by Dr. J. A. Fleming describing the campograph, see "Proc." Phys. Soc., Lond., June, 1915, in Fig. 8 of that Paper the reduction in area of a hysteresis loop due to the passage of a current along the wire is erroneously attributed to heat, whereas it is, in fact, due to circular magnetisation.

of a cycle of magnetising force, reaches a maximum value for some particular strength of current through the wire.

A result of considerable interest, and perhaps of practical value, is the proof that the passage of a strong unvarying or else alternating current through an iron wire immensely decreases the hysteresis due to a superimposed slowly varying longitudinal magnetic force

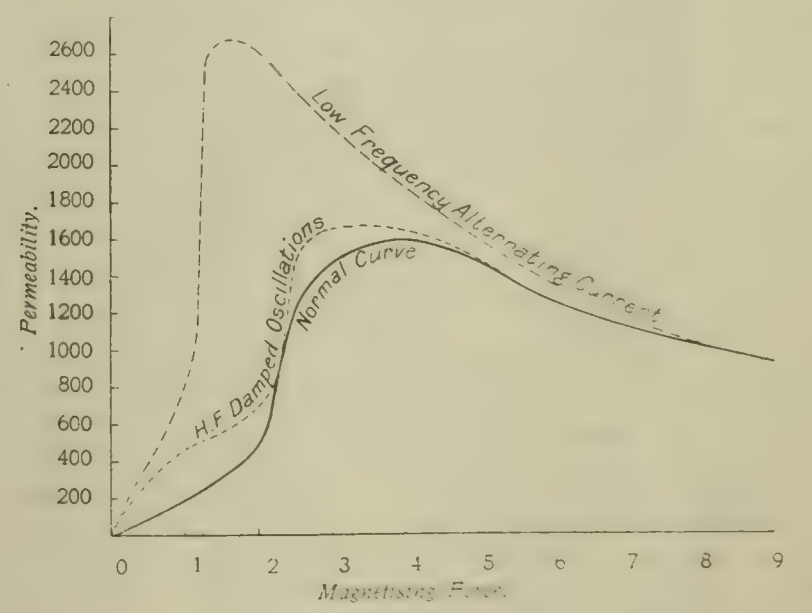


FIG. 7.

Effect of oscillatory fields on the permeability of iron wire.
L.F. current = $60\cdot10^{-3}$ amp. at 100 ~. H.F. current 60 10^{-3} amp. at $0{\cdot}75\times10^{6}$ ~ and decrement = 0·68.

(*see* Fig. 6), and that in some cases this may result also in a very considerable increase in the apparent permeability of the iron to this longitudinal force. The above results carry with them an explanation of the action of magnetic detectors of all kinds in wireless telegraphy.

LORD KELVIN AND TERRESTRIAL MAGNETISM.*

BY C. CHREE, SC.D., F.R.S.

Like most branches of physics, terrestrial magnetism was associated with the name of Kelvin, the association being at the confines of the subject, the immediately practical and the speculative. He introduced important changes in the design of the compass. Apart from this practical line of work, Lord Kelvin was interested in the origin of magnetic disturbances on the earth. He called attention to the difficulties in the way of accepting any sensible direct magnetic action between the sun and the earth, and showed that if the sun were a magnet as intense on the average as the earth, the magnetic force it would exert at a distance equal to the earth's would be only 1/8,000,000 of the earth's surface magnetic force, and therefore its effect would be absolutely insensible. Later on he pointed out that if the sun is to produce a direct effect it must be a magnet of not much short of 12,000 times the average intensity of the terrestrial magnet. Further, he showed that the work which must be done by the sun to produce a terrestrial magnetic storm on the earth would be equal to the amount of work done during four months of normal radiation of heat and light. Such an expenditure of energy is wildly improbable, but it must be acknowledged that such an estimate has little bearing on the theories of solar action mainly current to-day, in which the tendency is to regard the sun as ultimately responsible for magnetic storms, the immediate cause being something which bears an electric charge, originally projected from the sun and present in the earth's atmosphere.

Secular Change.—Fig. 1 shows the secular change in magnetic declination in London since 1580, from which it is seen that the total

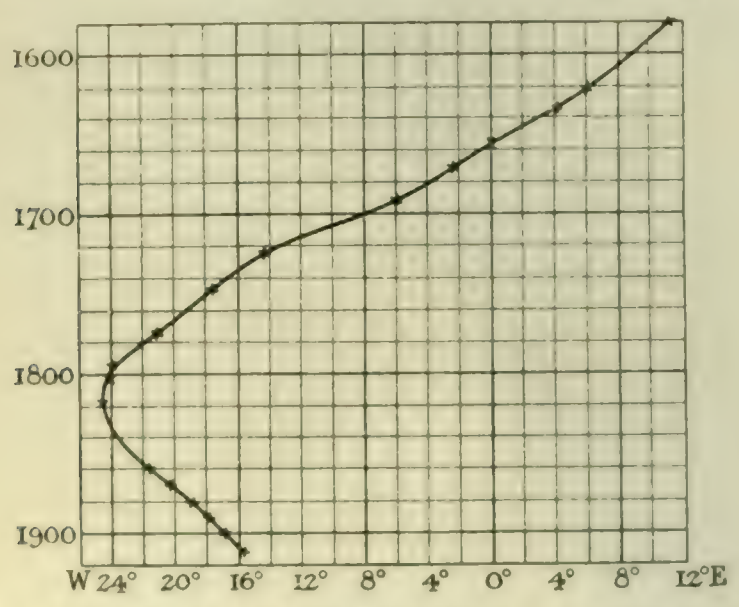


Fig. 1.—Changes of Magnetic Declination at London since 1580.

range of declination observed in London has exceeded 35 deg. in this time. The only actual turning point observed occurred in 1818. The value is the same at present as in 1730, but whether it will ever be the same again we do not know. The rate of change has markedly increased of late years.

In the variation in the dip, as seen in Fig. 2, the highest point presented itself about 1723, or nearly a century before the turning point in the declination. The dip in London is now lower than it has been since observations began, and of late years the rate of change has been very small. By drawing a curve in which the declination is the abscissa and the dip the ordinate, a curve is obtained which may be part of a closed loop, but if the curve is closed the completion of the cycle appears to be still far in the future.

Various theories have been proposed as to the cause of secular change. Among these is the theory of Leyst that secular change in declination is more rapid in the years of many than in the years of few sunspots. The author gives figures showing that this theory is not well supported by the facts.

The change in *H* is noticeable not merely over a term of years, but from day to day, and observations show that the daily rate of change of *H* is not uniform, and that it even differs in sign on days of different kinds. The change in the average 24 hours is only 0·07γ, but the mean of 1,500 selected quiet days at Kew showed a daily increase of 2·9γ. The abnormal rise on quiet days is neutralised by a tendency to abnormal falls on other days. In order to obtain the diurnal variation it is necessary to eliminate these irregular non-secular changes.

Diurnal Variation.—This is obtained by taking hourly values on all or selected days. The entries for each hour are summed, and the arithmetic mean deduced; the departures from the mean are known as the diurnal variation or inequality. Magnetographs show the two rectangular components of the horizontal force, but these may be combined in a vector diagram showing the direction and intensity of the force required to produce the observed departures from the mean value on the day. Fig. 3, referring to Kew, is an example of such a diagram, the origin being at the intersection of the NS and WE lines, the arms of which are 10γ in length, thus showing the scale (γ=0·00001 C.G.S.). The line joining the origin to any hour marked on the curve gives the magnitude and direction of the variation at that hour, the hours being counted from midnight. The dotted line from the origin to *M* shows the magnetic meridian. In the original Paper similar diagrams are given for the winter and for

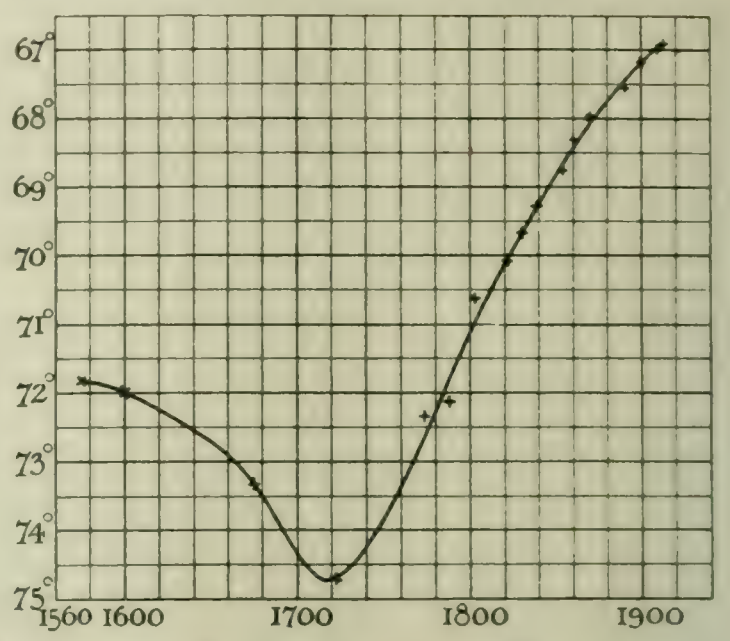


Fig. 2.—Changes of Magnetic Inclination (Dip) at London since 1576.

summer and for the Antartic. The vectors in the last named are longer than in the Kew diagrams, and there is less difference between day and night. There is a difference between ordinary days and quiet days, as indicated in Fig. 4, which also emphasises a difference between Kew and the Antarctic. In the curves for Kew the difference-vectors between corresponding points of the two curves mostly have much the same direction (though not sense) in azimuth, whereas in the Antarctic the difference-vector swings round. Curves corresponding to the Antarctic curve are obtained at Kew if, instead of ordinary and quiet days, years are taken of maximum and minimum sunspot frequency. Years of few sunspots have been conspicuously quiet magnetically.

Magnetic Disturbance.—Definiteness is given to this form of disturbance by considering its effect on the regular diurnal variation,

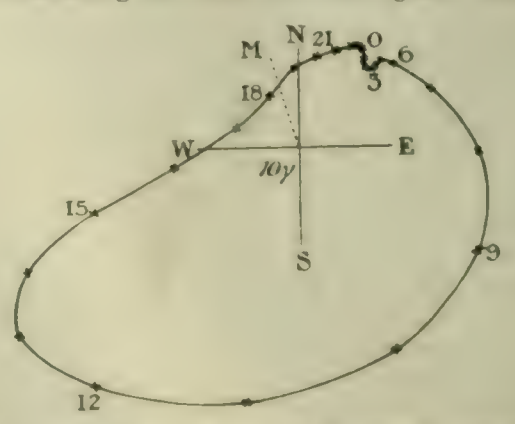


Fig. 3.—Diurnal Variation-Vector Diagram. Equinox (March, April, Sept. 23rd, and October) at Kew.

assigning "character" figures according to an international scheme. Thus character 0 assigned to a day indicates that the regular diurnal inequality is practically unaffected by the disturbance; character 2 indicates that the diurnal inequality is not satisfactorily recognisable. This gives a means of comparison, but one that is not altogether reliable in comparing one year or one season with another. Investigation shows that days of large disturbance in temperate latitudes are almost always days of large disturbance in the Antarctic. Graphical records show that the incidence of 2's and 0's is opposite in character, the 2's being above their average at times of day when the 0's are below their average. The disturbance tends to be in excess simultaneously at the Antarctic and in this country, which is what would happen if there were a general tendency for the daily maximum disturbance to occur at the same absolute time over the whole world.

A remarkable feature in magnetic disturbance is the so-called

* Abstract of the seventh Kelvin Lecture, delivered before the Institution of Electrical Engineers on Thursday, the 17th inst.

27-day period. The difficulty in deciding whether such a period exists is due to the fact that if only large disturbances are considered these are rare; and if a large number of disturbances are regarded as magnetic storms, mere chance may bring in repetitions in 27 or any other number of days. The author is of opinion that all we are entitled to say is that, if a certain day is disturbed, then days from 25 to 30 days later have more than the usual chance of being disturbed, and this probability is greater for the 27th day than for the 26th or 28th. In the original Paper curves by the author are given based on 27,060 entries, and referring to the two periods 1890-1900 and 1906-1911. These curves support the 27-day period. The years

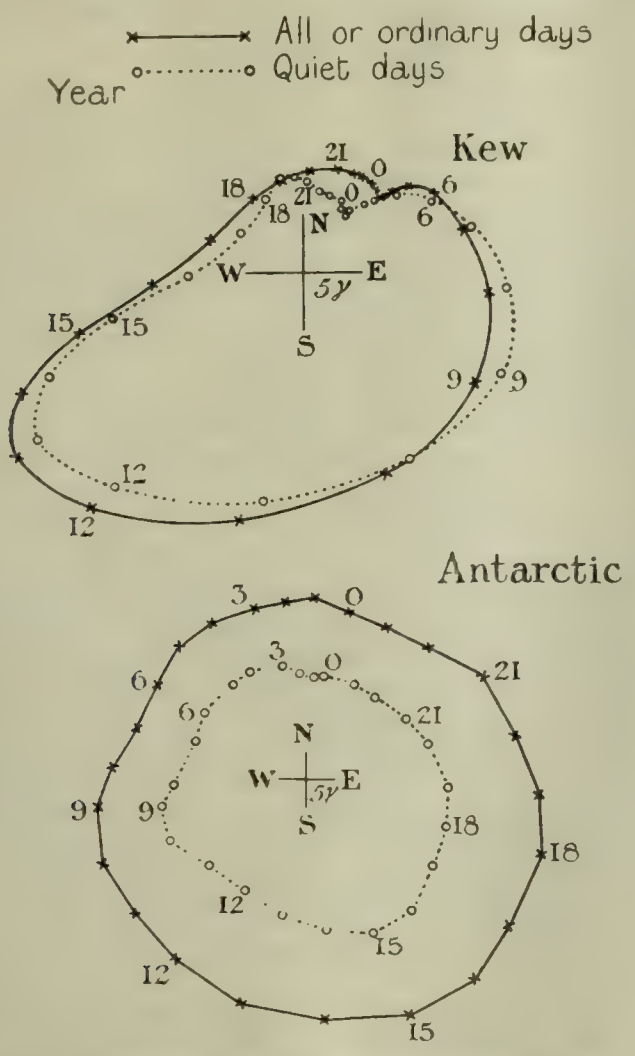


Fig. 4.—Diurnal Variation Vector Diagrams.

in which the 27-day period is most evident in these intervals are years of few sunspots. This affords some support to the sunspot origin theory. In order to test this theory the author has taken the "projected" areas of sunspots. The five days a month of largest projected area were taken as representative, and the areas for days previous and subsequent were entered as in the case of the magnetic character figures. A similar 27-day period was found; but certain other evidence is contradictory. In some years there seems a clear connection between disturbance and sunspots; in others little, if any.

In conclusion, the author refers to the work of Birkeland, Störmer, Hale and others.

THE PROPAGATION OF ELECTRIC WAVES AT THE SURFACE OF THE EARTH AND THE IONISED LAYER OF THE ATMOSPHERE.*

BY PROF. H. NAGAOAKA.

The hypothesis of an ionised reflecting layer appears to have first been given by Fitzgerald in 1893, and without referring to any cause of ionisation by O. Heaviside in 1902. This hypothesis was used by A. E. Kennelly and others in 1902 to explain wireless telegraphy to great distances. They explained that the waves were travelling between the ionised layer and the earth without great loss of energy such as would occur in space waves. The object of this article is to develop the same idea. If one admits partial reflection one is able to explain generally the problems of the rising and setting of the sun in signals, the transmission along or across meridians and the presence of strays.

The existence of such a surface, and the constant capture of ionising corpuscles seem proved by the work and experiments of Birkeland, Störmer and Arrhenius. Paradoxical though it may appear, this bombardment of the earth's atmosphere does not differ greatly by day or night.

We have good reason for thinking that the ionisation of the atmosphere by ultra-violet rays takes place at heights above 10 km. The observations of Wigand by balloons appear to indicate that there is a maximum ionisation above 9 km. It is probable it reaches a maximum and then decreases. The maximum surface of ionisation due to ultra-violet rays has been estimated at about 50 km., where the pressure is a little less than 1 mm. and corresponds to the pressure of minimum potential in ordinary sparking experiments with vacuum tubes

This surface is situated in the stratosphere not far from the hydrogen surface, and the region where the corpuscles are captured is probably in the hydrogen sphere (the geoco onium of Wegener) and exists at a height of 200 km. to 500 km. Norwegian observations and measurements prove that the auroral discharges occur at

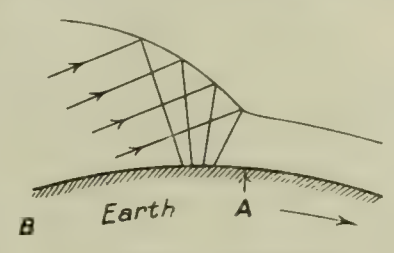


Fig. 1.—Sunrise.

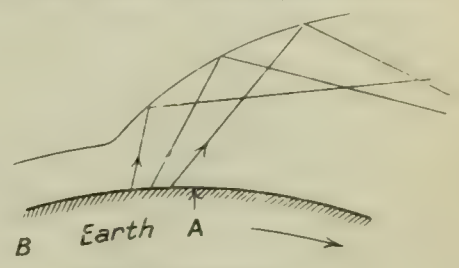


Fig. 2.—Sunset.

this height. Since the ultra-violet ionisation is confined to a region relatively low the effect ought to be particularly felt in the rising and setting of the sun. The ionisation of the atmosphere is, therefore, ruled by these two causes.

The existence of such a surface should cause an absorption as well as a reflection of the incident waves. The reflection would be analogous to that of sound by mists or fogs and would resemble a sort of "whispering gallery" round the earth. Although the coefficient for the transmission of the wave across the layer is not known, the law for loss of energy, viz., inversely as the distance, ought to hold very approximately. If we suppose that the reflecting layer is at a distance of 20 or 30 wave-lengths, the mode of propagation round the earth's curvature becomes very complex on account of the multiple reflections between the layer and earth, and it is a problem not easy to explain either by diffraction, surface-wave or higher speed of the wave in the upper layers of the atmosphere. By adopting the view of ionisation sketched above the effect of sunrise or sunset is shown in Figs. 1 and 2. The author gives two other figures showing the effect of sunrise and sunset which agree generally with those given by Marconi for transatlantic messages. He points out if we assume a layer during the day at a relatively low altitude, then it is subject to all sorts of meterological disturbances. Perhaps the existence of folds or wrinkles cause diffraction, and so he considers it preferable to work with long wave-lengths. During the night the capture of corpuscles is of a complicated nature, as shown by Störmer, and the folds are of much greater dimensions than by day. When there is an ionised layer there is a condition for a best wave-length. With a wrinkled surface in highly elevated regions partially acted upon by the rotation of the earth, feeble maxima and minima would alternate. The equatorial zone of the earth's atmosphere is not nearly so complex as that of higher latitudes where the neighbourhood of the auroral bands occur. Since the section of the reflecting layer does not change abruptly with curvature it should be much more easy to signal from north to south than from east to west. At present it is not safe to come to any conclusion regarding seasonal variation.

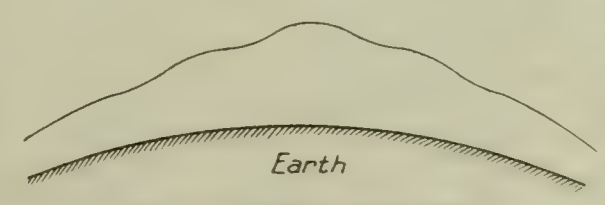


Fig. 3.—Effect of Eclipse.

According to H. Ebert the electric oscillations of the sun have a period of $6\frac{1}{2}$ seconds, and during periods of solar activity the electrical excitation of the sun is able to propagate waves in the universe. If it was possible to observe such waves transmitted through the ionised layer, it would throw considerable light on our knowledge of atmospheric ionisation. The effect of eclipses can be explained in a similar simple manner. The ionised layer raises itself gradually into the higher regions just as totality is reached. It is evident that the strength of signals will be weakened at the commencement of eclipse, will attain a maximum, and then decrease again. It is necessary, however, in considering results of such observations to take care that they are not marked by some other electrical disturbance in the atmosphere.

* Abstract of an article in "La Revue Générale des Sciences."

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MORTGAGING THE FUTURE.

In his interesting Paper on "The Organisation of Scientific Research," of which we gave an abstract in our last issue, Prof. J. A. FLEMING divided the question into the three sections : Methods, means and men. It is pleasing to us to note that the lecturer submitted that the organisation of scientific research should be a matter undertaken by scientific men themselves, and should not be taken over independently of them by a Government Department. He further stated that the organisation of such research should be conducted by bodies representative of the best technical and scientific opinion, and be closely in touch with the members of each of the several scientific and technical societies.

As long ago as last July we commented upon the scheme, proposed by the Board of Education for the organisation and development of scientific and industrial research. In October last we pointed out that beyond an attempt to ascertain the researches in progress (in the colleges from which practically all the senior students had enlisted), little *real* work had been done in connection with the scheme. More recently we discovered that the Board was dabbling in the training of munitions workers, and in the inspection of classes in toy making. Four months ago we suggested to the Board the advisability of turning over their scheme to the several engineering and scientific institutions, giving to each definite instructions as to expenditure, and leaving the institutions a free hand as to the nature of any research contemplated. Although we have received a good deal of encouragement from many quarters as yet engineers and scientists will neither speak

up nor speak together. For this reason we welcome Prof. FLEMING'S Paper, and the outspokenness of several of the speakers who took part in the discussion. At the same time we have no doubt as to the future of the scientific research that will be pursued at our great seats of learning. We hope and believe the day is far distant that will see a decrease in the number of men who pursue research from motives of sheer pleasure and interest. But we have the gravest doubts as to what the future has in store for us if we continue to neglect the importance of science in industry, and to disregard the effect of modern education on the welfare of the community.

It is common knowledge that, by allowing the technical colleges to be denuded of young men by the recruiting sergeant, in the days of voluntary enlistment, the authorities have dealt a blow to technical education, from the effects of which it will take many years to recover. Heaven knows that prior to the war the whole of technical education in this country was in a parlous state. Our people have yet to learn the effect, on the trade of the country, of sacrificing trained technologists in what has been appropriately called a "gamble." Woe unto us if our Statesmen continue to gamble with the lives of our potential leaders in industry. Every successful business man gambles, not with the whole but with a part of his capital. The wise man of business sees to it that he holds gilt-edged securities sufficient to enable him to cover possible losses in his other investments. At the present time we are gambling with our entire capital.

We say that prior to the war technical education was in a parlous state. To many it will come as a surprise to learn that when the clamour for technical education grew so loud in Britain that it could not be ignored, Parliament increased the duty on whisky (or other alcoholic drink) a few coppers per gallon in order to provide for such education. In a word reliance was placed upon the intemperance of our people for the furnishing of the necessary means. Or, rather, the more our people drank the better were the chances of success of a system of education of which our legislators, for the most part, were ignorant. Had Parliament recognised the urgent necessity of technical education, and had they been anxious to insure its success, in the first place they ought surely to have made the public houses more attractive and then to have muzzled the temperance advocates. The money, known as "whisky money" by every local education authority, was doled out by the Board of Education, and in all likelihood the grant awarded to a particular college was made to bear some relation to the drink consumed in the locality in which the college was situated.

That the Board is unaware of the importance of technical education is shown by the absurd difference in the allowances made to technical colleges and training colleges. As an illustration may be given two colleges each costing £6,000 per annum. In the case of the technical college the allowance is, approximately, £1,500—the whisky money now being given to the general education fund—and in the case of the training college the allowance is £4,500. Those having the interests of ratepayers at heart quickly learn that it is less costly to run a training college than a technical college, and but for the munificence of certain of our far-seeing citizens it is doubtful whether there would be any facilities, to-day, for higher technical education. There are those who bemoan the fact that the names of these men seldom figure in "Honours Lists"; but we are not of the number, nor shall we be as long as money poured into the party coffers is a surer road to honour than is the record of man's work. Such record, however, is written on the scroll, and by it alone shall man be judged.

In framing a scheme for the organisation of research it has to be remembered that technical education is the foundation of research, and it is not for us to advise engineers to attend to the foundations before commencing to build. But we fear that many of them are too fully occupied with other work at the present time to realise what is happening around them. Taking their cue from those who urge economy, members of local education authorities, and others, are agitating for the closing of our colleges during the war. And in the meantime, as we have said, the Board of Education is sending out its inspectors to investigate the working of classes in toy-making.

LONG-DISTANCE RADIO TRANSMISSION.

BY LOUIS COHEN.

Summary.—The author first refers to the formula by Dr. Austin and the theoretical formula connecting the received unit with the distance. He then suggests another formula involving a reflection coefficient. The three formulæ are compared with observed results.

There are two formulæ available for radio-transmission calculations. One is an empirical formula which was deduced by Dr. Austin and the writer from the Brant Rock experiments,* and the other is a theoretical formula recently developed by several writers. The two formulæ are as follows:

Empirical formula,

$$I_r = \frac{K}{d} \varepsilon^{-0{\cdot}0015 d/\lambda\sqrt{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Theoretical formula,

$$I_r = \frac{K}{d} \varepsilon^{-0{\cdot}0019 d/\sqrt[3]{\lambda}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In both formulæ d is the distance, λ is the wave-length, both in kilometres, and K is a function of the heights of the transmitting and receiving antenna, of the wave-length, and the resistance of the receiving antenna.

The two formulæ are of the same form, the only difference is in the exponents of the attenuation factor; it is greater in the theoretical formula, which indicates a more rapid diminution of the electric intensity. The recent experiments by Dr. Austin* have shown that the results obtained by the empirical formula agree very closely with observed values, while the theoretical formula does not give satisfactory results at great distances, the attenuation term produces a diminution in electric intensity considerably greater than the observed values.

The empirical formula seems to be very satisfactory in as far as it can be verified by the limited data available. The objection to it, however, is that it has no theoretical basis, mathematical or physical, and we can not be certain, therefore, that the formula is generally applicable, and can be relied upon to give correct results under all conditions. The absorption theory which originally suggested the formula is not tenable. It would seem, therefore, that if the theoretical formula could be modified so as to give results which are in agreement with the observed values, we would have a more reliable working formula.

Now in the development of the theoretical formula it is shown that the attenuation or scattering term represents the loss due to the escape of energy into the upper atmosphere on account of the failure of the waves to follow perfectly the curvature of the earth, and no account is taken of any possible

* "Quantitative Experiments in Radio-Telegraphic Transmission," by L. W. Austin, "Bulletin" Bureau of Standards, Vol. XI., pp. 69–86.

* "Some Quantitative Experiments in Long Distance Radio-Telegraphy," by L. W. Austin, "Bulletin," Bureau of Standards, Vol. VII., p. 315.

reflection or refraction in the upper layers of the atmosphere. It has been suggested by Dr. Austin that the neglect to take into consideration a possible reflection phenomenon may account for the difference in the observed values, and those obtained by the theoretical formula.

Acting on this suggestion, the writer sought to construct a semi-empirical formula, which would combine the theoretical formula and an additional factor to allow for any possible reflection or refraction. It is obvious that if any reflection does occur it must be cumulative in its effect, increasing as the distance is increased, and hence it is reasonable to assume that the reflection effect is a linear function of the distance. These considerations suggested the following formula

$$I_r = \frac{K}{d}(1 + Nd)\epsilon^{-0.00194d/\lambda^3} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where N is a reflection coefficient, and the other terms have the same significance as in equation (2). To obtain the value of N, we take any single observation, and assign such numerical value to N as to make the results obtained by the formula agree with the observed value. If for this value of N the results by the formula agree with all the other observations, then the formula may be considered as representing correctly the transmission phenomena. I have in this way checked by the above formula the data of Dr. Austin's recent experiments, and also a set of observations taken at random from the 1910 experiments. The results are given in Tables I. and II. It is seen that in both cases the agreement between the observed values and those calculated by formula (3) is remarkably good.

It cannot be said that this formula represents completely all the accompanying phenomena in radio transmission, the assumption of an average uniform reflection from all points along the entire distance can be questioned; yet as a first approximation it may be considered as a suitable formula for engineering calculations.

Table I. *Irlington Received on the "Salem," February–March*, 1913.
Reflection coefficient, N = 0·600945. λ = 3,800 metres.

Distance.		Received current, 10^{-6} amperes.			
		Calculated.			
Miles.	Km.	Eq. 1.	Eq. 2.	Eq. 3.	Obs.
300	556	431	335	507	410
400	740	278	200	340	300
500	925	195	128	240	225
600	1,110	140	85·2	174	160
800	1,480	79	40·7	97·6	95
1,000	1,850	47·6	20·7	57	59
1,200	2,220	29·7	11·0	34·1	34
1,500	2,780	15·3	4·42	16	19
2,000	3,700	5·65	1·07	4·8	5
2,500	4,630	2·20	0·28	1·5	.
3,000	5,560	0·89	0·074	0·39	...

Table II. *Salem Received at Point Reek, July*, 1910.
Reflection coefficient, N = 0·600945. λ = 1,000 metres.

Distance.		Received current, 10^{-6} amperes.			
		Calculated.			
Miles.	Km.	Eq. 1.	Eq. 2.	Eq. 3.	Obs.
20	37	12,500	12,300	12,400	12,000
50	92·5	4,610	4,430	4,530	4,700
100	185	2,000	1,850	2,015	2,200
150	278	1,170	1,037	1,160	1,200
200	370	760	654	763	750
300	555	382	307	383	370
400	740	218	162	216	200
500	925	132	91	130	130
Reflection coefficient, N = 0·600945. λ = 3,750 metres.					
20	37	4,460	4,400	4,486	4,505
50	92·5	1,710	1,640	1,720	1,800
100	185	880	770	845	850
150	278	495	455	499	500
200	370	345	292	349	350
300	555	198	155	200	190
400	740	129	93	130	115
500	925	90	59	88	88

THE NOMINAL CANDLE-POWER OF INCANDESCENT LAMPS.*

BY DR. ERNST SALOMON.

The question of the nominal candle-power of incandescent lamps and the method by which this should be measured was of no great importance so long as all the filaments were wound on the same principle. Up to the year 1899 when the carbon lamp was the only ordinary kind, the matter was of no great importance. But the Nernst lamp was of a different kind, and raised difficulties. In the carbon lamp, the filament was so arranged that it ran more or less in the direction of the axis of the bulb; with Nernst lamps, on the other hand, there were varieties which might be described as horizontal, vertical, or bow-shaped, in so far as their arrangements of filament were concerned. The osmium, tantalum and the tungsten lamp in its original form followed largely on the example of the carbon lamp. Later on, the tungsten lamp showed deviations in the form of spirally wound filaments, or some had the light directed towards a focus, and the half-watt lamp is a later type again. If these are all rated on the method used for the older types, the result might be misleading, and lamps of different types could scarcely be compared with one another on this basis of light-output without some further explanation.

These difficulties have lately been felt by the German makers of tungsten lamps, and conferences have taken place between representatives of the different firms. The following notes have reference to the outcome of these conferences and contain the conclusions that have been arrived at. Measurements on a lamp can be made in three ways: (1) The light-output can be measured in a determined direction; for practical purposes the direction in which the output is a maximum is generally taken, and thus the mean horizontal candle-power has been found to be a convenient form of definition. (2) The light can be measured in every direction and the mean taken; this leads to the mean spherical candle-power. (3) The light can be measured over the lower half of the sphere, which is usually the most important; and this gives us the mean hemispherical candle-power. The first method suits for carbon, tantalum, and what may be called the normal tungsten lamp; all these have a decided maximum in one direction. There is very little difference between these lamps in the distribution of the light; in all these three cases there is little difference between the ratios of the light as found in (1), (2) and (3). With matt globes there is a slight difference; but this matters little. Little need be said about the Nernst lamp, which has only an historical interest; but curves are given showing that the distribution of light is very different in the vertical, horizontal and bow-shaped types. Passing to the tungsten lamp, curves are given for the spiral type, and for the half-watt lamp; these curves show that with the spiral type, for instance, the distribution of the light depends on the method of winding, and the same is true of the half-watt lamp. There is here no question of any pronounced maximum in any given direction; the curves for lamps of different makers and even of the same makers differ widely according to the method of winding the spiral and placing it in the bulb.

Thus we are led to the conclusion that the method of rating lamps by their mean horizontal candle-power is no longer suitable for the newer types. As for the mean hemispherical candle-power, there seems to be an inherent justification for this method; most lamps are required to illuminate over the lower hemisphere. But it is plainly impossible to rate two lamps as equal on this basis, if the one throws a considerable light upwards, while the other throws none at all upwards. Sometimes in a room a certain amount of light is desirable in an upward direction, and in any case reflectors can be used. So that two lamps, which have the same mean hemispherical candle-power, are by no means necessarily to be rated on the same basis. The mean spherical candle-power seems, therefore, better.

The main point to be solved is, therefore, the plain commercial one as to the denomination of the lamp as it appears in advertisement and price list, and the figures that should be marked on it for the information of the buyer. Thus a lamp ought to be defined by the following facts relating to it: its voltage, its current, the watts consumed, the candle-power, the watts per candle-power, its absolute length of life, as contrasted with its useful life which is usually defined as the length of time taken for the candle-power to fall 20 per cent., the changes that take place during its life in the watts consumed and the changes in watts per candle-power. Many of these quantities are inter-dependent and a few must be omitted in spite of their importance, when it comes to a question of marking them on the lamp. Many of them are rather variable and difficult to guarantee under the

* Abstract of an article in the "Elektrotechnische Zeitschrift," Heft 18, 1915.

conditions of burning. Each maker must use his own discretion as to making statements as to length of life and decrease of candle-power, having regard to fluctuations of voltage on the mains and many other difficult factors. It ought to be sufficient to state the voltage, the candle-power and the watts consumed. Nernst lamps may almost be left out of account for present purposes, and excepting them, it has been usual to state the voltage of a lamp and its candle-power. But spiral lamps have altered this. Taking the tungsten lamp, consuming 50 watts, it will be found that the old type will give 50 c.p. in a horizontal direction, whereas the spiral one will only give 30 c.p. But if compared on the basis of the light in a vertical direction or of the mean hemispherical candle-power, the spiral lamp will appear to give more light than the old normal type. The matter is still more complicated with the half-watt lamps. At first there were lamps of this kind giving 1,000 c.p. and upwards. These lamps competed with arc lamps for external lighting. They were, therefore, compared with arc lamps on the basis of mean hemispherical candle-power. Later on, lamps of 400 c.p. and 600 c.p. were made, and these lamps too were rated on the mean hemispherical candle-power. Lately we have seen lamps of this type giving 100 c.p. and 200 c.p., and now we reach the sphere of lighting which is no longer proper to the arc lamp, but is more generally the problem of internal illumination. The mean hemispherical candle-power seems no longer the proper denomination because we ought to know the total output; there are also objections, largely of the obvious kind, to the horizontal candle-power and to the mean spherical candle-power. Thus we seem led to the conclusion that no one of the three usual methods of rating lamps of this kind is suitable, having regard to the peculiarities and differences of the various kinds. Still if we change from the horizontal or hemispherical candle-power to the spherical candle-power, we should have to reduce the candle-power of carbon lamps and of tungsten lamps of the old normal type by 20 per cent. Spiral lamps have been rated by some makers on the basis of mean spherical candle-power, but the candle-powers of other lamps would require to be nominally reduced by 20 per cent.; thus, instead of the ordinary 16 c.p., we should have to talk of a 13 c.p. lamp and so on. Half-watt lamps would require to be altered in their ratings, in so far as they have hitherto been sold on the basis of hemispherical candle-power. Their nominal candle-powers would probably have to be reduced by 25 per cent. It is plain that a plan of this kind could not be carried out in practice. Both retailers and consumers would raise difficulties. The plan has been suggested of altering the electrical data of the different lamps in such a way that the spherical measurements should give the usual candle powers. But from the maker's point of view there are serious objections to this course. There are large stocks at present in hand, and it would take some time to introduce the new system. If lamps were rated according to the watts consumed, the ordinary candle powers of the normal tungsten lamp could be used, because ordinarily the lamp gives 1 c.p. for 1 watt. With the spiral type this rating by watts has been largely used; with the half-watt lamps, this system would soon be found acceptable, because up to the present this type is in the stage of development and it would adapt itself easily to any change. The case of America can be cited, if the objection is raised that it would be difficult to displace such an old-fashioned plan as the rating of lamps by their candle power. There, a few years ago, the plan of rating lamps according to their watts was introduced without the smallest difficulty. But in Europe we can also find instances in which by skilful leading the public has been accustomed very quickly to a change, which is necessary. The Nernst lamps, which came into very decided competition with carbon lamps of the period, were never sold according to their candle-power. And these lamps were sold in different types with horizontal, vertical and bow-shaped filaments and were said to take so-and-so many amperes. Also up to within a year ago, spiral tungsten lamps were sold according to their wattage. Arc lamps are rated according to the current they take; Welsbach burners according to the amount of gas consumed; and paraffin lamps are sold without any reference to their candle power or consumption.

There is a further advantage in rating according to watts. Owing to the opposition of England and France, there has been no uniformity in the candle-power. The English and French candle-power are about 10 per cent. more than the Hefner candle-power. This has always been a trouble to the maker. Neither is it likely that within any reasonable period of time there will be any agreement on the point. Scientific objections and other factors have always hitherto prevented any agreement. But England has shown that the lead of America to rate lamps on their watts has not been without effect. Another point might also be mentioned, and that is the fear that has been expressed by the central stations that improvements in efficiency of the lamp may lead to a smaller output of their commodity. It is commonly asserted that this is offset by an unconscious desire of the public for more light. But this difficulty would be met if lamps were rated according to their watts and not according to their candle-power. Thus if the 50-watt lamp could be made to give a candle-power for 0·8 watt instead of 1 watt, then the consumer would get 62 c.p. instead of 50 c.p., and his bill would remain the same as before. Thus the central station authorities would be satisfied, and also the consumer. The watt-rating would also be an advantage to the maker and improvements in efficiency would not require alterations in his uniform procedure. A great advantage would also be gained if it were found to be possible to introduce the decimal system into the method of rating according to watts

CORRESPONDENCE.

"THE PRINCIPLES OF MODERN PRINTING TELEGRAPHY."

TO THE EDITORS OF THE ELECTRICIAN.

Obligations outside personal considerations compel me to seek your kind assistance to enable me to correct a quite accidental, though none the less actual, misunderstanding. This has arisen in certain quarters regarding some amplifying-device figures in all good faith cited by my valued friend Mr. H. H. Harrison in his reply (p. 375, the "Journal" of the I.E.E., No. 256, February 15, 1916) following the discussion of his admirable and valuable Institution Paper on "The Principles of Modern Printing Telegraphy."

The said figures, quoted as from data obtained from myself among others, appear to make me part sponsor for the final conclusion arrived at by Mr. Harrison—that a modern amplifier will send up the working speed on a long cable 50 per cent.

Without going into the question of comparative excellencies in amplifier devices, all I beg to be allowed to place on record is my conviction—based on absolute knowledge of results actually obtained over Atlantic cables—that the amplifier system is capable of effecting a cable-speed increase of over 100 per cent. beyond previous ordinary-method maxima.

Sending-current impact in duplex working in one instance, and local electric disturbances in another, arose as obstacles in two concrete cases. These difficulties have been successfully tackled, it is reasonably believed, without any impairing or lowering of amplifier sensitivity or high-speed characteristics. Further trials—after the war—will show this.

Apart from these considerations, the use of Col. Squier's sine-wave alternations will vastly simplify duplex and disturbance problems in amplifier practice.

I will conclude with one further word of cordial thanks to Mr. Harrison for the heavy work and all else involved in the preparation and presentation of his Paper.

Westminster, Feb. 18. EDWARD RAYMOND-BARKER.

We submitted a proof of Mr. Raymond-Barker's letter to Mr. H. H. Harrison, and have received the following reply:—

TO THE EDITORS OF THE ELECTRICIAN.

I must thank you for your courtesy in allowing me to see Mr. Raymond-Barker's letter.

If I have given the impression that the figures I have quoted as to the performances of various amplifiers are taken from data supplied by Mr. Raymond-Barker, I regret this, and desire to withdraw it. The particular sentence referring to Mr. Raymond-Barker and others was intended as an acknowledgment for information courteously afforded, and should have been entirely separated from the figures themselves, which refer to amplifiers of various types employed by a large cable administration. Mr. Raymond-Barker has been good enough to show me recorder slips showing 100 per cent. increase of working speed, results attained, as he says, on actual cables.

London, Feb. 23. H. H. HARRISON.

THE ORGANISATION OF RESEARCH.

TO THE EDITORS OF THE ELECTRICIAN.

May I beg to comment on your note regarding Dr. Fleming's Paper on "The Organisation of Research."

I am sure we all regard Dr. Fleming as being one of the master minds among electrical engineers. It seems to me

that there are two things necessary in regard to research. Firstly, to know what is wanted, and, secondly, to find the master mind which will solve the problem.

The question of State aid is not to be desired, if it leads to a department of scientific research which is only filled by place-seekers who have obtained notoriety by doing one thing fairly well, and who are incapable of assimilating all the facts of chemistry, electricity, physics, mathematics and engineering. I suggest, as a method of State aid, that if the State has a problem to be solved, then a suitable reward should be given to anyone, either manufacturer, mechanic or scientist, in the same way that £20,000 was offered for the first reliable chronograph; this was offered by the State, and obtained (after the usual State delays) by Harrison in 1764.

Failing State aid to encourage individual genius, then the problem becomes one for those who are interested in the solution of a certain problem, and it is up against these to see to it that the reward is sufficient to bring out the right solution from the right man. This is the method which is surviving, and I venture to say that more problems are solved by manufacturers than will ever be solved by any research department under the State. Our Institution should see to it that they do their share in this work, which often fails because we are losing the faculty of discrimination and letting one popular invention influence our minds in preference to 99 really scientific pieces of work.

London, Feb. 21. HY. TINSLEY.

P.S.—On February 6th I attended a leading church at Croydon, where the minister was belittling "scientific progress," while his notes were illuminated with two excellent wire filament lamps!

CITY AND GUILDS EXAMINATION IN "WIREMEN'S WORK."

TO THE EDITORS OF THE ELECTRICIAN.

"Electric wiremen's work" concerns not only wiremen, but also a much greater number of people who are intimately concerned with and interested in what might otherwise be termed "everyday electrical applications." These other people are contractors, foremen, architects, charge electricians, inspectors, builders, clerks of works, students who will one day take up one of these callings, and many others.

To quote another writer: "The subject deals (or should deal) (*a*) with the elementary electrical principles involved; (*b*) with the hundred-and-one kinds of consuming devices and accessories that are to be or should be found in ordinary electrical installations; (*c*) with the simple theory of their construction and working; and (*d*) with the various methods of 'wiring them up.'"

The above shows the fundamental importance of the subject, and the City Guilds report for 1914-15 proves how grossly it is neglected by those in authority in some of our colleges and schools.

From p. 20 of the report we find that "electrical engineering" was taught at 117 centres last session, and "electric wiremen's work" at only 57. Turning to p. 22, we find, further, that there were 1,341 candidates for examination in "electrical engineering," and only 253 in "electric wiring work." The 1,341 above does not include those taking telephony, telegraphy and electro-metallurgy. These figures indicate a very topsy-turvy condition of things, and prove that fundamental training in applied electrical work is to a great extent ignored by those whose duty it is to foster it. For every student who is investigating the mysteries of dynamo design, alternating current work, transmission systems, electrical instrument making, &c., there should surely be a dozen or so who only desire a working acquaintance with everyday electrical matters.

It would be absurd, of course, to depreciate the value of the subjects included under "electrical engineering" in the City Guilds syllabus. But it seems quite evident from the above-quoted figures that we are paying too much attention to what might be termed exclusive subjects, and neglecting another subject which, if properly handled, should be spreading every-day electrical knowledge amongst thousands of people. This would be to the ultimate benefit of the whole electrical profession and industry.

It is a fact, we believe, that in many institutes the students, though they have practical tuition in jointing, &c., are not treated to lectures based on the "electric wiring work" syllabus, but have to attend the elementary electrical engineering classes. This, obviously, is very unsatisfactory.

Had things not been as they are, we should not, perhaps, have had the "Wireless World" saying in its February issue (p. 734) that the City and Guilds of London Institute was "not really very well known!" A rather remarkable statement, considering it has been carrying on its work for about 35 years.

Apologising for the length of this communication.

London, Feb. 21. A. P. LUNDBERG & SONS.

EARTHING.

TO THE EDITORS OF THE ELECTRICIAN.

May I describe a remarkable case of earthing which occurred here last week, and which may be of interest following your articles on earth-plate resistance of recent date.

The main steam generator here of 50 kw. output at 125 volts direct current, supplies, in addition to other apparatus, a 15 H.P. motor for driving a centrifugal pump for irrigation purposes.

On the 31st ultimo it was reported that this pump could not be stopped by releasing the motor starter handle, and that if stopped at the main switchboard by opening the circuit double-pole switch, it restarted again on this switch being closed, with the starter handle still on the open circuit, and pumped steadily, taking some 150 amperes (about 50 per cent. above normal full-load).

After uncoupling all mains from the starter switch, the motor again ran as previously, under, it will be allowed, most curious circumstances.

Careful testing discovered a dead-earth on the main dynamo negative brush arm, and a similar one on the interpole winding of the motor, and this current of 150 amperes was carried by the earth about 200 yards from the engine house to the river bank.

No doubt many cases of obscure earthing occur to your readers, but this, in my opinion and experience, is extraordinary, both machines being of first-class modern construction by one of the best English makers.

Gordon College, Khartoum, Feb. 3. S. C. RHODES.

SOME FUTURE POSSIBILITIES IN THE DESIGN OF INSTRUMENTS FOR MEASURING ILLUMINATION.

Last Tuesday evening the following questions were submitted for discussion at a meeting of the Illuminating Engineering Society:

1. What possible methods can you suggest for making illumination photometers of the ordinary type (*i.e.*, those involving the use of a comparison source of light) more convenient for the use of the general public?

2. What are the prospects of making a satisfactory instrument depending on—

(*a*) The principle of "extinction"—*i.e.*, diminishing the illumination to be measured until some small object just becomes invisible to the eye?

(*b*) The observation of fine type, a minimum illumination being indicated by the fact of fine type becoming indistinguishable when viewed by the prevailing illumination at the point studied?

3. What are the prospects of making satisfactory instruments depending on the following physical or chemical methods—

(*a*) The use of selenium or other photo-electric cells.

(*b*) The use of thermopiles or other instruments for measuring radiation with or without a suitable solution or screen for absorbing the non-visible rays.

(*c*) The difference in expansion of two metallic elements, one polished so as to reflect a maximum of visible light, the other coated with an absorbent mat black material, but otherwise similar.

(*d*) The use of photographic methods, such as the darkening of light-sensitive paper.

4. What instances can be quoted of the above principles being used successfully in other fields of photometry—for example, in records of daylight meteorological observations, determining polar curves, observing fluctuations in the light given by various lamps, &c.

5. Are you aware of any methods which could conveniently be employed in the design of instruments to indicate automatically when the illumination in an interior has fallen below a prescribed minimum, and an increase in illumination is therefore necessary ?

The discussion was opened by Mr. J. S. Dow, who gave the substance of a number of communications which had been received from the following members not able to be present:—

Mr. A. P. Trotter expressed disbelief in the value of extinction as a principle for photometers. Such devices as bolometers could be used, but they were only suitable for laboratories.

Mr. H. T. Harrison thought it would be an advantage if the eyepiece could be suppressed in instruments for general public use. He regarded the extinction principle as one that was possible, but disapproved of fine type for photometric purposes. Selenium in his experience was unsatisfactory.

Prof. E. W. Marchant thought it was desirable to fit voltmeters to illumination photometers so as to show whether the accumulators were in good condition, and thus to permit correction when necessary. He forwarded a diagram showing how Mr. C. J. Turner, of Hoylake, used selenium for the purpose of controlling street lighting.

Mr. P. Waldram thought that something practically useful might be developed on the lines of sensitised paper photometers.

Prof. Fery sent a description of an instrument which he had devised, based upon a thermopile.

Lastly Mr. H. E. Ives stated that he had been developing photo-electric cells in which the current obtained was proportional to the illumination. So far, however, there were considerable divergencies between one cell and another. He thought it was possible to use a current amplifier for rendering photometric instruments more sensitive.

A number of speakers took part in the discussion that followed.

Mr. A. Cunnington described an attachment for holding a white card at a definite distance from a hand illumination photometer so as to avoid the moving about of a tripod when taking a number of readings over an area. He also showed an illumination gauge having eight standards of illumination from 0.05 up to 10 ft. candles. This was a portable device, and was useful for the rapid judging of illumination. In his opinion a photometer should not be too complicated. Some of the photometers advertised were more like a laboratory in miniature than a simple portable apparatus. He thought that something might be done on the extinction principle, and he showed a rough instrument devised from this point of view.

Mr. J. M. G. Trezise showed some extremely small and ingenious portable illumination photometers which he had constructed, and also photometer screens which showed remarkably good results. In devising these screens he had found it difficult to get uniform illumination throughout the area. He had found that for this purpose opal glass illuminated on the face, but viewed on edge, gave much the best results, the illumination being quite uniform.

Mr. Walsh thought that selenium must be disregarded, but that something might be done with photo-electric cells or with thermopiles. He gave an outline of photo-electric cell action and described some light filters.

Mr. F. J. W. Whipple described the instruments used in meteorological work for measuring the intensity of sunshine, as it might be that similar principles could be used. One method depended on the use of two metal strips, one being heated by the sunlight and the other by passing a current through it of such a value as to give an equal expansion. Such an instrument had the objection that it was slow, but this difficulty was got over in the Michelson bimetallic instrument which was extremely rapid in its indications.

Mr. G. L. Addenbrook referred to the dielectric properties of selenium and the fact that commercial specimens contained considerable impurities. Light action seemed to be due to these impurities, and, therefore, it would be difficult to obtain definite standards based on this material.

Mr. W. R. Cooper outlined the properties of selenium, which rendered it difficult to use the substance for photometric work. It was essential that it should be calibrated and used only for illuminations of the same quality. It seemed to him that much more quantitative work was necessary before definite selenium resistances could be obtained. Although there were difficulties in using selenium as a direct measuring instrument, it might possibly be used as a detector in balancing illuminations. Its use as an indicator, when continually exposed, did not seem to be possible except for indicating between wide limits. He objected to the view of Mr. Addenbrook that the light action of selenium was due to impurities, as this idea was entirely contrary to all recent work. With regard to the use of a voltmeter on illumination photometers, it must be remembered that a small voltmeter would not show easily a difference of 1 per cent. and that this difference would mean several per cent. variation in the illumination.

Mr. Goodenough, the Chairman, was glad to see that the discussion had fully justified the programme. The measurement of illumination was very important if legal penalties were to be made dependent upon it.

Mr. L. Gaster mentioned that Ruhmer had found no difficulty in purifying selenium. As regards accuracy we must not expect too great an accuracy from portable apparatus.

PHYSICAL SOCIETY.

The annual general meeting was held on February 11 at the Imperial College of Science, Dr. A. Russell, M.A., Vice-President, in the Chair.

The following is the list of officers elected for the ensuing year: –

President : C. Vernon Boys, F.R.S.

Vice-Presidents (who have filled the office of President) : Prof. G. C. Foster, F.R.S., Prof. R. B. Clifton, M.A., F.R.S., Prof A. W. Reinold, C.B., M A., F.R.S., Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S., Prin. Sir Oliver J. Lodge, D.Sc., F.R.S., Prof. S. P. Thompson, D.Sc., F.R.S., R. T. Glazebrook, D.Sc., F.R.S., Prof. J. Perry, D.Sh., F.R.S., C. Chree, ScD., F.R.S., Prof. H. L. Callendar, M.A., F.R.S., Prof. A. Schuster, Ph.D., F.R.S., Sir J. J. Thomson, O.M., D.Sc., F.R.S.

Vice-Presidents : W. R. Cooper, M.A., B.Sc., F. E. Smith, S. W. J. Smith, M.A., D.Sc., F.R.S., W. E. Sumpner, D.Sc.

Secretaries : W. Eccles, D.Sc., R. S. Willows, M.A., D.Sc. *Foreign Secretary :* R. T. Glazebrook, D.Sc., F.R.S. *Treasurer :* W. Ouddell, F.R.S. *Librarian :* S. W. J. Smith, M.A., D.Sc., F.R.S. *Other Members of Council :* H. S. Allen, M.A., D.Sc., Prof. W. H. Bragg, M.A., F.R.S., S. D. Chalmers, M.A., Prof. G. W. O. Howe, D.Sc., Prof. J. W. Nicholson, M.A., D.Sc., C. C. Paterson, C. E. S. Phillips, F.R.S.E., Prof. O. W. Richardson, M.A., D.Sc., F.R.S., G. F. C. Searle, Sc.D., F.R.S., F. J. W. Whipple, M.A.

At the conclusion of the general business the chair was taken by the President, Prof. C. V. Boys, F.R.S., and an ordinary meeting was held. A Paper

"On a General Bridge Method for Comparing the Mutual Inductance between Two Coils with the Self-inductance of One of Them,"

was read by Prof. C. H. Lees, F.R.S.

It is shown that the self-inductance L of a coil of resistance S may be compared with the mutual inductance M between the coil and another by making the first coil one arm of a bridge, $PQRS$, of which the second coil and a resistance $U+V$ in series form one diagonal, the galvanometer forming the other. The cell is connected through a key to the point of contact of U and V. When the steady balance has been obtained U or V can be varied so as to get an induction balance for any value of L/M without P, Q, R or S having to be changed. Then $L/M = -\{Q+S+(1+Q/P)V\}(T+U)$.

Dr. A. Russell said that the author's arrangement was a great improvement on Maxwell's original method. As a student at the Cavendish laboratory he had experienced great difficulty with that method. The greatly increased accuracy in inductance measurements due to the use of vibration galvanometers had led to neglect of the older methods, but some of them would be useful in special cases. He asked the author why in his final formula he had made the mutual inductance negative.

Principal Skinner said that he had also found difficulty with Maxwell's method, and congratulated Prof. Lees on the simplicity of the apparatus required in his modification.

Mr. W. Duddell welcomed an addition to the methods of measuring inductance. The more alternative methods available for checking results the better.

Prof. Howe suggested that T and N should be inserted in the figures as well as in the text. He thought figures 2 and 3 should be drawn in a similar way to show their close correspondence.

The President said that he had always experienced trouble in obtaining a balance with Maxwell's arrangement, and he was relieved to find that similar difficulty had been experienced by workers in the Cavendish Laboratory.

The Author, in reply, said he had simply followed Maxwell with regard to the negative sign of the mutual inductance. He would be pleased to make the alterations to figure 3 suggested by Prof. Howe.

A Paper on

"An Enclosed Cadmium-Vapour Lamp"

was read by Dr. H. J. S. Sand.

The lamp shown was similar in general principle to the well-known mercury lamp. It is constructed of quartz glass. To start the lamp the metal is melted by means of a bunsen burner, and the arc struck by tilting. Before introduction into the lamp the metal is freed from oxide and dissolved gases by a special process of filtration while at the pump. It is prevented from adhering to the glass, which might lead to fracture, by the presence of a small amount of a loose powder in the lamp. The lamp gives a powerful light, and once started will continue burning indefinitely.

Dr. J. A. Harker mentioned that when Benoit and Michelson were performing their celebrated experiments on the length of the metre in terms of the wave-length of light it was necessary to make up a large number of cadmium vacuum tubes. One of these only lasted about one

day. The light was incomparably poorer than that given by theauthors lamp, and the windows were constantly becoming obscured with condensed metal.

Dr. R. S. Willows said he had seen this lamp working satisfactorily for four or five hours on end. For diffraction experiments it was of the greatest importance to have really strong sources of monochromatic light. With suitable filters the cadmium lamp would prove extremely useful for such purposes.

Dr. T. M. Lowry, in a written communication which was read by the secretary, expressed a high opinion of the utility of the cadmium arc lamp. He had used one of Dr. Sand's lamps for over a year, and for laboratory purposes there was no particular in which it could be improved. Five years of additional experience had confirmed the conclusion which he had come to in 1909, that the best series of lines for exploring all the chief regions of the visible spectrum is obtained by combining the arc spectra of mercury and cadmium with the flame spectra of lithium and sodium. The complete series of lines was as follows:

Li. 6708; Cd. 6438; Na. 5893; Hg. $\frac{5,769}{5,790}$; Hg. 5461; Cd. 5086; Cd. 4800; Cd. 4678, Hg. 4358. His own experiments on the production of a strong cadmium spectrum had been described elsewhere, and it, as he believed, these had helped to stimulate Dr. Sand in his endeavour to produce a practical arc, their publication had been even more fully justified than he had hoped.

The President asked if the cadmium vapour arc acted as a rectifier in the same way as the mercury arc.

Two slides were shown by Dr. S. Russ. The first of these showed the ultra violet spectrum of the Simpson arc, compared with that of carbon. This arc is a very strong source of ultra violet light, giving a practically continuous spectrum with all but very short exposures. With a short exposure the lines are seen to be very close together, and to be beautifully graded in intensity. The electrodes are said to be made from Wolframite, the chief constituent of which is tungsten. The next slide showed the ultra violet spectrum of pure tungsten compared with the Simpson arc. From this it was evident that the spectrum of the latter was almost wholly due to tungsten.

LEGAL INTELLIGENCE.

Grocott v. Lovatt and Another.

At the Staffordshire Assizes last week, before Mr. Justice Avory and a jury, Mr. R. J. Grocott, trading as Gaskell & Grocott, manufacturers of electrical earthenware fittings, brought an action against Joseph Lovatt, general secretary, and Jabez Booth, organiser of the National Amalgamated Society of Male and Female Pottery Workers, to recover damages for libel.

Mr. Graham said the alleged libel was contained in a handbill issued on May 25 last. In that month there was considerable agitation all over the country for an advance in wages on account of the increased cost of living, and on May 7 Mr. Lovatt, general secretary of the union, wrote to plaintiff's firm stating he was instructed by the operatives to ask for an advance of 10 per cent. in wages to all day wage and piece workers on account of the increased cost of commodities. That appeared to be a gratuitous interference between Mr. Grocott and his workpeople because the majority of them belonged to a special union which looked after the interests of their particular branch of the trade. Plaintiff took no notice of the letter or of a similar letter written a little later, in which it was stated that the manufacturers had agreed to pay a bonus of 7½ per cent. Recognising the general demand for an increase of wages as being a just one, Mr. Grocott, in common with most other employers in the district, granted of his own accord a war bonus of 7½ per cent. to his employes, and paid it for the first time upon May 22 for the week beginning May 15. Three days later a handbill was distributed outside the works. It convened a meeting and stated that the business to be discussed was the 7½ per cent. war bonus, and added, "If you are anxious to secure the war bonus attend this meeting. You can only obtain it by joining this society. Now is the time to join."

Mr. Muir Wood (for defendant) asked the jury to say that there was no libel and no intention to libel plaintiff. His clients had no knowledge of the handbill.

The Judge, in summing up, said the jury knew how dangerous it was in these days when the relations between employers and employed were delicate to ruffle or disturb relations between masters and men which were amicable. In that case there appeared to be no ground for the imputation alleged, because plaintiff was already paying the war bonus when the handbill was issued, and that fact could easily have been ascertained from any of plaintiff's workpeople.

The jury returned a verdict for plaintiff, and assessed the damages at £200.

Farrell v. Bloxam.

The action of this action, which is brought by Mr. A. B. Farrell, late resident superintendent of the Belfast electricity supply station, against the city electrical engineer, Mr. T. W. Bloxam, for alleged slander, has been changed from the High Court, Dublin, to the county of Antrim.

Re Float Electric Co. (Ltd.)—A debenture holder's action by Chas. Joseph Wild Blundell against this company was mentioned to Mr. Justice Neville on Feb. 18, upon a motion by plaintiff for the appointment of a receiver.

Mr. Jenkins, K.C., said his client was now the only debenture holder. He had been financing the company and the interest was long overdue. The business was that of manufacturing electric lamps, but it had not been profitable. According to the evidence there were pending contracts which might show a profit if completed, but it was doubtful. Under these circumstances the appointment of a manager was not asked for.

His Lordship appointed a receiver to whom he gave liberty to complete any pending contracts that he thought it desirable to complete.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Pryor, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

722 Siemens-Schuckertwerke Ges. Safety devices or vacuum relays for electric circuits. (16 1 14. Patent of addition not granted.)

A safety device or vacuum relay for electric circuits in which the vacuum tube in a relay circuit is under the influence of a magnetic field due to the current in the conductor which is to be protected, and in which parts are so adjusted that the current in the relay circuit is only allowed to pass through the vacuum tube or is only interrupted when the conductor current rises above or falls below the desired limit.

1,093 Stone & Co. & Darker. Regulation or control of electric currents.
1,346 Wagner. Insulation of telephone cables. (20/1/14.)
1,470 Relay Automatic Telephone Co., formerly Betulander Automatic Telephone Co. & Aitken. Automatic and semi-automatic telephone systems.
1,525 Joel. Construction of electric batteries.
1,641 Webber & Standard Time Co. Electrically-driven clocks.
1,670 Samuel. Treatment of air or a gas with an electric arc.
2,388 Fairweather. (Wallace Novelty Co.) Portable electric lamps. 3,442. Georg Mendheim (Firm of). Manufacture of carbon electrodes. (4/3/14.)
4,046 Lundberg, Lundberg, Lundberg & Pegg. Electrical switches.
4,348 Eastern Telegraph Co. & Gardiner. Telegraphy.

The combination in a telegraphic transmitting station of two polarised relays which act as a pole charger for the signalling battery, one relay being operated by the depression of the Morse signalling key and the other by its release after a signal has been sent.

5,076 Boot & Scourfield. Electric signalling systems for use on railways.
6,807 B.T.-H. Co. (G.E. Co.) Stereoscopic X-ray apparatus.

Two rectifying X-ray tubes are employed, these tubes being directly and oppositely connected to a source of alternating current without the provision of any auxiliary contact-making apparatus, so that each will receive alternately impulses of current.

7,006 Marks. (Landers, Frary & Clark.) Electrical toasting devices.
7,433 McKinnon. Electric air heater.
7,554 Railing, Garrard & Searle. Combined electric switches and plugs.
9,915 Samuel Slingo, Gunton & Douglas. Brake for elecrically-propelled vehicles. (Divided application on 15,539/14. 28 1/15.)
11,375 Graham. Means for the production of sound by electromagnetically-operated diaphragms.

Use of Low-Grade Fuel.—Mr. R. H. Fernald, in a technica Paper of the Bureau of Mines, U.S.A., entitled "Notes on the Use of Low-grade Fuel in Europe," states that the Bureau, by means of investigation, is endeavouring to prolong the life of the nation's supply of high-grade fuel by lessening present waste and by bringing about a wider utilisation of fuels now neglected.

An attempt was made to procure in Europe during 1914 definite information on the utilisation of high ash coals, wood refuse, recovery of by-products, the developments in the use of peat, results of low temperature distillation, the possibilities of the slagging type of gas producer, and the use of powdered fuel. Owing to the outbreak of war the notes are inconclusive, but indicate the trend of some important fuel problems. One well-known engineer believed the problem should be solved by the economical use of high grade fuels, and he considered powdered fuel as a promising solution. Samples of colliery refuse gave about 5,400 B.Th.U. per lb. The producer gas from refuse heaps gave about [illegible] coke breeze gave 9,000. As regards the use of refuse, several manufacturers of gas producers report successfully using wood shavings, sawdust, coffee husks, rice husks, straw and spent bark tan. The following gives the lbs. per horse-power-hour for some materials: Salmon grass 2·5, Jarrah shavings 2·4, spent bark tan 3·13, pine shavings 2·31. Plants using sawmill refuse find that the cost of a horse power hour including wages is 0·112d. for Cypress waste, the waste being gasified. Hopes point to low temperature distillation in England, cannel coal, shale high ash coal, peat and even sewage sludge being used, the residue from the last material being an excellent fertiliser. Samples tested gave 9,000 to 12,000 B.Th.U. per lb. The manager of a Welsh steel plant stated that he was using refuse coal containing 25 per cent. ash—a mixture of colliery and coke dust. Tests showed the boilers to be working with 75 per cent. efficiency, and although they had only been running a short time the indications pointed towards success.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	749
Imports and Exports of Electrical Manufactures	750
Business Notices	750
Bankruptcies, Liquidations, &c.	750
Electricity Supply	750
Traction Notes	751
Empire Notes	752
Foreign Notes	753
Miscellaneous Notes	753
The Round Table	141
"Ironsafe" Switchboards. Illustrated	142
Ediswan Shell Inspection Lamp. Illustrated	144
The Lighting of Drawing Offices. Illustrated	144
"Arora" Electric Fires. Illustrated	146
Electric Vehicle Progress Supplement—No. 25.	
An Electric Battery Locomotive. Illustrated	1*
The Coming of the Electric Vehicle—A Review of the American Situation	2*
Ward Light Delivery Van Mileage Record	4*
Petrol v. Electricity	6*
A Stake Body Industrial Truck. Illustrated	6*
Tenders Invited	754
Tenders Received & Accepted	754
Companies' Meetings and Reports	755
New Companies, &c.	757
City Notes	757
Electrical Companies' Share List	758

COMMERCIAL TOPICS.

Electric Supply Companies in 1915. As a number of companies have now issued their reports on the past year's working, it is possible to form an estimate of the effect of the war upon the various branches of the industry. Naturally, the lighting restrictions, the obstacles to the connection of new consumers and the high prices of coal and other materials have adversely affected most electric supply companies, even those with a large power load. For instance, the profit of the London Electric Supply Corporation was only £77,688, against £93,234 in 1914, although nearly 4½ million more units were sold than in the previous year. The total costs of the company for 1915 were 0·64d. per unit sold (against 0·50d.), the increase being due to the great advance in the price of coal and wages. There was a satisfactory increase of 11 per cent. in the power supplied for traction, power and industrial, and but for this fact the results of the year's working would not be so good. Nearly all the other London supply companies, including the Westminster, St. James' & Pall Mall, Notting Hill, Chelsea and Kensington & Knightsbridge Companies, have a similar tale to tell, namely, reduced net profits and a slight drop in the ordinary dividend owing to the increased cost of coal, higher wages, allowances made to men serving with the Colours, &c. As all these companies are sound, well-managed concerns, it only requires a return to peace conditions to enable them to resume their old dividend-paying basis. An exception to the general rule is provided by the South Metropolitan Electric Light & Power Co., whose credit balance for 1915 is £49,190 against £43,054, and is able to pay a dividend of 4 per cent. on the ordinary shares against nil in 1914. The Company reports the connection of over 300 new consumers and a large development of the power load. Some of the provincial electric supply companies, especially those in industrial areas, have also had a satisfactory year's working. The Yorkshire Electric Power Co. has had a fairly good year, with increased demand for power from collieries, mills, &c., and its subsidiary, the Electrical Distribution of Yorkshire, is able to pay the same dividend as in 1914 and to strengthen its position. The Newcastle companies are in a similarly happy condition.

* * * *

The British Industries Fair. The Second British Industries Fair was opened in the Victoria and Albert Museum, South Kensington, London, S.W., on February 21st, and will remain open till March 3rd. In order to avoid interference with the production of munitions of war, exhibits at this year's Fair have been carefully limited to the following trades: Printing and stationery; china, earthenware and glass; fancy goods; and toys. Exhibitors have been obliged to obtain permission to exhibit from any Government departments with which they have contracts.

About 100,000 invitations to the Fair have been issued by the Board of Trade to wholesale buyers in this country and abroad. Of these over 20,000 were sent out to oversea firms some time ago, and further invitations were distributed by British Consuls and Trade Commissioners. Wholesale buyers in the trades in question who have not received invitations should apply to the Board of Trade, British Industries Fair, 32, Cheapside, London, E.C.

Successful as last year's Fair was from the point of view of exhibitors and buyers alike, this year's Fair promises to be equally successful, as the trades included are well represented. It is anticipated that one of the most interesting and useful features of the Fair will be the inclusion among the exhibits of excellent specimens of articles resembling those which Germany used to supply in large quantities both to this country and oversea markets. Notwithstanding the demand on many works for the manufacture of munitions, it is satisfactory to note that British manufacturers as a whole are becoming alert to the extensive markets open to them, providing the necessary attention is paid to the question of cheapness, design, colour, utility and so forth. There is plenty of evidence that plans are being laid with enterprise and discretion to extend business on the cessation of hostilities. Arrangements similar to last year's are being made for the assistance of buyers. Interpreters are provided, there are Board of Trade officers in the different sections at which trade inquiries can be made, special provision has been made for writing and reading purposes, and a large smoking room and lounge has been erected in the quadrangle.

* * * *

Trading with the Enemy Act. It is announced that Sir Edwin Cornwall, M.P., has been appointed a member of the Advisory Committee in connection with the Trading with the Enemy Amendment Act, in place of Sir Geo. Croydon Marks, M.P., who finds himself unable to serve on the Committee.

* * * *

Battery Locomotives. In "Electric Vehicle Progress" this week we describe an interesting application of the electric battery for haulage purposes. The difficulties in the labour market are compelling many industrial undertakings concerned with efficient haulage to adopt devices which can be entrusted to unskilled labour for their operation. The battery locomotive for shunting purposes is a case in point. It will be noticed that it has proved its superiority during 12 months' service over capstans, hoists and similar apparatus for the shunting and marshalling of wagons in a railway goods yard. The work required by the Midland Railway Co. is, we believe, typical of hundreds of goods yards in different parts of the country, and the introduction of the battery locomotive for this class of service may be regarded as but the beginning of an important development in accumulator traction. Both the Midland Railway Co., who have initiated this important step, and the D.P. Battery Co., who have been responsible for the electrical equipment of the locomotive in question, are to be congratulated upon the results obtained. We expect to see a number of similar locomotives put into service in this country in the imme diate future.

* * * *

Electricity and Gas Consumption in New York. There is a note of distress running through the last report of the Consolidated Gas Co. of New York. It appears that the combined sales of gas by the company and its affiliated companies amounted in 1915 to 1,213,329,998 cubic ft. less than in 1914, or a loss of 4·12 per cent. The gas sales of the Consolidated Company fell off by 5·02 per cent., and in Manhattan there was a drop of 5·38 per cent. The president (Mr. Geo. B. Corteyou) assigns the following reasons for the abnormal drop in consumption: (1) The European war had affected manufacturing concerns which were dependent on Europe for their raw material; (2) the growing popularity of moving-picture theatres, which operated to decrease the domestic consumption for illuminating purposes; (3) the *ever increasing use of electricity for such purposes, as well as the growth of the use of small electric appliances, which supplanted the gas consuming ones heretofore used*; (4) the weather conditions during January, February, March, November and December, 1915, which were not favourable to the normal consumption of gas; (5) the policy of the department of Water Supply, Gas and Electricity, which had led to the displacing of a very large number of gas street lamps and the substitution

therefor of electric lights; (6) the practice of greater economy in the use of gas for illumination as well as for domestic purposes, and the growing pupularity and use of incandescent gas mantles. It may be true that each of these causes had an adverse effect upon his company, but for ourselves we should not go beyond the third and fifth reasons so frankly set out by Mr. Corteyou. "Moving-picture theatres" have been blamed (and very often rightly so) for the demoralisation of the minds of the young, and for their deleterious effects upon the character of those people who frequent such places, but it is the first time that we have heard of "picture theatres" being responsible for a decrease in the consumption of gas.

* * * *

Enemy Shareholders in in Australian Companies.

The High Commissioner of the Commonwealth has received particulars of the action taken in Australia with reference to enemy subjects and naturalised persons of enemy origin who are shareholders in companies incorporated in Australia.

It is required (1) that all naturalised persons of enemy origin (unless exempted by the Attorney-General), and all enemy subjects, shall transfer to the Public Trustee, before the 16th April next, shares held by them in companies incorporated in Australia; (2) a Public Trustee is to be appointed by the Government, and is to have authority to hold shares for 12 months after the end of the war or to sell them, at the request of the transferor or by direction of the Attorney-General; (3) the proceeds of the sale of the shares are to be paid by the Public Trustee to the transferor, unless the Attorney-General otherwise directs; dividends on shares transferred to the Public Trustee or held by enemy subjects are to be paid to the Public Trustee, and dividends on the shares of naturalised persons are to be paid so, if Attorney-General, requires; (4) applications from naturalised persons to be exempted from the Regulations must be made in writing to the Attorney-General, accompanied by a Statutory Declaration giving full particulars of the name and address of place and date of birth, parentage and occupation of the applicant, and setting out a list of the names of companies in which he holds shares, the number and value (estimated) of the shares and the grounds upon which the application is based. "Naturalised person of enemy origin" means a person who, having been a subject of a country with which the United Kingdom is now at war, is a naturalised British subject by virtue of a certificate of naturalisation issued in any part of the British Dominions to himself, father, or mother, or in the case of a married woman, to her husband, and includes the wife of any such naturalised person. The regulations apply to the London Register of Australian Companies equally with the Australian Register.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 14, 1916, *to* Feb. 19, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

U.S.A.: Elec. machinery, £1,801; lamps, £764;

EXPORTS.

£324; wire and

Elec. machinery, £111; wire and cable, £260; unenumerated, £303. *Singapore:* Unenumerated, £684. *Ceylon:* Unenumerated, £72. *Madras:* Elec. machinery, £780; wire and cable, £64.

CHINA.—*Shanghai*: Wire and cable, £67; unenumerated, £53. *Hankow*: Elec. machinery, £62.

JAPAN.—*Yokohama:* Unenumerated, £15.

FRANCE.—*Paris:* Unenumerated, £957. *Bordeaux:* Unenumerated, £147. *Boulogne:* Unenumerated, £89. *Dieppe:* Unenumerated, £490. *Dunkirk:* Unenumerated, £28.

CANADA.—*St. John's:* Unenumerated, £472. *Montreal:* Unenumerated, £535. *Halifax, N.S.:* Unenumerated, £129. *Toronto:* Elec. machinery, £11; unenumerated £38.

DENMARK.—*Copenhagen:* Wire and cable, £30; unenumerated, £77.

NORWAY.—*Bergen:* Unenumerated, £110. *Tonsberg:* Unenumerated, £30.

ITALY.—*Genoa:* Elec. machinery, £1,645; wire and cable, £105; unenumerated, £584. *Leghorn*: Unenumerated, £148.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £39. *Adelaide:* Unenumerated, £12. *New York:* Unenumerated, £27. *Bombay:* Unenumerated, £121. *Auckland:* Unenumerated, £20. *Madras:* Unenumerated, £73. *Durban:* Unenumerated, £55. *Pelotas:* Unenumerated, £8. *Perth:* Unenumerated, £42. *Rotterdam:* Unenumerated, £44.

IN TRANSIT.

Cape Town: Elec. lamps, £620. *Gisborne:* Elec. lamps, £80. *Wellington:* Elec. glow lamps, £91.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The Electric Appliances Co. (Ltd.), 8, Fisher-street, Southampton-row, London, W.C., advertise for electricians accustomed to small armature work.

Mr. R. J. N. Franki, one of the managing directors of Warburton, Franki (Ltd.), of Sydney and Melbourne, has resigned his position with the company and has commenced practice as a consulting engineer in Sydney.

Plant for Sale.—Stoke-on-Trent County Borough has for sale two Bellis and four Raworth engines with d.c. and a.c. generators. Particulars from the Borough Electrical Engineer, St. Peter's Chambers, Glebe-street, Stoke-on-Trent. Offers to the Chairman, Electricity Supply Committee, Town Hall, Stoke-on-Trent. *See advertisement.*

Patent Development.—The owner of patent No. 1,800/1908, for "Improvements in or relating to railway signalling systems," desires to dispose of the patent or to grant a licence.

The owner of patent No. 28,352/1910, relating to "New or improved method of forming dielectric films in aluminium and other electrolytic cells," also desires to dispose of the patent or to enter into arrangements for granting a licence thereunder.

Particulars from Mr. A. E. White, Patent Agent, 89-90, Chancery-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A resolution has been passed to wind up voluntarily the Letters Patent Insurance Co. (Ltd.), and to appoint Mr. W. H. King, 13, Basinghall-street, London, E.C., as liquidator.

Eades Hoist Co. (Ltd.) is being wound up voluntarily, and Mr. A. Taylor, 32, Woodstock-road, Moseley, Birmingham, has been appointed liquidator.

Claims against Electro-Steel Foundries (Ltd.), Booth-street, Darlaston, are to be sent by March 4 to Mr. H. E. Burgess, 33, Carey-street, London, W.C.

Composition Scheme.—The High Court approved on Feb. 8 a composition or scheme under which the secured creditors of John Taylor Peddie, mechanical engineer, Exhibition-buildings, Aldwych, London, W.C., are to be paid in full forthwith, and the unsecured creditors will receive a composition of 5s. in the £, payable in quarterly instalments of 1s. 3d. The receiving order has been discharged and the adjudication annulled. Mr. F. S. Salaman, 1-2, Bucklersbury, London, E.C., is trustee.

ELECTRICITY SUPPLY.

EXTENSIONS.

St. Pancras (London.)—The Electricity Committee has received a report from the Electrical Engineer (Mr. S. W. Baynes) in regard to laying new feeder mains in the north-west district.

The report points out that since the beginning of last year applications had been received for an addition of 708 H.P. in the district. That load was fed through the northern and Prince of Wales road mains, and there remained 400 H.P. yet to be dealt with. To cope with this extra load it will be necessary to put in a new feeding main of larger section, terminating at the corner of Grafton and Prince of Wales-roads at a cost of £4,184. The existing feeding main to the "Shipton" would then be diverted to

assist the pressure in the Highgate-road district. Owing to the increase of power in the St. Paul's-road district Mr. Baynes finds it necessary to link up the distributing mains between Camden-square and Cantlowes-road, and the latter road to St. Paul's-road, at a cost of £342.

Reporting upon Mr. Baynes' proposals, the Committee states that it recognises the necessity of the extensions and recommends that authority be given for laying the new mains at a cost of £4,526.

In the course of his report Mr. Baynes referred to the cost of the cable for the new feeder recommended, and stated that the result of the Committee's decision in October, 1914, to purchase copper ahead at £54 per ton (when schedule prices were also arranged for the cost of manufacture) was a clear saving of £2,669.

The Finance Committee of the L.C.C. has now agreed to recommend the County Council to sanction the borrowing of £13,000 in respect of the King's-road Station extension on the understanding that the balance of the loan in respect of work destroyed (£232), which may be regarded as included in the loan of £19,000 secured by deed dated June 2, 1904, is repaid to the County Council.

West Ham.—The Electricity Committee recommend the Corporation to apply to the L.G. Board for sanction to borrow the following sums :—

£3,000 for mains and £5,000 for sub-stations, transformers and switchgear, in order to cover amounts overspent, and to provide a balance for applications which may be made ; also £11,000 for increasing the capacity of the mains in the Silvertown district, owing to the increasing demand by the Port of London Authority, £4,500 for the linking up scheme with Poplar, £3,275 for plant at the generating stations, and £1,000 for meters.

The L.G. Board has given consent to the borrowing of £2,000, being the balance unexercised on the sanction of £17,500 for mains, services, &c.

GENERAL.

Barnet.—The North Metropolitan Electric Power Supply Co. has allowed the Council £66 off the account for public lighting during the past quarter.

Birmingham.—The Electric Supply Committee proposes to hand over £25,000 to relief of rates in the current year, compared with £35,000 in the previous year.

The Gas Committee will give £28,000 (against £30,000) and the Tramway Committee £50,000 (against £30,000). The reason for the falling off in the amount from the Electric Supply Committee is the increased cost of materials and labour. There will be no increase in the borough rate for the first half of the year.

Blackburn.—The Electricity Committee recommend the Council to increase the salary of the Borough electrical engineer (Mr. P. P. Wheelwright) by £100 per year to bring it up to the level of salaries paid to other officials of similar standing.

Brighton.—Last week the Council considered the amended report of the Lighting Committee recommending certain changes in the scale of charges for electrical energy, &c.

Councillor LINTOTT, who moved the adoption of the report, said it recommended for the third time, and he hoped the last, the revision of tariff charges. There were three courses open. The first was to charge everybody, irrespective of load factor or quantity taken, a uniform flat rate. The objection was that the short-hour consumer would pay too low and the long-hour consumer too high a price. The second course was to charge every consumer, irrespective of consumption, in proportion to the load factor which they could use—in other words, the maximum demand system. That in theory was the soundest method of charge, but it was difficult to explain to customers and had become very unpopular. The third course was the one they were recommending—to charge every consumer alike on a uniform basis, with rebates for quantities taken. That seemed at present the most satisfactory method of solving their difficulties. He urged the Council to take the opportunity of doing away once and for all with the endless anomalies and the complicated scale of charges they had suffered from for so long. He pointed out that that system could easily be adjusted without departing from the principle. It was only fair to give the customer taking a large quantity special consideration. If they had charged their consumers in common with other towns, no doubt they would have had a larger balance, which would have augmented the reserve fund or gone towards relief of rates. No consumer using under 5,000 units per annum could say they were being asked an unduly high price for their electricity. After the war, if coal came down in price and they found the initial charge was too high, they could easily adjust the tariff and reduce the charge to 4½d. or 4d. a unit.

Councillor TINDALL said they were seizing the opportunity to hit people when they could not retaliate, and to introduce radical changes. He proposed that they should adopt a plan which was thrown out by the Town Clerk in committee, and instead of having the set of charges now introduced, charge a universal increased percentage to all customers for electricity on the pre-war prices, keeping on the same tariffs as before, because he did not think it fair to change them in war time. The time to alter the tariff was when the war was over and they were able to reduce the price. The large concern, on the existing prices, got a decrease, whereas his poor unfortunate brother, especially in the hotel line, had to pay a total increase of 77 per cent. on pre-war prices and a further 50 per cent. increase on the prices paid now. He suggested an all-round increase to all classes of consumers alike of 33 per cent. above pre-war prices, and moved an amendment that an increased percentage should be charged to all consumers on pre-war prices.

Ald. CARDEN said the Committee and the Engineer had considered the question from every possible point of view, and he asked the Council to have confidence in them and adopt their proposal.

Ald. GRIFFITH thought the only right way to deal with special war conditions was to face the fact that they were producing electricity at great additional expense, assume the old charges to have been fair, add a proportion to each, and when the war was over consider whether they wanted to alter the whole scheme. To alter it now simply because of temporary conditions, without knowing in the least what the change would produce when they returned to old conditions, seemed not altogether wise.

Councillor CAMPBELL held that the suggestion to add a percentage to the present accounts would make matters very much worse and accentuate the difference between the low-price user and the high-price user, the very thing they wanted to avoid. The present complicated tariff system operated very unfairly against the electricity undertaking, and he welcomed the new proposals because they would give a uniform rate.

The amendment was lost.

Councillor LEWIS considered the Engineer had not on the whole budgeted sufficiently for the extra cost of coal, labour, &c. He therefore moved that the minimum price for the larger consumers should be 4d. per unit. This would mean that after 4,000 units had been consumed the charge should be 4d. per unit.

Ald. WELLMAN seconded, and considered that the range of prices from 5½d. to 4d. between small and large consumers was extensive enough.

The amendment was carried.

Councillor LINTOTT then moved that for the next financial year, commencing April 1, a contribution be made by the district fund to the electricity fund of £1,250 to cover certain loan charges and standing charges in connection with public lighting, credit being given against such contribution for all current taken for street lighting purposes.

Ald. GRIFFITH moved that it be referred back. He was of opinion that it was ultra vires to bring it up in that form, as the question was under consideration of the Finance Committee.

The amendent was carried and the amended report was then carried.

Hythe.—The Folkestone Electricity Supply Co. have arranged to supply electric current to the Hythe Corporation for pumping purposes at the Saltwood waterworks.

Kingstown.—Last week the Council decided to apply to the L.G. Board for sanction to a loan of £6,000 to defray the Parliamentary expenses in connection with the acquisition of the Kingstown Electric Lighting Order.

London Linking-up Scheme.—The Board of Trade is prepared to approve the proposed agreement between the Borough Councils of Hackney and Poplar for linking-up their electricity undertakings if executed in the form of the draft submitted, subject to an amendment to meet a point raised by the L.C.C.

Middlesbrough.—At the last meeting of the Gas and Electricity Committee, the electrical engineer (Mr. R. H. Scotson) reported that the Cleveland & Durham Power Co. had granted further privileges in regard to the maximum load taken from them.

The Committee need not now consider the question of bringing the battery up to date. It was recommended that a gas engine should be obtained for use in case of emergency. The suggestions were approved, as were recommendations that advances of salary should be made to certain of the staff.

Monaghan (Ireland).—The Urban Council have given permission to the promoters of the company to be formed for the electric lighting of the town to employ overhead poles and cables.

Poplar (London).—Owing to the increasing cost of removing clinker and the increasing output, the Electricity Committee recommends the Council to purchase (for joint use with the works department) a 4-ton Edison electric wagon and a 4-ton Foden steam wagon, at a cost of £2,000.

Sheerness.—The Urban Council has agreed to the proposal of the Sheerness and District Electric Power Co. to increase the charge for electrical energy to the Sewage Works by 15 per cent., provided there is no further advance during the war.

TRACTION NOTES.

Doncaster.—The Woodlands tramway extension was opened for traffic on Monday.

Lancashire & Yorkshire Electrification.—At the recent meeting the chairman (Sir Geo. Armytage) said that the electrification of the Manchester and Bury line was now almost complete, and the electric trains would be gradually brought into use at an early date. When the service was fully instituted he had not the least doubt it would

prove to be equal, if not superior to, any other service in the United Kingdom, both as regards speed and comfort.

Llandudno.—A Board of Trade inquiry was held last week into the proposal of the Llandudno & Colwyn Bay Electric Railway (Ltd.) to introduce double-decked cars on the route between Rhos Promenade and the Queen's Hotel, Old Colwyn.

The Board of Trade had intimated that they saw no reason to object to the company's proposal, but the Council, however, objected very strongly, and they applied for a local inquiry at which their objections and their protest against the decision of the Board might be heard.

Mr. AMPHLETT said that one of the Council's objections was that if passengers were allowed to sit on the tops of the cars they would be able to look into the lower rooms of the residences along the route, and even into the bedrooms, and that would interfere with the privacy of a good deal of valuable property. The roads were in many places very narrow and there were sharp corners round which the traffic even now was conducted with difficulty. Then there was an invidious distinction between Llandudno and Colwyn Bay. These places were in all respects catering for the same class of people; they were both first-class seaside resorts, the only difference being, of course, that Colwyn Bay was much the larger place, and certainly ought to have equal facilities and equal privileges with Llandudno. There had not been a dissentient vote at the Colwyn Bay Council meeting on the matter. He asked the Board of Trade to take into consideration the opinions and the sentiments of the district. He further submitted that the track was not fit to carry the proposed traffic, owing to its being of narrow gauge, and also owing to the construction and the gradient. The public interest would be better served if a more frequent service of cars was run, and if they wanted open cars by all means let them be put on, but let them be of the single-deck type.

Mr. WM. JONES, engineer, and Mr. J. H. ROBERTS, accountant to the Council, and Sir JOHN BARLOW, M.P., gave evidence against the proposal.

Mr. J. T. TAYLOR, chairman of the Finance Committee of the Council, put in a petition signed by 80 householders on the route between the Cayley Promenade and the municipal offices.

The INSPECTOR asked whether Colwyn Bay Council had ever considered the possibility of running single-decked trailer cars.

Mr. AMPHLETT replied that he believed there was an undertaking by the company that they would not make use of trailers.

For the company, Mr. BALFOUR said it was difficult under present war conditions to maintain a regular service, and practically all the tramway companies had announced that they must be free to alter or curtail or even suspend the service without notice.

Mr. H. L. WILLIAMS, on behalf of the Company, said that there were 34 other towns in the country where double-decked cars were used on a track of the same gauge, and in a great many of the towns the gradients and curves were less favourable than at Colwyn Bay.

The INSPECTOR remarked that Bournemouth was a typical place for comparison with Colwyn Bay.

Mr. AMPHLETT: May I ask was there any opposition to double-decked cars there?

The INSPECTOR: The cars belong, there, to the local authority.

Mr. WILLIAMS said that there would be less overcrowding with two-decked cars, and the cars would either be shorter to carry the same number of passengers, or, if they were the same length, of course, they would accommodate more passengers. With regard to Llandudno, the company would like to run double-decked cars, but there was a sleeper track between the two towns, and the Board of Trade rules would not allow double-decked cars on the sleeper track, where it was not paved between the rails. There was a much shorter length of stringer track in Llandudno than in Colwyn Bay. With regard to the complaints as to the state of the track, the construction was approved by the Board of Trade, and was similar to that of tramway tracks in many other places.

London County Council.—At the fortnightly sitting of the Council on Tuesday an estimate of £2,000 for the provision of accommodation of trailer cars at the Evelyn street depot was passed.

L. & S.W. Railway.—In the directors' report for 1915 it is stated that the first stage of the electrification work, including the erection and equipment of the power house at Durnsford road, Wimbledon, and the sub stations, has been completed, and electric trains are now running over a large portion of the lines in the metropolitan area. Between Waterloo and Wimbledon, *via* East Putney, electric trains have been running since Oct. 25 last, and at the end of January a similar service was commenced on the Kingston "roundabout" line *via* Malden and *via* Richmond, and on the branch line to Shepperton. The electric service on the Hounslow loop line will be inaugurated on Sunday next.

Walthamstow.—The Tramways Committee recommend a revision of the fares and fare stages, including an increase of 50 per cent. on the prices of workmen's tickets.

Having considered a report of the engineer (Mr. C. R. Speed) as to the difficulty of obtaining materials for the maintenance of the cars, &c., the Committee recommend that the manager be instructed to obtain prices for the supply of commutators and axles.

Having been advised by the contractors for the supply of tickets that the restriction of the importation of wood pulp would have the effect of their being able to supply the Council with only 50 per cent. of the usual requirements of tickets, the Council has been reminded to communicate with the Board of Trade, pointing out that the proposed increase of 50 per cent. would place the undertaking in considerable difficulty, and asking the Board to withdraw the restriction as far as tramway undertakings are concerned.

The Council in Committee has decided to recommend that the charge for current supplied to the undertaking be fixed at 1½d. per unit, and that this charge should come into operation at the commencement of the financial year following the close of the war.

West Ham.—As the length of tramway in Beckton-road is unproductive, the tramway manager (Mr. Moffett) recommends the pulling up of the rails and the re-laying of as many as are required in the doubling of the Connaught-road terminus track.

The manager has also reported that, with one exception, no offers had been received for the supply of rails. The exception covered an offer of 100 tons at £13 per ton, which he had accepted. The manager's suggestions were adopted, subject to the sanction of the Board of Trade.

Mr. Moffett has reported on fares and stages and he recommends (inter alia) the abolition of halfpenny fares.

The cost of new track working requiring to be put in hand as soon as it is possible to do so is put at about £100,000, and, under the circumstances, Mr. Moffett is of opinion that some action should be taken to increase revenue by a revision of the present scale which, he says, is not a model one looked at from the point of view of every passenger paying the cost of his ride, for whereas the actual cost of carriage per passenger works out at 0·67d., excluding capital charges, 47 per cent. of the total number carried only pay one halfpenny. This fact and the incidence of competition have been gradually undermining the financial stability of the undertaking. A scale of fares should be made which gives the journey desired at not less than cost price, and should be periodically revised in accordance with the requirements of the financial side of the undertaking.

The Tramways Committee, therefore, recommends the Corporation to put into operation the following fares on all cars running in the borough as and from the beginning of the next financial year: (1) A universal 1d. fare for a continuous journey on any one car; (2) a 1½d. workmen's return fare for a continuous journey on any one car; (3) existing through fares where necessary to be adjusted to comply with the above scheme; (4) children's stages to remain in force as at present.

EMPIRE NOTES.

Australasia.—H.M. Trade Commissioner in Australia (Mr. G. T. Milne) reports that the New South Wales Government has decided to grant a 10 per cent. preference to goods or material of local, United Kingdom or Empire manufacture as against those of other countries. This will include any preferential customs duty that may obtain in the case of the material affected. Government Departments and corporate bodies in New South Wales have been asked to give effect to the new policy.

Grafton and South Grafton (N.S.W.) Councils have adopted a hydro-electric scheme on the recommendation and approval of the New South Wales Department of Public Works. Power will be obtained from the Nymbodia river, and the scheme is estimated to cost £23,000.

A patents investigation board has been appointed by the N.S.W. Government to examine inventions in regard to chemistry electrical, mechanical and marine engineering. The board includes representatives of the university, the works department, the department of technical education, the department of navigation, &c. Mr. J. D. Fitzgerald is the president, and Mr. A. C. Brown is the general secretary, to whom applications for consideration should be made. If, after investigation by the Committee, it is shown that an invention possesses novelty and merit, and is likely to be of assistance to industry, the general board will consider it, and if favourable will recommend the Government to assist the inventor in developing and perfecting it, and experimenting with it.

Bills were introduced in the Victorian Legislative Assembly recently to authorise the Hawthorn Tramway Trust to acquire land to construct tramways in Footscray and to generate and use electrical energy for lighting the route, subject to agreement with the municipal authorities.

The "Commonwealth Engineer" says Balaklava (S. Australia) Council has been authorised by the ratepayers to borrow £3,750 for electric lighting.

Recently Brunswick (Victoria) Council fixed a sliding scale of charges for all electricity used between midnight and 5 p.m. the next day, varying from 2d. per unit for the first 1,000 units per month to 1½d. per unit for consumption exceeding 3,000 units. As the city surveyor reported that with these charges the Council could not compete with suction and town gas engines, the prices were altered to 2d. per unit for the first 500 units per month, 1½d. for next 3,000 units per month and 1½d. per unit after.

The Government's power plant at Canberra is now running continuously and supplying current to the Royal Military College (Duntroon), administrative offices and dwellings (Canberra), sewerage works, engineers' and carpenters' workshops, gravel pits, sawmill, &c. The plant includes four Babcock & Wilcox boilers, each of 2,437 sq. ft. heating surface, one Green economiser of 400 tubes, superheater, Nicholson feed pumps, coal elevator and weighing plant, &c., one 150 kw. Belgy Hall and two 600 kw. Belliss & Morcom Brush sets, giving 5,500 volts at terminals, condensing plants, Paterson water softening plant, &c.

Prahran (Victoria) Council has accepted the offer of the Melbourne Electric Supply Co. to instal and maintain 67 additional electric street lamps at 9l. 4s. per lamp per annum. These lamps will replace the same number of gas lamps.

Wollongong (N.S.W.) Council has decided to call tenders for the installation of electric light.

FOREIGN NOTES.

China.—A consular report on the trade of Mengtzu in 1914 says the great drawback to British trade in this province has been the lack of any British house to represent British manufacturers and push the sale of their goods; but there is a good prospect of this deficiency being remedied in the near future.

The present moment is exceptionally favourable for such an enterprise, as the two German firms of Carlowitz & Co. and Speidel & Co., who have hitherto supplied local buyers with machinery, &c., can now obtain no further supplies, and the Chinese would welcome the establishment of a British house here. There are inquiries for irrigation pumps, electric light machinery, the installation of waterworks in Yunnanfu, locomotives and trucks for the Pishihchai Railway and other items, but they can only be dealt with by a man on the spot who is prepared to make a contract for the goods delivered c.i.f. at Haiphong, to assist possibly to some extent in their erection and to arrange the question of exchange. The representative of the machinery department of a Hongkong house is in the province looking into these matters, and there is a prospect of some of the inquiries resulting in the placing of orders with British manufacturers.

Mr. C. A. W. Rose (C.I.E.), Assistant British Attaché in China, states that a large number of inquiries have reached him from firms desiring to introduce their goods into China.

Most of the big importing houses are reluctant to open new connections unless the article offered is well known and is in great demand, or unless it is quoted at a lower price than that paid at present. In introducing new makes of articles which are in general demand it is customary to send a representative to tour in the Far East with samples. One man can work China, Malay States, Straits Settlements, Java and Sumatra. Some also include Japan and India. He should have some idea of trade in the East and carry literature. Quotations must be c.i.f. to port of delivery. If the manufacturer is not disposed to accept orders from native firms direct, a merchant house in China will carry on the business on a commission basis. The representative should be of good class and not too young. It is generally useless to entrust the initial work to merchant houses, but they handle many lines efficiently when the demand has been created. If the merchant is convinced that the manufacturer is willing to do some of the pioneering work and to share some of the initial expenditure, he is often disposed to make special efforts. Such efforts may be encouraged by placing in his hands a few trial shipments at considerably reduced prices as an inducement to push the goods. The Chinese are conservative in business, as in everything else, and repeat orders follow automatically if once satisfaction be given. Travellers sent out from home are furnished with introductions by the office of H.M. Commercial Attaché, and placed in touch with interested firms, foreign and Chinese. A few of those already at work are willing to undertake new agencies which will not conflict with their present lines. In cases where manufacturers are unable to send their own representative, H.M. Commercial Attaché's office is prepared to place them in touch with travellers. Their terms range from £50 to £150 a year as a contribution to expenses, with a commission.

There is a steady demand for hardware, tools, glassware, lamps, wire ropes, electric hand lamps, engine packing, electric lamps and fittings, novelties, textile and flour mill stores, metal furnishings and fittings for motors, tramcars, railway carriages, &c., pressure gauges, fans, compasses, telegraph instruments for ships, drawing and surveying instruments, belting, &c. Mr. Rose urges once more the advantages of getting as close as possible to the consumer. The China market is undeveloped; the cheapest and most effective method of advertising in that country is to place goods in the hands of the people who will use them.

In his report on the trade of Hankow in 1914, Mr. Pro-consul J. C Hill says electrical materials imported into Hankow were valued at 213,188 taels (about £30,500), against 194,596 taels in 1913. A Chinese company has installed electric light in the principal houses and streets at Wuchan, and the enterprise appears to have been fairly successful.

Russia.—The acting British Consul-General at Moscow states that a local trade organisation for opening up of business with allied and neutral countries has received an order for the supply of scientific instruments to the Russian universities, &c., and desires to obtain price lists from United Kingdom manufacturers of instruments and appliances for chemistry, physics, electromechanics, astronomy, &c.

MISCELLANEOUS NOTES.

British Industries Fair (1916).—The second British Industries Fair opened on Monday at the Victoria and Albert Museum, South Kensington, London, and remains open until Friday next, March 3. There are few exhibits of specific electrical interest, but we were pleased to learn that numerous novelties which were previously imported from Germany are now being manufactured in this country. Messrs. Ward & Goldstone, who exhibit, informed us that since the outbreak of hostilities, in order to supply the South American market and our Allies and Neutrals on the Continent, they have put down machinery for the manufacture of flexible cords of the cheaper class, high and low tension wires for motor-car work, armoured motor-car lighting wires, pocket volt and ammeters and pocket lamp cases.

All the above goods were previously imported in large quantities from Germany. On the firm's stand, besides these goods, are shown electric torches, pocket lamps, hand lamps, dry batteries, cycle lamps and novelties. The Efandem Co. show British made bells, portable lamps, hand lanterns, signalling sets for trench work, inspection lamps suitable for tram conductors, &c., accumulators, dry batteries and a comb nation buzzer, Morse flasher and hand lantern. Messrs. F. Darton & Co. have on show pocket lamps and batteries, hand lamps, small motors and dynamos, accumulators, brass pushes, tappers and buzzers, &c. The British Ever Ready Co. have a good display of the novelties for which they are noted, consisting of pocket lamps, torches, hand lamps, &c., and pocket lamps and batteries are also exhibited by Messrs. W. A. & R. J. Jacobs, the Surrey Electrical Co. and Mr. T. Baxter. On the latter stand we noticed a number of "electrical" teddy bears, the eyes of which consist of small electric lamps which the child can flash on and off by means of a small switch. The battery is in the bear's "tummy." Messrs. H. Wolff & Co. exhibit electric light shades, and in the pottery and glass section we were interested to note exhibits of glass for electric light bulbs, tubing and rods, for flash and midget lamps, for X-ray tubes, &c., laboratory and scientific glassware, combustion tubing, miners' lamp glasses, &c. This is an important development, as few of these articles were manufactured in this country before the war.

British Westinghouse Employees War Relief Fund.—The balance-sheet of this Fund for the period from Aug. 22, 1914, to Dec. 31, 1915, shows that employees have contributed £13,647, the Company £19,938, and other donations amount to £37.

The total payments to dependents have been £12,046, and donations to hospitals, other relief funds, &c., have absorbed £680; £4,000 has been transferred to the Widows' and Orphans' Fund, and the balance in hand is £2,311.

Owenized System of Seasoning Timber.—A system that will obviate the stocking of timber for prolonged periods for the purpose of seasoning should be welcomed by all connected with the timber trade.

The plant used in this system of rapid seasoning is simple. It consists generally in placing the unseasoned timber in one or more large cylinders or chambers and subsequently being subjected to steam, introduced into the cylinder, and a vacuum, or repetition of the steam and vacuum actions, which depends on the class of timber that is being treated, and other conditions, hot air, conjointly with certain gaseous products produced in a simple distilling apparatus, are then introduced into the cylinder containing the wood, which is subjected to them, and their effects. The particular gaseous products employed will depend upon the class of wood that is being seasoned. When the operation has been completed, the timber will, it is claimed, be found to be seasoned and possess the advantage (amongst others), of being able to withstand the action of the weather equally with timber weather seasoned, while at the same time, the timber is not checked or split, and, moreover, retains all its "Life." The system is owned by Messrs. Joseph Owen & Sons, Ltd., Liverpool.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during January, 1916, with the increases or decreases compared with January, 1915:

Electrical generators and motors other than for aeroplanes, motor cars and cycles, £16,353 (increase £6,505), electrical machinery unenumerated, £81,152 (decrease £84,074); telegraph and telephone cables, submarine £6,233 (increase £6,233), other than submarine £7,175 (increase £4,036); telegraph and telephone apparatus, £14,749 (increase £9,865); other electrical wires and cables, rubber insulated, £2,724 (decrease £1,554); with other insulations, £627 (decrease £516); carbons, £11,364 (increase £4,409); glow lamps, £13,515 (increase £9,473); arc lamps and electric searchlights, nil (decrease £206); parts of arc lamps and searchlights (other than carbons), £6,424 (decrease £1,136); primary and secondary batteries, £24,645 (increase £15,308); meters and measuring instruments, £5,027 (increase £2,736); switchboard, £223 (decrease £1,222); electrical goods and apparatus unenumerated, £26,196 (increase £14,611). Total of electrical goods and apparatus other than machinery and uninsulated wire, £118,902 (increase £62,037).

Exports.—The exports of electrical machinery, material, &c. during January, 1916, with the increases or decreases compared with January, 1915, were as follow:—

Electric railway and tramway motors, £3,144 (increase £552); other electric generators and motors except for aeroplanes, motor cars and cycles, £54,638 (increase £27,336); electrical machinery unenumerated, £44,831 (decrease £22,305); telegraph and telephone cables, submarine, £19,226 (decrease £30,710); other than submarine, £54,205 (increase £28,619); telegraph and telephone apparatus, £23,963 (increase £7,021); other electrical wires and cables, rubber insulated, £38,713 (increase £9,379); with other insulation, £4,212 (increase £7,594); carbons, £527 (increase £245); glow lamps, £12,018 (increase £3,530); arc lamps and searchlights, £1,958 (increase £1,691); parts of arc lamps and searchlights (other than carbons), £1,958 (increase £1,691); primary and secondary batteries, £22,699 (increase £366); meters and measuring implements, £14,541 (decrease £2,140); transformers, £3,087 (increase £165); switchboards, £5,547 (increase £392); electrical goods and apparatus unenumerated, £37,471 (decrease £15,634). Total of electrical goods and apparatus, other than machinery and uninsulated wire, £279,933 (increase £10,040).

TENDERS INVITED.

Telegraph and Railway Stores.

THE GREAT CENTRAL RAILWAY CO. invite tenders for the supply of various stores and materials including: Telegraph Materials, Electric Light Carbons, Casing, Accessories and Lamps, Asbestos Packing, Sheets and Boiler Covering, Colours, Files, Glass, India Rubber, Iron Bars, Sheets, &c., Nails, Oils, Screws, Signal Materials, Steel Boiler Tubes, Buffers and Castings, Sundry Tools, &c. Samples can be seen from Feb. 28 to March 6, inclusive, in the Public Hall of the Conservative Club, Gorton-lane, Gorton, Manchester. Specifications and forms of tender from the Stores Superintendent, Mr. Walter Williams, Great Central Railway, Gorton, Manchester. Tenders to the Secretary, Mr. Oliver S. Holt, Marylebone Station, London, N.W., by 9 a.m., March 7. *See an advertisement.*

Electric Lamps, Wiring, &c.

KENSINGTON (London) Board of Guardians invite tenders for the supply of Electric Lamps to their Infirmary at Marloes-road, Kensington, for a period of six months from April 1. Forms of tender, &c., may be obtained up to the 8th prox. from the Clerk to the Board, Mr. W. R. Stephens, Marloes-road, Kensington, W. *See an advertisement.*

SWANSEA Education Committee require tenders by noon March 6 for Wiring Brynmil Infants' School and Cwmbwrla Girls' and Infants' School. Specifications from Clerk, 9, Grove-place, Swansea.

Electrical and General Stores.

BELFAST Tramways & Electricity Committee invite tenders for the supply of materials, including Mill Furnishings, Packings and Asbestos Goods, Rubber Goods, Tools, Ironmongery, Steam, Gas and Water Tubing; Trolley Wire, Overhead Line Material and Galvanised Wires, v.b. Insulated Cables and i.r. Cables and Wires, Electrical Accessories, Lamps, Carbons, Carbon Brushes, Bitumen, Tape, Joint Box Compound, Fuse Wires, Troughing, c.i. Street Boxes, Frames and Covers, Conduits, Electricity Meters, &c., m.d. Indicators, &c. Forms of tender and further particulars from the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast, and tenders must be lodged at the office of the town clerk, Mr. R. Meyer, City Hall, Belfast, by 10 a.m. of Wednesday, March 15. *See an advertisement.*

PONTYPRIDD Urban Council require tenders by March 13 for one year's supply of Stores and Sundries, including Joint Boxes, Service Cut-outs, Tramcar and Overhead Equipment, Cables, Wires, Insulating Materials, &c. Forms of tender, from the Engineer, Generating Station, Treforest, Pontypridd.

NEWPORT (Mon.) Guardians want tenders by Feb. 29 for Electric Light Fittings, Engineers' Stores, &c. Forms of tender from the Clerk, Queen's-hill, Newport, Mon.

WEST HAM Guardians want tenders by 10 a.m. March 2 for three months' supply of Electrical Fittings, Oils, &c. Forms of tender from the Clerk, Union-road, Leytonstone.

EDMONTON Guardians require tenders for six months' supply of Electric Lamps, Ironmongery, Oils, &c. Forms of tender from the Clerk, Lower Tottenham.

BIRKENHEAD Corporation require tenders by March 9 for supply and laying of Cable, and two Rotary Converters, with Switchgear. Specifications from Borough Electrical Engineer.

The METROPOLITAN WATER BOARD want tenders by 11 a.m. March 7 for supply of Electric Lamps, &c. Forms of tender from the Chief Engineer, Savoy-street, London, W.C.

BARROW Corporation require tenders by noon March 6 for one year's supply of Electrical and Engine-room Stores, Ironmongery, Oils, &c., for their electricity department. Forms of tender, &c., from the Borough Electrical Engineer.

HESTON AND ISLEWORTH Urban Council require tenders by March 11 for one year's supply of Electric Cables, Troughing Boxes, Electricity Meters, Sundry Electrical Goods, Castings, Oils, &c. Forms of tender from the Surveyor, Council House, Hounslow, London, W.

DOVER Harbour Board require tenders by March 9 for 3, 6 or 12 months' supply of Electric Cables, Electrical Sundries, Tubing, Asbestos Packing, Paints, Oils, &c. Schedules, &c., from the Register of the Harbour Board, Castle-street, Dover.

Electrical and General Stores.

BOLTON Electricity Committee require tenders by noon March 2 for one year's supply of Joint, Service and Fuse Boxes, Meters, Motors, Starting Switches, Transformers, &c. Specifications, &c., from the Borough Electrical Engineer.

BOLTON Tramways Committee also want tenders by noon March 6 for Overhead Materials, Castings, Lamps, Carbons, Insulating Materials, &c. Specifications, &c., from the General Manager.

ABERDARE Urban Council require tenders by March 11 for one year's supply of Cables, Meters, Joint Boxes, Ironmongery, Paints, Oils, Electric Lamps, &c. Specifications, &c., from the Manager, Elec. and Tramways Dept.

DUNDALK Urban Council require tenders by 4 p.m. March 21 for 12 months' supply of Cables and Wires, Incandescent Lamps, Lighting Accessories, Meters, &c. Forms of tender, &c., from the Engineer and Manager, Elec. Works, Dundalk.

Tenders are required by first post March 15 for one year's supply of Electrical Goods for the Cheshire County Asylum, MACCLESFIELD. Tender forms from the Clerk.

The BEDWAS NAVIGATION COLLIERY CO. require tenders by 10 a.m. March 2, for 12 monhs' supply of Electrical Goods, Oils, &c. Forms of tender from the Secretary, Bedwas, Mon.

The POWELL DUFFRYN STEAM COAL CO. require tenders by 10 a.m. March 8 for supply of Electrical Goods, Rubber, Asbestos, Steel, Steam Tubes and Fittings, &c. Forms of tender, &c., from the Stores Manager, Aberaman Office, near Aberdare.

Railway Carriage Lighting.

THE GREAT NORTHERN RAILWAY CO. (IRELAND) require tenders by 10 a.m. March 1 for Electric Battery Materials for Carriage Lighting. Specification from the Secretary, Amiens-street Terminus, Dublin.

Telegraph and Telephone Material, &c.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tramcars, Electrical Equipments, &c.

DUNEDIN (N.Z.) City Council require tenders by 5 p.m. May 17 for six Electric Tramcars and sections of Cars (Bodies, Electrical Equipments and Trucks). Specifications, &c., from the Town Hall, Dunedin.

Turbo-Alternator, Hydro-electric Set, &c.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

The Town Clerk, RAETIHI (North Island), N.Z., will receive tenders until 4 p.m. March 14 for supply and erection of a 40 kw. Hydro-electric Generating Set, Switchboard, &c. Specification and drawing from Messrs. H. W. Climie & Son, Raetihi, N.Z.

TENDERS RECEIVED AND ACCEPTED.

POPLAR (LONDON).—The following tenders have been received by the Electricity Committee for the provision of switchgear required for linking up with the Hackney system:—

British Westinghouse Co. (*recommended*) £1,498. 10s., Siemens Bros. Dynamo Works £1,504, Johnson & Wright £1,621, and Ferranti Ltd. £1,750.

ST. PANCRAS (LONDON.)—The Electricity Committee recommends the acceptance of the tender of Wm. Downs, Ltd., at £3,583 for foundation and building work for King's-road station extensions.

Government Contracts.—The following tenders were accepted by the British Government Departments during January :—

War Office.—British Insulated & Helsby Cables, I. Frankenburg & Sons, Hooper's Telegraph & India Rubber Works, Johnson, Matthey & Co., Johnson & Phillips, Liverpool Electric Cable Co., St. Helens Cable & Rubber Co., and Siemens Bros. & Co., elec. cables and wires ; Aster Engineering Co. and Austin Motor Co. (1914), generating sets ; Balfour Baring (Ltd.), electric lamps ; Jackson Elec. Stove Co., oven parts ; British L. M. Ericsson Mfg. Co. and Johnson & Phillips, electrical instruments ; Girdlestone & Co., electric lighting, Haynes Park ; Mackenzie & Moncur, electric lighting, Bridge of Allan and Kinross ; Grindlay, Ross & Co., electric lighting, Dunfermline ; N. G. Middleton, electric light, bells, &c., War Hospital, Bath.

H.M. Office of Works.—Vickers (Ltd.), motor-generator, &c. for Teddington research building ; General Elec. Co. and W. T. Henley's Telegraph Works Co., elec. cable and wire. Automatic Telephonic Mfg. Co. and Western Electric Co., telephone apparatus ; Bullers (Ltd.), insulator brackets ; Union Cable Co., telephone cable ; Western Electric Co., repeating coils ; British Insulated & Helsby Cables, flexible cords ; T. Bolton & Sons, F. Smith & Co. (Inc. in London Electric Wire Co. & Smiths), and Shropshire Iron Co., bronze wire ; Rylands Bros., g.i. wire.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Westminster Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Wednesday, under the presidency of Mr. J. Browne Martin, the Chairman of the Corporation.

The SECRETARY (Mr. W. A. Pearman) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said : You will, no doubt, recognise that a company of this character has, during the last year, had to contend with many adverse causes, and so will be prepared for reduced profits. For the first half-year we have paid an interim dividend at the rate of 6 per cent., and we now propose, subject to your approval, to pay for the last half-year a dividend at the rate of 8 per cent., making 7 per cent. for the year. Our normal expansion of business has naturally been checked, and we have suffered considerably by reason of the lighting restrictions. Rigid economy in lighting has been practised by many of our consumers. While the total output in units shows a slight increase, the revenue has decreased by about £4,080. This is due to the large increase of 1,040,000 in the units sold for power, heating and cooking, whilst those sold for lighting purposes are less by 750,000. You are, no doubt, aware that the power units are sold at a much cheaper rate than those for lighting. These adverse causes are, we hope and believe, only for a temporary nature, depending upon the duration of the war. Some of the costs of generation have naturally risen appreciably ; those of distribution remain much the same as last year. The sum appearing in the accounts under the heading of " public lighting " as the cost of providing carbons, &c., for the lighting of the streets of the City of Westminster in our district, has increased by over £700, but as the accounts for the year 1914, included painting of the posts, the real increase of cost, as compared with 1914, is considerably over £1,000. This is due to the greatly increased cost of carbons, which, before the war, came from Germany. Fortunately, we held a large stock, so that the full effect was not felt in 1915. We anticipate that their cost this year will be increased by at least another £1,000. Rent, rates and taxes (apart from income tax) are up by some £800 over last year, but they appear as £4,400 less. This is owing to a change in the method of keeping the accounts this year. Some companies, like ourselves, have charged in the costs the sums deducted from the share and debenture holders for income tax on their dividends and debenture interest, while others have charged the full amount of the dividends or interest against their net profits. The majority of companies have chosen the latter method, and we have decided to discontinue our former practice.

In comparing the accounts with previous years this must be borne in mind. Management expenses are £738 up. This is due to the extra wages necessitated by the enlistment of so many of our staff. As regards the depreciation account, the sum of £23,500 set aside in this year's accounts as against £30,868 in 1914 is in accordance with the recommendation of Sir Alexander Kennedy, our engineer-in-chief, who furnished the Board with a report on this matter some time ago. In the early days of the Company we put very little aside for depreciation, but as soon as the revenue was sufficient the Board increased this sum to make up for the deficiency in the early years of the Company. This has now been made good, so that the Board will henceforth be able to reduce the rate. The fund now amounts to £316,000, the whole of which has been provided out of revenue. We have reviewed the whole of the investments of the Company, and have set aside this year out of the revenue a sum of £2,500, which has been added to the reserve fund to provide against losses on realisation, and this practically agrees with the ascertained loss on the investments realised during the year. We have complied with the Government request by selling some of our American securities and by offering others on loan to the Treasury. The proceeds of such sales have been invested in War Loan and Treasury Bills, which together aggregate upwards of £70,000. In December, 1914, and again in March last, we considered the question of raising the price of electricity, as some of the other companies of London had done, but after having carefully looked into the special circumstances of our distries, we decided that it would not be advisable to increase the price at those dates. In June, however, we were served with a notice increasing the assessment for rates on the Company, and were also faced with much heavier charges for coal and increased wages. We then felt ourselves reluctantly compelled to give notice to our consumers that the price of the current would be increased by 10 per cent., so that a portion of the burden should be borne by them and not carried wholly by the shareholders. This increase took effect in the last quarter of the year only. Owing to the uncertainty of the coal supply, we decided, in order to ensure an efficient reserve, to rent some ground adjoining one of our stations on which to store sufficient coal for a complete winter's consumption of our own stations ; Grove-road also obtained a large stock of coal for the same purpose. This has increased the cost per unit generated. With reference to the increased assessment, the Board, having failed to obtain any substantial relief from the Assessment Committee, notwithstanding decreased receipts and increased expenses, have appealed to Quarter Sessions.

Mr. C. O. Grimshaw, our chief assistant engineer, in addition to his other duties, undertook, without remuneration, the organising of a large number of factories for the manufacture of munitions of war. We have been able to render some assistance to the authorities by placing at their disposal portions of our premises for the use of various regiments. We have lost from among our colleagues on the Board Mr. Hayes Fisher, whom we have to congratulate on his appointment to the post of Parliamentary Secretary to His Majesty's Local Government Board. We were very sorry to lose him, not only on account of his long association with the Company, but because of the great value of his work and advice as one of its Directors. We do not propose at present to fill the vacancy by his retirement, and meanwhile the fees accrue to the Company. From our chief officials we have lost the services of our manager, Mr. Hordern, who was formerly in the Royal Navy and is now serving again as a Commander in that branch of His Majesty's Forces. Our mains superintendent, Mr. W. A. Jones, is serving his country in Egypt, and nearly all our eligible men have been attested under Lord Derby's scheme. We have 97 of our employees—roughly, one-third—on active service, and I regret to say that one of our staff has been killed in France, while another is missing, 10 have been wounded, and three are in hospital through sickness. It has been difficult at times to carry on the work of the Company efficiently in all its departments, but owing to the conscientious devotion of those remaining with us, I am glad to say that by various readjustments of duties, by overtime work, and by the employment of some few substitutes whom we have engaged temporarily, none of our consumers have had cause of complaint, nor have the interests of the Company appreciably suffered.

Our late secretary, Mr. Frank Iago, who had been in failing health for some time, felt compelled to resign his post in August last. The Board granted him a pension, but I regret to say he did not live to enjoy it ; he died early in December last. He had been secretary for a period of over 27 years—ever since the Company started. The Board have made a suitable grant—a sum of money—to his widow. He has been succeeded by Mr. W. A. Pearman, who has been the accountant of the Company for upwards of 20 years. I now beg to move the adoption of the report and accounts.

Mr. C. S. GILMAN, J.P., seconded the motion, which was carried unanimously, and a dividend at the rate of 8 per cent. per annum for the half-year ending Dec. 31, 1915, making 7 per cent. for the year (less tax) was declared.

The retiring directors, Capt. Bax and Mr. Gluckstein were re-elected, as were the auditors, Messrs. Jackson, Pixley & Co.

Votes of thanks to the staff and to the Chairman terminated the proceedings.

CENTRAL LONDON RAILWAY CO.—This company's share of the common fund created under the London Electric Railway Companies Facilities Act, 1915, is 20 per cent., or £90,273. 3s. 2d. This sum, plus £15,412. 14s. 4d. brought forward, makes £105,685. 17s. 6d. which is available for dividends on ordinary, preferred and deferred ordinary stocks. The company's gross receipts for 1915 were £316,527, increase of £39,151 over 1914, and expenditure was £156,523, increase £12,164, leaving total net income £160,004, increase £26,987. Adding balance from last year (£15,412) and deducting interest, rentals and other fixed charges (£38,131), appropriation to reserve (£10,000) and dividend on preference stock (£21,600), the balance available for dividends on ordinary, preferred and deferred ordinary stocks is £105,685. The interim dividend of 1½ per cent. which was paid on the ordinary stock and of 2 per cent. on the preferred ordinary stock for the half-year ended June 30, 1915, absorbed £38,492, leaving £67,193, which will admit of the payment of a dividend of 1¾ per cent. on the ordinary stock, of 2 per cent. on the preferred

ordinary stock for the half-year ended Dec. 31, 1915, and of 2 per cent. on the deferred ordinary stock for the whole year, making 3 per cent. on the ordinary stock and 4 per cent. on the preferred ordinary stock for the year, leaving £15,685 to carry forward. The dividends paid for 1914 were 2⅝ per cent. on the ordinary, 4 per cent. on the preferred ordinary and 1¼ per cent. on the deferred ordinary stock, with £15,412 carried forward. The capital expenditure during the year amounted to £35,440.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—During 1915 the number of houses and shops connected with the system increased by 70 from 4,941 to 5,011, and the energy consuming devices (calculated in 30 watt lamps) by 21,873 from 488,912 (14,660 kw.) to 510,785 (15,320 kw.). The lighting restrictions reduced the units sold by 9 per cent., which entails a still greater percentage of reduction in the net profit. The net profit for the year available for dividends is £11,653. 1s. 7d., and with £1,628. 11s. 1d. brought forward the total is £13,281. 12s. 8d. Interim dividends paid during the year at rate o 6 per cent. per annum on the ordinary shares, 6 per cent. per annum on the first preference shares to June 30, and 5 per cent. per annum on the second preference shares to Sept. 30, amounting to £6,525, leaving £6,756. 12s. 8d., out of which must be deducted the second half-year's dividend on the first preference shares, which absorbed £1,500, and provision for the dividend on the second preference shares from Oct. 1 to Dec. 31, amounting to £625, leaving a balance of £4,631. 12s. 8d. Out of this the board recommend payment of a dividend at rate of 8 per cent. per annum for the last half-year, which will absorb £4,200, making with the interim dividend already paid. 7 per cent. for the year on the ordinary shares, and leaving to carry forward £431. 12s. 8d.

LANCASHIRE UNITED TRAMWAYS (LTD.)—The traffic receipts for 1915 were £90,578, miscellaneous receipts and electrical energy sold produced £6,249. Deducting working expenses (£54,933), cost of generating electrical energy sold (£4,076), general charges (£5,240) and rent of leased lines (£5,191), and adding dividend on holding in New St. Helens & District Tramways Co. (£1,534), the profit was £28,901. Interest and dividends from operating companies and sundry receipt amounted to £14,017. After deducting interest on the prior lien debenture stock and expenses there remains £198, which has been carried to depreciation account. There is also a balance on the year's working of the operating companies after paying interest and dividends of £16,263.

LONDON ELECTRIC RAILWAY CO.—This company's share of the common fund created under the London Electric Railways Facilities Act, 1915, is 26 per cent., or £117,355. 2s. 2d. This sum plus £11,547. 3s. 1d. brought forward makes £128,902. 5s. 3d., which is available for dividend on the ordinary shares. The gross receipts of the company during 1915 were £963,131 (increase of £181,186 over 1914), and expenditure was £428,307 (increase £82,306), leaving total net income £534,824 (increase £97,880). After adding balance brought forward (£11,547) and deducting interest, rentals and other fixed charges (£270,522), appropriation for reserve (£20,000), and paying dividend on preference stock (£126,947), the balance available for dividend on the ordinary shares is £128,902. The interim dividend for the half-year ended June 30, 1915, on the ordinary shares was ½ per cent. This absorbed £46,640 and leaves £82,262, which admits of the payment of a dividend for the half-year ended Dec. 31, 1915, on the ordinary shares of ½ per cent., making with the interim dividend 1½ per cent. for the year, leaving £12,303 to be carried forward. The dividend on the ordinary shares in 1914 was ½ per cent., with £8,000 placed to reserve and £11,547 carried forward. The capital expenditure during the year amounted to £157,160. A section of the extension of the "Bakerloo" from Paddington to Queen's Park was opened for traffic on Jan. 31, 1915; on Feb. 11, 1915, the train service was extended to Queen's Park, and on May 10, 1915, a service of through trains to the new Willesden Junction station of the London & North-Western Railway was inaugurated. The traffic is satisfactory and shows a substantial growth since its opening.

LONDON ELECTRIC SUPPLY CORPN. (LTD.)—The report of the directors states that the profit for the year ended Dec. 31, 1915 is £77,687 18s. 1d., against £93,234 0s. 10d. last year. To this has to be added the amount brought forward (£8,828), less balance of interest on temporary loan and expenses of debenture stock issue (£223), making a total of £86,293. Interest on debenture stock required £21,774 7s. 0d. and sinking fund for redemption of debenture stock in 1931 £12,527, leaving a balance to be appropriated of £50,991 12s. 0d. The board propose to pay a dividend of 6 per cent. on the preference shares (of which an interim dividend of 3 per cent. was paid on Sept. 1 last, which will absorb £26,952) and a dividend of 3 per cent. on the ordinary shares (£9,950), to place £3,000 to contingencies account, and to carry forward £2,049 12s. 0d. The supply has been efficiently maintained during the year. The number of units sold amounted to 50,757,884, against 46,343,065, the total costs per unit sold being 0.646d. (against 0.566d. in 1914), caused by the great increase in the price of coal and wages owing to the war. The power supplied for traction, tramway and industrial purposes shows 14 per cent. increase over last year. The average receipt per unit sold (lighting and power) was 0.95d., compared with 0.91d. No provision has been made for excess profits duty, although it seems fair that accounts for the year ended Dec. 31, 1914 should bear part of the two previous years. The board are advised by their solicitors that, although these profits are slightly over the average of the profits of the years 1912 and 1913, they are of opinion that an electric supply undertaking with a 30-year expiring in 1931 comes (if need be) under the provision in sec. 42 of the Finance Act referring to businesses which may apply for an increase of the statutory percentage in special circumstances; and that, when all proper adjustments are made, it will be clear that the corporation is not liable to the payment of such excess profits duty. The expenses of generation during 1915 were increased by nearly 50 per cent. owing to the war.

MATHER & PLATT (LTD.)—At the meeting on Wednesday the directors' report for 1915 stated that the net profit amounted to £103,622, after charging depreciation, directors' remuneration and doubtful debts. With £66,838 brought forward, the balance is £170,461. The directors recommend a balance dividend on the ordinary shares of 9½ per cent., making 12½ per cent. for the year, carrying forward £75,461. The company's works were declared a "controlled establishment" under the Munitions of War Act on Aug. 18, 1915. The company has made payments to employees serving with H.M. Forces or interned abroad, and to their dependents. Contributions have also been made to various war funds. These payments have amounted to £10,000 during the year, which amount has been charged against revenue.

METROPOLITAN DISTRICT RAILWAY CO.—The report states that as one of the companies which are affected by the London Electric Railway Companies Facilities Act, 1915, it is entitled to 12 per cent. of the common fund created under the Act, and accordingly it receives £54,163. 17s. 11d. This sum plus £13,888. 3s. 10d. brought forward makes a total of £68,052. 1s. 9d., which is available for dividend on the second preference stock and further reserve. The total receipts of the company for 1915 were £1,066,247, and expenditure was £511,721, leaving total net income of £554,526. After meeting interest, rentals and other fixed charges (£350,432), appropriating £25,000 to reserve, and paying dividends on guaranteed and first preference stocks (£124,930) the balance available for dividend on second preference stock and further reserve is £68,052. The interim dividend of 1½ per cent. which was paid on the second preference stock for the half-year ended June 30, 1915, absorbed £22,050, leaving £46,002 available, which will admit of the payment of a dividend of 1½ per cent. for the half-year ended Dec. 31, 1915, making 3 per cent. for the year. It is proposed to carry £10,000 to reserve, making £35,000 for the year, and to carry forward £13,952. The dividend paid on the second preference stock for 1914 was 2 per cent., with £13,888 carried forward. The capital expenditure during the year amounted to £17,059.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The gross profit for 1915 was £34,439. 5s. 5d., and after adding £14,617. 8s. 3d. brought forward and deducting interest on debentures and loans (£18,474) the available balance is £30,582. 13s. The directors recommend that £2,260 be transferred to second mortgage debenture redemption fund, £500 be written off debenture issue expenses, and that the balance of £27,822. 13s. be carried forward. Although the net profit for the year shows an increase over last year, the directors do not deem it expedient to recommend payment of a dividend in consequence of the abnormal conditions due to the war. Owing to the large increase in the cost of coal and other material the price for electrical energy supplied to the ordinary consumers was raised as from the June quarter meter readings, and the increased demand for power has more than compensated for the loss incurred due to the lighting restrictions. The capital expenditure for buildings, plant and mains during the year amounted to £48,817. 11s. 8d.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The directors' report for the year ended Dec. 31, 1915, states that the expenditure on capital account has been increased during the year by £1,556. 7s. 5d., making the total £253,677. 11s. The expenditure on capital account exceeds the receipts by £44,325. 1s. The cost of the joint station at Wood-lane to date has amounted to £224,955. 14s. 5d., and joint debenture stock amounting to £231,500 has been issued. The profit for the year was £22,617 (against £24,221 in 1914), and the equivalent of 238,981 30-watt lamps is connected (against 234,608 in 1914). The number of consumers is now 4,358, and, with the exception of 20, are supplied at 200 volts. The revenue from the sale of current for the year was £42,418. 13s., an increase of £332, and the reduction of £1,604 in the profit is mainly due to the higher rate of income tax, which was £2,653. 2s. 6d., against £1,499. 5s. 9d. in 1914. From the available net profit of £26,028. 15s. 2d., depreciation, renewal and reserve (£3,000), debenture interest (£2,266. 13s. 4d.), Kensington & Notting Hill joint debenture stock interest (£2,323. 8s. 3d.), interest on loans (£328. 8s. 2d.) and sinking funds (£1,518. 17s. 3d.), income tax (£2,653. 2s. 6d.) and amount to be distributed to staff under co-partnership scheme (£252. 13s.), leaving an available balance of £13,685. 12s. 8d. Both classes of 6 per cent. preference shares have received their full dividend, which absorbed £7,488, and left £6,197. 12s. 8d. The directors recommend payment of a dividend of 5s. per share (less tax) on the ordinary shares, absorbing £5,860. 16s. 8d., carrying forward £336. 16s. The scheme of co-partnership with the company's staff, brought into operation during 1912, is still working satisfactorily. Under this scheme there will be distributed among the staff an addition to their wages of nearly 8 per cent.

PARA ELECTRIC RAILWAY & LIGHTING CO. (LTD.)—The gross receipts for the past year were £243,483, and operating expenses were £115,309, the net revenue earned in Para being £128,174 compared with £117,400 in 1914. As the accounts are based upon the legal exchange rate of 16d. per milreis, there must be deducted £53,265, being the actual loss incurred on remittances. After providing for London expenses, the balance is £70,759, against £100,147. After paying debenture interest and sinking fund (£38,500) and interim dividend on the preference shares (£9,750), the balance is £63,185. The directors recommend the transfer to depreciation and renewals reserve of £15,000; payment of a final dividend of 3 per cent. on the preference shares for the half year to Nov. 30, 1915 (making 6 per cent. for year), payment of a dividend of 5 per cent. on the ordinary shares (less tax) for the year, carrying forward £18,935.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—The report for 1915 states that the credit balance is £49,190. 9s. 3d. (against £43,054 in 1914), which, with £5,591 brought forward and £1,001. 14s. a dividend of 10 per cent. declared on the company's holding of shares in the West Kent Electric Co., makes a total of £55,783. 3s. 11d. After deducting £12,612 for interest on debenture stock paid and accrued, and £7,253. 17s. 7d. for interim dividends on the preference shares, the balance is £35,917. 0s. 2d. The directors recommend payment of final dividends to Dec. 31 upon the 7 per cent. cumulative first and the 6 per cent. cumulative second preference shares, placing £16,750 to depreciation, payment of a dividend of 4 per cent. per annum on the ordinary shares for the year 1915, the balance of £6,604. 18s. 7d. being carried forward. There are 6,781 consumers (against 6,468), and the connections are equal to 19,389 H.P. (against 15,529 H.P.). The revenue from sales of current shows a satisfactory improvement, but the cost of coal during the year continued abnormally high, and there was a considerable increase in wages. In order to cope with the continuous growth of the business the plant at the power house is being added to by the installation of a 5,000 kw. turbo-generator, which it is expected will be in commission next month. With the sanction of the Treasury, a further £10,790 4½ per cent. first debenture stock and 15,926 6 per cent. cumulative second preference shares were issued during the year. The business of the West Kent Electric Co. has made substantial progress, its gross revenue having risen from £1,596. 8s. 6d. in 1914 to £13,320. 7s. in 1915, while the net revenue increased from £541. 6s. to £3,051. 3s. 3d.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week the chairman (Sir Herbert Leon) said that the capital had been increased by £1,354. 14s. 6d., which included the balance of the cost of the Diesel plant which was outstanding last year. The board had now come to a satisfactory settlement with the Diesel Company, and had been able to order a new generating set, which should be at work in a few months. The cost of producing the current had been much heavier owing to the war. Their oil contract luckily carried them over last year; it was now double the price, and to meet that they had been obliged to follow the example of other electrical undertakings and increase the charge for current to customers. The total cost of generating current in 1915 was 6 per cent. higher than in 1914. Other items had also increased. Their receipts from current were actually more than last year, in spite of war conditions, but the total receipts were less, owing to the natural disinclination of consumers to spend money on extensions and alterations. The net profit (£2,816) was only £324 less than 1914. The board had decided to again recommend payment of a 2 per cent. dividend, after having placed the usual amount to debenture stock sinking fund, and £1,250 to depreciation (against £1,000), carrying £1,296 forward. A serious accident, against which they were fully insured, had taken place on the 7th of this month. One of the compressors of a Diesel engine exploded, killing one man and wounding another. The cause was being investigated and would doubtless be ascertained.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The accounts for the year 1915 show a net profit of £108,707. 14s. 7d. after charging the interest on the debentures. With £111,406. 11s. 4d. brought forward the total is £220,114. 5s. 11d. From this amount is deducted the interim dividend of 5 per cent. (paid in July), amounting to £22,410, leaving £197,704. 5s. 11d. The directors propose to distribute a further dividend of 10 per cent., together with a bonus of 12s. per share, tax free, absorbing £67,230, and to supplement the reserve fund by £20,000 (making it £165,000), leaving £110,474. 5s. 11d. to be carried forward. The general business of the company during the past year has been satisfactory. The company's works and steamships have been maintained in their usual state of efficiency. The Rt. Hon. the Earl of Selborne, K.G., having accepted office in the Government in May last, resigned his directorship of the Company.

TOTTENHAM DISTRICT LIGHT, HEAT & POWER CO.—At the meeting last week the chairman (Sir Corbet Woodall) stated that their electricity supply plant had proved entirely satisfactory, and in the second half-year of the establishment of the undertaking it was paying its way, and there was a small balance to the good.

WADEBRIDGE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting it was reported that the results of the past year's working were satisfactory, and it was proposed that a dividend of 6 per cent. be declared. During the year there were numerous applications from existing consumers for additional lights. In order to popularise the use of irons they were offering to supply them on loan at a low charge of 4s. per annum. No thrifty housewife who had once tried them was willing to return to the discomforts of the ordinary flat iron. A scheme was under consideration to make it possible to supply the tenants of small cottages with the light at a weekly cost.

YORKSHIRE ELECTRIC POWER CO.—At the meeting last week the chairman (Mr. A. G. Lupton) said that there had been a satisfactory growth of receipts owing to increased output, but the very high prices of coal had greatly increased the costs. To some extent that would be recouped during the first half of 1916, owing to the sliding scales in force in their agreements. The plant had been run at great pressure and maintenance and repairs were in consequence very high. New and larger units of plant had been put on order. It had been a great disappointment to the directors to be unable to recommend a higher dividend upon the ordinary shares than that paid in 1914, but they felt that in these difficult times it was absolutely essential to consolidate and secure the resources of the company.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES

COATES & CO. (SHEFFIELD) (LTD.) (143,006)—Reg. Feb. 14, capital £3,000 in £1 shares (500 preferred), to take over the business of an electrical engineer and contractor carried on by J. Coates as Coates & Co. Private company. J. Coates is first permanent director.

J. E. LESTER & FOLWELL (LTD.) (143,015)—Reg. Feb. 15, capital £3,000 in £1 shares, to take over the business of J. E. Lester & Folwell, motor garage proprietors and electricians, to carry on same and the business of carriage, motor or omnibus manufacturers or dealers, electricians, mechanical engineers, &c., and to adopt an agreement with J. E. Lester. Private company. J. E. Lester is permanent director. Reg. office: 40, Humberstone Gate, Leicester.

LIDGETT ENGINEERING CO. (LTD.) (142,921).—Reg. Feb. 4, capital £5,000 in £1 shares (1,500 preference), to take over the business of a mining, electrical and mechanical engineer carried on as Steavenson & Co., at Barnsley. Private company. First directors are: G. S. Marple and G. F. Steavenson.

LOWER THAMES LAND DEVELOPMENT & POWER CO. (LTD.) (143,059) Reg. Feb. 18, capital £7 in £1 shares, to acquire and turn to account a certain estate at Barking, Essex. Private company. First directors are J. B. Braithwaite, H. B. Renwick and F. W. Reynolds. Reg. office: Moorgate-court, Moorgate-place, E.C.

MAKIN & CO. (LTD.) (143,007)—Reg. Feb. 14, capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers and manufacturers, &c., and to adopt an agreement with Makin & Co. (Ltd.) (in vol. liq.) and P. Toothill. Private company. First directors are R. C. Smith and R. C. Smith, jun. Reg. office: 39, Townhead-street, Sheffield.

REGULUS METAL & PLUMBING CO. (LTD.) (142,874).—Reg. Jan. 31, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in metallic specialities, fittings, furnaces and moulds, &c., gas and electric light fitters, dealers in paints, varnish, &c. Private company. First directors are: T. W. Lovatt, P. J. Jemmett, H. L. B. Lovatt, R. S. Lovatt and W. H. Manley. Secretary: H. J. Cooper. Reg. office: Birch-street, Wolverhampton.

SCOTT ELECTRICAL CO. (LTD.) (142,970)—Reg. Feb. 9, capital £100,000 in £1 shares, to carry on the business of manufacturers of and dealers in lighting sets and starting apparatus, lamps, dynamos, magnetos and electrical and other apparatus and accessories and parts thereof, for use in connection with motor vehicles, airships, aeroplanes, &c., also electrical, mechanical, automobile and general engineers, &c., and to adopt agreements with the Efandem Co. and Jesse Varley. First directors are J. Varley, E. J. Hardy and G. H. Cornwallis. The Efandem Co. (Ltd.) shall for a period of 10 years have the right to nominate a director so long as they hold 500 shares. Reg. office: National Provincial Bank-chambers, Queen's-square, Wolverhampton.

MORTGAGES AND CHARGES.

COLSTON ELECTRICAL WORKS (LTD.)—Mortgage on certain moneys dated Jan. 25, 1916, to secure all moneys due or to become due from or to Capital & Counties Bank.

ENFIELD ELECTRIC CABLE MFG. CO. (LTD.)—Deed of further charge on certain hereditaments and premises dated Jan. 27, 1916 (supplemental to mortgage dated Nov. 5, 1914), to secure £2,750. Holders: Viscount Grimston, G. J. Andrews and F. Plutte.

MASHAM & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Particulars of £500 debentures, created Jan. 19, 1916, have been filed, amount of present issue being £440. Property charged: Company's undertaking and property, present and future. No trustees.

CITY NOTES.

MEMORANDA (Feb. 16).—**Bank rate 5 per cent. (since Aug. 8, 1914). Consols** 58¼. **Consols Pay Day, March 1. Stocks and Shares Ticket Days, Feb. 23 and March 9. Pay Days, Feb. 24 and March 10. Price of silver,** 26 15/16d.

BOURNEMOUTH & POOLE ELECTRICITY CO. (LTD.)—The directors' recommend a final dividend on the ordinary shares at rate of 7 per cent. per annum (less tax) for the half-year to Dec. 31, making 6 per cent. for the year.

CROSSLEY BROS. (LTD.)—The directors have declared a dividend on the preference shares at rate of 5 per cent. per annum and at rate of 6 per cent. per annum on the ordinary shares (making 5 per cent. for the year); £20,000 has been placed to reserve and the balance (£30,330) carried forward.

DAVIS & TIMMINS (LTD.)—The directors recommend a balance dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year, (tax free), making 8 per cent. for 1915, together with a bonus of 15 per cent.

DIRECT WEST INDIA CABLE CO. (LTD.)—The directors announce an interim dividend at the rate of 6 per cent. per annum (tax free) for the past half-year.

GUERNSEY RAILWAY CO.—The net profit for 1915 (including £528 brought forward), after writing off £886 for depreciation, paying debenture interest, and placing £500 to reserve, amounts to £1,729 against £1,785. An ordinary dividend of 5 per cent. (the same as in 1914) has been declared.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The directors announce an interim dividend at rate of 6 per cent. per annum (tax free) for the past half-year.

MACKAY COMPANIES.—The regular quarterly dividend of 1 per cent on the preferred shares and the regular quarterly dividend of ½ per cent. on the common shares in the Mackay Companies will be paid on April 1, 1916, to shareholders of record as they appear at the close of business on March 10. The transfer books will not be closed.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors recommend payment of a final dividend of 3½ per cent. on the ordinary shares, making, with the interim dividend of 2½ per cent. already paid, 6 per cent. for the past year.

OXFORD ELECTRIC CO. (LTD.)—The directors have declared a dividend at rate of 3½ per cent. (less tax) on the ordinary share capital for the half-year to Dec. 31, making 6 per cent. for year, against 6½ per cent. in 1914.

VULCAN BOILER & GENERAL INSURANCE CO. (LTD.)—A final dividend of 6s. a share and a bonus of 2s. a share (less tax), making 12s. for the year, have been declared, and £8,338 has been carried forward.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Feb. 22, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	17½d.
Solid Drawn Copper Tubes	18½d.
Brazed Copper Tubes	16½d.
Brazed Brass Tubes	19d.
Brass Wire	16½d.
Copper Wire	18½d.
Rolled Brass	16½d.
Brass Sheets	16½d.

	per ton.
Copper Sheets	£148 0 0
Spelter	£105 0 0

	per ton.
English Lead	£33 10 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£96 0 0
Brazziery Copper Scrap	£89 0 0
Clean Scrap Brass	£69 10 0
Old Lead	£27 0 0
Old Zinc	£25 0 0
Hollow Pewter	£120 0 0
Black Pewter	£90 0 0
Gun Metal	£82 10 0

Messrs. A. Jones, Earlestreet, Lambeth-road, Southwark, London, S.E., quote under date Feb. 22 the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£150 0 0
Clean Mixed Brass	£68 0 0
Clean Copper	£96 0 0
Braziery Copper	£90 0 0
Gun Metal	£80 0 0

	per ton.
Old Lead	£27 10 0
Tea Lead	£25 10 0
Old Zinc	£70 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

Mr. Joseph Sankey's sales at the Hadley works yesterday were: Phosphor Bronze Ingot Bars (28), Delta Metal Ingots (18), Brazing Spelter (115).

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Feb. 22. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shs.	Last Dividend	NAME.	Price, Tues., Feb. 22	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electricity Supply.			
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 5 5	Mar, Sept
10	4½%	*Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	*Do. 6% Cum. 2nd Pref.	12⅞	5 14 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St.	81	4 18 9	..
St.	4%	Charing Cross West End & City Debs.	87	4 11 1	Jan, July
5	2/3	Do. 4½% Pref.	31⅜	6 9 9	..
5	5%	Do. Ord.	3⅝	7 5 6	Aug, Feb
5	4½%	Do. City Pref.	5⅛	8 9 5	Jan, July
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅜	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	1⅛	7 4 9	Feb, Aug
10	6%	Do. 6% Pref.	1⅜	5 11 4	Mar, July
St.	5%	Do. 5% Deb. St.	97½	5 2 6	Jan, Dec
St.	4½%	Do. 4½% Debs.	84½	5 12 11	Jan, Dec
10	7%	County of London Ord.	12⅜	6 12 9	Mar, Sept
10	6%	Do. 6% Pref.	11⅜	5 18 6	Feb, Aug
St.	4½%	Do. 1st Deb.	96½	5 4 1	Jan, July
St.	4½%	Do. 2nd Deb.	93½	4 12 9	Mar, Nov
5	9%	Edmundson's Elec. Supp. 4½% Debs.	6	7 10 0	July
St.	4%	Kensington and Knightsbridge Ord.	7⅛	7 5 5	Feb, Aug
5	3/0	*Do. Deb. St.	77½	5 5 11	Jan, July
St.	4%	London Elec. Supp. 6% Pref.	4	7 1 7	..
5	3½%	Do. 4% Mort. Debs.	79½	6 4 6	Jan, July
St.	4½%	Metropolitan E. Supp. Ord.	2⅛	8 7 3	Mar, Aug
St.	5%	Do. 1st Mort. Deb.	92	5 11 6	Jan, July
..	6%	Midland Elec. Corpn. 1st Mort. Deb. St.	99	5 1 0	Jan, July
St.	5%	Newcastle & Dist. E.L. 6% 2nd Debs.	99½	6 0 6	Mar, Sept
..	6%	Newcastle-upon-Tyne E.S. 5% 2nd Mt. Db. St.	100	5 0 0	Mar, Sept
4	5%	North Metropolitan E.P. Supp. 6% Pref.	1⅛	5 16 4	Apl, Oct
		South London E.S. Ord.	3⅛	6 10 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shs.	Last Dividend	NAME.	Price, Tues., Feb. 22.	Rate per cent. Yielded. £ s. d.	Dividend Due.
		Electricity Supply—*cont.*			
5	10%	St. James' & Pall Mall Ord.	5⅞	8 10 3	Feb, Aug
5	7%	Do. do. Pref.	5⅛	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅜	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	5⅛	7 6 11	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4⅛	5 10 9	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82¾	6 0 10	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	75½	7 19 4	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	69½	5 15 4	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99⅜	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½	8 0 0	Feb, Aug
10	½%	London Electric Ry. Ord.	1⅛	3 9 0	Jan, July
St.	4%	Do. 4% Pref.	64½	6 4 0	Mar, Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23	4 6 11	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	71	5 12 8	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan, July
St.	4%	Do. 4% Guar. Stock	67⅞	5 18 9	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅛	5 6 8	Apl, Oct
1	6%	Do. 6% Pref.	1⅜	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	89½	5 11 9	Jan, July
1	6%	Do. 6% Pref.	⅞	6 15 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅜	6 19 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5½	5 17 1	Jan, July
1	6%	British L.M. Ericsson Mfg. Cm. 6% Pref.	⅞	6 17 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅜	6 17 2	April
100	6%	Do. 6% Prior Lien Debs.	102	5 17 11	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	65½	6 2 7	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11½	6 10 5	Jan, July
5	2/6	Do. 5% Pref.	4½	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jan, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	1⅜	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	1	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅝	6 6 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	71	5 12 8	Jan, July
..	10%	General Electric Ord.	10⅛	9 6 7	July
10	6%	Do. 6% Pref.	9⅝	6 5 6	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅛	7 9 6	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅛	10 15 3	Feb, Aug
10	5%	Do. Pref.	7⅛	6 11 2	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37⅛	6 8 3	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅛	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅛	5 6 8	May, Aug
St.	4%	Do. 1st Debs.	79	5 3 5	Jun, Dec
..	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 18 4	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69½	5 13 9	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 11 2	May, Nov
10	10%	Do. 10% Pref.	15⅛	6 11 2	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	†Direct United States	6⅛	6 12 0	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127⅛	5 10 0	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77½	5 3 3	May, Nov
St.	4%	†Eastern Extension Tel. Co., 4% Debs.	80½	5 0 5	Feb, Aug
10	7%	Do. Ord.	12⅛	5 9 3	Ja, Ap, Jly, O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	34	6 9 5	Ja, My, Jly
25	13%	Indo-European	50½	6 8 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1½	4 2 4	July
10	1%	West India & Panama Ord.	1⅛	9 15 1	May, Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 5 11	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	75¼	5 6 0	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99¼	4 10 3	May, Nov.
		Telephones.			
1	7½d.	Monte Video Telephn. Ord.	⅞	6 12 5	Nov.
1	10%	*Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db. St.	74	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	83	5 8 5	Jan, July
..	8%	United River Plate Ord.	5⅛	6 15 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	94½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust.	10½	5 18 8	Sp,De,Mr,Jn
10	6%	Do. 6% Pf.	9⅝	6 5 6	Sp,De,Mr,Jn
100	5%	Mackay Companies' Common	80½	6 4 7	Ja, Apl, Jly, O
..	4½%	Do. $100 Pref.	67½	5 18 0	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 10 9	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs.	95	5 5 3	Jun, Dec
10	6%	Bombay E. S. & T. 6% Pref.	10	6 0 0	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	6	7 10 0	May, Nov
5	5%	Do. 5% Pref.	4½	5 11 11	Mar, Sept

* And 13½% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 759
Arrangements for the Week .. 762
The Wave-Shapes Obtaining with Alternating-Current Generators Working Under Steady Short-Circuit Conditions. By A. E. Clayton. Illustrated.—*Concluded* 763
A Variable Speed Transmission Gear. Illustrated 764
Tests on Oil Switches. By Bruno Bauer. Illustrated .. 767
Methods of Chord Winding for Continuous-Current Armatures. By F. Leyerer. Illustrated 771
Apparatus for Starting and Controlling Electrical Running Machinery. By C. C. Garrard. Illustrated 772
Portable Galvanometer 774
Founding a Large Power Station on Soft Marsh. Illustrated 775
ELECTRICITY SUPPLY IN THE COLONIES 776
REVIEWS 777
A Course of Modern Analysis [Whittaker] : Reviewed by Dr. A. Russell.
Rapid Reckoning Chart [Fournier D'Albe].
The Testing of Machine Tools [Burley].
Mechanical Technology [Charnock].
Spon's Architects' and Builders' Pocket Price Book [Young and Brooks].
Steel Cars for Michigan Railway. Illustrated 778
The Testing of Underground Cables with Continuous Current.—*Discussion* 779
CORRESPONDENCE 781
Permeameter for Straight Bars (Robert Beattie).
City Guilds Subject "Electric Wiremen's Work" (W. Ellerd-Styles).
LEGAL INTELLIGENCE 782
The "Electrician" Commercial and Industrial Section .. 783-792

NOTES.

Oil Switches.

THERE can be no doubt that one of the chief limits—in fact, in the opinion of some people it is the determining limit—of the size and scope of electrical supply systems is to be found in the switchgear, and more especially in the oil switch. Already the largest installations have short-circuit values beyond the capacity of any known form of oil-switch construction, and means for reducing the short-circuit current by reactance coils have to be introduced. The study and standardisation of oil switches are, therefore, subjects of the utmost importance, and should have the continuous attention of all electrical engineering societies and institutions. The word standardisation must here be interpreted in its wide sense, as meaning, in the first instance, the arriving at a system of rating of oil-switch construction which will enable a satisfactory switch to be installed for any given set of operating conditions. Recognising this, special committees have been set up in the leading industrial countries (with the exception of this country) having the special object of making a thorough examination of the subject and the collecting together of the facts in a convenient form for the industry. From this point of view the first report, which we abstract elsewhere in our columns, of the Commission on High-tension Apparatus, &c., appointed by the Schweizer Electrotechnischer Verein and Verband Schweizer Elektricitätswerke, is of particular interest, as showing that even a small State like Switzerland is, in this matter, more alive to present-day requirements than we are here, and is tackling the problem in a scientific and business-like manner.

THE first report is mainly theoretical in character, and applies the methods of mathematical analysis in a very ingenious manner to the formation of arcs at the contacts of oil switches. The theoretical considerations are supported by a number of actual tests ; but as these latter did not extend to heavy short-circuit tests they are not absolutely conclusive. In fact, some of the results obtained cannot be said to be borne out in practice. Thus, the conclusion is arrived at that it is "more dangerous to switch off a load from a generator of poor regulation than from one of close regulation." This may be true for the range of experiments considered, but when dealing with the very severe conditions of short-circuit, since poor regulation results in a much smaller short-circuit current, the direct opposite result is found. An interesting point of the report is the endeavour to arrive at a constant for an oil switch which, when multiplied by the total energy flow at the moment of operation and by the time taken to operate, gives the heat generated in the switch due to the rupture of the current. For modern oil switches at 50 cycles this constant was found to vary between 2 and 7 per cent. There can be no doubt that it is only by a scientific study of the subject along these lines, backed up by an intelligent interpretation of practical results, that progress in this difficult subject can be made. For these reasons we welcome this first report of the Swiss society, and look forward with interest to the further reports which are to follow.

Pull Down the Blinds.

THE account of the recent Board of Trade inquiry into the proposal of the Llandudno & Colwyn Bay Electric Railway (Ltd.) to introduce double-decked cars, which was given in our last issue, makes interesting reading. It was stated that one of the Council's objections was that if passengers were allowed to sit on the tops of the cars they would be able to look into the lower rooms of the residences along the route, and even into the bedrooms, and that would interfere with the privacy of a good deal of valuable property. We are of the opinion that the time of Board of Trade inspectors either is, or should be, too valuable to admit of such nonsensical objections being raised against reasonable proposals. If the people who live in the valuable property referred to desire to maintain their privacy they may do so by pulling down the blinds. Bournemouth is a typical place for comparison with Colwyn Bay, and it was stated that there was no opposition to double-decked cars at the former place because the cars belong to the local authority. Having granted permission to Bournemouth one would imagine that permission could be granted in all similar cases without the necessity of giving a hearing to those who believe that people ride on the tops of tramcars for the purpose of looking into other folks' bedrooms. Such people should endeavour to remember that this is the twentieth century, and should try, and try hard, not to make themselves ridiculous.

The Kingstown Provisional Order.

LAST week a Local Government Board inquiry was held into the application of the Urban Council for sanction to borrow £6,000 for the preliminary expenses in connection with the acquisition of the Kingstown Provisional Electric Lighting Order. It is difficult to understand how a body of men, who are supposed to be trustees of the ratepayers' money, could be so devoid of business capacity as to spend such a large sum in obtaining a provisional electric lighting order when, under ordinary circumstances, an order can be obtained at a cost of about £75 or £100. What chance of success has an electric supply undertaking in a comparatively small and poor urban area which is saddled with such a debt for preliminary expenses? The interest and sinking fund on this sum would amount to over £400 a year, and as the Council is still involved in litigation over the order it is probable that more money will have to be borrowed before any expenditure will have been incurred on generating plant or mains. We hope, therefore, that if the Board sanctions the application it will do so only on condition that the loan is repaid within a short period, say three or five years. By Sec. 7 of the Electric Lighting Act of 1882 the local authority has power to levy a rate for defraying the preliminary expenses of obtaining electric lighting powers, and we are of opinion that all preliminary expenses, including the cost of securing Parliamentary powers, should be paid for out of the current rate. It cannot be said that these charges are proper items of capital expenditure, and, therefore, they cannot be a legitimate subject for a loan. Of course, it may be said that this course will throw a heavy burden on the present ratepayers, but it is better that they should suffer a little now than that progress should be clogged, and that the electricity undertaking should be burdened with such a load of debt in its incipient stages.

Variable Speed Transmission Gear.

ELSEWHERE we publish an illustrated description of an ingenious transmission gear that is being manufactured by Messrs. Vickers (Ltd.). The gear consists of a variable-stroke oil pump, connected to the source of power, and a constant-stroke oil-motor connected to the load. A wide range of speed in a forward or backward direction can be obtained by altering the stroke of the pump, and means are provided for so doing. In those cases which demand the greatest nicety of control, to which the Ward-Leonard system cannot be applied, it would appear that such gears are eminently suitable for the purpose. In the article the gear is shown applied to the several mechanisms of a 240-ton revolving cantilever crane, but we understand that up to the present time upwards of 1,500 have been supplied for the purpose of turning turrets and training guns. At one time we believe the hydraulic engine was used exclusively for work of this kind. The various attempts to devise an all-electric control were only partially successful, and if the "Williams-Janney" gear gives satisfactory performance it matters little to electrical engineers what is interposed between the motive power and the load, but it is of the utmost importance to them that electricity be used as the motive power.

The I.E.E. and Alien Enemies.

LAST Wednesday a special general meeting of the Institution of Electrical Engineers was held to consider the following resolution, which, for the convenience of our readers, we reproduce once again :—

That the following words be added to Article 41 of the Articles of Association: (*a*) In the event of a state of war arising between Great Britain and any other country or State, any member of any class who at any time during such war shall be a subject of such enemy country or State shall forthwith cease to be a member of the Institution, and in the case of the European war of 1914 all such members shall cease to be members of the Institution on and after the 16th day of March, 1916.

An animated discussion took place, of which we shall give an account in our next issue. Finally the meeting struck on the "uncharted" rock to which we called attention in our issue of February 18th—namely, whether a member who has been naturalised in this country, but not denaturalised in his own country, would be excluded by this resolution from membership in the Institution. The President gave it as his opinion that the resolution would not affect such persons. Several prominent members expressed the opinion that the resolution was intended to include such members, and as there seemed no prospect of coming to a satisfactory conclusion the resolution was not put. The net outcome of the meeting is that a further meeting is to be called to consider what action is desirable and to discuss any resolutions that may be brought forward. In the best interests of the Institution, it is desirable that all members should give this delicate matter their earnest consideration.

Contemplated Taxation of Electricity in Russia.—According to preliminary calculations of the Ministry of Finance, this contemplated tax is expected to yield £2,600,000 per year.

Harmonic Analysis Schedules.—The "Physical Review" recently published an article by Mr. H. O. Taylor, entitled "A Mechanical Process for Constructing Harmonic Analysis Schedules for Waves having Even and Odd Harmonics." The illustration given also explains how a schedule for any particular harmonic can be made.

Electrical Coal Cutting.—Mr. H. T. Mackinnon read at Glasgow Technical College recently a Paper on "Some Coal Cutting Difficulties." The author referred to the causes of sparkings on bar, disc and chain type machines, and considered that plugs for machines and gate-end boxes should be standardised. It was stated that no other class of machinery was more certain to yield a return for its proper maintenance, or exact so severe a penalty for its neglect than the modern coal cutter.

Hebert Prize for Prof. M. I. Pupin.—This prize for physics has been awarded by the French Academy of Sciences to Prof. M. I. Pupin for his important services to telegraphy and telephony and for his method of harmonic analysis. The "Electrical World" states that Prof. Pupin has handed over the prize to a fund for women and children who have been made widows and orphans by the present European war. It is stated that of the 37 awards made 11 were to men who had fallen in battle.

Bakelite.—"Metallurgical and Chemical Engineering" refers to Dr. Baekeland's work in solving problems involved in the reactions of formaldehyde upon phenols, of which Bakelite is a condensation product. Instead of phenol, its homologues, cresols or other phenolic bodies can be used, and instead of formaldehyde other substances having the same functions may be utilised, such as methylal. It was also found by him that the mechanical properties of those condenstaion products were enormously improved by the introduction of fibrous substances.

70,000 kw. Turbo Unit.—It is announced that the Interborough Rapid Transit Co. of New York has ordered from the Westinghouse Co. a 70,000 kw. turbo unit. The unit will be in three sections, one high pressure and two low pressure, and on light load it will be capable of operation at high economy with the high-pressure and one low-pressure cylinder. The three electric generators of the unit will be of equal size, and at about 60,000 kw. will divide the load equally. The steam pressure to be used will be about 225 lb., and the superheat approximately 150°F.

Compound Antennæ Oscillation Frequency.—Mr. A. F Puchstein, writing in the "Electrical World," refers to a previous article by Mr. L. Cohen which dealt with "Electrical Constants of Compound Antennæ," and considers the case of two antennæ coupled together. Several cases are worked out, and those who wish to go deeper into the subject have methods of attacking the problem indicated to them.

Low-Pressure Turbine.—The "Iron Age" gives particulars of a 300 kw. Westinghouse low-pressure turbo-generator which is operating on exhaust steam from the steam hammers in a forge shop. There are 17 hammers, ranging from 800 lb. to 4,000 lb., the exhaust steam is collected in a 10-in. overhead main. The steam is used at a pressure of 2 lb. at the turbine, and connection with live steam is made to compensate for any inadequacy of exhaust steam. A saving amounting to £200 a month by this means is calculated.

Temperature and Young's Modulus.—Mr. H. L. Dodge, writing in the "Physical Review" on "The Change in the Elasticity of Aluminium Wire with Current and External Heating," points out that exactly the same kind of results were obtained with aluminium as for copper and mild steel. For these metals the following generalisations apply: They can be brought into a cyclic state in which Young's modulus is a function of the temperature, and Young's modulus decreases with temperature, the rate of change increasing with the temperature.

Large Electric Hoist.—Particulars were give in a recent issue of "Coal Age" of a large hoist installed by the Middle Fork Mining Co., of Benton, Ill. It is driven by a direct-current motor of 1,150 H.P. and running at 99 revs. per min. Fluctuations in current are prevented by the use of an Ilgner flywheel motor-generator set. The hoist is designed to raise 2·5 cars per minute from a depth of 670 ft. The load on the rope at starting is about 10 tons. Post brakes are used, operated by air, and acceleration and retardation are automatic. The hoist was built by the Vulcan Iron Works, and is fitted with speed limit and over-winding prevention devices.

University of Hong Kong.—The calendar for 1915-16 contains interesting information regarding the working of this University. The standard of attainment aimed at is that of the University of London. The students are allowed to pay their fees in three instalments per term. Books are also provided at a low cost at the bookstall. The students live in hostels under European supervision, and at the same time keep in touch with Chinese public opinion. All students must be over 16 years of age. We are pleased to see there is also an athletic association, the University colour being olive green with gold buttons on the blazers.

Repairing Electric Locomotive Resistance Grids.—The "Electric Railway Journal" has an article by Mr. T. B. Ray on this question. To repair burned grids after removal from the locomotive they are taken to the welding room and separated into classes according to the damage they have sustained. After the repair and cleaning of contact surfaces the grids are assembled on temporary steel rods for electric welding. The three obstacles to successful work are sand holes, blow holes, and slagging. Generally a good grade of cast-iron can be welded if the section is not too large, and the weld is soft and easily machined. Apart from welding cast-iron the author has successfully welded copper lugs to the cast-iron grids by controlling the arc length. In this case copper oxide and slagging of the copper are the chief difficulties encountered. Arc welding was used in each case.

Electrical Haulage and Winding in Mines.—Mr. R. A. Sheldon read an interesting Paper recently before the Association of Mining Electrical Engineers at Nottingham on "The Use of Electricity in the Conveyance of Coal from the Working Face to the Pithead."

Referring to accidents from shock, out of 86 fatal cases 40 were due to contacts with outer coverings inefficiently earthed, 12 to contact with uninsulated live parts and 32 to defective cables. The remaining two cases were due to misadventure. All apparatus should be constructed so that no live part was accessible. Regarding gas explosions, wire gauze over openings was very little use, as "after burning" generally set in which raised the gauze to a dangerous temperature. The most usual method was what was known as "flange" protection—broad flanges were used with about 1/1,000th in. clearance for escape of gas. These flanges should be wide enough to cool the gases below 650° C., even when after burning recurred. The apparatus should have great mechanical strength and be able to stand 100 lb. per square inch internal pressure. In other cases relief valves were fitted. Referring to haulage gear, it was mentioned that there was a development in small portable haulage systems for drawing coal out of the gates and so doing away with ponies. Electric winding had recently made great strides and gave every possible safeguard to life. Very exact control was also possible both for winding speeds and the low speeds required for shaft examination. In the discussion the Chairman referred to fatal accidents and considered it would be interesting to have data as to accidents in cases where the neutral point of three-phase motors was earthed. He thought the cost of electric haulage gears was less than for steam gear. Other speakers considered that electric winding would be extremely useful for emergency shafts.

Ideal Resonator.—Lord Rayleigh, O.M., F.R.S., at a recent meeting of the Royal Society, read a Paper on "The Theory of the Helmholtz Resonator." The ideal form is a cavernous space enclosed in a thin immovable wall, but communicating with the external atmosphere by means of a small perforation. When the escape of energy to a distance is neglected, the wave-length λ of plane waves having the period of the resonator is given by

$$\lambda = \pi v \, 2S/R \left(1 - \frac{9}{10}\frac{R}{2\pi C}\right),$$

where C is the radius, S the volume of the sphere, R the radius of the circular aperture.

Chattering Wheel Slip.—Mr. G. M. Eaton, in a Paper read before the American Institution of Electrical Engineers, points out that chattering slip is characteristic of all types of electric motive power when driving locomotives. With steam the acceleration when slipping of the driving wheels occurs is fairly uniform and rapid, whereas with electric power this is liable to be erratic, owing to its dependence on rotating masses and coefficient of friction between driving wheel and rail. The increasing torque in starting stores energy in the frame of the locomotive, and this is given up when slipping occurs, the coefficient of friction also dropping from its statical value to that for relative motion. By means of a rough oscillograph the chattering of a Norfolk & Western locomotive was measured, and on new tie rods being used to strengthen the frame the trouble disappeared.

Economy in Electric Railway Working.—Mr. C. C. Chappelle recently contributed to the "Electric Railway Journal" an interesting article on the "Fundamental Principles of Car Operation Efficiency." Some of the results of his analysis of efficiency of car operation are as follows:—

(1) The power input necessary to operate a given car and equipment at a given average schedule speed and with a given number of stops per mile is solely dependent upon the efficient utilisation of the time-element factors; acceleration braking and duration of stop. (2) The effect on the power input of variation in these time-element factors is in proportion to the coasting time, and the increase in per cent. coasting is in proportion to decrease in per cent. energy consumption. (3) Since efficient utilisation of power for given conditions is solely determined by these time-element factors, the correct method of checking the motorman's efficiency in the use of power is by a system giving him a positive, authentic record of his efficient utilisation of these factors, which, as explained above, is measured by the coasting time and the per cent. coasting. (4) Equipped with such a correct method of checking efficiency, the motorman has only to handle his equipment and to take advantage of physical conditions encountered in operation so as to obtain the greatest possible coasting time, with maintenance of schedule time, on each trip of his run. The coasting time can be increased only by the motorman's efficient utilisation of the time-element factors of acceleration, braking and duration of stop, these being the only factors under his control that can affect power input. (5) The economical schedule speed for given conditions is also dependent upon the efficient utilisation of the time-element factors, and to be economical the schedule must be such as to permit of coasting. (6) The average number of stops per mile, considered in connection with the efficient utilisation of the time-element factors, determines the limitations of possible schedule speeds with a given equipment. It is, therefore, necessary in determining the economical schedule speed to secure definite data in practical operation of the average number of stops per mile and the average duration thereof. (7) The per cent. coasting is the measure of the correctness of the relation of the controlling time-element factors for any given number of stops per mile and schedule speed, and of the motorman's efficiency without regard to the variation in number of stops per mile and schedule speed encountered in practice.

OBITUARY.

E. A. Stevenson.—The death occurred on February 13th last at Lee, London, S.E., of Mr. E. A. Stevenson. In 1860 Mr. Stevenson joined the head office staff of the Submarine Telegraph Co., and in the following year he joined Messrs. Glass, Elliott & Co., which company in 1864 merged into the Telegraph Construction & Maintenance Co. From Messrs. Glass, Elliott & Co. he went on to the telegraph staff at Alexandria, where he remained for four years, spending a further three years at Malta. He then went to the T.C. & M. Co.'s works at Wharf-road as instructor, and from 1870 until 1900, within a year or so of his retirement, he was engaged on many important cable-laying expeditions in various parts of the world, in many cases being in charge of the electrical staff on board ship.

Herbert Kingsford.—In reference to the notice of the death of Mr. Herbert Kingsford, which appeared in our issue of the 18th ult. (p. 693), we are informed that death was caused by pneumonia, and occurred on Feb. 5, at 33, Queen's Gate-terrace, London, S.W.

Mr Kingsford was born at Dover in 1857, and entered the service of the Telegraph Construction & Maintenance Co. in 1873. In 1879 he joined the Anglo-American Telegraph Co.'s cable ship "Minia," and in 1884 the Commercial Cable Co.'s cable ship "Mackay-Bennett." On May 20, 1886, he was appointed by President Seryniset as engineer to the Mexican & Central & South American Telegraph Companies, in whose interests he worked for the last 30 years of his life.

Killed in Action.—Second Lieut. Edward A. F. Goodfellow, 3rd Connaught Rangers, was killed in France on Feb. 20th. The deceased officer was educated at Eton and the Central Technical College, South Kensington, where he was Siemens medallist and David Salomons scholar and obtained diplomas in electrical engineering and in civil and mechanical engineering. He graduated B.Sc.Eng. (hons.) at London University, and became assistant engineer of the Burma Railways. He was granted a commission as temporary second lieutenant on May 7th, and was appointed to the 3rd Connaught Rangers. He proceeded to France on Oct. 13th last.

PERSONAL.

Royal Engineers (T.F.).—The following promotions and changes are announced :—

London Electrical Engineers : Sergt. R. C. Staunton, Lance-Corp. H. A. Voss and Sapper A. T. Sturgess to be second lieutenants (on probation).

Tyne Electrical Engineers : Second-Lieut. (temp. lieut.) E. H. Gibbon is seconded for duty with R.F.C.

APPOINTMENTS VACANT AND FILLED.

An installation inspector is wanted for a Corporation electricity supply in the Midlands. *See advertisement.*

A switchboard attendant is wanted for d.c. and rotary works in the Midlands. *See advertisement.*

A shift engineer is wanted for a supply authority in the Manchester district, with a.c and d.c. electrical and mechanical experience. *See advertisement.*

Mr. J. S. Hollinrake has been appointed engineer and manager of the Weaverham Electric Supply Co.

Mr. T. E. Boothby, of Wembley, has been appointed charge engineer at Southwark (London) Municipal electricity works, and Mr. W. E. Buckingham has been appointed junior engineer.

INSTITUTIONS AND SOCIETIES.

Institution of Civil Engineers.—At a meeting to be held on March 7, at 5:30 p.m., Mr. Harold Cox will deliver an address on "Industrial Development," with special reference to the economic issues which after the war must influence profoundly the future of engineering, as well as the industrial and commercial enterprises which are vital to its progress both in this country and abroad. It is understood that Mr. Cox proposes to treat the subject broadly, referring, among other things, to considerations bearing on the relations between employers and employed, and to other factors in efficiency of production and the prosperity of commercial undertakings.

Royal Society.—Amongst other Papers read at the meeting on the 10th ult. was the following—viz., "The Consumption of Carbon in the Electric Arc. III.—The Anode Loss," by Messrs. W. G. Duffield and M. D. Waller. It has already been shown that the rate of consumption of carbon from the cathode of a very short arc is such that the departure of one atom is accompanied by the transfer between the poles of four electronic charges. The above experiment gave a clue to the rôle played by the cathode. The following experiments were undertaken to determine the part played by the anode. An experiment described in the earlier Paper was repeated in the following manner : A carbon rod 18 mm. diameter was rotated in a lathe and an arc started between its curved surface and a pointed carbon rod which formed the cathode, and which could be moved rapidly to and fro along the anode. In this way the anode remained fairly cool and the crater did not have time to develop. Anode and cathode were weighed before and after each experiment. Whereas in the stationary form anode loss was invariably greater than cathode loss, with rotating anodes the total losses from the anode for currents of 4, 6, 8 and 10 amperes after running the arc for five minutes were only 3, 2, 8 and 13 milligrammes respectively, the ratios of the consumption of carbon per coulomb for fixed and rotating anodes for these current densities being 17·6 to 0·25, 13·5 to 0·13, 12·8 to 0·33 and 10.8 to 0.36 respectively. It appears that the anode loss of carbon is unimportant in the mechanism of the arc, and that the function of the anode is to receive the carriers of the current produced by the essential process occurring at the surface of the cathode. The formation of a crater in the normal type is not vital to the arc, though it is its most prominent feature. The reduction in P.D. in the arc with rotating anode is probably due to absence of electronic emission on a large scale from its cooler anodes.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 3rd (to-day).

Royal Institution.

5:30 p.m. Meeting at Albemarle-street, W. Discourse by Prof. S. P. Thompson, D.Sc., F.R.S., on "Corona and Other Forms of Electrical Discharge."

TUESDAY, March 7th.

Institution of Civil Engineers.

5:30 p.m. Meeting at the Institution, Great George-street, S.W. Address on "Industrial Development," by Mr. Harold Cox.

Röntgen Society.

8:15 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Discussion on "Injurious Effects produced by X-rays."

WEDNESDAY, March 8th.

Royal Society of Arts.

4:30 p.m. Meeting at John-street, Adelphi, W.C. Paper by Mr. C. R. Darling on "Optical Appliances in Warfare."

Association of Engineers in Charge.

8 p.m. Meeting at St. Bride Institute, Bride-lane, E.C. Paper by Mr. H. W. Petty on "Lubrication in Practice."

THURSDAY, March 9th.

Yorkshire Section, Institution of Electrical Engineers.

7 p.m. Meeting at the Philosophical Hall, Leeds. Paper by Mr. H. Joseph on "Hire and Maintenance of Continuous-Current Motors."

Institution of Electrical Engineers.

8 p.m. Meeting at Victoria Embankment, W.C. Paper by Mr. E. V. Pannell on "Continuous-current Railway Motors."

FRIDAY, March 10th.

Royal Institution.

5:30 p.m. At Albemarle-street. Discourse by Sir Napier Shaw, M.A., LL.D., F.R.S., on "Illusions of the Upper Air."

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Commanding Officer : Lieut.-Col. C. B. Clay, V.D.

Orders for week commencing March 6, 1916.

Drills, 6:25 to 7:25, 7:25 to 8:25 p.m.

Monday, March 6th. Sections 1 and 2, Technical ; Sections 3 and 4, Lashings and trestle bridging. Signalling Class and Recruits.

Tuesday, March 7th. School of Arms, 6 to 7 p.m.

Thursday, March 9th. Shooting for Sections 1 and 2 and Signalling Class.

Friday, March 10th. Sections 3 and 4, Technical ; Sections 1 and 2, Lashings and trestle bridging. Signaling Class and Recruits.

Saturday, March 11th. Uniform Parade, 2-45 p.m.

At the Parade on Saturday, March 11th, members will parade with the 4th East Central London Regt., and will proceed by train to Woodcote, where they will be given an opportunity of inspecting the trench digging now being carried on there. Members wishing to stay in camp on March 11th, at Woldingham, must give in their names at once.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 46, Regent-street, S.W. Sections for Shooting Parade at Mendipe Ranges. Unless otherwise ordered, all Parades at Chester House. Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate Hill, as soon as possible. Payment for uniforms to be made to the Adjutant.

THE WAVE-SHAPES OBTAINING WITH ALTERNATING-CURRENT GENERATORS WORKING UNDER STEADY SHORT-CIRCUIT CONDITIONS.*

BY A. E. CLAYTON.

(*Concluded from page 731.*)

Summary.—The Paper deals in detail with the action of single and polyphase alternators under short-circuit conditions. Both salient-pole and cylindrical field alternators are considered.

Experimental Results—Single-phase Machines.

The oscillograms here given were taken on ordinary polyphase alternators working single-phase. For the salient-pole machines no special damping coils were provided, and solid poles with laminated shoes were used. For the machines with cylindrical-field systems a squirrel-cage damping device was formed of the metallic slot wedges and the end covers of the rotor winding. The machines in every case date back at least six years.

The test results include machines of both types of field construction with one-third and two-thirds stator windings, obtained from ordinary three-phase star-connected alternators, and a salient-pole

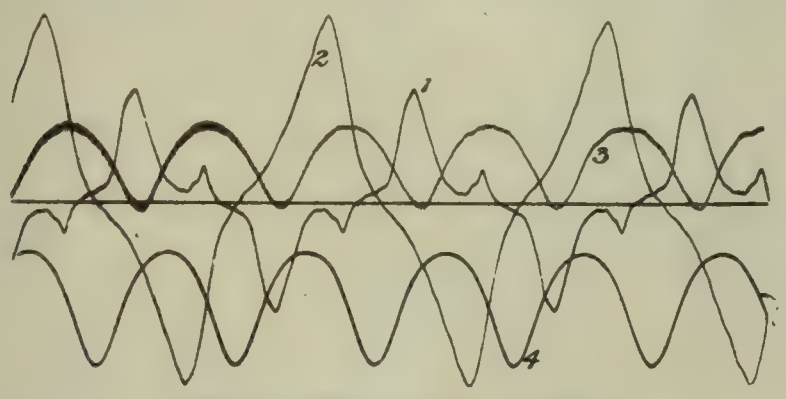


Fig. 8A.—Machine A. $s=2Q/3$.

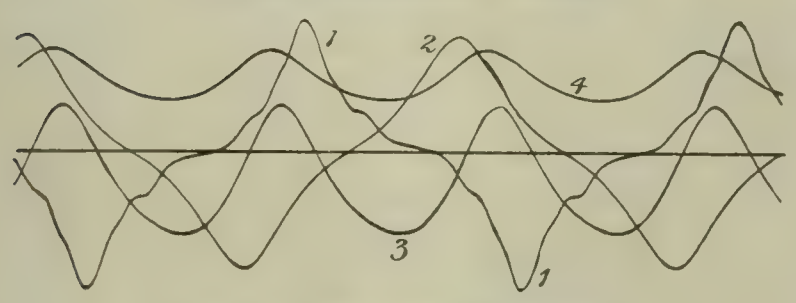


Fig. 8B.—Machine D. $s=Q/2$.

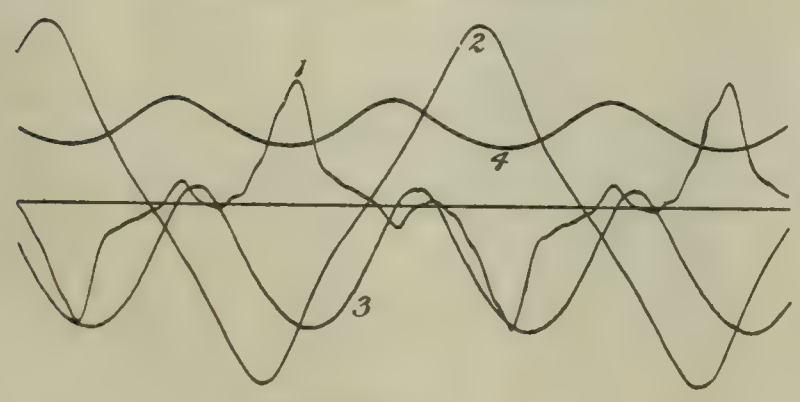


Fig. 8C.—Machine D. $s=Q$.

Figs. 8A–8C.—Short-circuit Waves on Single-phase Salient-pole Alternators. (Machines are normal polyphase machines and have no damping windings.)

machine with a one-half and a full-pitch winding, obtained from a two-phase alternator.

The records taken on each machine corresponded to those performed on the three-phase machines, and in every case the excitation was adjusted so that the active conductors of the stator winding carried their normal full-load current.

Remarks on the Experimental Results.

(*a*) Salient-pole Machines. (Fig. 8.)

1. *E.M.F. Induced in the Search Coil.*—For reasons already given no note was made of the position of the search wire, so that the wave-shapes of the E.M.F.s induced in the various cases show considerable variation. It will be noted, however, that the waves correspond very closely to the forms predicted.

* Abstracted from the "Journal" of the Institution of Electrical Engineers, Vol. LIV., No. 252.

2. *Armature Current.*—In every case the current curve contains a fairly prominent third harmonic, varying in amplitude from 16 to 35 per cent. of that of the fundamental. This represents a third harmonic in the total resulting E.M.F. wave of from about 50 to 100 per cent. of the amplitude of the fundamental harmonic in the E.M.F.

It will further be noted that wherever the pulsations in the magnetising current are large the third harmonic in the armature current is large and *vice versa*. It is a matter of interest that the cases given in which the third harmonic in the current wave is most pronounced are both for machines having a two-thirds stator winding. Moreover, in these machines the fifth harmonic is of appreciable magnitude in the current wave, being set up by a current of quadruple frequency in the exciting winding. Still higher harmonics due to further such actions are distinctly observable.

The harmonic analysis of the various current waves is given below.

1. *Machine A :*

$$s=2Q/3.$$

$$i=100\sin\theta-34{\cdot}5\sin 3(\theta-13^\circ)-9\sin 5(\theta-17^\circ)+18{\cdot}5\sin 7(\theta+12^\circ).$$

2. *Machine D :*

(*a*) $s=Q/2$.

$$i=100\sin\theta-22{\cdot}5\sin 3\theta.$$

(*b*) $s=Q$.

$$i=100\sin\theta-16\sin 3\theta.$$

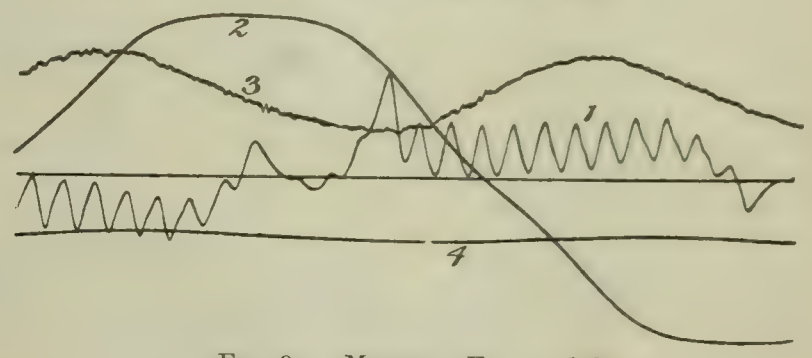


Fig. 9A.—Machine E. $s=Q/3$.

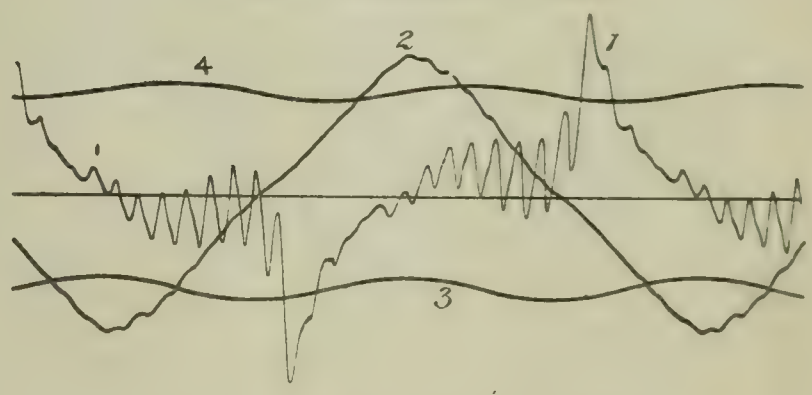


Fig. 9B.—Machine F. $s=2Q/3$.

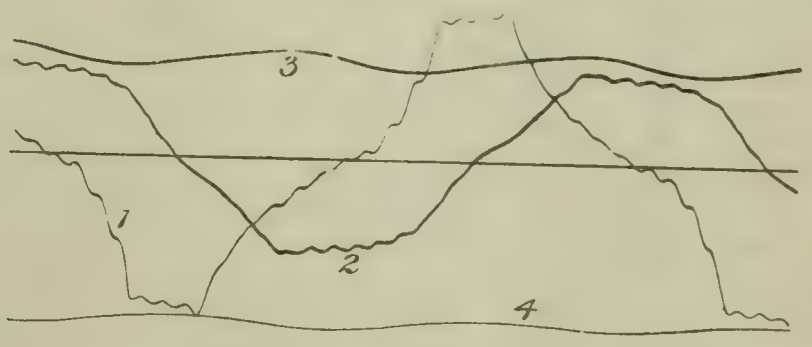


Fig. 9C.—Machine F. $s=Q/3$.

Figs. 9A–9C.—Short-circuit Waves on Single-phase Alternators with Cylindrical Rotors. (Machines are normal polyphase alternators, but have dampers.)

3. *P.D. Between the Excitation Slip-rings.*—The alternating E.M.F of double frequency due to the pulsating armature reaction is in every case very marked.

This double frequency E.M.F. is in no case a pure sine curve, but contains a more or less marked second harmonic—that is, of four times the main frequency—due to the reaction of the third harmonic in the armature-current wave. The larger the value of this third harmonic in the current the greater is that of the E.M.F. of quadruple frequency induced in the exciting winding. In addition there is distinct evidence in the case of machine A of an E.M.F. of six times the main frequency, set up by the fifth harmonic in the armature current.

4. *Exciting Current.*—Owing to the inductance of field windings the pulsations in the exciting current are considerably less than those in the exciting pressure. Not only does the inductance reduce the magnitude of the fluctuations in the exciting current, but it also

alters their wave-shape. This is due to the reactance of the winding increasing directly with the frequency, so that the higher harmonics are proportionally reduced. As a result the wave-shape of the ripples in the exciting current does not differ largely from the sinusoidal. In most cases, however, the presence of a ripple of four times the main frequency is distinctly discernible. In addition, the reactance causes a shifting of the phases of the various harmonics in the exciting current relative to those in the exciting pressure, and the flat-topped ripple in the exciting pressure gives rise to the pointed-topped ripple in the exciting current.

(b) Cylindrical Rotors. (Fig. 9.)

1. *E.M.F. Induced in the Search Coil.*—Again, owing to the varying positions of the search coil, the results for the cases given show considerable variation. The presence of serrated ripples due to the spacing of the exciting winding is again marked, as in the case of the three-phase machines.

2. *Armature Current.*—The deviation from a pure sine wave is very small, as shown by the analysis. Owing to the effective damping coils the third harmonic is practically non-existent except in one case, the chief of the higher harmonics being the fifth, and that is relatively very small and of no practical importance.

The analyses are :—

1. *Machine E :*

$$s = Q/3.$$
$$i_1 = 100 \sin \theta - 3{\cdot}5 \sin 5\theta.$$

2. *Machine F :*

(*a*) $s = Q/3.$
$$i_1 = 100 \sin \theta - 6 \sin 5\theta.$$
(*b*) $s = 2Q/3.$
$$i_1 = 100 \sin \theta - 9 \sin 3\theta - 4 \sin 5\theta - 4{\cdot}5 \sin 7\theta.$$

It will be noted that the fluctuations in the exciting current are only marked in the case of the machine for which the third harmonic apparent in the armature current.

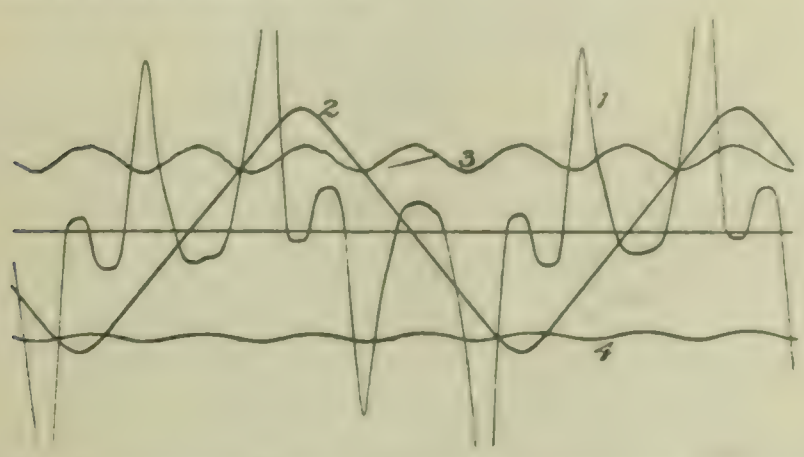


Fig. 10. Short-circuit Test on Two-phase Alternator. Machine D

The only machine tested was a salient-pole alternator.

3. *and* 4. *Exciting Pressure and Current.* For machine E, which is of early date, a considerable E.M.F. of double frequency is apparent in the exciting circuit. The reactance of the exciting circuit, however, was relatively so great that the fluctuations in the exciting current are hardly apparent. With the other cases the damping coils are very effective, and the fluctuations in the exciting pressure are very small; the variations in the exciting current are now trivial, although the reactance of the rotor circuit of the machines is not so large in proportion as that of machine E.

The tests on these machines emphasises in a remarkable manner the very great benefits obtained by the use of squirrel-cage amortisseur coils.

Two-phase Machines.

With two-phase alternators the rotating armature magnetomotive force is subject to considerable variations. The limiting values occur when the current in one phase is zero, and when the currents in the two phases are equal respectively. The frequency of the variations is thus four times the main frequency. As a result of these variations eddy currents will be set up in the pole-shoes, &c., which will tend to limit the changes in the values of the flux.

The pulsations in the value of the flux may also give rise to induced E.M.F. and currents of quadruple frequency in the exciting circuit. In turn these fluctuations in the exciting current may give rise to E.M.F. in the armature conductors of (4 ± 1) times the main frequency.

The pulsations in the armature magnetomotive force are much greater than with three-phase machines, so that the case of the two-phase machine differs from that of the ideal polyphase alternator to a much greater extent than that of the three-phase machine. The secondary effects are in general appreciable, and the variations in the armature magnetomotive force cause E.M.F. ripples of appreciable magnitude to be set up in the induced E.M.F., even when the conductor is in the interpolar region.

Experimental Results.—Two-phase Machines. (Fig. 10.)

1. *E.M.F. Induced in the Search Coil.*—Except for the pronounced effect of the pulsating armature magnetomotive force, the wave-shape of the induced E.M.F. does not differ from that obtained with the three-phase machines. At the same time the fifth and seventh harmonics are far more pronounced than with the three-phase machines, their origin being due to the reasons already given.

The analysis is—

$$e = 100 \sin \theta + 117 \sin 3(\theta - 24{\cdot}5°) - 94 \sin 5(\theta - 25°) - 95 \sin 7(\theta - 9°).$$

2. *Armature Current.*—As expected, the wave contains both third and fifth harmonics, its analysis being

$$i = 100 \sin \theta - 8 \sin 3\theta + 3 \sin 5\theta.$$

3. *Exciting Pressure.*—The pulsations of four times the main frequency are very apparent, their wave-shape being practically sinusoidal, and of an amplitude of 22 per cent. of the mean value of the pressure.

4. *Exciting Current.*—The ripples in the exciting current are quite marked, but the inductance of the winding again reduces their amplitude relatively to that of the fluctuations in the pressure.

A VARIABLE SPEED TRANSMISSION GEAR.

Summary.—In this article a description is given of an ingenious and efficient variable speed gear that is being largely used for the training of turrets and the elevating of guns, and for many other purposes where a wide range of speed control is necessary.

For certain purposes it is necessary not only to have complete control of the speed of a machine, but at the same time, to be in a position to vary the speed in a forward or backward direction by indefinitely small steps. Thus a maximum speed of ± 500 revs. per min. may have to be capable of imperceptible changes down to ± 1 revolution, or less, per minute. As a topical illustration of exact control may be given the turret turning gear of a warship. At a 5-mile range with a relative movement of target and turret of, say, one knot an hour, the rate of turret rotation necessary to follow the

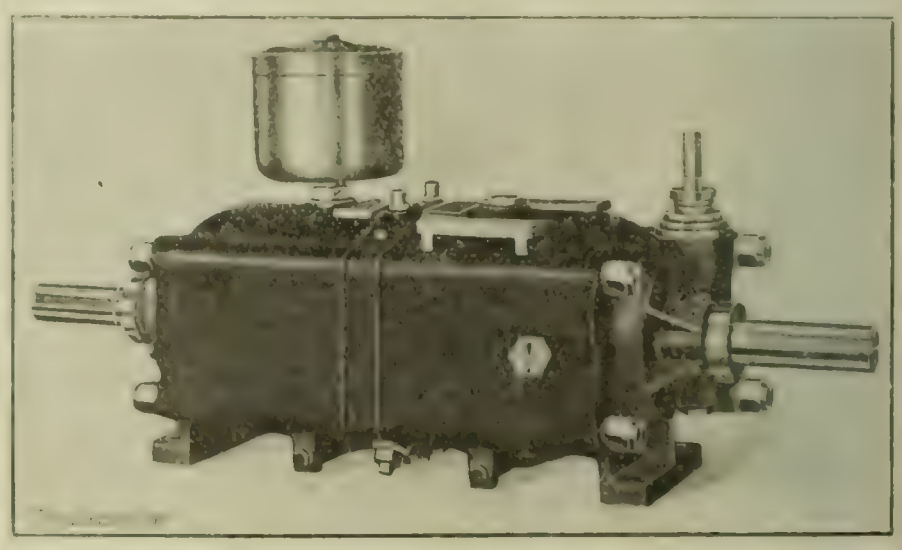


Fig. 1.—Variable-speed Transmission Gear.

target is 0·2 deg. per minute, which corresponds to a speed of one revolution in 30 hours; at a ½ mile range with a relative movement of 30 knots per hour, the rate of turret rotation necessary is 57·3 deg. per minute which corresponds to one revolution in approximately 6·3 minutes. The ratio of these speeds is 286 to 1. Neither example is an unreasonable one, and practice demands an even higher ratio.

By means of Ward-Leonard control it is possible to get practically any desired speed ratio in either direction, and for such purposes as the starting and control of electrically driven winders and rolling mills the Ward-Leonard system is unrivalled. There are, however, many machines to which such control cannot be applied, and it has long been the aim of inventors to devise a satisfactory transmission gear for connecting the motor to its load so as to obtain the desired speed ratio in either direction. We are approaching the time when battleships will be "all electric," and this will involve the solution of a number of difficult control problems. Equally difficult control problems will have to be solved when the electrification of our

factories is tackled in ea nest, as it assuredly must be tackled, and in our time.

It is the purpose of this article to describe the "Williams-Janney" hydraulic variable-speed gear, of which Messrs. Vickers (Ltd.), of Westminster, are sole licensees and manufacturers. The extent to which these gears have been applied for the purposes of training turrets and elevating guns may be gauged by the fact that close upon 1,500 are now in use in, or are being supplied to the United States, French, Russian, Japanese, Italian, Spanish and other navies. In addition they are used for gun pedestal mountings, ammunition hoists, steering gears for warships, submarines and other vessels, for motor boats, boat hoists, mine layers, cranes of all kinds, machine tools, printing and paper machines, swing bridges, presses. winches, coke pushers, motor vehicles, textile machinery, tramcars and capstans.

The Williams-Janney gear is a machine for transmitting rotary power at variable speed and in either direction without steps or abrupt gradations, while the source of power rotates continuously in one direction without any necessary change of speed. It consists of an oil pump operated by the driving power, and an oil motor connected to the load. The pump and motor are designated respectively the A-end and the B-end. By means of a control-shaft connected with the A-end the quantity, and direction of delivery, of the oil may be varied at will to meet the speed requirements and direction of rotation of the B-end. Of the many possible arrangements of the gear we will consider the most compact, or type C, form, an external view of which is given in Fig. 1. In order to simplify the description, the sectional views depicted in Fig. 2 have been prepared which the interested reader will be able to study at his leisure. It is convenient to deal with the non-rotating parts, the rotating parts and operation of the gear in separate sections and in the order named.

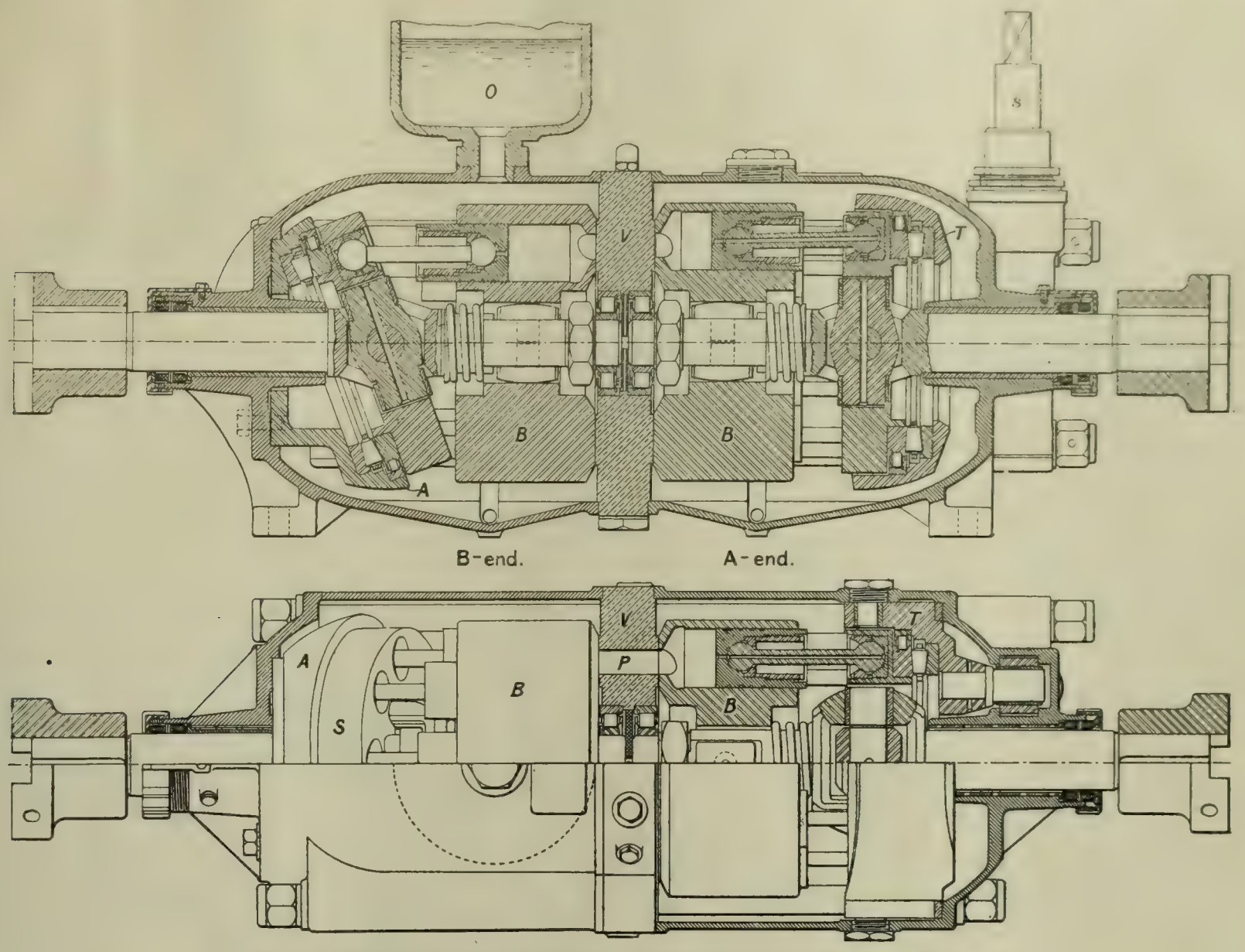


FIG. 2.—ARRANGEMENT DRAWINGS OF VARIABLE-SPEED TRANSMISSION GEAR.

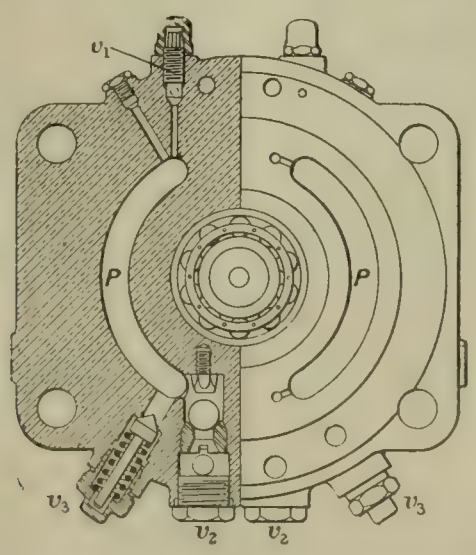


FIG. 3.—SECTION AND FACE OF VALVE-PLATE.

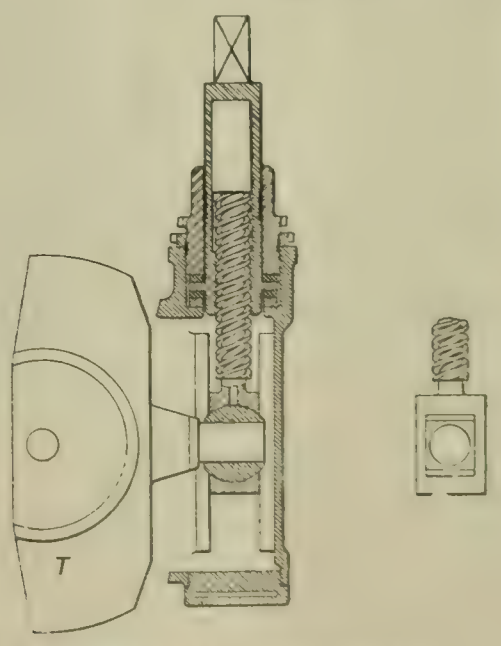


FIG. 4.—DETAILS OF CONTROL-SHAFT.

Non-rotating Parts.—The principal parts which do not rotate with the shafts are the cases C, the valve-plate V, the tilting-box T, the angle-box A and the control-shaft *s*. The two halves of the case with the valve-plate sandwiched between them form an oil reservoir

within which the active parts rotate, and the only active or pressure oil, which is used in transmitting the power, is enclosed within the port passages of the valve-plate and within the cylinders ahead of the pistons.

A view of the valve-plate is given in Fig. 3. On each of its faces is a contact surface against which the face of a cylinder-barrel B slides in its rotation. Passing through the plate are two semi-annular passages, P, called valve-plate ports, for the circulation of the oil. When power is being transmitted, one of these passages is under pressure and the other is in suction. Between the ports are flat faces, called "lands," which momentarily imprison the oil within the cylinder while being carried across from one port to the other by the rotation of the cylinder-barrel. At the centre of the

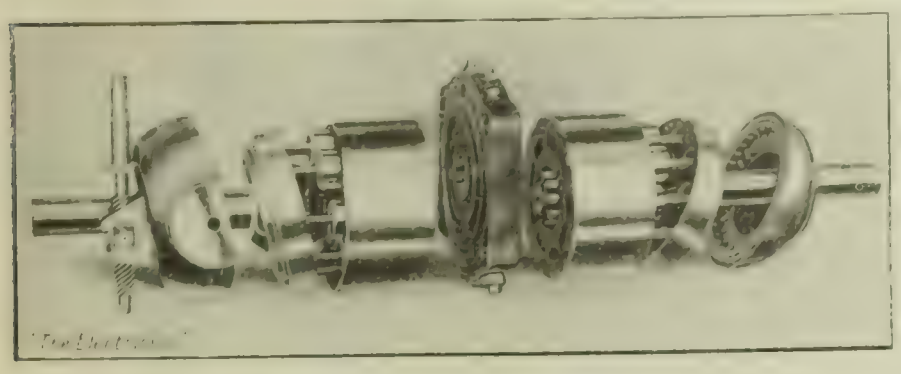


Fig. 5. Internal Parts of Gear.

valve-plate are housed two roller bearings for supporting the inner ends of the shafts. Valves v_1, v_2 and v_3 are connected with each of the passages. Of these, v_1 is a small valve for the escape of air when the gear is being filled with oil; v_2 is a ball-check valve for automatically making up any leakage (averaging about 0·13 per cent.) from the high-pressure side to the low-pressure, and v_3 is a safety-valve to provide relief should the gear be overloaded. There are plugged holes connected with each passage for the attachment of pressure gauges.

The purpose of the tilting-box T in the A-end, Fig. 2, is to carry a thrust roller track against which the socket-ring S may rotate in a plane at any desired angle to its shaft. By changing this angle the speed and rotation of the B-end are controlled. The tilting-box is suspended, and may be oscillated, on two trunnions, formed on the box itself and which bear in bronze bushings set in the sides of the case. It is retained in its bearings by a pair of trunnions screwed through from the outside of the case. In the B-end of the gear the socket-ring runs in what is called an angle-box A, Fig. 2. This consists of a wedge-shaped casting secured to the end of the inside of the case. It carries the roller track at a fixed angle of about 20 deg. from the perpendicular and thus gives to the B-pistons a constant reciprocating motion.

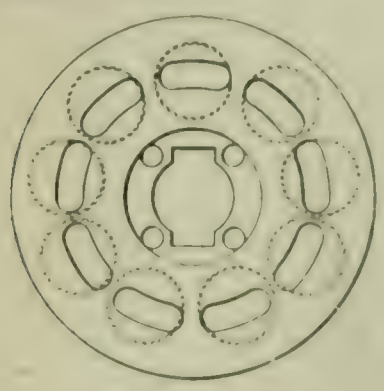


Fig. 6.—Port-end of Cylinder-barrel.

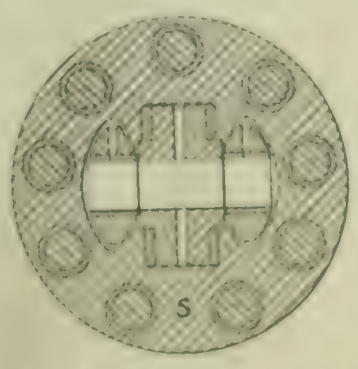


Fig. 7.—Section through Socket-ring.

A detail drawing of the control shaft and of the connection of this shaft with the tilting box is given in Fig. 4. As the load on the trunnions of the box is practically balanced the turning of the control-shaft is easy. In standard machines the pitch of the multiple-threaded shaft is such as to require two turns in either direction from the zero to tilt the box to its maximum angle.

Rotating Parts.—Since the rotating parts, Fig. 5, at both ends are practically alike, we may confine our attention to one end. As will be seen from Fig. 2 these comprise the shaft, the cylinder-barrel with the keys that connect it with the shaft, the socket-ring and universal joint that connects it with the shaft, and the pistons and connecting rods. The cylinder-barrel, Fig. 6, contains nine cylinders. It is loosely attached to the shaft by two keys provided with pivots fitting loosely in a hole through the shaft. The loose fit of the barrel on the shaft together with the pivoted keys gives it a slight freedom of movement so that its face can rest squarely against the face of the valve-plate. Moreover, aided by a spring, it can slide freely endwise along the shaft. When the oil is under pressure the barrel is held against the valve-plate by reason of the fact that the cylinder ports are smaller than the pistons, thus giving an excess internal pressure. The cylinder-barrel and keys do not transmit any of the working torque.

The socket-ring, of which a section is given in Fig. 7, is fitted with nine bronze ring-sockets against which rest the ball-ended connecting rods. These sockets are unequally spaced so as to correct certain irregularities of the universal joint. The back of the ring is provided with a chrome-vanadium steel track which has two roller faces, one for the main thrust bearing and the other for the diagonal thrust bearing. The body of the ring extends inwards in four arms forming slots into which the bronze trunnion-bearing blocks are secured. A universal joint, Fig. 8, connects the shaft and socket-ring. This joint consists of a shaft trunnioned block oscillating with the main shaft pin in the yokes of the main shaft. The trunnions of the trunnioned block operate in the bronze-bearing secured in the socket-ring as mentioned above. The entire working torque of the gear is transmitted through the socket-ring, the universal joint trunnions and the main shaft pin.

Operation.—The A-shaft, which is connected with the source of power, is supposed to run at a constant speed and in one direction. If the tilting-box is set at the neutral position, that is, perpendicular to the shaft, the latter in rotating will carry around with it the socket-ring and attachments, but the pistons will have no tendency to reciprocate in the cylinders. There will, therefore, be no transference of oil through the valve-plate, and the B-end will not be disturbed. If the control-shaft be turned so as to incline the tilting-

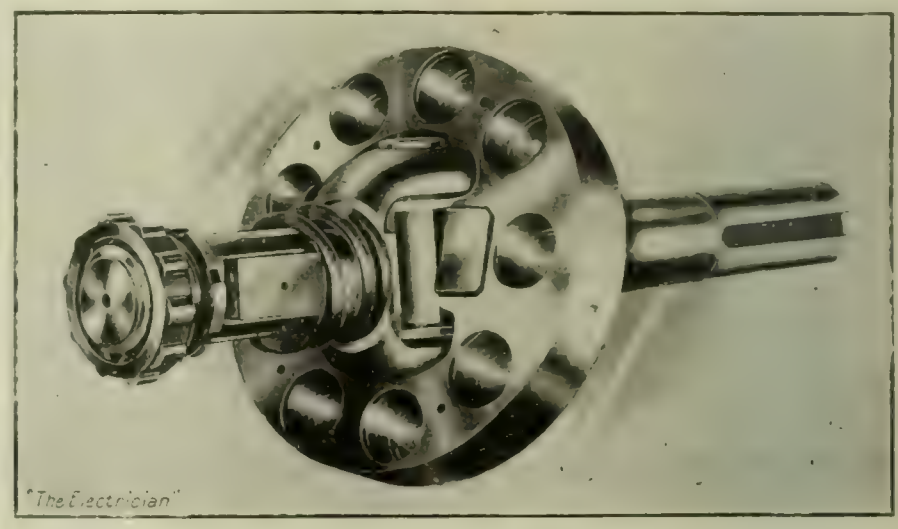


Fig. 8.—Shaft, Socket-ring and Universal Joint.

box the pistons reciprocate. During half the revolution every cylinder is connected with one of the passages in the valve-plate and is then receiving oil, which it carries across the "land" and delivers into the other passage during the second half of the revolution. The amount of oil transferred depends entirely upon the displacement of the pistons and consequently upon the angle through which the tilting-box has been displaced. But there can be no such transference unless there is a supply to draw upon and a space in which to deliver it. This is the function of the B-end of the gear. When oil is being forced into one of the passages (already full) the pistons in the cylinders of the B-barrel in communication with this pasasge move back to give space. This movement of the pistons communicated to the permanently inclined socket-ring causes the latter to rotate on its roller thrust bearing, and to carry the shaft around with it. The shaft in turn rotates the cylinder-barrel keyed to it, and the whole group rotates.

The speed of rotation of the B-shaft depends upon the quantity of oil supplied by the A-end. The B socket-ring being always set at its maximum angle gives the pistons their full stroke. If each cylinder has a capacity of, say, 3 cubic in., the revolving of all nine of the B-cylinders would transfer 27 cubic in. of oil. By slightly turning the control-shaft so as to tilt the A socket-ring, say, enough to reciprocate each piston to the extent of 0·01 cubic in., all nine of the A-cylinders will together transfer 0·09 cubic in. of oil. Hence, by simple division it will be seen that it is necessary for the A-shaft to make 300 revolutions for every revolution of the B-shaft. If the A socket-ring be tilted still further the B-shaft must rotate proportionately faster. The ratio is thus dependent upon the angle through which the control-shaft has been turned. Twisting the control-shaft

in the opposite direction causes the B-shaft to rotate in the opposite sense.

For filling the case any good lubricating oil may be used, but preferably a mineral oil. The oil pressure in the cylinders varies directly as the torque acting on the B-shaft, and the horse-power transmitted varies directly as the product of the oil pressure and the speed of rotation of the B-shaft. The normal working oil pressure varies from 300 to 500 lb. per square inch, but it may rise to 1,000 or even 2,000 lb. per square inch to overcome an unusual resistance. Under the most favourable conditions efficiencies ranging from 85 to 90 per cent. have been obtained, while under average working conditions the efficiencies vary between 80 and 85 per cent.

traversing mechanisms of a 250-ton revolving cantilever crane. The main lifting gear consists of two parts which may be used singly or in concert. Each is driven by a shunt-wound motor rated at 80 B.H.P. at 400 revs. per min., which is coupled to the A-end of the variable-speed gear. The B-end is connected to the barrel through the medium of a worm-gear (11 to 1) and a single reduction of spur gear (6 to 1), the maximum speed of the barrel being 6 revs. per min. To ensure that both are equally loaded and run at the same speed when used in concert there is a synchronising valve connection between the two B-ends. The auxiliary lifting barrel is driven by an 80 B.H.P. motor by means of a type "C" variable-speed gear and double reduction spur gear, the maximum barrel speed being 13 revs. per min.

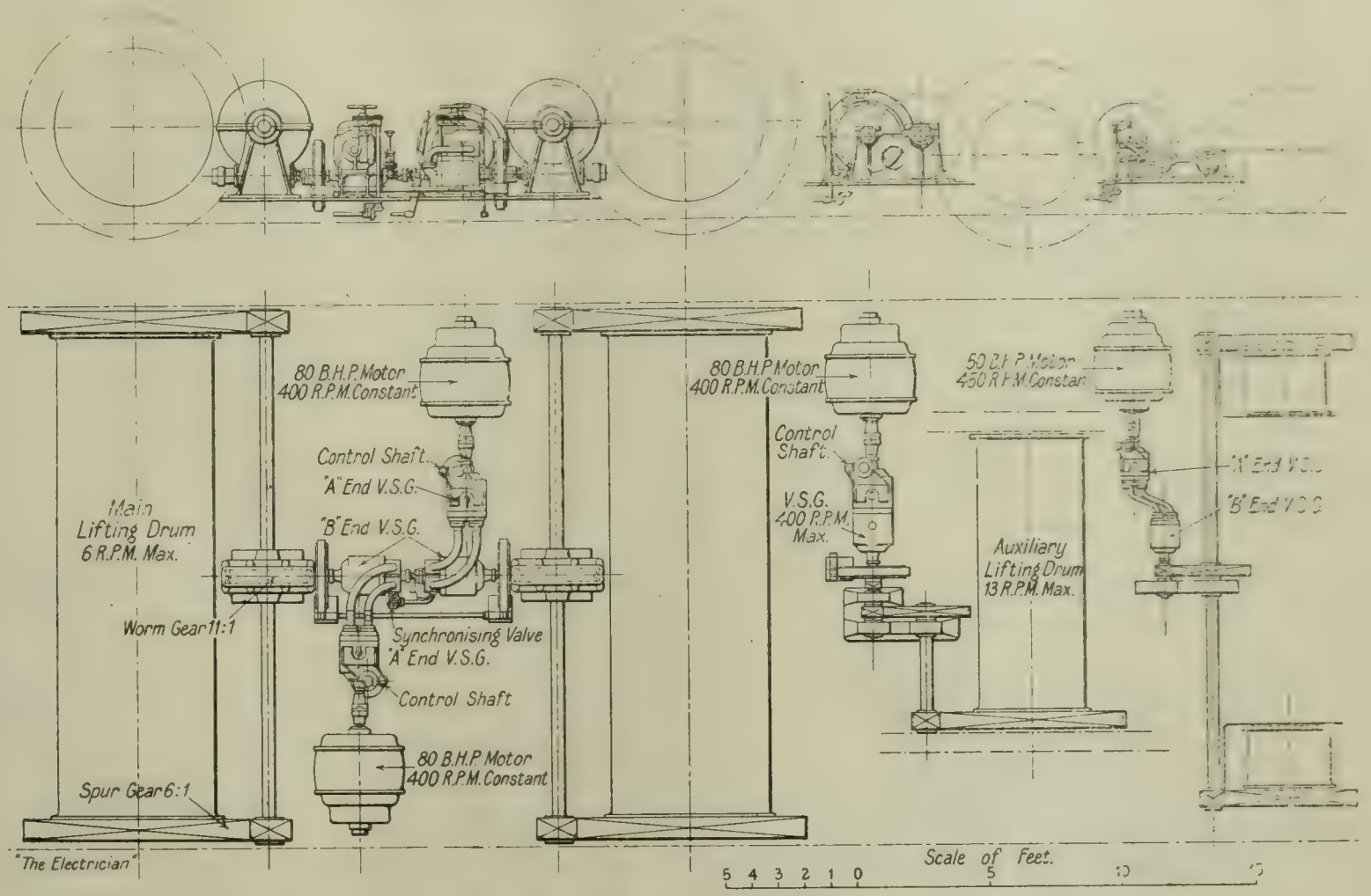


FIG. 9.—VARIABLE-SPEED GEAR APPLIED TO 240-TON REVOLVING CANTILEVER CRANE.

In the foregoing we have described the gear arranged for shafts having a common centre line. If, however, the shafts are to stand in any other position the shape of the valve-plate may be varied to suit. The conditions may be such as to require the locating of the A- and B-ends some distance apart. Each end will then have its own valve-plate, the two main oil passages being connected by two pipes.

Fig. 9 shows the gear applied to the main and auxiliary lifting and For driving the traversing drums a motor rated at 50 B.H.P. at 450 revs. per min. is used, and the drive consists of a variable-speed gear and two reductions of spur gear.

We acknowledge our indebtedness to Messrs. The Variable Speed Gear (Ltd.), of Westminster, for allowing us to see one of these gears in operation, and for courteously placing at our disposal technical data and drawings.

TESTS ON OIL SWITCHES.*

BY BRUNO BAUER.

Summary.—The conditions are investigated theoretically for the maintenance of an electric arc in an oil switch. Interesting conclusions are reached, and these are supported by experimental evidence.

In designing oil-switches care must be taken that they are able to carry the maximum current continuously without overheating, that they are insulated so as to withstand the working pressure with a sufficient margin of safety, and that they are able to dissipate the heat developed during one or several successive switching operations without injurious overheating or explosive action.

The first two of these conditions are easily satisfied by simple calculation, but the third is still shrouded in some obscurity. It is necessary to know what proportion of the energy that is being controlled is liberated at the switch contacts in the form of heat during the switching operation. The discharge at the switch contacts may take the form of a spark or an arc. The spark discharge is initiated if the velocity of the free ions in the applied electric field is sufficiently great to dissociate the neutral ions of the gas by collision with them. The rapid production of free ions by this dissociation ionises the gas and creates the condition favourable to a conduction of current, and this condition will be maintained if a sufficiently high P.D. is applied to the contacts. If an arc be started by these means it will burn steadily as long as the passage of the current is able to maintain a sufficiently high temperature in the negative crater, and as long as a certain minimum voltage is applied across the gas.

According to Mrs. Ayrton, if a current, i, be produced in an arc by an applied voltage, e_i, the power in the arc is given by

$$e_i i = ai - b.$$

It thus appears that a minimum power, b, is necessary to maintain the arc in addition to the condition already referred to, that e_i may not be less than a certain minimum value. This accounts for the fact that on decreasing i, the arc will suddenly collapse when the power becomes less than b, or the voltage becomes less than a, and will not start again until e_i reaches the required minimum value. This is borne out by oscillograms showing the currents in alternating-current arcs, and in continuous-current circuits during the moment of the interruption of the current by a knife-switch. Mrs. Ayrton has expressed the quantities a and b by the equations $a=g+as$ and

* Being the first report of the Commission on High-tension Apparatus and Fire Protection appointed by the Schweizer. Elektrotechn. Verein und Verband Schweizer. Elektrizitätswerke. The report appears in the "Bulletin" (No. 8 of 1915) of the Schweizer. Elektrotechn. Verein known also as the Association Suisse des Electriciens.

$b=\gamma+\delta s$, where s is the length of the arc. Thus to start an arc ($s=o$) a minimum voltage g and a minimum power, γ, are required, and if these minima are not reached the switching is characterised by an opening spark and no arc. The experimental investigation of switching operations in alternating-current circuits gave $g_{min.}=500-800$ volts (eff.) for rounded copper contacts, and $\gamma_{min.}=6{,}000-10{,}000$ watts (eff.) for copper contacts in oil vapour.

We shall consider an oil-switch operating on an alternating-current circuit, and assume that the quantities g, γ, a, δ remain unaltered during the switching. This assumption is not exact, but suffices for a qualitative investigation of the phenomena. At time $t=o$ the switch begins to open at a moment when the current and line voltage are i_o and e_o. After a small time Δt the current will have decreased by Δi_o, and the switch voltage will have reached a value Δe_i. This voltage will depend on the values of i_o and e_o, and on the form of the contacts, and as soon as it attains the value g an arc will form, vapourising the oil in the immediate neighbourhood of the contacts. The quantity of vapour formed will steadily increase on account of the rise of temperature, and the vapour pressure will increase. If it becomes permanently greater than the pressure of the surrounding oil the switching becomes explosive and abnormal. We shall assume that this does not occur, and that the vapour remains in equilibrium until the end of the switching. If the switch opens with a constant speed we may write $s=avt$, and if the load is non-inductive and equal to r ohms. If V_m is the maximum line voltage,

$$V_m \sin \omega(t+\Delta t) = ir + g + avt = (\gamma + \delta vt)\, i. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

from which we obtain

$$i = \frac{V_m \sin \omega(t+\Delta t) - (g + avt)}{2r} \pm \sqrt{\frac{\{V_m \sin \omega(t+\Delta t) - (g + avt)\}^2 - 4r(\gamma + \delta vt)}{4r^2}} \quad . \quad (2)$$

The arc voltage

$$e_i = V - ir. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Curves for V, e_i and ir are plotted in Fig. 1 from the above equations.

An examination of the expression for i shows that the current becomes permanently zero when

$$V_m - (g + avt) = o, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and

$$\{V_m - (g + avt)\}^2 - 4r(\gamma + \delta vt) = o, \quad . \quad . \quad . \quad (5)$$

if $\pm\Delta t$ be so chosen that the time of switching off is a maximum. Equation (4) expresses the condition already referred to of a minimum voltage ($g+avt$), and equation (5) the condition for a minimum power ($\gamma+\delta vt$). As V_m is the maximum value of the line voltage, it will be seen that for equal effective values the time of switching off t_e obtained by solving equation (5) depends on the wave shape of the voltage. As the arc length increases by the opening of the switch,

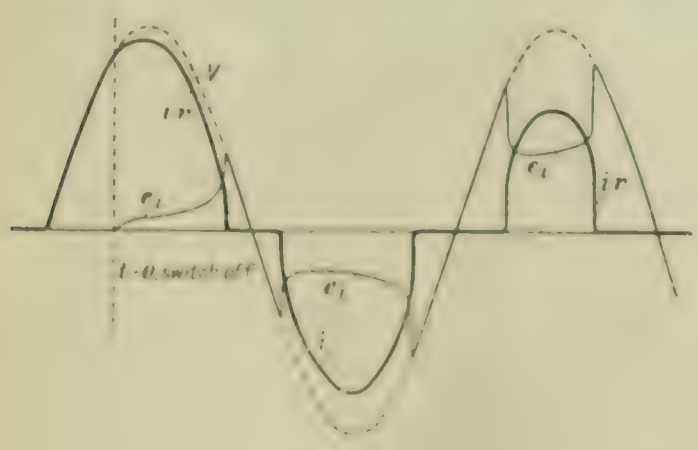


Fig. 1.

the relation (5) will be satisfied before the relation (4) and therefore the arc will break as soon as the heating required to maintain the arc just exceeds the electrical energy in the circuit. As a matter of fact, these two quantities are not quite in phase, owing to the heat capacity of the switch contacts, but it is shown that an allowance for this "arc hysteresis" has no appreciable effect on the length of the time t_e. It is also pointed out that the loss of heat during the period of arc extinction causes a diminution of the value of the maximum length of arc.

If the load is inductive the above calculations require modification. If E_m is the maximum internal voltage of the alternator we now have $E_m \sin \omega t = L\frac{di}{dt} + e_o$. Substituting $e_o = a + bi$, and the values $a=g+\ldots$ and $b=\gamma+\ldots$ in this equation, we obtain an equation that does not permit of easy solution. Curves are, therefore, drawn by analogy with Fig. 1, allowing for the phase lag of the current, and it is argued by their aid that the periods of current interruption are shorter than in the case of non-inductive load, and also that a given kilovolt-ampere load is broken at greater arc-lengths the greater the phase lag of the current. The total length of time $t_{r,L}$ occupied in switching an inductive load of power-factor $\cos\varphi$ is expressed tentatively in terms of t_r, the corresponding time with a non-inductive load, in the form

$$t_{r,L} = t_r(1 - k_1 \tan\varphi - k_2 \tan^2\varphi - \ldots). \quad . \quad . \quad . \quad . \quad . \quad (6)$$

When the load contains resistance and capacity similar considerations lead to the equation

$$t_{r,c} = t_r(1 - k' \tan\varphi - k'' \tan^2\varphi - \ldots), \quad . \quad . \quad . \quad . \quad (7)$$

and to the conclusion that the periods of current interruption are longer than with purely non-inductive load and the maximum arc length is shortened. Fig. 2 shows the switching off of an unloaded

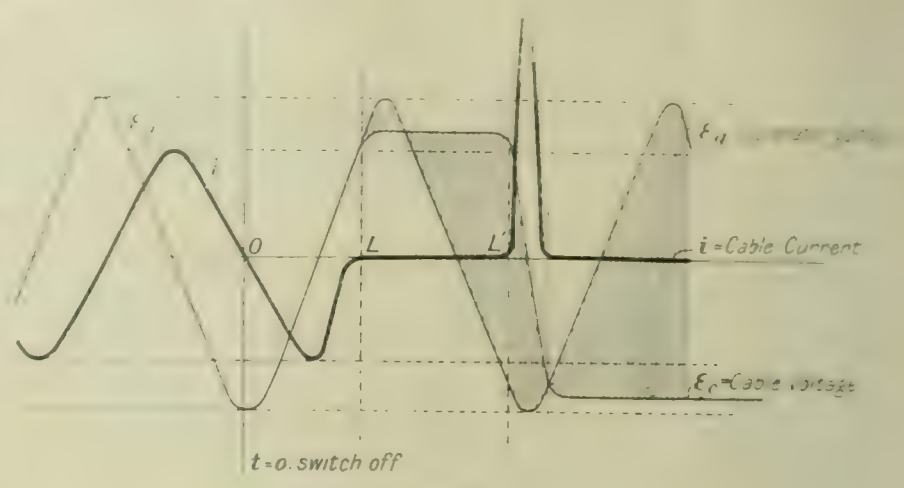


Fig. 2.

cable forming a pure capacity load. OL is the maximum duration of the arc, and L' the time when the difference of the generator and cable voltages is able to restart the arc if the ionisation of the gas suffices.

The heat generated at the contacts of an oil-switch is not equal to the total energy flow that is interrupted. Considering the case of a continuous-current load I_oE, the current may be considered to decrease gradually as the switch voltage e_i rises according to the assumed curves of Fig. 3. The curve for $e_i i$ shows the variation of the power in the arc, and it will be noted that this power has a finite value at the moment of interruption. It should be noted that in the case of an alternating current load the interruption takes place near to the point of zero current, and that on this account the strain on the switch is much less severe than in the case of a continuous-

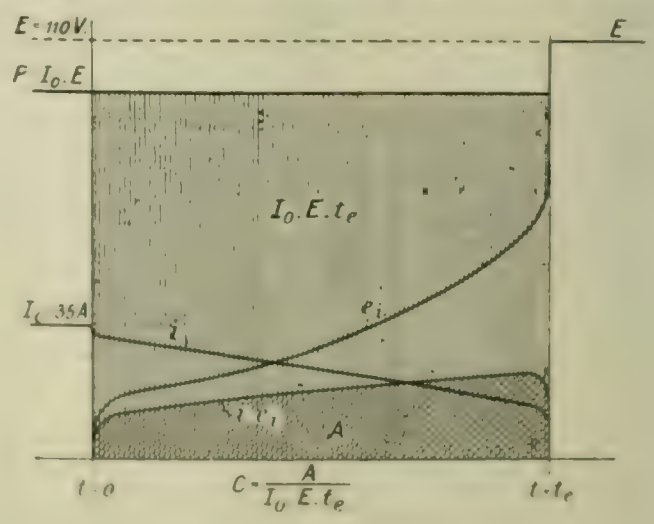


Fig. 3.

current load. The doubly-shaded area A represents the energy transformed into heat at the switch, and this bears to the total energy that would pass in the circuit during a time equal to the switching period a ratio C. We have thus—

$$A = CI_oEt_e. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

C is a constant of the switch, and at a frequency of 50 cycles a second C is found to vary in modern oil-switches between 0·02 and 0·07 and for continuous current to reach a value of 0·18.

Equation (8) may also be applied to the case of an alternating current load. If A is the energy dissipated in half a period $\tau/2$ at the switch contacts, and I and E, the effective current and voltage over half-cycles during the switching period, and n_e the number of half periods before the circuit is opened, we obtain

$$A = \frac{\tau}{2}\int_0^{n_e} IE\,dn.$$

The oscillograms show that I varies for successive half-periods approximately according to the law $I=I_0-an$ and E_i varies according to the law $E_i=\beta n$, where n represents the number of half-periods of the arc current, $a=(I_0-I_{\min.})/n_e$ and $\beta=E_{\max.}/n_e$.

$I_{\min.}$ is the effective value of the last half-period of the current, which is generally only a few per cent. less than I_0 and $E_{i\ \max.}$ is the effective voltage of the switch voltage in the last half-period.

Thus, $$A=\frac{\tau}{2}\int_0^{n_e}(I_0-an)\beta n\,dn=I_0E\frac{\tau}{2}n_e\left(\frac{p}{600}+\frac{pq}{30{,}000}\right) \quad . \quad . \quad (9)$$

where $$I_{\min.}=\frac{q}{100}I_0 \text{ and } E_{i\ \max.}=\frac{p}{100}E. \quad . \quad . \quad . \quad . \quad (10)$$

The value of C in equation (8) is now obtainable from an oscillogram from the relation

$$C=\frac{p}{600}+\frac{pq}{30{,}000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Tests were made in the power station of Beznau with one of the 1,000 kw. 8,000-volt 50-cycle generators installed there operating on a water load. Oscillograms were taken of the current, arc and line voltage and the length of the switch opening, the latter being determined by a mechanical attachment to the switch blade designed to actuate one of the oscillograph movements giving it a deviation proportional to the distance traversed by the switch contact.

The main object of the tests was the determination of the quantities C and t_e, and as C varies for a given form of contact between much narrower limits than t_e, it is the value of t_e that has by far the greater importance in estimating the capacity of a switch.

Table I. shows mean values of C obtained from a number of tests.

Table I.—*Tests with Normal Contacts.*

Voltage with I=0 to 150 amperes.	Great distortion of wave form in inductive circuit, C in per cent.	Non-inductive circuit, C in per cent.	Inductive circuit C in per cent.
3,000	3·2	...	3·1
6,000	4·1	...	3·0
8,000	3·3	1·5	2·7

A series of tests at 8,000 volts and non-inductive loads from 200 kw. to 800 kw. with switch velocity 55 cm./sec. gave as mean values $p=5{\cdot}6$, $g=98$, $C=2{\cdot}8$.

It is, therefore, permissible to regard C as a constant under normal conditions. Even in the extreme case of short-circuits on large units C does not exceed 5 to 7 per cent.

On non-inductive load the time t_e depends on the power P switched off.

We have $P=I_0V=V^2/r$ in kilowatts.

Combining this with equation (5), and calculating with effective values, we obtain—

$$P\{(V-g)-as\}^2=A(V-g)^2(\delta s+\gamma). \quad . \quad . \quad . \quad (12)$$

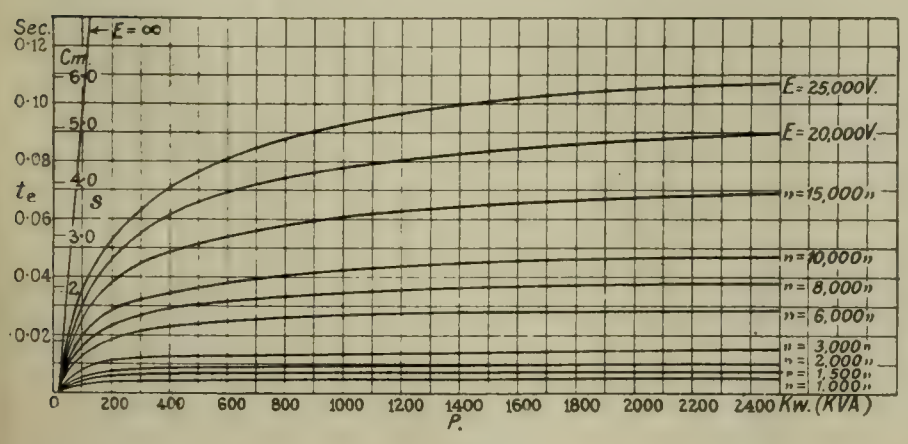


Fig. 4.

$g=0$. $a=3{,}150$ volt/cm. $\delta=5{,}000$ watt/cm. $\gamma=6{,}000$ watt.

For $S=v$ we obtain $P=4\gamma$, *i.e.*, the limiting value of the power that can be switched off without the formation of an arc; this value is independent of the voltage, and is a constant of the switch. For $P=\infty$ we obtain $s=(V-g)/a$, *i.e.*, with increasing power the maximum length of arc tends to a finite limit depending on the voltage and the properties of the switch.

Fig. 4 gives the relations between P and s for a series of voltages, and the relation between t_e and s at a switch velocity of 55 cm./sec.

Fig. 5 is given as a corroboration of the theoretical curve of Fig. 4. With the constants given in the figure the maximum calculated arc length is 2·5 cm., which compares very well with the test values.

The variation of t_e with the voltage V is obtained from the equation (12) giving for t_e as a function of V the family of curves of Fig. 6, from which it will be seen that the time t_e increases with the load switched off and for large loads increases nearly in proportion to the line voltage.

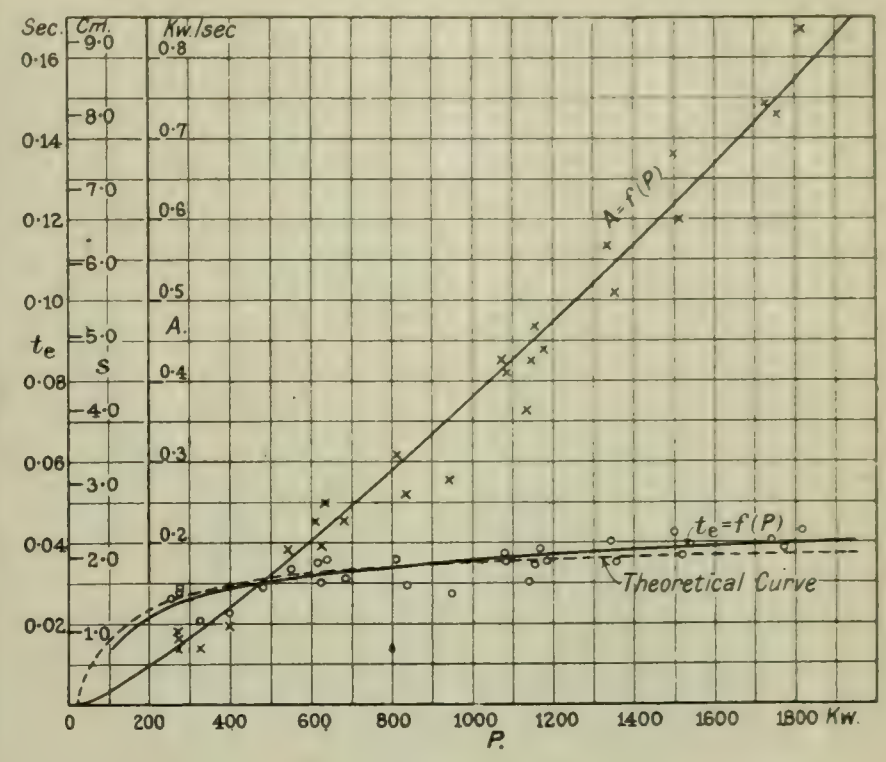


Fig. 5.—Supply from the Stations Beznau and Löntsch Non-sine Wave E.M.F. Non-inductive Load.

V=8,000 volts. $g=0$. $a=3{,}150$ volt/cm. $\delta=5{,}000$ watt./cm. $\gamma=6{,}000$ watts. C=0·011.

To determine the switch energy A we substitute $s=vt_e$ and $A=CI_0Et_e$ in equation (12), and obtain, after several transformations,

$$A^2\frac{v^2a^2}{C^2}-2APV\frac{va}{C}-4AV^2\frac{v\delta}{C}-4V^2P\gamma+V^2P^2=o \quad . \quad . \quad . \quad (13)$$

The curve for the switch-energy A at a constant voltage as a function of the total line energy P is parabolic in shape and similar to the experimental curve $A=F(P)$ of Fig. 5.

Suppose we consider the relation between the voltage and the load P for a given permissible value of the switch-energy A for a given switch, we obtain as the limiting value of the load that can be switched :—

$$P_{\max.}=2\gamma+\sqrt{\gamma^2+\frac{Av\delta}{C}} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Curves for the connection of P and V for given values of A are shown in Fig. 7. A_n represents the normal capacity of a given switch, and A_z the highest permissible value, and with the aid of this

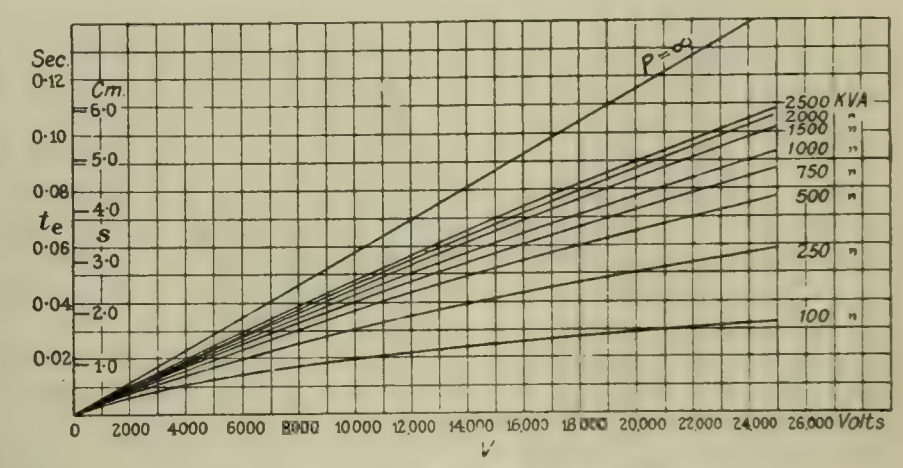


Fig. 6.

$g=0$. $a=3{,}150$ volt/cm. $\delta=5{,}000$ watt/cm. $\gamma=6{,}000$ watts.

figure the range of use of a given switch may be standardised. The effect of variation of voltage and switch energy A on the load that can be switched is visible in Table II., calculated from Fig. 7 :—

Table II.

Switch energy A_n (0·5 kw. sec.)...	100 p.c.	200 p.c.	300 p.c.	400 p.c
Load P in p.c. at 8,000 volts.....	100	186	284	435
Load P in p.c. at 24,000 volts.....	100	176	224	280

The influence of the power factor of the load has still to be examined. From equation (6) we see that the increase of length of the

switching time produced by changing from non-inductive to inductive load of power factor cos φ_n is :—

$$\Delta t_e = t_{r,L} - t_r = t_r \left\{ k_1 \left(\frac{Px}{V^2} \right) + k_2 \left(\frac{Px}{V^2} \right)^2 + \dots \right\} \quad . \quad . \quad . \quad (15)$$

where $$\frac{Px}{V^2} = \tan \varphi - \tan \varphi_n = \frac{Px}{V^2 \cos^2 \varphi_n},$$

and x is the reactance of the alternator, and $P = I_0 V \cos \varphi_n$.

Using these formulæ and calculating with an internal reactance of the generator $x = 53$ ohms we obtain Table III. for switching load off the single generator :—

Table III.—*Load Switched Off from a Single Generator.*
Voltage = 8,000 constant.

Load in kilowatts.		200	400	600	750
$t_{r,L}$ in sec.	Cos φ_n 1	0·0335	0·0435	0·0525	0·0620
	Cos φ_n 0·9	0·0565	0·0780	0·0100	0·0130
	Cos φ_n 0·8	0·0810	0·1120	0·1420	0·1750

These figures show that for a given load at a constant voltage the arc length increases as the power factor decreases, and the conditions become most unfavourable if the generator is overloaded.

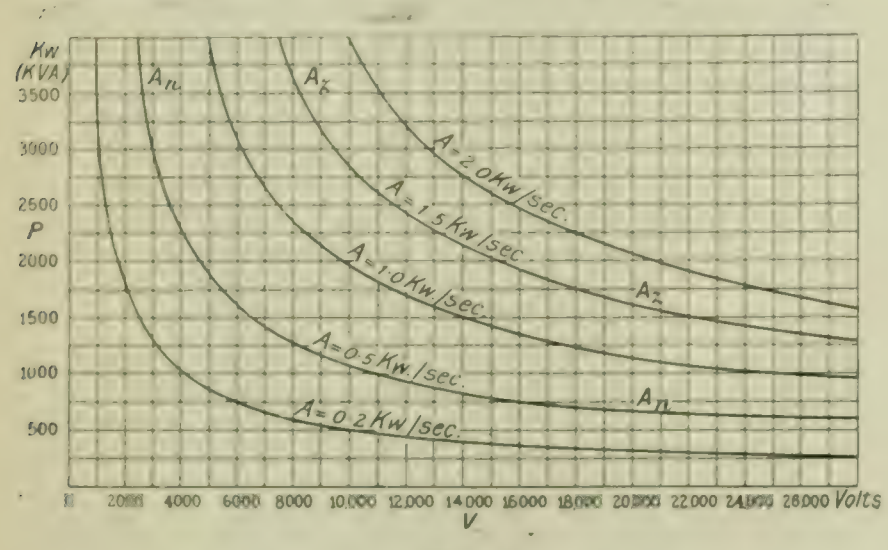


Fig. 7.

$r = 0$. $a = 3{,}150$ volt cm. $b = 5{,}000$ watt cm. $\gamma = 6{,}000$ watts.

If a relatively small inductive load be switched off in a large station we may write approximately :—

$$t_{r,n} = t_r - t_r \{ k_1 \tan \varphi_n - k_2 \tan^2 \varphi_n + \dots \} \quad . \quad . \quad . \quad . \quad (16)$$

Using this expression, the values in Table IV. are calculated for the length of arc when switching off load from the bus bars of the Beznau and Lontsch stations at 8,000 volts and cos $\varphi_n = 0{\cdot}8$, the values for cos $\varphi = 1$ being obtained exeprimentally.

Table IV. *Load Switched Off from a Large Station.*

Load in kilowatts.		100	250	500	705	1,000
Length of arc in cm.	Cos $\varphi_n = 1$	1·09	1·46	1·73	1·93	2·10
	Cos $\varphi_n = 0{\cdot}8$	1·82	2·66	3·15	3·51	3·82

Comparing Tables III. and IV. we see that when switching full load (600 kw.) at a power factor cos $\varphi_n = 0{\cdot}8$ off one machine the increase of arc length is 270 per cent. over the length at power factor unity, whereas the increase of length when the load is switched off the whole station is only 82 per cent. Thus, it will be seen that from the point of view of switch energy a feeder switch may be overloaded to a far greater extent than a generator switch. The switch energy A was measured on non inductive load at 8,000 volts for a number of loads switched off in the first instance from the combined Beznau and Lontsch stations, and in the second instance off one of the generators. These experimental results, together with calculated values (in brackets) for a power factor of 0·8, are set out in Table V.

Table V.

Load in p.c. of full load (600 kw.).	25 p.c.		50 p.c.		75 p.c.		100 p.c.		125 p.c.		150 p.c.	
Cos φ	1·0	0·8	1·0	0·8	1·0	0·8	1·0	0·8	1·0	0·8	1·0	0·8
Load on combined stations kw. sec.	0·05	(0·09)	0·13	(0·23)	0·21	(0·34)	0·30	(0·55)	0·40	(0·73)	0·50	(0·92)
Load on single generator kw. sec.	0·12	0·30	0·33	0·96	0·60	1·82	0·95	3·14	1·48	5·00	2·40	8·00
Percentage increase	140	233	154	291	186	435	217	471	270	585	380	770

It thus appears that the length of arc and the switch energy depend not only on the magnitude of the load and the constants of the switch, but also on the constants of the generating plant. For a given load the switch energy increases with the reactance of the generator. This effect is most marked with heavy loads. The length of arc and the switch energy decrease the greater the number of generators running in parallel. If the load is inductive and constant in value, the phase displacement in the mains is added to the displacement produced by the internal reactance of the generator, so as to cause the switch energy to increase rapidly with the external phase displacement.

It may be pointed out that the results of Table V., borne out by equation (15), indicate that it is more dangerous to switch off a load from a generator of poor regulation than from one of close regulation. This is contrary to the accepted opinion of switch designers, who consider that a large drop of voltage in the generator assists the interruption of the load current. This point is of particular importance in connection with the switching off of short circuits. In

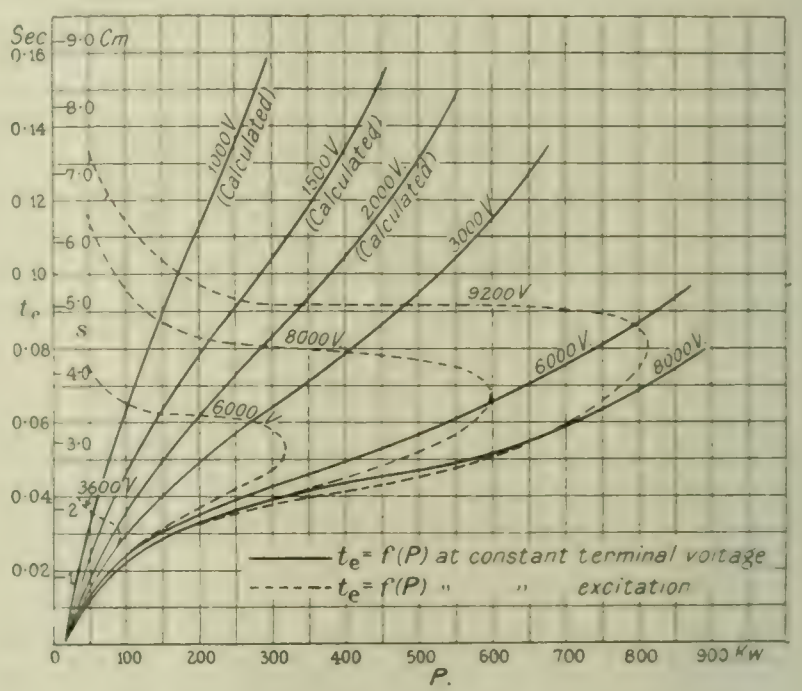


Fig. 8.—Sine-wave Non-inductive Load.

these cases it is not permissible to assume constancy of the generator voltage. From equation (15) we note that if tan $\varphi = 0$, $\Delta t_e = 0$; this condition is not realisable in practice, as φ can never become zero, although it may be very small. If P is kept constant and V is gradually reduced to zero Δt_e will become infinite for $\varphi = 90$ deg.; this is the condition at short-circuit. Seeing that t_r must have a finite value in both these extreme cases, we must assume that the constants k_1, k_2, &c., either remain independent of V or increase with decreasing values of V. Thus, $\Delta t_e / t_r$ must increase more rapidly than linearly with decrease of voltage V, but from Fig. 6 we see that t_r is nearly proportional to V at constant load P; thus, we are led to conclude that $\Delta t_e / t_r$ increases more rapidly than t_r decreases. In other words we obtain the apparently paradoxical result that for a given load the arc length at the switch increases the more the generator voltage is reduced. This is fully borne out by tests, as the figures of Table VI. show :—

Table VI.

Kw. load switched off. Cos $\varphi = 1$; $r = 55$ cm. sec.	Duration of arc in seconds at 3,000 volts.	6,000 volts.	8,000 volts.
100	0·0300	0·0245	0·0230
250	0·0570	0·0390	0·0368
350	0·0705	0·0460	0·0413
500	0·0948	0·0570	0·0473
600	0·1150	0·0653	0·0524

Reasoning from these values a series of curves are drawn to show the probable relation between t_e and P at constant excitation and non-inductive load. The theory leads to t_e curves (Fig. 8), with a point of inflexion at the value P_{max}, and with values of t_e increasing asymptotically to infinity as P approaches its zero value in the short-circuit direction. Curves with this character are plotted from actual tests. These curves show the operation of

switches at constant excitation, and variable load and constitute the solution of the main problem forming the basis of the investigations.

Some interesting results follow from a theoretical examination of equation (15); the following are selected :—

The arc length of a given switch is mainly dependent on the proportion of full load being switched off and is nearly independent of the absolute magnitude of the load.

The use of large reactances to protect alternators are harmful from the point of view of the switch-energy developed.

Up to this point the influence of the form of the switch contacts and the switch velocity have not been considered. Tests are described that were carried out with a great many types of contacts. The conclusions arrived at are that for the smallest switch energy to be developed both the switch contacts should be made of copper (brass and iron giving far worse results); the usual commercial forms of contacts do not show any marked difference in respect of the switch energy developed; diminishing the mass of the contacts tends to increase the switch energy, but increase of mass above that usually employed does not lead to any marked improvement; the contact area should be not too small and well rounded off, as points and edges become a seat of negative arc craters, and thus increase the voltage across the switch.

Regarding the switch-velocity, it is shown by tests that the arc duration, and, therefore, the switch energy, decreases, as would be expected, according to a hyperbola as the switch-velocity is increased and that the switch-energy does not diminish appreciably with switch velocities exceeding 55 cm. per second.

In some types of switches the interruption takes places at several breaks in series. If there are n breaks, we have to write V_m/n for V_m in equation(5),and it follows that the switching operation is effected just as in the case of a single-break, but with the difference that the constants g, a, γ and δ are increased n-fold, and the limiting value of the power that can be switched off without the formation of an arc becomes $4n\gamma$ instead of 4γ.

The results of actual tests on a multiple-break switch on an 8,000-volt line supplying a non-inductive load of 740 kw. with a switch velocity of 55 cm./sec. are shown in Table VII. :—

Table VII.

No. of breaks.	t_e (sec.).	Single arc length, cm.	Total arc length, cm.	C in p.c.	$A=Ct_eIE$.	A in p.c.
1	0·048	2·640	2·640	2·6	1·09	100
2	0·034	1·870	3·740	2·0	0·59	54·5
3	0·030	1·650	4·950	1·5	0·39	36·0
4	0·027	1·482	5·928	1·1	0·25	23·5
6	0·015	0·825	4·950	1·0	0·13	12·0

METHODS OF CHORD WINDING FOR CONTINUOUS CURRENT ARMATURES.*

BY F. LEYERER.

Chord winding means that the pitch of the winding is either greater or less than the corresponding distance between the poles; in the diametral or full pitch winding, the pitch corresponds to the distance between the poles. The terms "diametral" and "chord winding" are derived from ideas associated with two-pole machines. Looking at the armature in the direction of the axis, in the one case the winding appears to be a diameter, and in the other case a chord. Chord windings were commonly used in former days on machines that had no commutating poles, but with the introduction of these auxiliary poles, chord windings fell into disuse, seeing that for commutating purposes diametral windings were necessary. But the following considerations with regard to chord windings may be of interest.

Fig. 1 shows the currents in a two-pole winding, consisting of 20 turns; there are 20 upper conductors and 20 lower ones and 20 commutator segments. The upper conductor is connected to the lower conductor 8; the pitch may, therefore, be said to be 7, whereas with a diametral winding it would have been 10. The chord, therefore, may be said to be 70 per cent.—*i.e.*, 70 per cent. of the full diametral value. Fig. 2 gives a section through the armature at right angles to the axis. The armature is supposed to be without slots; the hollow circles and the black circles distinguish the directions in which the currents flow. The short-circuit currents are not considered in this case. It will be seen that the currents in the upper and lower conductors 6 to 12 and 16 to 2 are in the same directions; the reverse is the case with the conductors 3 to 5 and 13 to 15. If the currents are added together or superimposed, as in Fig. 3, we get currents in the one direction in 6 to 12, in the other direction in 16 to 2, while in 3 to 5 and 13 to 15 the algebraic sum is zero. The two zones of current 6 to 12 and 16 to 2 constitute the two sides of a coil, the axis of which, AB, represents the direction of the resulting armature field. If the winding is of the diametral kind, the two zones arrange themselves symmetrically with regard to the poles, and the axis of the armature field is then along the line joining the brushes. If a precisely similar winding is carried out with a pitch greater than 10—*e.g.*, with a pitch of 13, or a chord of 130 per cent.—similar diagrams may be constructed showing the flow of the current. The result is very similar to that shown in Figs. 2 and 3, except that the axis of the resultant armature field is displaced on the opposite side of the neutral axis, and should be drawn from 8 to 18. Thus, from a consideration of these various conditions, we see that other things being equal, the resultant armature ampere-turns are smaller with chord winding than with a diametral winding, and the position of the field is shifted. Thus, beside the field in the direction of the line connecting the brushes, there is also another component in the direction of the main magnetic flow between the poles. This field must be added to the main field for the one direction of rotation, while in the other direction, as shown by the dotted arrows, it must be subtracted and therefore it must be regarded as weakening the main field. This is, of course, true both for dynamos and motors. The difference between the dynamo and the motor effects must be conceived by supposing the direction of the field to be changed, while the direction of rotation remains the same as before.

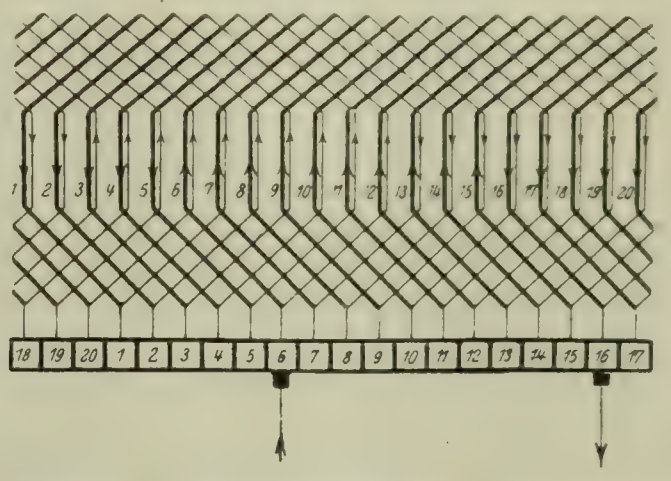


Fig. 1.—Showing a Chord Winding with a Pitch Shorter than the Distance between Consecutive Poles.

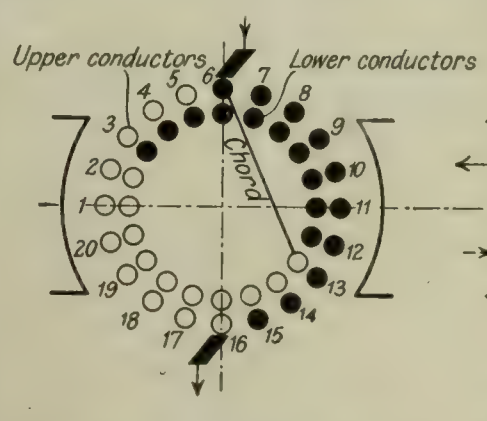


Fig. 2.—Showing the Direction of the Current in the Conductors of a Chord Winding, in which the Pitch is Shorter than the Distance between Consecutive Poles.

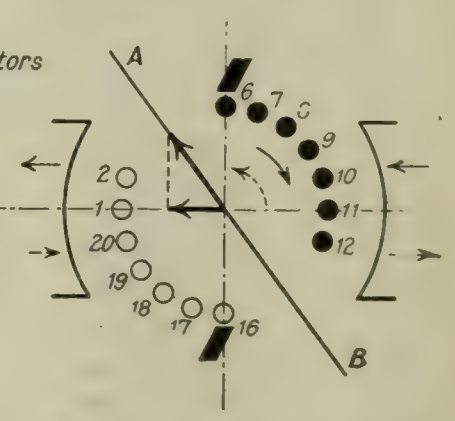


Fig. 3.—Showing the Resultant Ampere-turns in a Chord Winding, in which the Pitch is Shorter than the Distance between Consecutive Poles.

If the brushes are displaced, the axis AB is also correspondingly displaced. The components in the direction of the main magnetic flow are thus increased or diminished; this depends on the magnitude of the chord and on the direction of rotation. The brushes are displaced in a dynamo in the direction of rotation and in a motor in the opposite direction. Therefore, the counter-ampere-turns, which thus arise, increase or diminish the components which are due to the chord winding. It is desirable, of course, to diminish the amount of copper necessary for the windings on the main poles;

* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 40, 1915.

therefore, for a given chord winding a certain direction of rotation should be chosen. Motors with chord winding must for this position of the brushes have slightly different speeds in the two directions. This geometrically neutral position for the brushes is practically of no importance. The neutral-induction position is quite simply found by the following plan. The armature being supposed to be at rest, current is switched on and off in the magnet windings, a millivoltmeter is connected between the brushes, and that position is found in which there is no deflection. This gives the neutral-induction position. In this case, let us consider the winding element connecting the two brushes; this must have such a position with regard to the lines of force that the sum of the voltages induced in it by the cutting of the lines of force is zero. In all the upper conductors of such a winding, as well as in all the lower conductors, voltages in the same direction must be induced; the upper conductors move through the field in the opposite direction to the lower conductors; therefore the sum of the voltages in the upper conductors must be equal to that in the lower conductors. There must be a lower conductor, corresponding to every upper conductor, in which there is an exactly equivalent voltage induced; for any configuration of the field the upper and lower conductor must be symmetrically placed with regard to the line perpendicular to the line joining the middle of the poles.

Let us now consider again the chord-winding shown in Fig. 2, and let us take the winding which consists of the upper conductors 6 to 15, and the lower conductors 13 to 2. Then we see that this has not the symmetrical position we want. We get this only in Fig. 4, in which the brushes are so far displaced that the upper conductors a, b, c, are symmetrically placed with regard to the conductors d, e, f. The angle of displacement is about the same as that which the chord makes with the diameter. The resultant line AB then coincides with the geometrically neutral line, *i.e.*, there is no component in the

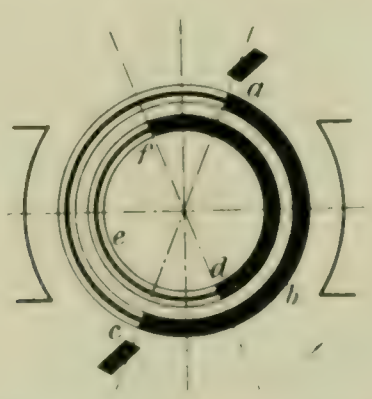


Fig. 4.—The Neutral Induction Position for the Brushes in a Chord Winding.

direction of the main magnetic lines of force. The exciting current does not, therefore, depend on the direction of rotation, and motors with brushes in the neutral-induction position rotate therefore with equal speeds in the two directions, and this is the case both with chord and diametral windings. Thus in practice the afore-mentioned peculiarities of chord winding are never observed.

The amount of the armature ampere-turns can be calculated as follows: Let us suppose the conductor a to be connected to the conductor b, and let the conductor c be the one immediately preceding b. Then the current zone ac includes a central angle amounting to $\frac{2\pi}{p} - 2\alpha$ where α is the angle between the resultant line and the geometrically neutral line, and p is the number of poles. If k is the total number of windings then the number of active ampere-turns is to the number which would be active with a diametral winding as y_1 is to $k \cdot p$, where y_1 is the pitch. If I is the total current and a is half the number of the parallel current paths, then the armature ampere-turns for two pole machines are $kI/p\pi$, and for a chord winding this becomes $Iy_1\,\alpha$. The difference of the number of ampere-turns is, therefore, $\frac{kI}{p\pi}\left(1 - \frac{y_1 p}{k}\right)$. The counter and cross ampere turns are, therefore, the components in the directions of the line joining the middle of the poles and the line at right angles to it. The angle between the resultant line and the geometrically neutral line is $\pi\left(\frac{1}{p} - \frac{y_1}{k}\right)$. The author also adds a diagram showing how the induced voltage varies in coils of different widths, supposing the flow of the lines of force to be undistorted; from this it appears that chord windings are only practicable within certain limits, and that the chord must rather more than span the interval between two successive poles.

APPARATUS FOR STARTING AND CONTROLLING ELECTRICAL RUNNING MACHINERY.*

BY C. C. GARRARD.

Summary.—The apparatus dealt with consists of variable resistances to enable electric motors to be started up without taking an excessive current from the mains and without mechanical shock, and also to enable the running speed of the motors to be varied at will.

Continuous Current Motor Starters

The continuous-current motor starter consists of a variable resistance which is placed in series with the motor at the moment of starting, and is gradually reduced in value to zero when full speed is attained. The switch part of the starter may be one of many varied forms, either automatic or hand-operated, while the resistance portion of the apparatus, in the vast majority of cases, consists of resistance wires or grids. A number of attempts have been made from time to time to construct starters of such materials as a mixture of carbon and mica powders, varying the resistance of same by compression. It cannot be said, however, that these forms show any likelihood of displacing the metallic resistance starter. Now, the efficiency of the latter depends, in the first instance, upon the correct design of the resistance having regard to the duties to be performed. We will firstly consider therefore the

Grading of Direct-current Starter Resistances.—(*a*) *Shunt Motors.*—It is obvious that in order to secure the most even starting the following condition must be met: In moving from step 1 of the starter to step 2 there will be a momentary rush of current, which will subside as the motor picks up speed. If the current on the first step under steady conditions be I_1, then the momentary current on going over to the second step

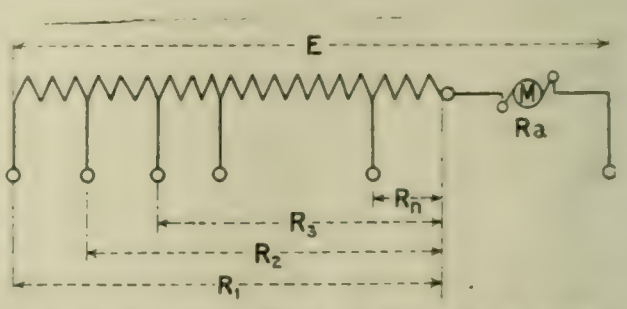


Fig. 1.—Diagram Illustrating Grading of D.C. Starters.

can be written as kI_1. Similarly, if the current under steady conditions on the second stop be I_2, the momentary current on going over to the third step will be kI_2. That is to say, the momentary percentage increase of current from step to step must always be equal.

In Fig. 1 let

E = Voltage of supply; R_1, R_2, &c., the total resistance of the starter at each stop.

E_{a1} = Back e.m.f. of armature with starter on first stop.

R_a = Resistance of the armature.

Then the ratio of the momentary current in going from stop 1 to stop 2 will be to the steady current on stop 1,

$$\frac{E - E_{a1}}{R_2 + R_a} = k\,\frac{E - E_{a1}}{R_1 + R_a}$$

as the back e.m.f. E_{a1} does not alter during the instant of change-over.

Similarly,

$$k\,\frac{R_2 + R_a}{R_1 + R_a} = \frac{R_3 + R_a}{R_2 + R_a} \cdots \frac{R_{n-1} + R_a}{R_n + R_a} = \frac{R_n + R_a}{R_a},$$

where n = number of steps on the starter.

From the above we get

$$R_n = R_a k - R_a.$$
$$R_{n-1} = R_a k^2 - R_a$$
$$\cdots\cdots\cdots$$
$$R_1 = R_a k^n - R_a.$$

* Copyright. All rights reserved.

which gives the following rule for grading :

$$R_1 + R_a = k^n R_a, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (i.)$$
$$R_2 + R_a = k^{n-1} R_a, \text{ \&c., \&c.}$$

As an example, suppose the total resistance of the starter be 20 ohms and the number of resistance steps be 7 : then

$$20 + R_a = k^7 R_a,$$

which enables k to be calculated.

The ohms in circuit on the second step of the starter can then be calculated from the equation

$$R_2 + R_a = k^6 R_a, \text{ and so on.}$$

Use of Slide Rule in Determining Grading of Starting Resistances.—It is obvious that calculations made in the method given in the preceding paragraph are very tedious. E. A. N. Pochin (*Electrician*, Vol. XXXIX., p. 38) has, however, given a method whereby the labour can be materially decreased.

We have from equation (i.) :

$$R_1 + R_a = k^n \times R_a$$
$$\therefore \log (R_1 + R_a) = n \log k + \log R_a.$$
$$\therefore \frac{\log (R_1 + R_a) - \log R_a}{n} = \log k.$$

A slide rule is taken and the linear distance between the values as marked on the slide rule of $(R_1 + R_a)$, and R_a is divided by n ; the result is the value of log k.

If, then, this distance be measured along the rule from R_a, the point so found will be $R_a \times k$, and the value of the last step of the starter is $R_a \times k - R_a$, and so on.

If the slide rule be provided with a slider having an evenly divided scale on it, the readings can be made quickly and with the greatest ease.

(*b*) *Series Motors.*—In arriving at the rule for grading of the starting resistance for shunt motors, the fact that at the moment of switching over from one contact to the next the back E.M.F. does not alter forms the basis of the calculation. When dealing with series motors, however, such a simple rule for grading cannot be arrived at. With the series motor the back E.M.F. may increase when changing over from one contact to the next on the starter. This has the effect of decreasing the momentary rush of current in going from step to step. Moreover, the extra self-induction of the series field coil acts in the same manner to limit the momentary rush. Thus, if the series starter be graded in the same manner as if it were for a shunt motor, then, other things being equal, the momentarily increased current in passing from step to step on the starter is less with the series motor than with the shunt motor. For many purposes, therefore, it is sufficient if the same grading be adopted in both cases. Especially is this so if the field magnets are near saturation at that point in the speed curve at which one is working. In this case there will be very little change in back E.M.F. at the moment of changing over from contact to contact.

In making the calculation, instead of taking the resistance of the armature alone (as with the shunt motor), the total resistance of the armature and series winding must be used.

On the other hand, as generally the series motors that have to be dealt with in commercial work are larger than shunt motors, it will be of value to study the following theoretical method of grading which is due to Bragstad. (Compare Arnold, "Die Gleichstrommaschine," 2nd edn., Vol. II., page 419, and Edler, "Switches and Switchgear," translated by Laubach. London : Constable, 1913.)

Let the terminal voltage be E and the back E.M.F. of the motor be e volts. If the motor be started up at constant current, I, then the back E.M.F. will be proportional to the speed n. If R be the total resistance in the motor circuit, then

$$e = E - IR = kn \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (ii.)$$

where k is a constant.

It is clear from this that, in order to start up at constant current, the resistance must be continuously cut out in direct proportion to the speed—*i.e.*, if the speed and R be plotted on squared paper, the curve connecting them will be a straight line.

Graphical Method for Determining the Grading of Series Starter.—Let curve AB, Fig. 2, show the relationship between current taken by the motor and the speed with the full voltage E applied to the terminals of the motor. Each point in the curve, of course, corresponds to a certain definite torque which the motor will exert at that speed and current.

Let us suppose that C corresponds to the opposing torque at starting, and B to the increased current allowed to flow through the motor by the starter in order to provide the extra torque necessary for acceleration. The problem is to design the starter so that there will not be a greater current than I_B taken from the mains.

If the resistance of the starter be made equal to $(E/I_B) - R_m = R$, where R_m is the total resistance of the armature and the series field winding, then on the first step of the starter the current through the motor will be I_B amperes. The point F is taken in a horizontal level with B and at a distance equal to R_m from the left of the vertical axis. The point G is taken at E/I_B ohms from the null point 0. F and G are joined. If the resistance in the starter be cut out continuously in inverse proportion to the speed, then the speed will increase along the line GF. The line JH is obtained in a similar manner, setting OJ equal to E/I_c. The speed would rise along

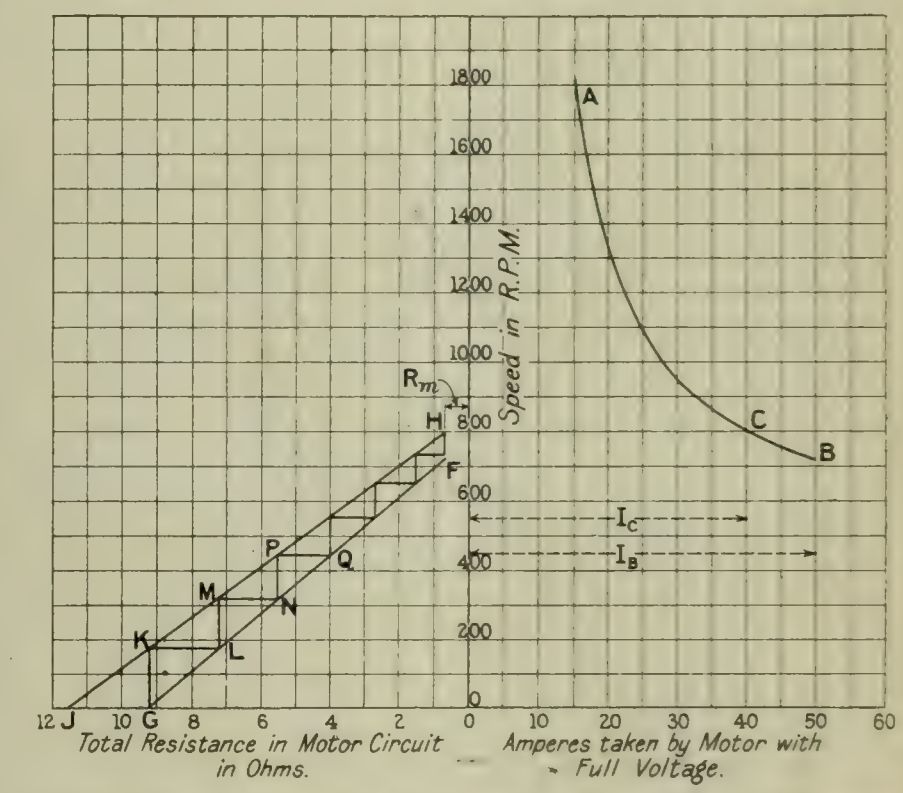


FIG. 2.—CONSTRUCTION FOR GRADING OF SERIES MOTOR STARTER.

JH if on the first contact the current were E/I_c and the resistance were cut out continuously inversely proportionally to the speed. It is clear, of course, that it would take infinitely long to advance from J to H, as the opposing torque is equal to the driving torque, and there would be nothing left over for acceleration.

Suppose, now, the starter be switched on at G ; the current will fall and the speed increase along the vertical line GK until K is reached, when acceleration would stop and the motor continue running at constant speed. The first step of the starting resistance is next cut out. It is obvious that the maximum value of this step must not exceed KL, otherwise the current will exceed I_B. The construction can be extended in a similar manner along the zigzag line KLMNPQ, &c., the various horizontal lengths KL, MN, PQ, &c., representing the maximum values of the resistance steps it is possible to allow if the current is not to exceed I_B at any time.

Of course, lesser resistance steps may be used if desired ; but the construction shows the minimum number of steps it is possible to use with the assumed maximum starting current and with the motor starting against the particular torque considered. It will be found that the first steps are smaller with a series starter than with a shunt one, but that the last steps to be cut out in starting up are larger.

This method of arriving at the grading may be useful when dealing with large series motors used with drum controllers with which the number of steps is usually small.

Choice of Starters for Squirrel-Cage Motors.

Small three phase squirrel-cage motors (say, up to 3 H.P.) are used very often without any starting switch whatever, being directly connected to the line by means of the motor switch. With such an arrangement care must be taken that the protecting fuses are large enough not to be blown by the starting current. Double-contact switches have been proposed whereby the fuses are cut out of circuit during starting. These have, however, not been used to any very great extent. With regard to squirrel-cage motor starters proper, three types are in use, the auto-transformer starter, the star-delta switch, and the resistance type. These will be considered *seriatim*, and the advantages and disadvantages of each type stated.

Auto-transformer Starters for Squirrel-cage Motors.—Auto-transformers are used for starting up squirrel-cage motors when it is desired either to draw less current from the mains when switching on than is necessary with star-delta starting, or to obtain a larger starting torque than is possible with a star-delta starter, but at the same time not to give such a shock to the system as is entailed by switching the motor direct on to the mains.

The auto-transformer starter is made up in many different forms. Generally speaking, it only has three positions—viz., "Off," "Starting" and "Running." For large sizes there are sometimes two starting positions.

It is necessary in order to get the best starting conditions to study each case separately. The auto-transformer is usually provided with several alternative tappings, and this renders its application very convenient when the starting conditions are not known beforehand. Thus, for foreign orders where squirrel-cage motors are stocked a long way from the factory, it is best to stock auto-transformer starters for the same, as these enable very varied conditions to be met.

In order to keep down the first cost of an auto-transformer it is necessary to cut down the material as much as is reasonably practicable. This necessitates some care on the part of the operator. When starting up a new motor a careless man will have a habit of making several starts in rapid succession without allowing sufficient cooling intervals for the starter. This may easily cause damage to the same. Again, it will sometimes be found that the motor fails to start up with the tapping that happens to be in use. The remedy, then, is to alter the tapping so as to apply a higher starting voltage to the motor rather than, as is oftimes done, to leave the starter in circuit for a lengthy period in the hope that the machine will eventually start up.

It will be seen from the foregoing that the rating of an auto-transformer is a matter of very great importance, especially if it be desired to compare one make with another.

The Rating of Auto-transformer Starters.—There is considerable confusion at the present time as regards the rating of auto-transformer starters, and it would be very desirable if the British Engineering Standards Committee would give attention to this matter, and issue a standard specification. As an example, one leading manufacturer defines the rating as follows: "The auto-transformers are all designed for starting motors of their rated full power against full load torque during a maximum period of 1 or 1½ minutes in the starting position. This must be followed by a period of running or rest of not less than 10 times the starting period."

Now this definition does not give one any information whatever about the starter itself. In the first instance the tapping is not specified to which the rating applies. Of more importance, however, is the fact that the proportion of full load current to give full load starting torque varies considerably with squirrel-cage induction motors. Thus, the rating given above might be satisfactory with one type of motor and totally inadequate in another type. A more scientific method of rating is to specify that the starter is capable of drawing a certain proportion (say, 2½ times) the full-load current from the mains. If we consider the internal losses in the auto-transformer it is clear that the iron loss is always the same so long as the primary voltage is unaltered. With constant primary current, however, the copper loss will vary according to the tapping to which the motor is connected. It is not sufficient, therefore, to specify only the current which the transformer can withdraw from the mains; it is necessary also to state the tapping. For convenience doubtless the 70 per cent. tapping is best. Taking all these points into consideration, the following definition of auto-transformer starter rating is put forward as meeting all the difficulties that have been mentioned:—

RATING OF AUTO-TRANSFORMER STARTERS.

Auto-transformers are rated to take a current from the mains not exceeding 2½ times full-load current of the motor with the motor connected to any tapping (see below) for a period not exceeding 1 minute (or 1½ minutes), followed by a cooling period of at least 10 times the starting period. This can be repeated an indefinite number of times with a maximum temperature rise not exceeding 100°F. (measured by increase of resistance of the windings).

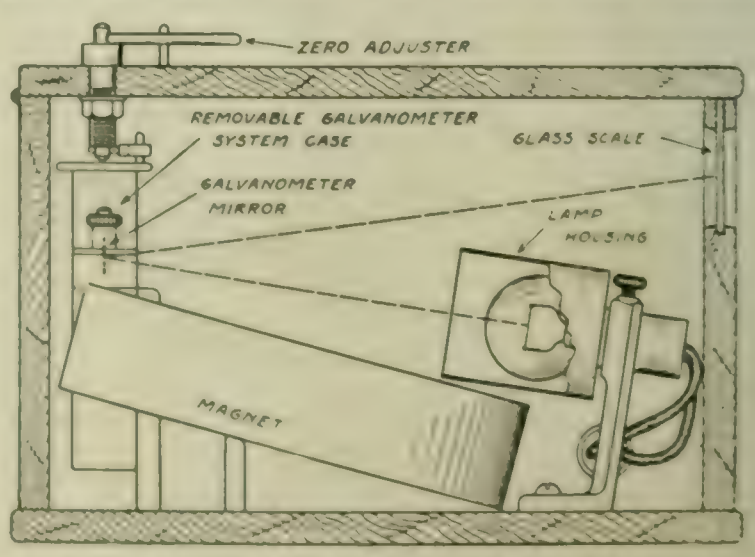
N.B.—The above rating has particular reference to a test made with the motor connected to 70 or 80 per cent. tapping. No commercial squirrel-cage motor when connected to the 40 or 60 per cent. tapping will take as much as 250 per cent. of full-load current from the mains even when stationary.

Number of Tappings on Auto-transformer Starters.—The great advantage of auto-transformer starters is that it is possible to adjust the starting current and torque to suit the local conditions. This is specially necessary for the export trade where it is impossible to know how the various motors are going to be used. A reasonable number of tappings should be provided so as to secure a wide range of starting conditions. Some makers do not appear to appreciate this point. As an example, one manufacturer of auto-transformers only provides a 60 per cent. tapping on starters below 5 H.P., which is equivalent to a transformer having a ratio of 1/1·67, which is almost exactly the same as the star-delta switch. Such a transformer will therefore not do any more than the star-delta switch, which may as well be used. The same maker for 5 H.P. sizes and above provides 50, 60 and 70 per cent. tappings. This is much better. For all round service the present writer would recommend four taps, as follows: 40, 60, 70 and 80 per cent.

(*To be continued.*)

PORTABLE GALVANOMETER.

This galvanometer, made by the Leeds & Northrup Co., has mounted in it a lamp and scale by means of which any movement of the system is very easily noted. This makes it more convenient to



Section showing Arrangement of Optical System.

use and less tiring upon the operator than either a pointer or a telescope and scale type galvanometer. It is well adapted for shop Wheatstone bridge or Kelvin bridge measurements, or for any other purpose where a sensitivity of 20 megohms is sufficient and where a

large number of measurements are to be made. In addition to its ease of reading and comparatively high sensitivity for a portable instrument, it is quick in its action, having a period of about 4 seconds. The instrument is quite strong in its construction, and will withstand as much rough usuage as an ordinary voltmeter.

The scale is black on a translucent background. It is regularly furnished with zero in the centre, but is furnished with zero at one end if so desired. The optical system will be understood from an inspection of the figure.

The lamp provided with this instrument has a single straight filament of high intrinsic brilliancy. It operates on 4 volts, and requires a current of 5 amperes. It may be operated either from a storage battery or from an ordinary lighting circuit. If run from a lighting circuit a lamp of proper capacity or a fixed resistance must be put in series with the small lamp.

FOUNDING A LARGE POWER STATION ON SOFT MARSH.

Summary.—A description is given of the foundations required for a large electric generating station built on a tidal marsh. The full area is piled at minimum spacing and an unreinforced concrete mat caps the piles.

A difficult foundation problem was presented in the construction of a large generating station in a tidal marsh at Newark (U.S.A.). The soil is very soft, peaty and alluvial marsh ground to a depth of about 35 ft., to which depth the foundation necessarily had to go. We have prepared the following description of this interesting work from a well-illustrated article in a recent number of "Engineering News."

Piles were the logical solution, but with very heavy concentrations of load it seemed impracticable to provide isolated pile groups. Apart from the cost of the footings, the weight of the station is very large—approximately 2 tons average weight per square foot over the entire area, but by no means uniformly distributed—so that sufficient pile capacity could be obtained only by covering the whole area with piling.

Under these conditions, resource was had to a concrete slab or mat over the whole site, supported by piles driven all over at substantially minimum spacing. There is no steel reinforcement in the mat of the boiler-house or turbine room (except under the canals). In the switch house the 15 in. mat between column piers is reinforced and has no piles under it. The latter arrangement was selected, as the column loading did not require piles over the whole area, and the 15 in. mat ties the structure together, as there is a complete system of piling around and under the outside walls.

A key plan of the generating station is given in Fig. 1, and sections of the turbine-house and boiler-house foundations, with complete piling and with uniform mat, on which are supported stepped footings and piers for the columns, are shown in Figs. 2 and 3.

Piles are spaced 30 in. on centres, minimum spacing; there are about 9,000 in all under the entire group of buildings. They were driven after excavating to below low-water behind a pile-and-earth bulkhead coffer-dam. The space between piles was re-filled with cinders and earth to the desired bottom of the mat, 9 in. below cutoff. The tops of the piles were then peeled to give a clean contact with the mat concrete.

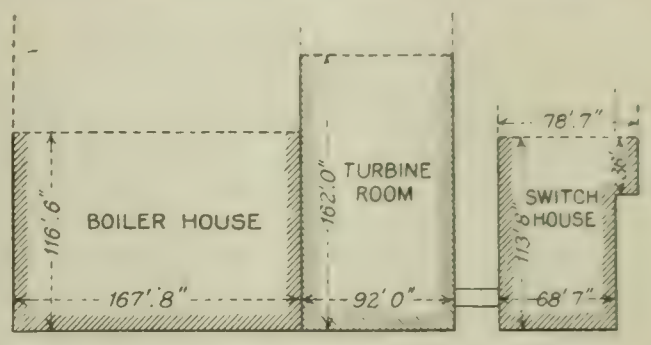


Fig. 1.—Plan of Power Station.

The mat in the boiler house is 3 ft. thick, thickened under the stack columns up to 5 ft. in order to distribute the load over the required number of piles, but maintaining a uniform elevation of bottom over the remaining area. Thus there is ordinarily 27 in. of concrete over the pile tops except under the columns.

The concrete was placed in sections about 20 ft. to 40 ft. square, as conditions permitted. No attempt was made to form vertical construction joints. A single curb timber of 6 in. by 6 in. was placed along the free edge of a section, its top flush with the intended top of the concrete, while below this curb the concrete was allowed to taper off outward at its own slope. Thus a long flat sloping bond surface was produced, with a 6 in. rabbet or gain at its upper edge. The latter feature avoided the formation of a feather-edge joint on the surface of the mat.

The top of the mat is 7½ ft. below the column bases. Concrete piers are built on it to support the bases. Under several rows of columns in the turbine house and the switch house these piers are connected to form a continuous wall, which assists in the load distribution. Concrete floor surfacing will be laid on a cinder filling placed between walls and piers.

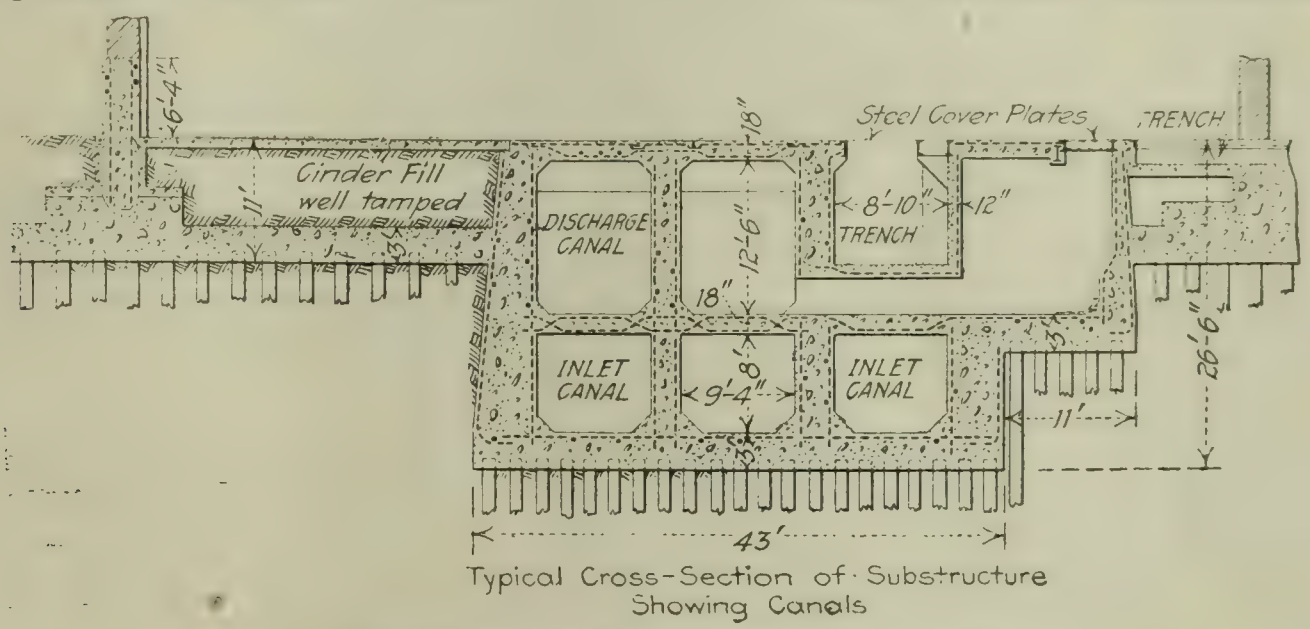


Fig. 2.—Section of Turbine-house Foundation.

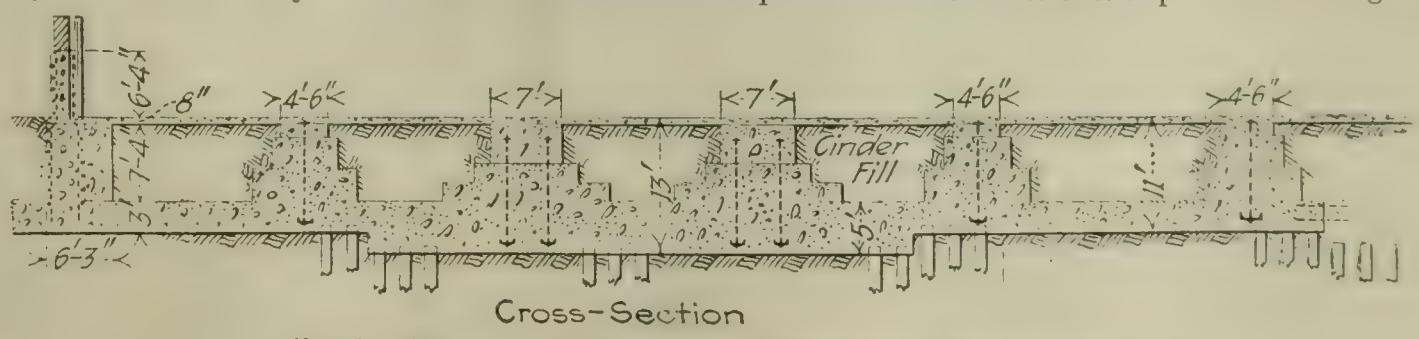


Fig. 3.—Section of Boiler-house Piling and Foundation Mat.

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SPECIAL NOTICE.

In order that we may be able to supply the newspaper trade effectively and meet the requirements of the Post Office, we are sending THE ELECTRICIAN to press a few hours earlier every week. All editorial and news matter for the next current issue of THE ELECTRICIAN must reach us as much earlier as possible, but not later than WEDNESDAY MORNING, and advertisement text and blocks must reach the offices as much earlier as possible, but not later than TUESDAY EVENING, during the continuance of the War. Displayed Advertisements not for proof before first insertion can be taken until NOON ON WEDNESDAY, and Official Announcements, Auctions and "Smalls" of all kinds of which no proofs are required before insertion can be accepted up to FIRST POST THURSDAY MORNING.

ELECTRICITY SUPPLY IN THE COLONIES.

It is somewhat difficult to keep in touch with the development of electricity supply in the Colonies, notwithstanding all the present-day facilities for communication. With a view to helping engineers in this respect we have for many years issued tables giving particulars of the principal electric supply and tramway undertakings in the Colonies, and also some typical foreign supply works. The tables for this year are published with our present issue.

The information that we give is of particular interest at the present time, when our thoughts are frequently directed towards colonial and foreign trade, a subject which is second in importance only to the prosecution of the war. Of all markets, those of the Colonies should be most beneficial to British trade, and the greater the extension of electricity supply in the Colonies the greater should be the market for all kinds of electrical goods. In certain districts the progress is already well known. For example, we have the Canadian Falls of Niagara, with an aggregate plant capacity of 300,000 kw., Montreal and Shawinigan with 204,000 kw., the Hydro-Electric Commission of Ontario with 179,675 kw., Vancouver 126,000 kw., Toronto with 70,000 kw., Hamilton 53,000 kw., Winnipeg 51,600 kw., and Victoria (B.C.) with 22,000 kw. Of course, Canada has some magnificent water-powers, of which she has taken full advantage.

In the Australian Commonwealth considerable expansion is also noticeable. In Victoria, which is perhaps the most highly developed of the States from the electrical point of view, the sum of over £3,000,000 has been spent on electricity supply works alone, in addition to plant for electric tramways and railways, mines and collieries. Over 110 provisional electric lighting orders have been granted in

the State since the passing of the Electric Lighting and Power Act of 1896. Apart from the Melbourne, Geelong and Ballarat supply schemes, the majority of the stations are small, which is partly due to the fact that, excepting New Zealand and Tasmania, there are no hydro-electric schemes.

As in this country, it is noticeable that numerous small stations are springing up, worked by means of oil engines or gas plant. In the colonies, however, such stations have the great advantage of being unhampered in their development. Very possibly the supply that is given is not as good as that from corresponding stations in this country; but when cheapness of supply is the prime consideration it is necessary not to be too exacting. For example, where lighting is all that is required, the consumers may be content with light during periods of darkness, no supply being given in the daytime. This has a materially cheapening effect, and enables a small undertaking to pay its way more easily in the early years of its development. Also, in the Colonies, overhead cables are freely used, and the administrative regulations seem to be less exacting than in this country.

In glancing through the Tables our readers will be struck by the great diversity in the frequencies that are employed. We notice such frequencies as 40, 45, 48, 50, 60, 66, 76, 83, 125 and 133, apart from the commonly adopted frequencies of 50 and 60. Considering that many of these undertakings are comparatively new, it seems very unfortunate that something like a uniform policy should not have been adopted, and shows a remarkable lack of foresight. Not only do these numerous frequencies mean increased cost of manufacture, and, therefore, increased cost to supply undertakings, but they have a distinct hampering effect on manufacturers, who are prevented from adopting standardised lines for their plant.

In regard to tariffs, attention may be called to those based on floor area, which find favour with some undertakings. Thus, at London (Ontario) a floor space charge of 3 cents per 100 sq. ft. of floor area is made. For this purpose outside dimensions are taken, omitting bay windows and similar projections. The area derived from such dimensions, multiplied by the number of floors and reduced by 10 per cent., gives the net area. The charge for energy is at the rate of 2 cents per kilowatt-hour up to an amount equal to 4 kw.-hours per 100 sq. ft. for the first 1,000 sq. ft., and 3 kw.-hours for each additional 100 sq. ft. of floor area charged, and 1 cent per kilowatt-hour for all additional consumption per month.

In the past a great deal of German and American plant has been used in the various supply undertakings, but there is now a reaction in favour of British goods, especially in Australia. Our manufacturers should see to it that full advantage is taken of this friendly feeling, and that the plant that is supplied fulfils the requirements of the purchasers completely.

The Tables dealing with railways and tramways contain brief particulars of Buenos Ayres and Melbourne electrification schemes. The latter is of particular interest, and has been referred to in detail in our columns.

This year, in the Table dealing with foreign stations other than colonial, we give a few particulars of the Lagan scheme for transmitting electric power from Sweden to Denmark. As far as we are aware, this is the first case of export from one country to another by submarine transmission. Three-phase current is used at 25,000 volts. Another very important Continental system is that of Telemarken, in Norway, with a capacity of 460,000 kw. We also include a good deal of information in regard to Russian stations. The opening in this direction in the near future should be considerable, as it may be said that the empire of our great ally, which has numerous waterfalls, is almost a virgin field for the electrical engineer. Hitherto the Germans have had the field practically to themselves, and one result of the war should be to exclude German imports to the advantage of ourselves and of France. Information of the kind we give, no matter what the country, is not easy to obtain, nor is it easy to keep thoroughly up to date, more particularly under present circumstances. We trust, however, that the particulars we have been able to collect will be of material use to those engaged in the export of electrical plant.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s Add 10 per cent. for abroad or for foreign books.]

A Course of Modern Analysis. By E. T. WHITTAKER, D.Sc., F.R.S., and G. N. WATSON, M.A. Second edition. (Cambridge: University Press.) Pp. 560. 18s. net.

Prof. Whittaker states in the preface that the recent publication of the treatises by Bromwich and Hardy made him consider the advisability of omitting the first four chapters of this book. We are very glad that he has not done this. The book is now complete in itself, and will be far more useful to those who are not familiar with the theorems and the notation of modern pure mathematics.

As Prof. Whittaker, besides being a pure mathematician of the highest rank, is also thoroughly familiar with mathematical physics, it is not surprising to find that he has made a most judicious selection of mathematical theorems. Those that are merely curious or metaphysical are entirely absent, and we have not been able to find that any really important theorem from the point of view of the physicist or engineer has been omitted. This treatise is of great value as a work of reference. In particular it will save a great deal of trouble to many by pointing out differences in the definitions of mathematical functions given by various authors.

The book is quite within the comprehension of the old-fashioned mathematician. The authors in a few places indicate that they regard "analysis" as one of the highest, if not the highest, expression of human intelligence. The sine of an angle, for instance, should, in their opinion, be defined as a power series without any reference to geometry. It is illogical and "unæsthetic" to mix up geometry with arithmetic. We have no sympathy with this attitude. We doubt whether Prof. Whittaker got more pleasure from reading the logical "Principia Mathematica" of Whitehead and Russell than from reading that other and less logical "Principia Mathematica" written by Isaac Newton.

There is a tendency for pure mathematicians to develop the logical faculty too highly and for their æsthetic sense to become too fastidious. They get so in the habit of throwing the limelight on the weak points of a theorem that they are apt to forget sometimes its great practical usefulness.

The present authors deserve unqualified praise for the endless pains they must have taken to make this volume theoretically and historically accurate. Sometimes, however, their accuracy will prove embarrassing. As, for instance, when a lecturer discovers that what he has been in the habit of calling Euler's constant should be called Mascheroni's.

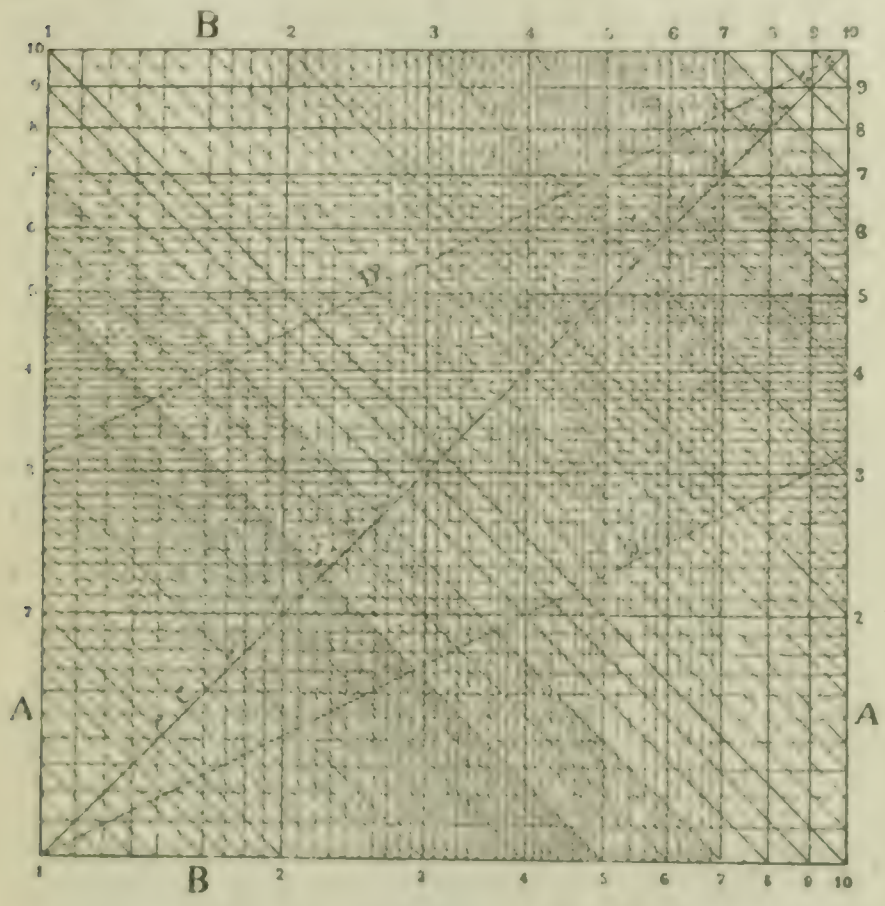
We are sorry that the ber, bei, ker and kei functions are not mentioned. The tables of them about to be published by the British Association prove that they are found useful by some whom the mathematician would call practical men. Many interesting and curious relations exist between these functions which would be most suitable in this volume.

We are afraid, however, that foreigners may have a difficulty in understanding the mystic words (Math. Trip.), (Clare), (Trinity), &c., which appear after several of the theorems. In

conclusion the publishers are to be congratulated on the admirable get-up and clear printing of this standard English text book on Analysis. A. RUSSELL.

Rapid Reckoning Chart. By E. E. FOURNIER D'ALBE. (London: Educational Supply Association.) 3d. net.

We reproduce herewith, on a small scale, a chart which has been devised by Dr. Fournier D'Albe as a substitute for the slide rule. It will be seen that it consists of a diagram ruled on logarithmic paper, and it has the important advantage over the slide rule that it requires no setting. Ordinary multiplication is effected by taking the ordinate and abscissa corresponding to the two numbers to be multiplied and then passing from their point of intersection to the diagonal. The diagonal scale C also



gives squares directly or square roots by the inverse process. One of the most interesting features is the ease with which cube roots can be obtained. All that is necessary is to find the number on the scale A, then proceed horizontally to scale D, and thence diagonally to the scale C. It is obvious that a similar method is applicable for any root, by taking a line similar to the line marked D at a suitable inclination, and this would be particularly useful in the case of fractional indices.

The Testing of Machine Tools. By G. W. BURLEY. (London: Scott, Greenwood & Son.) Pp. viii.+231. 4s. net.

In this book an attempt has been made to deal with the various aspects of machine tool testing in such a way as to make the book suitable for engineer apprentices and students as well as responsible engineers. The author rightly devotes a good deal of space to the testing of machine tools and machine tool elements for accuracy. As a rule more space is given to the description of methods and instruments than to the consideration of published results of tests, though the latter have not been neglected in view of their importance from the point of view of machine tool design.

Of the eight chapters in the book, the first is introductory, and the next three deal with accuracy tests, speed and feed tests, and mechanical efficiency tests. In the fifth, sixth and seventh chapters are considered cutting force tests, output and power consumption tests, and comparative tool testing. The subject of commercial machine tool testing is briefly dealt with in the last chapter, and a blank of a lathe test report is given as an appendix. Though small, the volume contains a large amount of excellent matter and can be strongly recommended to electrical engineers as to their mechanical brethren. Hitherto it has not been easy for those who are not specialists to determine what tests should be made on a machine tool and how such tests should be conducted, and one of the most valuable features of the book is that the author does not write over the heads of the practical men. The illustrations, of which there are 110, are well drawn, and the get-up of the book maintains the high standard noticed in earlier volumes of this useful series.

Mechanical Technology. By G. F. CHARNOCK. (London: Constable.) Pp. x.+635. 7s. 6d. net.

This book deals in an elementary manner with the materials and preparatory processes of the mechanical industries. It is divided into three parts. The first part, Chapters II. to XX., is given to the production and properties of the chief materials of construction. Preparatory processes depending upon the property of fusibility are described in the nine chapters forming the second part, and processes depending upon the properties of malleability and ductility are considered in the third part, which runs into 11 chapters. We agree with the author that when going through the shops young engineers are rarely permitted to devote any time to the foundry or smith's shop, although a knowledge of the operations there carried on is of paramount importance to the designer and constructor. Also that an acquaintance with the methods of the rolling mill and of the possibilities of stamping and drawing is desirable. These chapters are among the best in the book. From a careful perusal it is evident the author has endeavoured to bring into prominence the things which matter. The book forms a useful guide for beginners and for those with limited time at their disposal.

Spon's Architects' and Builders' Pocket Price Book, 1916. Edited by C. YORKE and S. M. BROOKS. (London: E. & F. N. Spon.) Pp. vii.+304. 2s. 6d. net.

This compact little publication is now so well established that the annual issue revised for 1916 is already assured a welcome. Its compact form and the clear and logical manner in which a vast amount of intricate data has been arranged in a successful and accessible manner has established for the volume a unique reputation.

A stronger cautionary note is, however, necessary with regard to current pricing. Under the present market conditions the costs of all building materials and supplies are unstable and inflated, and the actual quantities of certain goods so limited, that the greatest caution should be exercised, and a careful interpretation of prices made before adoption. The authors appear to have realised this difficulty, and have left most of the prices at their pre-war values, leaving a percentage to be added.

Subject to this reservation in its use the volume can be heartily commended on its appearance, and it should again find its way into the office and "pocket" of the building world.

R. G. H. C.

STEEL CARS FOR MICHIGAN RAILWAY.

The all steel passenger and express cars recently placed in service by the Michigan Railway Company on its new 2,400-volt third-rail line, which was described some time ago in the "Electric Railway Journal," are remarkable in many respects. They are equal in appointment and provisions for the passengers' comfort to the finest steam railroad coaches, and they are the first cars to carry 600-2,400-volt electrical equipment operated from a third rail, possessing also the specially notable feature of storage-battery operation for the lighting system, control and all auxiliary equipment. Three types of cars have been provided for the different services—limited, local and express or goods—and the features of each type are outlined in the following paragraphs. The motor cars for limited passenger train service are, without doubt, the finest in inter-urban service in America. They are of the side-entrance type, a feature adopted to provide exclusiveness for the parlour-observation compartment which occupies the rear end. The principal dimensions are as follow:—

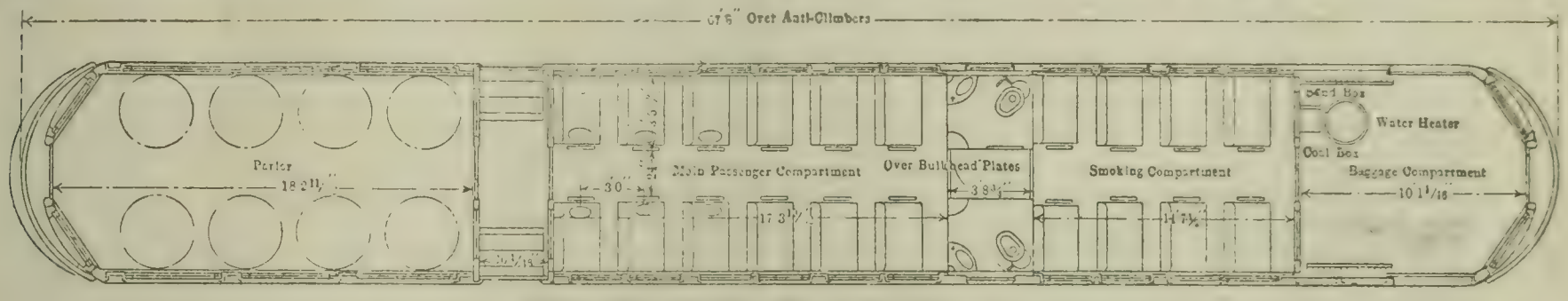
Length over all	67 ft. 8 in.
Length over vestibules	6 ft. 10 in.
Length parlour compartment	18 ft. 2 in.
Length passenger compartment	17 ft. 3 in.
Length smoking compartment	11 ft. 7 in.
Length baggage compartment	10 ft. 4 in.
Width over sheathing	9 ft. 6 in.
Height rail to top of floor	4 ft. 4 in.
Height rail to top of roof	13 ft. 7 in.
Truck centres	42 ft. 2 in.
Wheel base	8 ft. 6 in.
Wheels	37 in. diameter
Journals	6 in. by 11 in.

Undoubtedly the most unusual structural feature in these cars is the fish-belly girder type of underframe, which was necessitated to simplify the framing for the side entrances and for the large windows in the parlour section. Relatively light cross-bearers and side sills transfer all the load to the centre sills, which also absorb buffing and pulling strains when the cars are operated in trains. The space between the sills is utilised to carry the conduits and some of the brake rods. The maximum depth of the centre sills is 26½ in., tapering off to a depth of 8 13/16 in. inside the bolsters and to 7 13/16 in. at points just inside the corner posts. They are made up of 5/16 in. open-hearth steel plates with 3½ in. by 5/16 in. by 3 in. angle flanges, and they are spaced 20 in. face to face of web plates, the top cover plate being 30 in. wide by 3/16 in. thick. The intermediate sills are formed of 3 in. 6·7 lb. Z bars, and the side sills of 8 in. 11¼ lb. channels. The Z bars are supported on 4 in. 6¼ lb. channel cross-bearers. Riveted to the tops of the side, intermediate and centre sills is a No. 14 open-hearth steel plate, upon which is placed two courses of ½ in. Salamander hair felt for insulating purposes. Over this, and fastened to 7/8 in. by 1 in. nailing strips, is Keystone flooring, which in turn is covered with Flexolith.

The roof is of the plain-arch type, and is formed of 1¾ in. by 1¾ in. by 3/16 in. angles joined at the centre and quarter points with 3¼ in. by 3/16 in. by 12 in. and 8 in. gusset plates respectively. Fireproof Agasote ¼ in. thick and covered with No. 6 duck forms the roof covering, and 3/16 in. Agasote was adopted for the head lining. In order to give additional rigidity to the roof, longitudinal rafters consisting of 1¼ in. by 1¼ in. by ⅛ in. angles were installed just above the side plates, and 1½ in. by 1½ in. by 3/16 in. angles 16 in. each side of the car body centre line. These are continuous between bonnets and reinforced by additional longitudinal members over the side entrances and at the supporting points of the trolley and pantograph. Steel finish, except for the window frames and stools, obtains throughout the entire car body.

The doors in the partitions are all hinged and equipped with door checks. Each end of the car is provided with a centre end door, and to facilitate handling the trolley the rear door has a brass hand rail.

Sixteen Peerless exhaust-type ventilators are installed in the roof, with brass registers on the inside of the car. These, combined with



FLOOR PLAN OF CAR FOR LIMITED SERVICE.

Pressed-steel U sections of ⅛ in. metal form the panel and single window posts. These are framed into the side sills and the 5 in. channel side plates. The posts were arranged for six double windows, two large parlour compartment windows, the side entrances and one baggage door. The side sheathing below the window is 3/32 in. sheet metal, over which is riveted Pullman beaded-steel car siding, and just inside the sheathing is a ¾ in. layer of Flaxlinum insulation. The inside finish is of ⅛ in. open-hearth steel backed by 3/16 in. Agasote insulation. The belt rail along the bottom of the windows is formed of a 3 in. by 3/16 in. by ⅜ in. angle on the outside, riveted to a 2 in. by 2 in. by 2½ in. angle on the inside. In the transverse section of the car body it will be noted that all rivets in the inside and outside finish are covered with pressings, which in some instances were spot-welded in place.

a Sorocco blower, provide a satisfactory ventilating system for the several compartments. A specially designed hot-water heating system, equipped with a double-circulating system through a central tank. This supplies eight 1½ in. coils supported on racks just above the floor line on each side of the car, and assures efficient heating at the low temperatures prevailing during the Michigan winters. With the exception of a change of the type of ventilators, this heating and ventilating system is the same as that used in the Michigan United Traction Co.'s steel cars described on p. 108 of the July 18, 1914, issue of the "Electric Railway Journal." An inside width of 9 ft. permits the use of stationary seats 3 ft. 5 9/32 in. in length, practically equal to the standard seat width for steam railroads. The parlour compartment is furnished with four revolving chairs and seven upholstered armchairs.

THE TESTING OF UNDERGROUND CABLES WITH CONTINUOUS CURRENT.

The following is a report of the discussion on Mr. O. L. Record's Paper at the Manchester meeting of the Institution of Electrical Engineers on the 8th ult. An abstract of the Paper appeared in our issue of the 11th ult., p. 661 :—

The CHAIRMAN (Mr. B. Welbourn) asked why the ratio of alternating current to continuous-current presure became smaller as the alternating-current pressure increased? Was it due to the transformer becoming overloaded? The present knowledge of insulating materials dictated that alternating-current overhead lines could only be constructed for a maximum pressure of 150,000 volts, but the information given in the Paper would suggest that continuous-current pressures of even 300,000 volts would be practicable for overhead lines. It would be interesting to know the highest limit of continuous-current pressure which could be used.

Mr. C. J. BEAVER said the distribution of stress with continuous current was quite different to that with alternating current; it depended upon different factors—viz., resistance in the former case and capacity in the latter—therefore the effects would be quite different. Regarding the object of testing cables after laying, it would be agreed that it was not so much a question of verifying the dielectric qualities of the cable as to ensure that any damage incurred in laying was rectified. The speaker did not entirely agree that there was no relation between the dielectric strength and the insulation resistance. A cable having a dielectric of given dimensions would at a given temperature have a certain constant insulation resistance and a certain constant dielectric strength. Variations of insulation resistance would indicate corresponding alterations in the dielectric strength of the particular cable, because the former would be due to some deteriorating influence. Regarding the weight of the testing apparatus which was referred to in the Paper to the disadvantage of the alternating-current method, there was not enough detail to make a comparison with the Delon apparatus. There was no reference to the influence of the transformer voltage on the weight of apparatus, and this would be fairly appreciable. It was pointed out that the equivalent continuous-current value was 2·53 times the alternating current. Since the voltage given by the condensers was 2·8 times the alternating-current voltage of the transformer it followed that the transformer voltage would have to be about 90 per cent. of the corresponding transformer for alternating-current testing. The only advantage in size and weight of the transformer lay in the fact that it had only to be designed for a small current. Dimensions which were contingent on insulation requirements for high voltage applied equally in both cases. Fatigue of the dielectric did not enter into the testing of modern cables; at any rate sound dielectrics were not affected by pressures several times the working pressure, and the factors-of-safety employed ensured that the dielectrics were far removed from any such effects. The author had stated that observations in the case of continuous currents had not shown any of the phenomena of fatigue. This raised the question as to the nature of this fatigue, and it would probably be agreed that it was nothing other than the reaching of the limit of disrupture voltage of some component of the dielectric. The fatigue stage would, therefore, be far removed from any effect which could be brought about by such voltages as were likely to be applied to the cable under working conditions. The remark that manufacturers energetically opposed the repeated application of alternating pressure tests higher than the working pressure must surely refer to the dark ages of the industry. A manufacturer might show some disinclination to take the responsibility for a cable suffering from things over which he had no control, but otherwise it would not interest him very much if the cable was tested repeatedly at twice working pressure. The most important factor in connection with the continuous-current apparatus was whether it would satisfactorily burn out faults. Evidence was give in the Paper that faults produced by maltreating a cable with a hammer could be broken down and ultimately carbonised, but the conditions would be altogether different if the fault was due to moisture. Taking the case of a moist patch in a paper-insulated cable there would first be a general leakage through the wet patch and then a selective action of some accidental kind whereby a patch was selected in which the current density was

greater than in the surrounding bulk of wet material. Then more or less quickly, according to the power available and the current that could be passed through, it would dry up, heat and char. Wet cables were extremely difficult to break down, and the more water-logged the cable the more difficult the task. It would be interesting to know how the Delon apparatus would deal with such a fault.

Prof. E. W. MARCHANT said the relationship existing between the breakdown strength of material tested by direct-current and alternating current was one of the most remarkable phenomena met with in electrical work. A cable having a non-uniform dielectric would have an entirely different distribution of stress in the two cases, the continuous-current case depending upon the specific resistance of the material and the alternating-current case depending upon the specific inductive capacity. This was one of the reasons why the direct-current method of testing could not be regarded as entirely satisfactory. The ratio between strength of dielectric for continuous current and alternating current could not be assumed a constant quantity. Regarding the question of fatigue, a number of tests had been made at Liverpool on the dielectric strength of ebonite, with the object of determining the amount of fatigue. A special switch enabled a 50-cycle current to be applied for 0·1 second, this application being used as a gauge of the strength of the material. In order to identify fatigue another source of pressure was applied to the dielectric. In one series of tests it was found that ebonite about 0·5 mm. thick broke down after a pressure of 16 k.v. had been applied for a considerable time. An alternating pressure having a maximum value of 13 k.v. was applied for about 4½ hours, after which the material broke at 15·2 k.v. This seemed to indicate that the amount of fatigue in ebonite was extremely small. Further, even when the auxiliary pressure applied was as much as 95 per cent. of the actual ultimate breakdown pressure the observed fatigue was not more than 2 or 3 per cent. The fatigue referred to in the Paper was due to heating and not to dielectric strain. Rayner had shown that when nearing the point of breakdown of a cable the temperature of the dielectric rose suddenly with a great increase in consumption of power, and then breakdown followed immediately. The speaker had tried to find what might be styled "mechanical fatigue," but the tests had failed to reveal it. The speaker described a Wimshurst machine designed by Mr. Watson for direct-current testing and giving an output of 4 to 5 milliamperes at 150,000 volts. Mr. Watson had also designed a special voltmeter reading up to 100,000 volts. The instrument was of the reflecting type and was only a foot in diameter, the moving parts being arranged in a chamber filled with compressed air at 200 lb. per square inch pressure.

Mr. H. A. RATCLIFFE thought the continuous current test did not meet the requirements of a test under working conditions on alternating-current cables. The application of an excess alternating pressure at normal frequency was undoubtedly the correct method of testing alternating-current high-tension cables before being put into service, and where possible it was advisable before applying the excess pressure to warm up the cables for several hours by circulating through them the maximum load current. This could easily be done, using a suitable low-voltage transformer. Any test which ignored the effect of dielectric losses was necessarily incomplete. The speaker agreed that there was no definite relationship between "dielectric strength" and "insulation resistance," and judging from the results of recent research it was doubtful whether there was any direct connection between the two properties of an insulating material. The statement that at all ordinary temperatures the voltage which could produce the breakdown did not vary very much required some qualification. Certainly the dielectric losses increased appreciably with increase in temperature, and the effect of such increased loss was to reduce the dielectric strength of the material under test. It was difficult to obtain consistent and reliable comparative results on sheets of insulating material, but such difficulties should disappear to a great extent when testing several lengths of cable. Insulation resistance or excess pressure tests were in themselves insufficient, and in future all tests of any value would include accurate measurements of the dielectric losses. In the case of sample lengths tested at the manufacturers' works, the pressure should be applied for several hours, and if possible a superposed low-voltage current equal to the maximum load should be passed through the conductors, all tests being made at normal working frequency. Whilst a high insulation resistance was not necessarily an attribute of a good high-tension cable, it greatly facilitated the location of leaky joints and fittings. The difficulties of testing with alternating pressure seemed rather magnified, as 12 miles of cable would never be tested at 40,000 volts with portable equipment. Tests after laying were usually made in lengths of about a mile, and after locating defects and making the joints, excess pressure was applied to the full length from the generating station or sub station. Such a final test was required by the Board of Trade, and, despite the energetic opposition of the cable makers, it was likely to be repeated. The difference between figures given in the Paper served to emphasise the importance of testing with alternating pressure at working frequency, and the speaker could not understand how a continuous or static pressure could ever be regarded as the equivalent of an alternating one.

Mr. F. FERNIE considered that the curve in the Paper showing the relation between breakdown voltage (alternating current) and duration of test was not always true. A certain paper-insulated cable broke down under test at 91·5 kv., but when 90 kv. was applied to another portion of the same cable for some hours—in fact, until the temperature became constant—there was no breakdown. The pressure was again applied and raised steadily until 91·5 kv. was recorded, and the cable again broke down. Other cables tested at the same time gave similar results. Similarly, the statement regarding the decrease of breakdown voltage with increase of frequency was not true for frequencies below 100. Any decrease which did occur would certainly be under 5 per cent. Nearly all statements regarding dielectrics were to be accepted as true for a specimen rather than a substance. In view of the high factor-of-safety employed by most British cable firms it was surprising to note that manufacturers energetically opposed the repeated application of an alternating-pressure test higher than the working pressure; also the contention that a cable was often subjected to damage during laying was surely a myth. Regarding the ratio of alternating-current pressure to continuous-current pressure, dealt with at the end of the Paper, the speaker expected to find different factors for apparently similar cables if made by different firms.

Prof. A. B. FIELD suggested that the analogy of the steel test bar might be applied to the question of straining a dielectric. It would be interesting to know whether the dielectric stress very near the breaking point permanently changed the material a little, so that several repetitions of the stress would ultimately cause breakdown. Would the same approximate ratio of alternating and direct-current hold good in the case of a damaged cable?

Mr. H. D. SYMONS said the experiments described by Prof. Marchant confirmed his own experience with homogeneous materials. It would certainly be very interesting to know how the Delon apparatus would deal with a moisture fault, as this class of trouble was entirely different to that in the case of mechanical damage or of impurity or lack of homogeneity in the dielectric. It was important that means be adopted for discharging a cable after test.

Mr. J. H. C. BROOKING was surprised to know that the Delon apparatus, which had been practically unheard of until now, started its life as far back as 1910. Photographs or even working models would have been interesting to those desirous of more detail.

Mr. H. CRELLIN referred to the statement that the relation between dielectric strength and temperature was unknown. Test room experiments had shown that heating a cable to the temperature of boiling water did not perceptibly reduce the breakdown voltage. Granted that a change in power factor of the charging current involved a corresponding change in the breakdown pressure, according to Humann's experiments on the effect of temperature on the power-factor of actual cables, there should be an increase in the breakdown pressure of a well-made cable with an increase in temperature up to 50°C. This effect was quite apart from the effect of temperature on capacity, as the capacity would increase with temperature with consequent higher charging current, but not necessarily higher power-factor. The Delon apparatus would be well worth consideration as a check test after laying where alternating-current apparatus was unavailable. In the case of a cable damaged in laying, assuming the dielectric to be partially cracked so that it was composed partly of air and partly of impregnated paper, with continuous-current pressure the drop across the dielectric would be directly proportioned to the resistance of the layers. The pressure from the Delon apparatus being applied gradually to the cable, the leakage current through the cable would also gradually increase. Likewise the pressure across the crack would gradually increase, being fixed by the product of leakage current and resistance to surface leakage of the crack (until, of course, the dielectric actually broke down). It might easily happen with continuous pressure that the potential gradient would so adjust itself across the dielectric that the presence of a crack would remain undetected. On the other hand, with alternating pressure the voltage drop across the dielectric would be fixed by the capacities of the layers and not the leakage current. Impregnated paper had a dielectric constant approximately three times that of air, consequently as the potential gradient was inversely proportional to the capacity the alternating pressure would easily spark across the crack and so break down the fault.

Regarding repetition tests on continuous-current supply, some discretion was necessary if tests were made immediately after taking a heavy load off a cable, as the potential gradient through the dielectric might be completely reversed. Whereas a difference in temperature between the inner and outer layers of the dielectric tended to make the potential gradient through the dielectric more uniform with alternating pressure, a difference of temperature of but 10°C. would, with direct pressure, cause the outer layers to be stressed much more than the inner layers. Regarding the ratio of continuous-current to alternating-current pressures referred to in the Paper, it was not generally realised that the ratio of secondary to primary pressure of a transformer was considerably increased by the charging current of a cable due to the effect of the leading current on the magnetic leakage of the transformer. The charging current further affected the voltage of the generator, the leading current strengthening the field so enormously that for the same terminal voltage the existing current required to be very much smaller when the machine was supplying a leading current, as compared with a current near unity power factor. It was not clear whether the author's figures applied to the transformer only or included the whole circuit from the generator.

Mr. J. L. LANGTON said the Delon apparatus would have a good application to the testing of line insulators *in situ*. Some years ago the question of fatigue in porcelain insulators, which had been working for some time, had been investigated, and a difference of opinion arose as to whether the porcelain deteriorated in its chemical structure or on account of mechanical cracks having developed. The speaker's experience during the past year had shown that the cracks, which were due to temperature variations, expansion of cement, &c., were really the cause of the so-called fatigue in porcelain. Weak insulators on a system were very difficult to locate, but the Delon apparatus would probably be very useful for line insulator testing, the voltage employed being so much

greater than that generated by the usual megger. Such methods, however, would never supersede factory tests, as weak insulators, which would break down with the usual transformer test, would not be disclosed by the Delon apparatus. The smallest crack required alternate stress and heating in order to develop into a distinct fault. When stating that the measurement of the insulation resistance gave no indication of the dielectric strength, it was necessary to define the type of insulation referred to. Air, for example, had a very high insulation resistance and low dielectric strength, whilst a solid insulation of mineral origin had a much lower insulation resistance but very high dielectric strength. There was no relation between the two factors. In the case of a solid insulation of vegetable origin, however, there seemed to be some relation, as moisture was a predominant factor when present in fibrous material. An increase in temperature would drive out moisture and increase the insulation resistance, but diminish the dielectric strength. Regarding the effect of frequency on dielectric strength, the speaker's experience with solids of mineral origin showed no difference between 33 and 100 cycles. The measurement of potential differences up to 100,000 volts would involve a very cumbersome instrument unless compressed air were used as described by Mr. Watson. The speaker suggested the use of the spherical gap for high voltage measurement as this has been adopted as a standard method for measuring alternating-current high pressures.

Mr. H. Alcock referred to the statement that the tests in question were only intended to show up faults produced in laying cables. The provision of a metallic test sheath interposed between the conductor and lead sheathing already achieved this object, and further refinements seemed quite unnecessary.

Mr. J. W. Record thought the word "rectified" should be substituted for "continuous" in the title of the Paper. The success of the apparatus seemed to depend upon the two capacities forming the sides of the triangle being kept very small, in order to limit the current required to charge after each discharge. The use of the cables instead of small condensers might easily involve a transformer of 300 kva. capacity, such as required in testing with alternating current. If such a test as described should appear advantageous in future it could only be put into peration after some competent authority had established the relationship between continuous-current and alternating-current pressures. The author's figures might certainly be laid down provisionally.

The Author, in a brief reply, said that in the case of cables for voltages at present in vogue the margin of safety was so great that the question of fatigue was negligible. He cited a case where a 10,000-volt cable was subjected to 80,000 volts, after which the engineer had no qualms of conscience in testing at 20,000 volts, *i.e.*, double working pressure, every time there was trouble with the joints. With 50,000 or 60,000 volts the margin of safety was much smaller, and special precautions had to be taken. The author did not advocate replacing the alternating-current test altogether by the direct-current test. Refinements of all kinds could be introduced in the test room, but after laying it was unnecessary to make elaborate tests of the insulating material, the only check required being for mechanical damage and access of moisture, for which the Delon apparatus catered. The difficulty lay in getting cable makers and supply authorities to agree as to the ratio between alternating-current and direct-current voltages for any particular material. One of the main objections raised seemed to be the question of power. This was not so small as it might appear. The capacity of the transformer was 3 kw., and of course this 3 kw. was actually effective power in the case of the direct-current test. Considering the extremely low power-factor, in the case of the alternating-current test it would be obvious that, in spite of the large capacity of the testing transformer, the effective power would be very small. It was unfortunate that photographs which were submitted with the Paper were not suitable for reproduction in the "Journal."

CORRESPONDENCE.

A PERMEAMETER FOR STRAIGHT BARS.

TO THE EDITORS OF THE ELECTRICIAN.

In their interesting Paper on the magnetic testing of straight bars, reproduced in abstract in your issue of February 4th, Messrs. Campbell and Dye state that for certain tests the simplest method of determining H is to withdraw or reverse a small search coil placed alongside the bar at its centre ("J." I.E.E., December 1, 1915, p. 42). Without any knowledge of their work, and before I had read their Paper, I had come to the same conclusion, and some time ago I had a permeameter constructed on the withdrawable-search-coil plan for the ballistic testing of straight steel rods for retentivity and coercive force.

In my apparatus—which was put together in a hurry, and could certainly be improved in several respects—the magnetising coil is in two parts (MM, Fig. 1), separated by a gap, G, to allow of the introduction and withdrawal of a narrow "H" search coil. This search coil is either U-shaped or V-shaped, according as the test bar is round or square, and is placed astride the bar at its centre in the manner shown in Fig. 1. The "B" coil, as usual, embraces the bar at its centre, or is wound in two sections displaced a little to either side of the centre.

To ensure that the field in which the "H" coil lies is as uniform as possible in a radial direction, the inside diameter of the magnetising coil is made considerably greater than the diameter of the test bar. In the actual apparatus the coils M are 4 in. long, 1 in. inside diameter and 3 in. outside diameter, while the test bar is $\frac{3}{8}$ in. diameter.

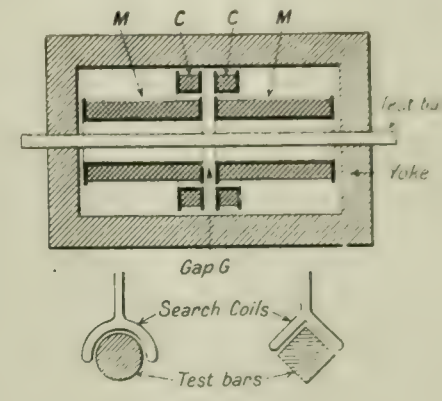


Fig. 1.

It is an obvious criticism of my arrangement that the uniformity of the magnetising field is disturbed near the gap. One merit of the search coil method of measuring H, however, is that the magnetising field need not be uniform except in the immediate neighbourhood of the "B" and "H" coils. The curves of Fig. 2, moreover, show that it is possible to have a gap sufficiently wide to admit a narrow search coil and yet leave the field substantially uniform over a length of from

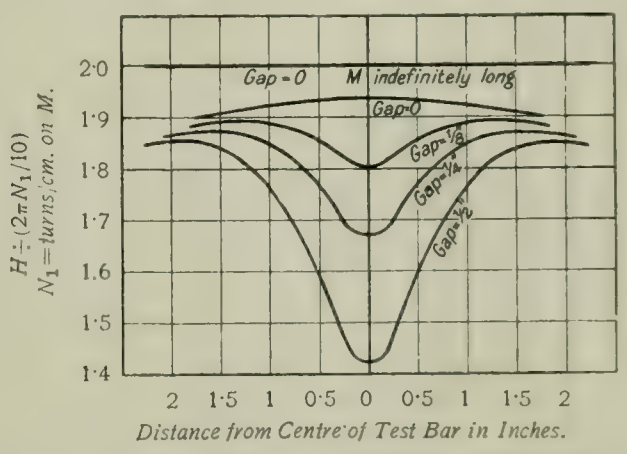


Fig. 2.—Magnetising Force along Axis of Test Bar due to Coils M alone.

$\frac{1}{2}$ in. to $\frac{3}{4}$ in. at the centre of the test bar. Fig. 2 represents the variation of the applied field—that is, the field due to the magnetising coil alone; but as the test bar in my apparatus is fairly long the true or resultant field in which demagnetising actions are taken into account is not likely to be much less uniform near the centre of the bar.

If desired, the region of uniform H can be extended by the use of properly adjusted compensating coils, CC, in series with

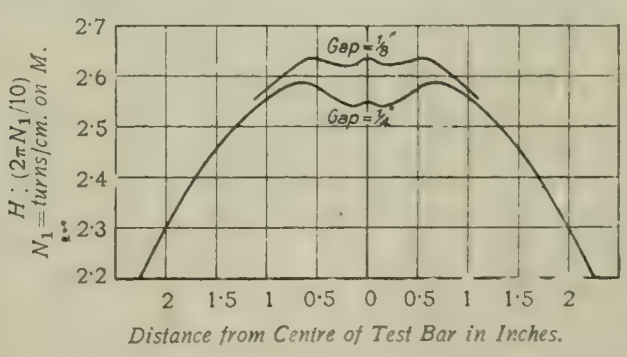


Fig. 3.—Magnetising Force along Axis of Test Bar due to Coils M and C acting together. The Latter are One-quarter the Length of the Former, and are Wound to the Same Depth.

the coils MM. The effect of these compensating coils in levelling up the field is seen in Fig. 3. It should be possible by the proper spacing of several such compensating coils, or by varying the winding depth of the main coils MM from point to point, completely to annul the disturbing effect of the gap

and to secure a practically uniform applied field over a large fraction of the length of the bar.

An objection to the search coil method of measuring H is that it reveals the magnetic properties of the specimen at one section only. To get an average result a test bar a few inches longer than is necessary should be used, and measurements made at several different cross-sections by sliding the test bar along $\frac{1}{2}$ in. or so between successive tests.

In all but specially accurate tests a fluxmeter may be used in the "B" coil circuit with advantage. The procedure in determining the residual induction B_r and the coercive force H_c is then greatly simplified. Reversing the maximum magnetising current with the fluxmeter shunted so as to reduce its sensitiveness to one-half gives B_{max}. The shunt is then removed and the magnetising coil circuit broken. The remaining deflection measures B_r, subject, of course, to correction for any small demagnetising force that may exist. Finally, the magnetising current is reversed and gradually increased till the fluxmeter returns to its initial position, when the "H" coil is withdrawn and the resulting throw measures H_c.

Manchester University, Feb. 21. ROBERT BEATTIE.

CITY GUILDS SUBJECT "ELECTRIC WIREMEN'S WORK."

TO THE EDITORS OF THE ELECTRICIAN.

I have read with interest the letter under the above heading from Messrs. A. P. Lundberg & Sons.

The most important feature missing from the letter is the fact that the classes do not attract the men engaged in this section of the electrical industry. The bulk of the students with whom I have come into contact are invariably engaged in occupations outside the scope of electric wiremen's work.

There are indications of considerable modification in the subject matter of the syllabus, which it is hoped will bring the tuition in the classes into line with the requirements of so-called "wiremen," and thereby encourage larger classes and more candidates in the examinations. In addition, electrical contractors should interest their employés in technical training and the advantages appertaining thereto.

London, Feb. 29. W. ELLERD-STYLES.

LEGAL INTELLIGENCE.

Attewell v. West Ham Corporation.

Last week defendants unsuccessfully appealed to a Divisional Court (Ridley and Avery) against a verdict and judgment at Bow (London) County Court in favour of Mr. H. E. Attewell, electrical engineer, for £350 damages for personal injuries received through the negligence of the Corporation's servants. Plaintiff's case was that he was working at a h.t. chamber when an explosion occurred, with the result that he was severely injured. West Ham Corporation appealed on the ground that there was evidence of contributory negligence, but Counsel for respondent took the preliminary objection that the appeal was out of time and that all the grounds of appeal were inadmissible. The Court upheld the preliminary objection and dismissed the appeal with costs.

Breach of Mining Regulations.

At Merthyr on Friday last Mr. H. Thomas, manager of the Hills' Plymouth Co.'s Graig Collieries, and Mr. W. W. Green, agent to the collieries, were summoned for nine alleged offences against the Regulations for the Use of Electricity in Mines.

Mr. A. VACHELL, who prosecuted on behalf of the Home Office, explained that at the collieries in question (Nos. 1 and 2 South Pits) there was a very extensive electrical plant with over 20 miles of cable and 26 motors. The plant was one of the oldest, and was getting very antiquated. In August last there was a non-fatal accident at the collieries, and one of H.M. inspectors made an examination and found the plant was "extremely neglected" and was in "a very dangerous condition." No doubt the excuse would be made that in these times of war it was impossible to get the cable put right, but "there is nothing to justify the state in which it was found."

Mr. W. J. CHYNOWETH, Inspector of Mines, said that when he called Mr. Thomas's attention to the condition of the cable he said he had no idea it was in such a bad state, and he quite agreed that it was unfit for use.

In examination he said he understood the company was trying to comply with the rules; it was gradually putting in armoured cables and replacing old cables.

Mr. W. W. GREEN said he had been for 12 years agent to the Hill's Plymouth Collieries. He was not aware of any breach of the regulations in regard to the electric apparatus in the mine. There was now a great difficulty in obtaining cables. The cables were from time to time damaged by falls of roof, &c., and there were exceptionally bad roofs in those collieries, probably the worst in South Wales. The overlying strata were very weak and saturated with water. Probably those mines were the wettest in Wales, and possibly in the Kingdom. The difficulty was not only that the water was in the bottom, but it was in the roof as well.

Mr. H. THOMAS, manager, gave evidence, and said the company was gradually introducing new plant. The electrician had reported from time to time up to Oct. 7 that the insulation was good. It was impracticable for witness to follow the electrician step by step to see that he was doing his duty.

The cases were adjourned until a date to be mutually agreed upon.

Kingstown Provisional Order Litigation.

Last week the Irish Court of Appeal dismissed the appeal of the Dublin Southern District Electric Supply Co. from a decision of Mr. Justice Barton refusing an application for an order directing the Taxing Master to tax the costs of the company against the Urban District Council of Kingstown, referred for taxation by order of the Court on March 31 last on the scale provided by the Acts for the taxation of Parliamentary costs, or, in the alternative, directing that the costs should be taxed as Chancery costs on the higher scale. The question arose out of the arbitration award made by Mr. S. L. Brown, K.C., dated Feb. 11, 1915, in an arbitration between the Kingstown Urban Council and the Dublin Southern District Electric Supply Co. in connection with the transfer of the Kingstown electric lighting order.

The LORD CHANCELLOR said their view was that the appeal should be dismissed with costs; but as some questions of general importance had been raised in the case they would give their considered judgment at a later date.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1913 SPECIFICATIONS.

20,856 ZIVNOSTENSKA BANKA (FIRM OF). Telephone exchange systems. (28/10/12.)

1915 SPECIFICATIONS.

97 TAYLOR & GRAY. Recording and transmitting instruments.

1,087 COOLEY. Telephone systems. (23/1/14.)

1,435 J. STONE & CO. & DARKER. Dynamo-electric machines and electrical systems connected therewith.

1,471 RELAY AUTOMATIC TELEPHONE CO. (formerly Betulander Automatic Telephone Co.) & BYGRAVE. Automatic and semi-automatic telephone systems.

1,500 GRIGSBY. Lamp supports and casings, particularly designed for use with electric incandescent lamps.

1,545 LEACHMAN & CHAMBERLAIN. Flashlight advertising devices.

1,857 SIGNAL GES. Submarine electric leakage telegraphy. (5/2/14. Addition to 13,919/13.)

Consists in reducing the internal resistance of the sending equipment by reducing the resistance of the conducting parts, so that the resistance of the entire circuit of the sending equipment in the ship is comparable in its order of magnitude with the resistance of the short-circuit formed by the ship's hull.

2,078 STILES & PERL. Coin-freed electric illuminating apparatus.

2,343 AUTOMATIC TELEPHONE MFG. CO. & SMITH. Telegraph or like systems and apparatus therefor.

2,624 SUNDERLAND FORGE & ENGINEERING CO., SCOTT & ROBERTSON. Rotors of dynamo-electric machines.

2,687 SUTTON & SUTTON. Electric batteries.

4,209 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Rheostats.

Consists of a rheostat provided with an insulating base having a flat face, a resistance [illegible] upon the flat face of said base, [illegible] secure said resistance and contacts in position thereon.

5,224 ROBERTSON & LENNOX. Electrically-operated reversing mechanism for planing-[illegible].

5,261 LYON. Device for testing the actual available working current in electric batteries or cells.

5,513 OLDHAM. Miner's electric safety lamps.

[illegible]

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	783	"Lektrik" Switches. Illustrated	150
Imports and Exports of Electrical Manufactures	784	The "Diffusa" Anti-Aircraft Light Screen. Illustrated.	151
Business Notices	784	Gyratory Foundry Riddle. Illustrated	151
Bankruptcies, Liquidations, &c.	784	B.T.-H. Incandescent Electric Lamps	152
Electricity Supply	784		
Lighting and Power Notes	785	Tenders Received & Accepted	788
Traction Notes	785	Municipal Accounts	788
Empire Notes	786	Companies' Meetings and Reports	788
Foreign Notes	786	New Companies, &c.	791
Miscellaneous Notes	786	City Notes	791
Tenders Invited	787	Electrical Companies' Share List	792
The Round Table	147		
Kohler Printing Press Control System. Illustrated	148		

COMMERCIAL TOPICS.

Relations between Capital and Labour. From day to day schemes for the capture of German trade, for the expansion of our foreign trade after the war and other desirable objects are being launched, but we have not noticed that any particular thought or attention is being paid to the conditions which are likely to exist when peace prevails once more, or to the very important question of the relations between capital and labour. To capture German trade or to maintain our present position in the foreign markets will require more strenuous work, and closer and more harmonious relations between employers and employed than have existed in the past. It is with pleasure that we notice this important aspect of the question has been dealt with by the Right Hon. Sir Wm. Mather, chairman of Messrs. Mather & Platt, at the recent meeting of the company. We reproduce lengthy extracts from Sir Wm. Mather's speech, which we consider to be an eminently practical and commonsense contribution to a subject of vital importance to us as an industrial nation. He advocates the re-organisation and co-ordination of capital and labour, better training and education, profit sharing, &c. There is no one who is better qualified to speak with authority on these topics than Sir Wm. Mather, because the company of which he is the chairman is one of the most modern, progressive and best-managed firms in the country, and in the past it has made interesting experiments in connection with labour which should prove advantageous to it in the strenuous times which are in front of us. We recommend our readers to peruse the abstract of his speech which we give in another column.

* * * *

"The Necessity of Gas." We think that the following extract from a letter by Mr. Sidney O. Stephenson, published in the "Worthing Gazette," reveals a state of mind which we trust is not common in gas circles at the present time. The italics are ours :—

In your current issue I notice a paragraph to the effect that electric light is to be installed at the Grange at a cost of £58. 10s., and appealing for contributions towards the cost. It is a little item which is peculiarly indicative of the indifference displayed by the country generally towards the seriousness of the war in which we are committed to fight for our very existence as an independent nation.

The big toll in the wastage of our men's lives was in the main due to the want of high explosive shells. The high explosive is tri-nitro-toluol. The great source of toluol is coal, and it is obtained from coal by destructive distillation. Two industries are carrying out this work : (*a*) The coke ovens, and (*b*) the gas works, the latter being the greater.

Now, both these industries are carrying out this work for the Government loyally and well, and not only doing it without profit, but at a distinct loss to themselves. The position is this, that we have not only got to keep our own army supplied, but those of our Allies as well.

Every installation of electricity at the present time, if it is displacing gas, has to be paid for in the blood and lives of our soldiers and those of our Allies. Incidentally, it is prolonging the war and heaping up the indebtedness and taxation of the country.

The Government have already spoken out and given good advice, but I fear they do not speak with a loud enough voice. They have asked through the Press and otherwise for the use of gas as far as possible, to enable them to obtain the toluol they require. They have asked that money should not be spent on luxuires, and that money should not be spent which will go out of the country if it can be avoided.

Now, let us see how this advice is regarded in the case of the Grange. The installation of electricity is obviously a luxury, for it could have been done without quite conveniently till after the war, and, thirdly, a large portion of the money so spent of necessity goes abroad. And subscriptions are asked for this purpose. Surely there are many worthier objects to subscribe to just now. And the irony of it is that the Grange is at present a convalescent home for wounded soldiers.

Mr Stephenson is the manager of the Worthing gas undertaking, though he does not sign himself as such. Does the British Commercial Gas Association approve of this sort of thing ?

* * * *

Public Lighting Contracts. The judicial decision in the recent case of the Leiston Gas Company against the Leiston-cum-Sizewell Urban District Council was referred to at the recent meeting of the Association of Municipal Corporations, and the matter was referred to the Law Committee for further consideration, with instructions to take such steps on behalf of the Association as it might deem advisable in the interests of Councils which are parties to similar agreements, including, if practicable, an appeal against the decision in the case referred to.

* * * *

Trade after the War. Various questions connected with trade after the war were discussed at the meeting of the Association of Chambers of Commerce of the United Kingdom, which commenced on Tuesday, and notices of resolutions had been given urging the Government (1) to establish a department of commerce and industry and to appoint a Minister of Commerce with Cabinet rank ; (2) to consult the Dominions on the trade problems arising from the war and the regulation of trade relation, with enemy countries ; (3) to inquire into the desirability of protecting those industries in the country which since the beginning of the war have been engaged in the manufacture of articles formerly made in enemy countries ; (4) to consider the question of reciprocal trading relations between all parts of the British Empire and Allied countries, with favourable treatment for neutrals, and to render impossible a return to pre-war conditions with the enemy ; (5) to reorganise the consular service with the view of providing better facilities for the maintenance and expansion of the trade of the Empire ; (6) to consider the present banking system in this country with the view of ascertaining whether steps can be taken further to encourage industrial enterprise. The resolutions were carried with some slight amendments.

In this connection the speech delivered by the Chancellor of the Exchequer (Mr. R. McKenna) at the luncheon given by the Association on Tuesday is of considerable interest. In the course of his remarks he said that we must learn by the experience of the past. We had seen a nation which in profound peace planned, prepared for, and eventually provoked war. We had found ourselves dependent on that nation for many essential matters of our own trade. He did not think that as a nation, whether by the individual efforts of our traders or with the necessary assistance of the Government, we ought ever to allow ourselves to be placed in that position. It did not follow, though trade may be free, that the help of the Government should not be given to assist our traders. "We are prepared, and we have already shown in a way which I am not yet able to state to you that we are prepared, to give the assistance of the Government to the development of foreign trade in order to ensure that those rivals who are now our bitter enemies shall not have the control of foreign trade which they have enjoyed in the past." He did not fear that the spirit and resources of our manufacturers and merchants and bankers would fail us. In the past there has been some complaint that the Government had not given the assistance in distant parts of the world which was rendered by other Governments in similar circumstances. It might be that the policy which was right at one time was not right at another. And it might be that we had to learn that the policy of Government assistance became necessary to procure the development of what might be called the master trades and to secure the extension of our commercial influence through neutral countries.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 21, 1916, *to* Feb. 28, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE.—*France:* Elec. glow lamps, 5 pkgs.; unenumerated, 22 pkgs.
GRIMSBY.—*Denmark:* Carbon electrodes, 75 pkgs.
LIVERPOOL.—*U.S.A.:* Electrodes, 160 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £1.740; carbon candles, £283; elec. lamps, £2,452; batteries, £1,719; wire and cable, £6; unenumerated, £3,245—160 pkgs. *Holland:* Elec. lamps, £4,173—72 pkgs.; elec. wire and cable, £670; elec. machinery, £190. *France:* Carbon candles, £283; unenumerated, £36. *Switzerland:* Carbon candles, £531 unenumerated, £536. *Italy:* Wire and cable, £2,201 pkgs. *Japan:* Unenumerated, £185. *Sweden:* Unenumerated, £363.
SOUTHAMPTON. *France:* Unenumerated, 40 pkgs.

EXPORTS

TO AUSTRALASIA. *Auckland:* Elec. machinery, £33; unenumerated, £298. *Melbourne:* Wire and cable, £1,537; elec. machinery, £435; unenumerated, £3,380. *Sydney:* Elec. machinery, £97; telegraph material, £195; unenumerated, £662. *Wellington:* Wire and cable, £2,186; elec. machinery, £130; unenumerated, £495. *Adelaide:* Elec. machinery, £289; unenumerated, £359. *Perth:* Wire and cable, £37; unenumerated, £327. *Christchurch:* Wire and cable, £52; unenumerated, £90. *Dunedin:* Wire and cable, £676; unenumerated, £158. *Lyttelton:* Elec. machinery, £150; unenumerated, £154.
AFRICA.—*Durban:* Elec. machinery, £89; wire and cable, £2,001; unenumerated, £1,253. *Cape Town:* Submarine telegraph cable, £600; unenumerated, £2,219. *Port Elizabeth:* Unenumerated, £289. *Beira:* Unenumerated, £82. *East London:* Wire and cable, £20; elec. machinery, £120; unenumerated, £78. *Mombasa:* Unenumerated, £19.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £1,244; elec. machinery, £4,495; telegraph material, £29; unenumerated, £766. *Monte Video:* Unenumerated, £58. *Rio de Janeiro:* Unenumerated, £31. *Pelotas:* Wire and cable, £29. *Santos:* Unenumerated, £56. *Bahia:* Unenumerated, £32.
HOLLAND.—*Amsterdam:* Unenumerated, £52.
RUSSIA.—*Petrograd:* Elec. machinery, £257; unenumerated, £307.
U.S.A.—*New York:* Unenumerated, £117.
GIBRALTAR.—Telegraph material, £75.
EGYPT.—*Alexandria:* Telegraph material, £143; unenumerated, £228. *Aden:* Telegraph material, £21; unenumerated, £10. *Suez:* Unenumerated, £37.
WEST INDIES.—*Barbados:* Unenumerated, £44. *Dominica:* Telegraph material, £73.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Elec. machinery, £42; wire and cable, £751; unenumerated, £1,194. *Calcutta:* Elec. machinery, £42; wire and cable, £1,210; unenumerated, £558. *Singapore:* Elec. machinery, £25; unenumerated, £258. *Ceylon:* Unenumerated, £59. *Madras:* Elec. machinery, £780; unenumerated, £55. *Karachi:* Elec. machinery, £170; unenumerated, £336. *Kilindini:* Telegraph material, £21; unenumerated, £10. *Bankok:* Unenumerated, £425.
CHINA.—*Shanghai:* Unenumerated, £451. *Hongkong:* Unenumerated, £50.
JAPAN.—*Tokio:* Unenumerated, £547.
FRANCE.—*Paris:* Unenumerated, £730. *Bordeaux:* Elec. machinery, £50; unenumerated, £90. *Boulogne:* Unenumerated, £2,454. *Marseilles:* Unenumerated, £976. *Rouen:* Unenumerated, £164. *Treport:* Elec. machinery, £2,029.
DUTCH GUIANA.—*Para Maribo:* Wire and cable, £151.
SWEDEN.—*Stockholm:* Unenumerated, £170. *Landskrona:* Unenumerated, £93.
SOUTH SEA ISLANDS.—*Fiji:* Telegraph material, £136; wire cable, £13; unenumerated, £81
NORWAY.—*Christiana:* Unenumerated, £170. *Trondhiem:* Unenumerated, £275.
MALTA.—Elec. machinery, £27.
PORTUGAL.—*Lisbon:* Wire and cable, £72; unenumerated, £512.
ITALY.—*Genoa:* Unenumerated, £142.
SPAIN.—*Bilbao:* Unenumerated, £101. *Cadiz:* Unenumerated, £17.
PORT MADRYN.—Telegraph material, £111.

FOREIGN GOODS (duty paid and free).

Melbourne: *Unenumerated*, £541. *New York:* Unenumerated, £128. *Bombay:* Unenumerated, £381. *Perth:* Unenumerated, £91. *Bankok:* Unenumerated, £188 *Barbados:* Unenumerated, £22. *Cape Town:* Unenumerated, £33. *Lisbon:* Unenumerated, £420. *Singapore:* Unenumerated, £29. *Boulogne:* Unenumerated, £13. *Port Elizabeth:* Unenumerated, £11. *Sydney:* Unenumerated, £150. *Wellington:* Unenumerated, £25.

IN TRANSIT.

Bombay: Elec. lamps, £376. *Karachi:* Elec. lamps, £105. *New Plymouth:* Elec. glow lamps, £800.

NOTE. The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

Mr. J. Martin Blair, engineer and manufacturers' representative, has removed to Central House, Kingsway, London, W.C.

Electrical Apparatus for Sale. Messrs. Isenthal & Co. advertise for sale a small electric range and an electric oven, both for 240 volt circuits.

Increase of Prices. The Benjamin Electric (Ltd.), 14, Rosebery-avenue, London, E.C., notify that, owing to further increases in costs of raw material, particularly metal, they are compelled to increase the advances in the lists of certain of their lines as from March 1.

On catalogue Nos. 2 to 93 and 400 to 610 inclusive, 50 per cent. instead of 25 per cent. increase. On other numbers an increase from 20 to 25 per cent. is made, except in regard to Nos. 8,111 to 8,244, on which the increase is 33⅓ per cent. instead of 20 per cent. On other prices not set out in the notice the existing rates will apply.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Geo. J. T. J. Parfitt, consulting electrical engineer, of Keynsham, application was made at Bristol Bankruptcy Court on Friday last for the discharge of the bankrupt.

The Official Receiver stated that the liabilities expected to rank would probably amount to £3,119. 1s. 1d., and assets had realised £97. 6s. 1d. Failure attributed to giving guarantees for the Bristol International Exhibition and to loss of business caused by the war. The discharge was granted, subject to two years' suspension.

A meeting to receive an account of the winding up of the Renew Electric Lamp Co. will be held at 6, Old Jewry, London, E.C., on March 29.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bolton.—The electricity department has received several applications for electric current for power, and it has been decided to appoint a special committee to confer with the Finance Committee on the question of capital expenditure involved.

Bridlington.—The L.G. Board have refused to sanction the proposal of the Council to erect a refuse destructor on a site adjacent to the electricity works.

Heston and Isleworth.—Application has been made to the L.G. Board by the Council for sanction to borrow £175 for main extensions.

Ipswich.—The L.G. Board have sanctioned the borrowing of £3,100 for coal-handling plant.

Leigh (Lancs).—The Council have applied to the L.G. Board for sanction to borrow £18,300 for extensions of the electric supply undertaking £65,713 has already been expended on the works.

Luton.—It was reported at the last meeting of the Council that the L.G. Board had sanctioned the use of a part of the highways depot as a site for a new cooling tower, and had also authorised the borrowing of £30,327 for electricity supply purposes.

The electrical engineer (Mr. W. H. Cooke) reported that since Jan. 6 1,183,219 units had been generated for general supply and 20,665 units for traction, and the equivalent of 478 8 c.p. lamps, four motors of 7½ H.P., and 7 kw. in heating connected, making a total of 1,899 consumers with 71,164 lamps, 1,105 motors of 6,341½ H.P. and 1,528½ kw. in heating. The units generated for general supply showed an increase of 54 per cent. over the number generated during the corresponding period of 1915, and that there are at present applications in for over 4,807 additional lamps, 657 H.P. in motors and 575 kw. in heating.

Stirling.—The Secretary for Scotland has authorised the borrowing of a further sum of £3,000 for the electric supply undertaking. The Council have decided to borrow £1,000 for urgent extensions.

Woolwich.—In regard to the Borough Council's application for a loan of £3,622 for mains, transformers, switchgear, &c., the Finance Committee of the L.C.C. has agreed to recommend sanction to the borrowing of £3,290 only, subject to Treasury approval.

The Borough Council has now decided to accept the reduced sanction, and to charge the £332 to revenue (special expenses) account.

Mr. E. W. Martin, assistant distribution engineer, is to be promoted to the position of distribution engineer, at a commencing salary of £170 a year. The salary of Mr. Penning, deputy electrical engineer, has been increased to £250 a year.

GENERAL.

Bingley. At the last meeting of the Council the Electricity and Tramways Committee recommended that the question of increasing the price of current for lighting be deferred for 12 months.

An amendment was moved that the charge for electrical energy be increased by ½d. per unit for both power and lighting. On a vote being taken an equal number of members voted for and against the amendment and as the Chairman gave his casting vote against it, the amendment was lost.

Blackpool. The output of electrical energy during January was 434,125 units, an increase of 243 units.

Last month the output for lighting was only 2,000 units, compared with 15,868 units in January, 1915. There have been 214 new consumers during the last 10 months.

Kingstown. An inquiry was held here last week into the application of the Council for sanction to borrow £6,000 for paying the amount of the arbitrator's award and costs connected with the transfer of the undertaking authorised by the Electric Lighting Order of 1914.

There was no opposition, and Mr. P. O'C. White, who appeared for the Council, said there were special clauses in the Act which was owing to the fact that the provisional order was promoted by a company, the Dublin & Southern Districts Electric Supply Co., and not by the Kingstown Urban Council. It was agreed that the undertaking should be

transferred within a certain time at a sum to be ascertained. The parties did not agree to the sum to be paid for the undertaking, and it went before an arbitrator, who made an award. The Council had to raise the money to pay the amount of the award, and it was to pay off that loan that the Council made the present application.

Leeds.—At the meeting of the City Council on Wednesday it was decided to increase by 10 per cent. the charges for the supply of electricity as from the 31st inst.

London Electricity Supply Charges.—The Charing Cross, West End & City Electricity Supply Co. have applied to the Board of Trade for their consent to an increase of 10 per cent. on the charges for lighting during the period of the war and for 12 months afterwards or for such period as the Board may determine.

Salford.—The Council have applied for sanction to a loan of £2,016 for the electric supply department.

Surbiton.—At the last meeting of the Council it was reported that the transfer of the electricity undertaking to Callender's Cable & Construction Co. had been completed.

The purchase money (£51,732. 1s. 10d.) will be paid in instalments as set out in the schedule to the agreement, and already the Council has received a cheque for £4,100. 14s. 7d., representing the previous losses on the undertaking, interest to date, instalment of purchase money, &c.

LIGHTING & POWER NOTES.

Asylum Lighting.—At the last meeting of the Joint Committee of the Richmond (Dublin) Asylum, it was stated that the cost of electric lighting for 1915, compared with the cost of gas lighting in 1911, showed a saving of £798, or practically 50 per cent.

The Committee's report stated that the saving was really much greater than the figures showed, because since 1911 new ranges of buildings had been completed and occupied, a bakery had been erected and the lighting and power for same was included in the 1915 cost. Fifteen new cottages had also been erected and the Finance Committee were pleased to report such substantial economy.

Bellingham.—The Rural Council have approved of an electric lighting scheme for the village.

Electric Lighting in Trains.—At the recent meeting of the Caledonian Railway Co. the chairman, Sir Charles Renshaw, referred to the Gretna Green disaster, and said the company was continuing to fit electric lighting into all their new carriage stock, and to provide tools and appliances for extinguishing fires that might break out in a wrecked train.

At the meeting of the North Eastern Railway Co. the chairman (Lord Knaresbrough) referred to the recent Jarrow accident, and to the suggestion of the jury that the use of gas on trains was dangerous and ought to be discontinued.

He said the question of carriage lighting had on several occasions engaged the attention of the directors during the last few years, and all new stock, as well as East Coast joint stock, had been fitted with electric light. At the same time, schemes had been approved for reducing the number of gas cylinders on much of the existing stock, and by strengthening the cylinders and improving their position, reducing the risk of fire as far as possible. The question of taking further steps in that direction was under the consideration of the board when the war broke out, when in view of the depletion of their staff, it was postponed. The whole question would be carefully considered in the light of the evidence given in connection with the accident.

Maidstone.—It has been decided to reduce the price of electrical energy for heating to 1d. per unit from April 1.

Public Lighting Contracts.—At the last meeting of Barton-on-Humber Council it was reported that though the public electric lamps had not been lit for a long time the local electric supply company had sent in a bill for £140 for a half-year's lighting.

Last month the Council offered to pay 50 per cent. of the amount, but the company refused, and demanded 90 per cent., threatening proceedings. It was now decided to appeal to the L.G. Board for advice and to ask that legislation be introduced to deal with such cases.

Skibbereen (Cork).—The Urban Council has announced that it will give every facility for the introduction of electric lighting in the town.

Stoke-on-Trent.—At the last meeting of the Electricity Supply Committee, Ald. Leese referred to the fact that some consumers had got an idea that they could do anything they liked with regard to the electric light fittings in their premises, and that they could alter them if they chose.

He said he wanted it known by everybody that the Committee would take the matter into court if it occurred any more. Anyone wishing to alter their lighting arrangements must give notice to the department of what they wished to do, because some of them had made alterations, and when the department had the matter brought to their notice they had found things totally wrong.

TRACTION NOTES.

Belfast.—At the meeting of the Tramways and Electricity Committee on Monday it was announced that Mr. A. Nance would retire from the general management of the Corporation Tramways, but would be appointed consulting engineer to the undertaking at £500 a year.

Birmingham.—Owing to a shortage of motormen the general manager (Mr. A. Baker) has been asked to report upon the success of trailer-cars in the London area.

Interruptions of the Corporation tramway service took place on Monday. The first stoppage was of about an hour's duration. The supply of current from Summer-lane generating station failed at five minutes to three in the afternoon, and was not resumed until about four o'clock. Shortly after half-past four there was another failure of current for about half an hour. The official explanation of the Electricity Supply Committee was that, owing to the bad weather of the last few days, the supply of coal had been seriously curtailed. In consequence the coal stocks had been practically exhausted, and until adequate deliveries of fuel were received it would be necessary to discontinue the supply of electricity until sufficient coal had been accumulated to enable the supply to be resumed.

Blackpool.—It is proposed to discontinue the parcels express service on the tramways after April 1, as the year's experiment has not proved successful.

Electric Traction on Suburban Railways.—At the recent meeting of the L. & N.W. Railway Co. the chairman (Sir G. Claughton, Bart.) stated that during the past year they had expended £832,462 on capital account.

This sum included £143,500 advanced to the London Electric Railway Co. as part of the £1,000,000 which they agreed to lend that company in connection with the construction of the new extension of their line from Paddington to Queen's Park, the total amount at present advanced being £642,416. Of the total amount expended on capital account £651,625 was in connection with the Euston & Watford Electric Railway. The further amount estimated to be expended this year was £928,000, of which £630,000 was in connection with that railway. The extension of the Bakerloo Tube to Queen's Park was opened in February of last year, and, pending the opening of the through route to Watford, arrangements were made whereby certain of the tube trains had, since May last, run through from Queen's Park to Willesden, where connection was made with main line and local London & North-Western trains.

At the meeting of the L. & S.W. Railway Co. last week, Sir W. Wyndham Portal, Bart. (who presided), stated that the total net revenue was only £2,000 less than in 1914.

As the ⅛ per cent. reduction in the ordinary dividend meant £18,000, they had a surplus of £7,000 to add to the balance carried forward. On the electrification of their suburban services, up to the end of last year they had spent £970,000. Owing to the war progress had been very slow, and it was not until October last that they had been able to start the section of the line from Waterloo to Wimbledon via East Putney. A month ago they opened the "roundabout" service via Richmond and Kingston and the Shepperton line, and early in March the service to and from Hounslow would be commenced. There only remained the service to Hampton Court and Claygate, completing the whole of the scheme they had in hand. The contractors supplying the generating machinery for the power house were unfortunately very much behindhand, so that another three or four months might elapse before they would be able to electrify the last two remaining services. The delay in the completion of the power house had caused them to conduct their work under very serious difficulties, and one of the results was that they were getting a certain amount of overcrowding in the electric trains on the "roundabout" services during the morning and evening rush hours. It was early to give any figures, but, comparing the week just prior to the opening of the "roundabout" electric with the second week after the service commenced, there was shown an increase of no less than 16 per cent. in the bookings. He thought that was a happy augury for the ultimate success of their new system.

At the meeting of the North London Railway Co. last week the chairman (Lord Rathmore) said that, owing to adverse circumstances the hopes which had been expressed in regard to the electrification of the line had not yet been realised.

The electrification was part of the greater scheme for the electrification of the London & North Western suburban lines, and the directors of the London & North Western Co. were keenly desirous to commence the service as soon as possible. Owing to difficulties which were still being experienced with regard to obtaining electrical plant and also with respect to technical labour, difficulties due principally to the war, they were at present unable to fix a date when it would be possible to run a through service of electric trains between Watford and Broad-street. It was hoped, however, by Sept. next to work the present service between Broad-street and Kew and Richmond by means of electric trains, but probably not the more frequent service they intended ultimately to supply.

At the meeting of the London, Brighton & South Coast Railway Co. last week the chairman (the Earl of Bessborough), in moving the adoption

of the report, said the main item of capital expenditure last year was the sum spent on the equipment of the suburban lines for electric traction. The war necessitated a temporary suspension of part of that work, as well as certain rearrangements with the contractors, which would have the effect of prolonging the period within which the work was to have been completed. They were now, however, steadily proceeding with it in the hope that when normal conditions returned the scheme to which the proprietors had given their approval might be sufficiently far advanced to enable them to obtain at once some part, at any rate, of the benefit they had every reason to expect. While on the subject of electrification, he would like to say that the existing services were working most satisfactorily and giving excellent results. Recent statistics showed that last year there was an increase in the number of passengers carried by those services of nearly 70 per cent. over those carried in the last years of steam traction, and since their inauguration five years ago over 40 millions more passengers had been carried by them. The increase still continued, as was demonstrated by the fact that the number carried last year was 15 per cent. higher than in 1914.

Glasgow.—The new Clydebank swing bridge, which is operated electrically and was built to the order of Glasgow Corporation over the Forth and Clyde canal at Kilbowie-road, Clydebank, was formally opened on the 16th ult. It is proposed to extend the electric tramways to the north of Clydebank, as provision has been made for the running of electric tramcars over the bridge.

London Electric Railway Act (1913).—The Board of Trade have extended the period limited by this Act for the compulsory purchase of lands, &c., for one year from Aug. 15, 1916.

Tunnel Haulage.—At the recent meeting of the North Staffordshire Railway Co. the chairman, Mr. Tonman Moseley, said the electric haulage in the Harecastle Tunnel had been a great improvement, the tug making six trips each way daily, with an average of eight boats in tow.

EMPIRE NOTES.

Australasia.—A proclamation issued by the Australian Commonwealth Government on Dec. 22, 1915, prohibits the importation into the Commonwealth of electric or magnetic belts or any belt, or any article of wearing apparel, or article for toilet use, or any appliance which is alleged or intended to produce a therapeutic effect by electric or magnetic influences or by the presence of radio-active elements.

Mr. R. J. N. Franki, one of the managing directors of Warburton, Franki (Ltd.), of Sydney and Melbourne, has resigned his position, and has commenced practice as a consulting engineer in Sydney.

Bundaberg (Queensland) Gas & Coke Co. has been authorised to supply electricity for 25 years in an area in the shire of Woongarra.

Judge Murray (of New South Wales) has been appointed by the Federal Government as a Royal Commissioner to inquire into the dispute between Mr. J. G. Balsillie and Father Shaw, relating to their respective wireless systems.

A majority of the ratepayers of Balaklava (S. Australia) have recorded their votes in favour of borrowing £3,750 for electric lighting.

India.—"Indian Engineering" says Bangalore Municipal Commissioners have adopted a proposal to have the pumps of the water works driven by electricity to be supplied from Cauvery Falls works.

The Bangalore city tramway scheme has been postponed in consequence of the war and the difficulty of importing plant.

The electric supply scheme of Allahabad Municipal Board is making good progress, and it is hoped the work will be completed by the middle of April.

The Council of Regency (Bahawalpur State) has decided to give the City of Bahawalpur a supply of electricity for public and private lighting. The contract for the generating plant has been placed with Balmer, Lawrie & Co.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a new electric power house for the supply of light and power was recently inaugurated at Arcobel (Province of Santa Fé). It is owned by Señor Julio Hardy.

A non-Catholic Deputy has been authorised by the National Government to establish an hotel and open a church in the district of Pilar (Province of Buenos Aires), with the consent of the Municipal Corporation Tucuman.

It is stated that the Electrical Power Company, of Tucuman, took itself to a depth of seventeen owing to shortage of water. The company has addressed a note to the Municipality stating that it will be obliged to have the city in darkness unless the water required for the power station be forthcoming. The intendent replies that he does not consider the reason adduced by the company a sufficient one to excuse compliance with the obligations of the contract, as it "ought to have provided for the emergency by sinking wells." The Municipality owes the company $300,000 m/n (about £2,600) for lighting.

Public electric supply from the power house of Messrs. Barone & Hamsa, at Concepcion del Tio (Cordoba), was inaugurated in January, and private supply will be made available shortly.

The Municipality of Santiago del Estero have voted $300,000 (about £26,000) for a power house and plant for the public supply of electric light and energy.

Italy.—An American consular report from Bari states that in recent years an important business has been done in that part of Italy in electrical appliances, especially motors for industrial and agricultural purposes, electric light and power plants, &c.

The greater part of the machinery and equipment was supplied by German firms, who had branches in Italy. They were thus in a position to furnish complete plants, and if repairs were required their engineers and workmen being at hand, gave them an advantage over competitors. It is stated that the present war will give a considerable set-back to German trade in Italy, and an interesting field seems therefore open to enterprise, and deserves careful study.

The British Embassy at Rome reports that efforts are being made by the Italian Government to extend as far as possible the use of water-power for the production of electrical energy in substitution for coal, for the supplies of which Italy is entirely dependent on importation. The price of imported coal is up to an almost prohibitive level. On Jan. 16 a decree was issued authorising the Ministry of Finance to extend concessions for the diversion of public water courses by modifications of existing cuttings, siphons, plant, &c., without submitting the question to technical authorities for report, provided the rights of third parties are respected. A further decree published Jan. 25 states that such concessions can be granted when an increased diversion of water is required to provide power for munitions factories, electric traction, or other public services, or in important industrial centres threatened by shortage of coal and which is likely to interfere with the utilisation of water for purposes of minor importance, the extension may still be made, under obligation, however, to furnish electric power in substitution for the hydraulic power which may be interfered with by the extension, and also to provide the machinery necessary for transformation of power. Provision is also made for linking up different plants. Expropriations are facilitated by granting to the local Prefect authority to declare them of public utility. Provision is also made for electrification of State railways.

Japan.—It is stated that the Japanese Department of Communications has requested in its estimates for 1916-17 an appropriation of 25,000,000 yen (about £2,500,000) for extensions of the telephone system to be carried out during five years. This, however, has been reduced to 15,000,000 yen, of which 3,000,000 yen is appropriated for 1916-17.

MISCELLANEOUS NOTES.

Customs Decision.—It has been decided that wireless apparatus imported for use on vessels owned by the United States or operated under American registry, entered and installed under the conditions prescribed by the Secretary of the Treasury, can be imported into the United States of America duty free.

The Trinidad and Tobago Legislative Council recently passed a resolution fixing the following duties upon imports: Machinery for electric light and power plant on estates or mines (and parts thereof not imported for sale), machinery for railways and tramways on estates or mines, including rails and rolling stock (and parts thereof, not imported for sale), if admitted as such by the collector of Customs, 2½ per cent. ad val. under either the preferential or general tariff (formerly free); motor vehicles, intended solely for agricultural, industrial or trade purposes, if admitted as such by the collector of Customs: passenger cars to seat 10 or more persons and vans and wagons for the carriage of goods, 10 per cent. ad val. under the general and 8 per cent. under the preferential tariff (formerly £10 and £8 each under general and preferential tariffs respectively).

Prohibition of Exports.—On Feb. 23 the Privy Council resolved that the Proclamation of July 28, 1915, regarding the prohibition of exports be amended as follows:—

The heading "(a) Pig iron containing more than 0·1 per cent. of phosphorus, including hæmatite pig iron; (b) all other pig iron containing more than 0·1 per cent. of phosphorus but less than 1·5 per cent. of silicon together with less than 0·09 per cent. of sulphur" is substituted for "Hæmatite pig iron," the exportation of which is prohibited to all destinations.

Wills.—The will of the late Mr. Thomas Parker, consulting engineer, has been proved, and the estate is valued at £13,380 gross, with £6,096 net personalty.

The late Col. F. E. Vickers, C.B., late chairman and managing director of Vickers (Ltd.), left unsettled property of the value of £117,347, the net personalty being £106,899.

TENDERS INVITED.

Varnish Impregnating Apparatus and Storage Battery.

The Victorian Railway Commissioners, Spencer-street, Melbourne, require tenders by 11 a.m. April 19 for the supply and erection of a Complete Plant for Impregnating Electrical Apparatus with Insulating Varnishes and Solid Compounds. (Contract No. 29,678.) The Commissioners also require by the same date tenders for the supply and erection of a 1,000 Ampere-hour Storage Battery. (Contract No. 29,743.) Specifications, forms of tender, &c., from the offices of the Commissioners.

Electrical and General Stores.

BELFAST Tramways & Electricity Committee invite tenders for the supply of materials, including Mill Furnishings, Packings and Asbestos Goods, Rubber Goods, Tools, Ironmongery, Steam, Gas and Water Tubing; Trolley Wire, Overhead Line Material and Galvanised Wires, v.b. Insulated Cables and i.r. Cables and Wires, Electrical Accessories, Lamps, Carbons, Carbon Brushes, Bitumen, Tape, Joint Box Compound, Fuse Wires, Troughing, Meters, m.d. Indicators, &c. Forms of tender and further particulars from the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast, and tenders must be lodged with the town clerk, Mr. R. Meyer, City Hall, Belfast, by March 15.

PONTYPRIDD Urban Council require tenders by March 13 for one year's supply of Stores and Sundries, including Joint Boxes, Service Cut-outs, Tramcar and Overhead Equipment, Cables, Wires, Insulating Materials, &c. Forms of tender, from the Engineer, Generating Station, Treforest, Pontypridd.

BIRKENHEAD Corporation require tenders by March 9 for supply and laying of Cable, and two Rotary Converters, with Switchgear. Specifications from Borough Electrical Engineer.

The METROPOLITAN WATER BOARD want tenders by 11 a.m. March 7 for supply of Electric Lamps, &c. Forms of tender from the Chief Engineer, Savoy-street, London, W.C.

BARROW Corporation require tenders by noon March 6 for one year's supply of Electrical and Engine-room Stores, Ironmongery, Oils, &c., for their electricity department. Forms of tender, &c., from the Borough Electrical Engineer.

HESTON AND ISLEWORTH Urban Council require tenders by March 11 for one year's supply of Electric Cables, Troughing Boxes, Electricity Meters, Sundry Electrical Goods, Castings, Oils, &c. Forms of tender from the Surveyor, Council House, Hounslow, London, W.

DOVER Harbour Board require tenders by March 9 for 3, 6 or 12 months' supply of Electric Cables, Electrical Sundries, Tubing, Asbestos Packing, Paints, Oils, &c. Schedules, &c., from the Register of the Harbour Board, Castle-street, Dover.

BOLTON Tramways Committee want tenders by noon March 6 for Overhead Materials, Castings, Lamps, Carbons, Insulating Materials. Specifications from General Manager.

ABERDARE Urban Council require tenders by March 11 for one year's supply of Cables, Meters, Joint Boxes, Ironmongery, Paints, Oils, Electric Lamps, &c. Specifications, &c., from the Manager, Elec. and Tramways Dept.

DUNDALK Urban Council require tenders by 4 p.m. March 21 for 12 months' supply of Cables and Wires, Incandescent Lamps, Lighting Accessories, Meters, &c. Forms of tender, &c., from the Engineer and Manager, Elec. Works, Dundalk.

Tenders are required by first post March 15 for one year's supply of Electrical Goods for the Cheshire County Asylum, MACCLESFIELD. Tender forms from the Clerk.

The POWELL DUFFRYN STEAM COAL Co. require tenders by 10 a.m. March 8 for supply of Electrical Goods, Asbestos, &c. Forms of tender from Stores Manager, Aberaman Office, nr. Aberdare.

Tenders are required by 4 p.m. March 8 for 12 months' supply of Electric Lamps and Fittings, &c., to RICHMOND and PORTRANE (co. Dublin) Asylums. Forms of tender from Storekeeper.

LONDON County Council Asylums Committee require tenders by 11 a.m. March 10 for supply of Electric Lamps and Sundries. Forms of tender from the Clerk, 6, Waterloo-place, S.W.

HEYWOOD Electricity Committee require tenders by noon March 15 for one year's supply of Electricity Meters, Joint Boxes, Cable and Jointing Accessories, Motors and Starting Switches, &c. Particulars from the Borough Electrical Engineer.

Electrical and General Stores.

EAST HAM Corporation want tenders by noon March 10 for six or 12 months' supply of Engineers' Sundries for their electric lighting and tramways department. Forms of tender from the Town Clerk.

KENSINGTON (London) Board of Guardians invite tenders for the supply of Electric Lamps, Electric and Engineers Fittings, &c., to their Infirmary at Marloes-road, Kensington, for a period of six months from April 1. Forms of tender, &c., may be obtained up to March 8th from the Clerk to the Board, Mr. W. R. Stephens, Marloes-road, Kensington, W.

Rotary Converters and Boilers.

SALFORD Corporation require tenders by March 4 for the supply of Two 1,000 kw. and One 500 kw. Rotary Converters; and Two Water-tube Boilers. Particulars from the Borough Electrical Engineer.

Structural Steel Work.

EDINBURGH Corporation require tenders by 10 a.m. March 13 for Erection of Structural Steel Work at the new Portobello generating station. Specification, &c., from Mr. Jas. A. Williamson, City-chambers, Edinburgh

Telegraph and Railway Stores.

THE GREAT CENTRAL RAILWAY Co. invite tenders for the supply of various stores and materials including: Telegraph Materials, Electric Light Carbons, Casing, Accessories and Lamps, Asbestos Packing, Sheets and Boiler Covering, Colours, Files, Glass, India Rubber, Iron Bars, Sheets, &c., Nails, Oils. Samples can be seen up to March 6 in the Public Hall of the Conservative Club, Gorton-lane, Gorton, Manchester. Specifications from the Stores Superintendent, Mr. Walter Williams, Gorton, Manchester. Tenders to the Secretary, Mr. Oliver S. Holt, Marylebone Station, London, N.W., by 9 a.m., March 7.

Electric Wiring, &c.

SWANSEA Education Committee require tenders by noon March 6 for Wiring Brynmil Infants' School and Cwmbwrla Girls' and Infants' School. Specifications from Clerk, 9, Grove-place, Swansea.

Telegraph and Telephone Material, &c.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmasters-General.

Tramcars, Electrical Equipments, &c.

DUNEDIN (N.Z.) City Council require tenders by 5 p.m. May 17 for six Electric Tramcars and sections of Cars (Bodies, Electrical Equipments and Trucks). Specifications, &c., from the Town Hall, Dunedin.

Turbo-Alternator.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

Submarine Electric Cables.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

TENDERS RECEIVED AND ACCEPTED.

ISLINGTON (LONDON). The following tenders have been accepted by the Lighting Committee for annual supplies :—

Callender's Cable & Construction Co., W. T. Henley's Telegraph Works Co., India Rubber Telegraph Works Co., W. Lucy & Co., Sykes & Sugden, J. Gibb & Co., Dussek Bitumen Co., service and network boxes, tapes and iron castings ; Cryselco (Ltd.), Edison & Swan United Electric Light Co. and Goodman & Co., electrical sundries, lamps, arc lamp parts, &c. ; British Insulated & Helsby Cables, cables ; Chamberlain & Hookham and British Westinghouse Co., meters ; Doulton & Co., Young & Sons, Turner & Lisney, J. Knowles & Co., earthenware pipes, insulators, troughs, fire bricks, &c. ; British Electrical Transformer Co., Sheepbridge Coal & Iron Co., transformers and c.i. tanks ; Goodwin & Co., arc lamp globes ; Vacuum Oil Co., oils ; Dicks Asbestos Co. and J. Gibb & Co., engine room stores.

LIVERPOOL.—The Tramways Committee recommends the following tenders for 12 months' supply of materials for the electric supply and tramways departments :—

Liverpool Electric Cable Co. and St. Helen's Cable & Rubber Co., insulated cables and wires ; Ferranti Limited, meters ; Edison & Swan United Electric Lamp Co., carbon filament lamps ; Pope's Electric Lamp Co., metallic filament lamps ; Doulton & Co., J. E. Beard & Co., Callender's Cable & Construction Co., J. Bourne & Sons, J. Evans (Liverpool), Liverpool Building Material & Cement Co., and Middleton Fireclay Works, stoneware troughing, insulators, &c. ; Sykes & Sugden and British Electric Calibrated Fuse Co., electric fittings and sundries ; Callender's Cable & Construction Co., cables and accessories for street mains ; Whyman's Foundry Co., c.i. troughs and boxes ; Moston Malleable Castings Co., National Rail & Tramway Appliances Co., Interchangeable Brake Block Co., Jas. Allan (senr.) & Son, and John Needham & Sons, iron castings ; D. Laborn & Co. and S. Peace & Sons, steel, wrought iron and files ; F. W. Rowlands & Co., steel gears and pinions ; Vacuum Oil Co. and C. C. Wakefield & Co., lubricating oils, &c.

RAILWAY LIGHTING.—The Midland Railway Co. has accepted the tender of the General Electric Co. for the supply of Osram drawn-wire lamps for the ensuig 12 months.

Pope's Electric Lamp Co., Ltd., of Willesden, have secured a renewal of their contract with the Midland Railway Co. for the supply of their Elasta wire lamps, and also for carbon filament lamps.

New Zealand Government Contracts.—The Public Service Tender Board have accepted the tenders of the Electric Construction Co. (at £541) for 10,000 dry cells for telephone and Turnbull & Jones, at £653, for 1,000 yds. silk and 4,000 yds. silk and cotton-covered cable.

FINANCIAL MATTERS.

MUNICIPAL ACCOUNTS.

Liverpool.—The electric supply accounts for the year ended Dec. 31 show total capital expenditure £2,225,938 (increase £2,344), of which £1,430,863 is outstanding.

Revenue was £345,808, and after providing for working and general expenses, &c., the balance was £209,558. Interest required £65,749, sinking fund £57,635, and renewal fund £36,223, and £50,000 was contributed to general rate.

Willesden.—The accounts of the electricity departments for the year ended March 31, 1915, which were recently passed by the Council show gross capital expenditure £232,434 (increase £5,915), of which £152,126 is outstanding.

Revenue was £35,415 (against £36,891 in 1914), working and general expenses were £26,147 (against £26,008), and gross profit £9,268 (£10,883). Interest required £4,311 (£4,025), repayment of loans £7,223 (£5,880) and special items £1,147 (£735), leaving net deficit of £3,094 (against a profit of £434). Total working costs per unit were 1·572d. (1·61d.) per unit, and total costs, including capital charges, 2·335d. (2·269d.) Units sold were 3,992,580 (3,877,095). Total connections are equal to 260,083 (209,825) 30-watt lamps ; maximum demand was 1,905 kw. (2,110 kw.) and load factor 23·92 (20·97) per cent.

COMPANIES' MEETINGS AND REPORTS.

London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Thursday last week, Mr. ROBERT H. BESSON presiding.

The SECRETARY (Mr. H. C. Carter) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said : I assume that you will, as usual, take the report as read. Looking over the report of our proceedings last year I find I warned you that we could not this year expect such an increase of revenue as the year before, that, on the contrary, during war time all companies must expect a set back owing to the price of coal and the restriction of lighting. You will not, therefore, be surprised to see that, although our gross revenue breaks the record and amounts to £213,964, against £191,196, the net revenue is only £77,687 against £93,234. The cause is higher cost of coal and higher wages, so that the cost per unit sold was nearly ¾d. instead of 1d. After all, £77,687 is the third largest amount of net revenue in the history of the company, surpassed only by last year and the year 1905 (when we had exceptional receipts from the L.C.C. pending the completion of their own supply station). We are able, after paying fixed charges, to put £13,527 to sinking fund and £5,000 to contingencies account (together £18,527) and to pay a 3 per cent. dividend. This dividend takes £9,990, and you will observe that the amount thus placed to reserve is double the amount paid in dividend. I wish it were more ; but, none the less, it is a substantial amount against the risk of purchase in the year 1931. It is always the case that in anxious times, when there is less profit to go round, the work and responsibility of the staff is hardest. You can realise what a trying thing it has been to generate and sell 50,757,584 units, against 46,343,065 last year, under war conditions, with depleted staff and irregular supplies of indifferent coal, requiring careful selection and sorting. Your special thanks are due to Mr. Partridge and to the staff, and finally to the Managing Director, whose mind enters into every department. In troublous times, now long past, we used to endeavour to encourage you with the vista of power supply, which, while furnishing a prime necessity for London consumers, might also yield a fair profit to you as producers. But for the war we should have had a record year—£20,000 more net revenue, or even more. You must not expect me to predict now. We have just got to do what our hand finds to do, keeping things together as best we can, so as to be ready when peace comes to supply our customers as usual. I move the adoption of the report, and will ask Mr. Bain to second it and to give you the usual technical particulars which he so well understands.

The MANAGING DIRECTOR (Mr. R. Stewart Bain, C.A.) : Before seconding the report, gentlemen, the following figures may be of interest to you. The capital expenditure during the year was £21,730, consisting principally of a new battery of boilers and accessories and the laying of 5 miles of new mains, principally for the supply of power for industrial purposes, which, I am glad to say, continues to increase in a most satisfactory manner. The total horse-power of motors connected at the end of the year was 15,683 H.P., and in addition to this contracts for another 1,500 H.P. have been received. Turning to the revenue account it will be seen that, while the receipts increased by nearly £23,000, the expenditure increased by over £38,000, coal being responsible for over £30,000, and the balance being increased wages, both increases being due to the war. The consumption of coal during the year was 110,000 tons, as compared with 73,000 tons in the previous year, the average price paid being 19s. 9d. per ton, as compared with 14s. 1d. Great difficulty has been experienced during the year in getting deliveries, owing to the shortage of steamers, and the bulk of the supplies has been by rail. This coal has generally been of an inferior quality, which causes much larger quantities to be used at greatly increased prices. The difficulty of obtaining an adequate supply of coal has not diminished since our last meeting. While the cost of the units sold increased from 0·50d. to 0·64d., owing to the causes mentioned, the average price received per unit increased from 0·94d. to 0·96d. Every credit is due to the staff—greatly depleted by their response to their country's call—for their excellent work during the year, and for the manner in which they have overcome the many difficulties in connection with the supply of coal. In common with other companies, we have to deplore the loss of several valued members of our staff killed in action, whose future appeared full of promise. Those who have had to stay at home have also been doing what they can to help their country by manufacturing shells for the Army in addition to performing their ordinary duties. I beg to second the resolution.

The report was unanimously adopted, and a dividend at the rate of 6 per cent. per annum on the preference shares and of 3 per cent. on the ordinary shares (both less tax) for the year was declared.

The retiring director (Mr. Robert D. Norton) and the auditors (Messrs. Cane, Jackson, Jefferys & Freeman) were re-elected, and the proceedings then terminated.

Notting Hill Electric Lighting Co. (Ltd.)

The twenty-ninth ordinary general meeting was held on Tuesday, Sir WILLIAM CROOKES, O.M., P.R.S., presiding.

The MANAGER AND SECRETARY (Mr. R. G. Rawkins) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, I am pleased to say that, notwithstanding the war, the result of our year's work has been satisfactory, and I think that will be the opinion of every shareholder. Taking the accounts seriatim, it will be seen that no new capital has been required. Practically the whole of the capital expenditure (£1,556) was for meters and mains rendered necessary to connect up new customers. We have been exceptionally careful with regard to capital expenditure, and have only extended the mains where it has been absolutely necessary. In most cases it has been to strengthen the cables to consumers who are manufacturing munitions, and in this direction we are willing and anxious to assist in every way possible, but in our opinion it is advisable at the present time to keep expenditure on new work down to the lowest possible figure. The balance on this account (£14,325. 1s.), representing the amount expended in excess of capital received, has been provided by using the reserve fund in the business instead of investing it in outside securities and issuing new capital. The revenue went up £330 and the expenses £779. In view of the restricted lighting over the whole area due to the war, the increase in the revenue is, I am sure, particularly gratifying. This was brought about by a certain amount of new business, and an extra halfpenny per unit charged on the lighting supply during the last nine months. It is hardly necessary to explain the reasons for the increase in the expenditure, as it is common knowledge that the cost of fuel has increased enormously, and the total cost of generating and distributing current increased £1,200, although the units sold were 100,000 less. This increase has been partly nullified by a decrease in the management expenses, brought about by Mr. Schultz's retirement, and the Secretary now combines the two offices of Manager and Secretary. The net result is a drop of £450 in the profit for the year. The usual £3,000 has been allocated to depreciation and renewal account, but the balance available for dividends is lower by £1,185, owing to the heavy increase in income tax. This, you will notice, was £2,653. 2s. 6d., against £1,499.5s.9d. last year. In regard to the co-partnership bonus to the employees I may say that owing to the high rate of income tax the amount to be distributed this year would have been rather less than usual, but I am sure you will approve the action of the Directors in agreeing to bring the amount up to what it was in previous years. The balance to carry forward of depreciation, renewal and reserve fund account has now reached the substantial total of £48,355. 17s. 2d. The total of the Kensington & Notting Hill joint debenture stock sinking fund is £72,920. 8s. 5d., held in trustee securities, and the company has contributed £19,051. 7s. 2d. to it. After submitting his usual table of the progress of the company, Sir William said: We added the equivalent of 4,373 30-watt lamps to our system during the year. The units sold decreased by 102,000, and the profit shown is £22,617, against £24,221 the previous year. As previously explained, the reduction in profit is mainly due to income tax. The actual net result for the year is the payment of the same dividend as for 1914, but the balance carried forward is decreased from £655 to £336, and the difference, therefore, is only the small sum of £319. Our business has suffered considerably owing to the restriction of lighting, and although we have managed to maintain our revenue in the past I am not certain that it will be possible to do so during the current year, although when the long-looked-for peace is proclaimed I think we shall find that our output will increase to a large extent both by the removal of the restricted lighting regulations and from the new lamps which we are continually adding to the system. Expenses must necessarily be high for some time to come, and are swollen to some extent by the increase in wages and payments to many of our employés who have joined His Majesty's Forces. With regard to the Wood-lane works, I may mention that we have now obtained delivery of our new steam turbine which will effect a considerable saving in coal, and we hope will in a large measure counteract the high prices we are now having to pay for fuel. We are endeavouring to do our share in the war, and in addition to manufacturing munitions we are supplying electric power to many factories. He concluded by moving the adoption of the report and accounts.

Mr. JAMES THOMAS JERVIS, M.Inst.C.E., seconded the motion, which was carried unanimously.

The retiring directors, Sir Richard B. Martin, Bart., and Mr. J. T. Jervis, were then re-elected, and the auditors, Messrs. Kennedy, Fox, Oldfield & Co., were re-appointed.

A vote of thanks to the chairman terminated the proceedings.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The gross receipts for 1915 amount to £512,385, and working and general expenses and renewals to £413,521, leaving a net revenue of £98,864. After paying interest on the mortgage debenture stocks, &c., dividend on 4 per cent. preference shares for year, and interim dividend at rate of 4 per cent. per annum for half-year ended June 30, the balance is £61,183. 18s. 5d. It is proposed to pay a final dividend for half-year at rate of 6 per cent. per annum (making 5 per cent. for year), to add £20,000 to reserve fund for contingencies and renewals and to carry forward £5,055. 11s. 1d. The number of passengers carried during the year on the company's cars and motor omnibuses was 60,272,400, compared with 58,301,585. The motor constructional works and the tramway rolling stock works have been largely employed throughout the year in the production of war munitions.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—The net profit for 1915 (after charging £11,882 for depreciation and £2,500 for debenture interest) amounts to £22,593, to which has to be added £7,023 brought forward from last year, making an available balance of £29,616. The directors recommend that, after payment of the preference dividend (£5,999. 8s.), the balance be appropriated in paying 8 per cent. (tax free) to the ordinary shareholders (£8,000. 16s.), placing to reserve £9,000 and carrying forward the balance (£6,615. 17s. 4d.). The retiring director (Mr. A. Rogers Jenkins) offers himself for re-election, but it is not at present proposed to fill the vacancy caused by the death of Mr. P. G. Wayne.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—The gross earnings of the West End undertakings from sales of current, rent, &c., were £138,963. 12s. 4d., compared with £142,086 in 1914. The expenses (excluding depreciation) were £70,068. 1s. 11d., against £69,677. 5s. 1d., and the net earnings were £68,895. 10s. 5d., against £72,408. 15s. 9d. After adding the balance brought forward (£18,000), interest accrued (£2,977. 13s. 6d.), and transferring from general reserve £6,000, the total available is £95,873. 3s. 11d. After providing for interest on debenture stock (£17,829. 8s. 8d.) and setting aside for depreciation £22,000 the balance is £56,043. 15s. 3d., out of which have been paid the dividend on preference shares for the year and an interim dividend for the first half of the year 1915 at rate of 4 per cent. per annum on the ordinary shares, leaving to be dealt with £30,043. 15s. 3d. The directors recommend that a final dividend be paid on the ordinary shares for the second half-year at rate of 6 per cent. per annum (making 5 per cent. for the whole year), absorbing £12,000, and that £18,043. 15s. 3d. be carried forward. The company has now connected to its West End mains a total equivalent of 718,028 (30 watt) lamps—*i.e.*, 458,345 in lighting, 36,572 in heating and 223,111 (8,982 H.P.) in motive power.

The gross earnings of the City undertaking from sales of current, rents, &c., were £158,357. 8s., compared with £153,689. 8s. 10d. in 1914. The expenses were £94,590. 8s. 9d., against £86,983. 6s. 10d., and net earnings were £63,766. 19s. 3d., against £66,706. 2s. With balance from last year of £18,000 the total available is £81,766. 19s. 3d. After providing for interest on debenture stock, loans and advances (£30,458. 13s. 8d.) the balance is £51,308. 5s. 7d., out of which has been paid the dividend on the preference shares amounting to £18,000, leaving £33,308. 5s. 7d. The directors recommend that £15,308. 5s. 7d. be transferred to general reserve (income) account and that £18,000 be carried forward. The company has now connected to its City mains the total equivalent of 722,700 (30 watt) lamps (321,675 in lighting, 57,516 in heating and 343,509 (13,814 H.P.) in motive power).

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The profit for the year ended Dec. 31 was £34,955, which, with £3,100 brought forward and £2,312 for interest, makes a total of £40,367. After deducting interest on debenture stock (£7,875), interim dividend on preference shares at rate of 6 per cent. per annum (£900), interim dividend on ordinary shares at rate of 4 per cent. per annum (£4,943), the balance is £26,649. The directors recommend that £14,720 be placed to credit of reserve for renewals, depreciation and contingencies, £704 to credit of debenture stock premium redemption fund, to write £1,089 off cost of extinction of founders' shares, and £1,000 off investments, to pay final dividend on the preference shares at rate of 6 per cent. per annum, making 6 per cent. for year (£900), and a final dividend on the ordinary shares at rate of 4 per cent. per annum, making 4 per cent. for the year (£4,943), leaving a balance to be carried forward of £3,292. The number of 8-c.p. lamp equivalents connected on Dec. 31, 1915, was 319,840, an addition of 5,564 during the year, and the total number of units sold was 4,192,892, being 149,290 less than in 1914.

CITY OF LAS PALMAS WATER & POWER CO. (LTD.)—The report states that there has been a regrettable continuance of the hindrances in obtaining possession of sites for power houses and wayleaves for pipe-lines, &c., but an extension of time has been granted by the municipality for completion of the works. A supplemental contract has been entered into with the contractors, Messrs. Dick, Kerr & Co., to complete the works to the plans of the Government engineer within the time allowed.

CITY & SOUTH LONDON RAILWAY CO.—Under the powers conferred by the London Electric Railway Companies Facilities Act, 1915, the agreement between the company and the Central London, the London Electric Railway and the Metropolitan District Railway Companies and the London General Omnibus Co. for the creation of a common fund took effect as from Jan. 1, 1915. For 1915 the aggregate gross traffic receipts of the five companies which are parties to the agreement were £4,924,245. 0s. 5d., and the aggregate gross receipts of the companies from all sources were £5,481,144. 8s. 7d. The aggregate amount retained by the several companies for "revenue liabilities" which include working expenses, prior charges, reserves and other items specified in the first schedule to the agreement, and for reserve, was £5,029,778. 12s. 5d. The balance (£451,365. 16s. 2d.) was credited to the common fund authorised under the Act. Under the terms of the agreement the City & South London Co. is entitled to 2 per cent. of this fund, or £9,027. 6s. 4d. The gross receipts of the company for the year were £202,389, increase £56,472 over 1914, and expenditure was £110,609, increase £16,642, leaving total net income £91,780, increase £39,830. Deducting interest, rentals and other fixed charges, reserve and dividends on preference stocks, the balance (£9,027) is to be carried forward. During the year arrangements were made to obtain current for working the railway from Lots-road power station, and the station at Stockwell has been closed.

ELECTRO-BLEACH & BY-PRODUCTS (LTD.)—The report for 1915 states that after charging debenture interest and writing off 20 per cent. of

preliminary expenses, the net profit is £22,924. The directors recommend a dividend (less tax) of 7 per cent. on the ordinary shares. After providing for bonus to employees and additional remuneration of directors and placing £4,000 to reserve, £723 is carried forward.

FIFE TRAMWAY, LIGHT & POWER CO. (LTD.)—Mr. W. Low, who presided at the meeting last week, said that during the last few months the receipts slightly improved but for 1915 there was a decrease of about £2,500 compared with 1914. The revenue from the tramways had only decreased by £1,600. So far the current year showed a substantial improvement over the corresponding period of last year, and there was every indication that the tramway earnings would show an improvement on 1915. The Company had succeeded in getting an extension of time to construct tramways to the south of Dunfermline and for additional lines from Dunfermline to Rosyth and Inverkeithing, and from Lochgelly to Kinglassie. Pending receipt of the Treasury consent to raise the necessary capital they did not propose to make any arrangements for dealing with those lines. The growth of the power and lighting business had been quite satisfactory, and in accordance with previous forecasts, but all undertakings of that kind had been hard hit by increased costs, particularly the cost of fuel.

JARROW & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The total revenue for 1915 amounted to £8,855. 9s. 7d., an increase of £985. 15s. 7d. over 1914. After deducting all expenses chargeable to revenue (including interest on debentures and loans) and providing £800 for renewals, the surplus is £2,911. 1s. 6d. With £1,026. 10s. 3d. brought forward, the available balance is £3,937. 11s. 9d. The directors propose to place £900 to reserve and to pay a dividend on the ordinary shares at rate of 4 per cent. for the year, carrying forward £1,039. 15s. 9d.

HARROW ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting the chairman (Mr. J. N. Stuart) stated that during the year 80 new connections had been made, making a total of 1,794 consumers, equivalent to 1,862 kw. The year's output was 530,107 units. After paying debenture interest and interim dividend on the preference shares the balance was £2,402, and the directors recommended payment of the final dividend on the preference shares (£374. 19s. 3d.) and a dividend on the ordinary shares at rate of 5 per cent. per annum (£1,666. 15s.), leaving to be carried forward £360. 8s. He said that by constant care and attention to details on the part of the management, the expenditure, with the exception of the cost of coal, which was out of their hands, had been kept down; and in spite of the lighting restrictions the sale of electricity showed a falling off of only 8,000 units, about 1½ per cent., which had been almost compensated for by a slight alteration in the method of charging during the past half-year.

LIVERPOOL OVERHEAD RAILWAY CO.—The chairman (Mr. H. C. Woodward) stated at the meeting last week that the number of passengers carried during 1915 on railway and tramway (exclusive of season ticket-holders) was 15,082,502, an increase of 1,720,558 on 1914, thus creating a new record for the company. The increase was attributable to the abnormal conditions prevailing in the port of Liverpool, whose docks had never been so fully occupied. The receipts (£93,146) did not exactly represent the traffic carried, as it was obvious that so many more passengers must have added to their takings, but the surplus was not shown in the accounts, the difference having been handed over to the Government to assist in making up the deficiencies of some of the other railway companies. They had placed £4,000 to renewal fund and added £400 to contingent fund, and, after meeting interest on debenture stock, the balance was £24,011, which, added to amount brought forward (£7,013), gave a total of £31,054. They had distributed in the shape of interim dividends (at rate of 5 per cent. on the preference and 2½ per cent. on the ordinary shares) £10,215, leaving available for final dividend £20,839. Preference dividend would require £3,965, and out of the balance the directors were able to recommend payment of an increased dividend on the ordinary shares at the rate of 4 per cent. per annum (making 5½ per cent. for the year), which would absorb £10,000, leaving to be carried forward £6,873. The upkeep of the railway and tramway had been maintained as far as possible in the same manner as before the outbreak of war, but owing to the shortage of labour and the difficulty of obtaining adequate supplies of materials, certain work had had to be postponed, but would be brought up to date immediately opportunity again offered. The Government had agreed that companies so affected would be recompensed in respect of such deferred work. The heavy traffic of the year had considerably taxed the accommodation of their rolling stock and, although in the hours of heaviest traffic a three-minutes' service was in operation, some inconvenience had been inevitable. The Great Central Railway Co. had acquired the land for the Seaforth and Sefton Railway, and that the construction of the line would be commenced as soon as circumstances permitted. When that new railway was connected with their own at Seaforth, the interchange of traffic should prove beneficial to them.

LONDON ELECTRIC RAILWAY CO.—Lord Ritchie, who presided at the meeting last week, said that the gross receipts amounted to £967,131, an increase of £181,186 over 1914. A large part of the increase was due to the Queen's Park Extension, which was showing very satisfactory results, and to the increased traffic on the Charing Cross extension, and also to the general increase in traffic owing to the reduced accommodation on the streets. There was an increase of £87,700 in expenses, due to the Queen's Park extension, increased wages, and higher prices of coal and materials, &c.

MATHER & PLATT (LTD.)—The chairman (the Rt. Hon. Sir Wm. Mather), who presided at the annual meeting last week, said that they had considerably larger amounts invested in War Loan and other Government securities than they had last year. The fact that they had money to invest indicated two facts—first, that their turnover had been reduced, and, secondly, that the debts owing to them were being in general duly discharged. It was satisfactory that, notwithstanding reduced turnover, the profit had been sufficient to permit a dividend of 12½ per cent. without encroaching on the carry-over of last year. As a matter of fact, they had added to it, and propose to carry over £75,461, against £66,800 last year. They had thoroughly examined all the branches of their large undertaking in all the important countries of the world, with all of which they did business, and he was glad to be able to say that by far the greater part of the business was within the limits of the British Empire or with our Allies, and they had no reason to feel any special anxiety as to the soundness of their commitments. Theirs was a "controlled establishment," but no profit from munition orders had been credited in the year's accounts, or indeed earned. They were suffering from lack of skilled labour. In the earlier days of the war they encouraged their workmen, clerks and draughtsmen to enlist, and had paid out some £10,000 for the support of their dependents, and in contributions to war funds, all of which had been taken out of profits. The total number of their employees who had joined the colours was 668, of whom 36 held commissions; of those, 36 of the rank and file and two officers had been killed. Lieut. Welsh and Mr. Darwin, grandson of Charles Darwin, who were men of great promise, had been killed. A considerable number of their staff and workmen were interned in Germany. They had done what was possible to alleviate their hardships. It was to be hoped that when the war was ended and a lasting peace secured, the harmony throughout the industrial world in England would continue, but he was afraid a time of extreme anxiety and probable suffering awaited us; consequently for the time of peace they must now prepare with all the forethought and patriotism of which they were capable. The fruits of victory would be worthless were we to engender conflicting elements within our own borders. We must prevent this by calmly estimating the probable difficulties now. We shall have to train ourselves for maintaining our leading position among the nations of the world, and we can give no better example of our worthiness for this leadership than by settling down in industrial peace when the abnormal conditions have passed away. The re-organisation and co-ordination of capital and labour will be the immediate and vitally important duty. Unhappily there had been little training and education in this country to fit us for the duties which all classes will have to encounter, but he had great faith in the lessons taught by the war, which, resting on the ground of commonsense which we possess as a nation, may show us the way to self-discipline, self-control and mutual sacrifices. The great limited liability companies now prevailing in the realm of industry, and especially in the engineering branches, should, with the great trade unions, formulate a basis of unity, peace and goodwill to give security to the great interests of both capital and labour. The time to meet and take counsel together was now. "In times of war prepare for peace" was a sound maxim. There was one possible asset common to all industrial firms, companies, and corporations which hitherto had been rarely possessed by any, that was the hearty co-operation, zeal, concentration, and unity of purpose of the working people with employers. The possession of that asset should exist in every industrial enterprise, and would be as potent an element in the industrial world as capital itself in promoting continuity and economy in production and general prosperity. To acquire that asset more than fixed wages was needed. The inducement to a working man to invest as his capital in the business all his zeal, willingness, interest and goodwill, in addition to his time and skill which earned the working wage, ought to be a share in the profits in some form of dividend, just as a shareholder expected to receive a dividend on his money invested. No outlook in which they had to recognise a continuation of the terrible disputes and angry feelings that had from time to time for long years been displayed both on the part of capital and labour, could be regarded as a condition which any enlightened nation could be satisfied with in the future. The war had displayed the weak parts of all the peoples engaged therein, though in Great Britain there appeared to be greater possibilities for a continuous and happy future for all classes of our people if we took to heart the lessons now learnt and acted upon them, to prevent the disasters that had shaken the stability of industry and prosperity in the years of the past. He hoped it might be possible for their company to take some share in promoting changes as might ensure that happy state of things; to that end the shareholders and their directors, managers and foremen, and all classes of workpeople engaged in the great enterprise of engineering must give their earnest consideration in order that they might speedily arrive at the desired result.

METROPOLITAN DISTRICT RAILWAY CO.—At the meeting last week the chairman (Lord Cozs. Hamilton) said that there was an increase in the dividend for the year on the second preference stock from 2 per cent. to 3 per cent. In reply to suggestions as to higher fares, he said that for many years the ordinary stockholders had been expecting or hoping for a dividend, and he thought he might fairly say that they were approximating nearer and nearer to the period at which the possibility of a dividend on that stock might become likely. As soon as they legitimately could, they would be only too glad to pay such a dividend. Meantime the ordinary stockholders, by the making of a considerable reserve, were benefited at the expense of the second preference. On the question of revenue, he would point out that all the estimates in connection with the electrification of the District Railway had proved too optimistic. The expenditure upon the electrification had been very much larger, and

the receipts during the earlier years of the changed system of working very much less, than was anticipated. The railway had been resuscitated entirely by the exertions of three distinguished men, namely, Sir Geo. Gibb, Sir Edgar Speyer and Sir Albert Stanley, who had brought the railway up until there had been an absolute change in every way

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—Dr. J. B. Simpson, who presided at the meeting last week, said that third mortgage debentures for £30,000 had been issued to provide for the erection of new plant at Newburn, which came into operation at the beginning of the year and had been most efficient in enabling them to reduce the works costs. Loans had increased and had been expended in erecting plant for supplying the increased demand for electric power. The capital expended during the year was £48,817, of which £41,494 was for plant for supplying energy for power, £2,594 to complete the connection of the system of supply laid down at Newcastle and Newburn, £764 for motors on which they received a rental, and the balance (£6,965) for ordinary expenditure on cables, &c. The expenses had increased; wages, salaries, rates, &c., showed an increase of £2,262, and stores, coal, &c., of £4,914 (£4,440 being for coal). To meet the additional cost of coal and other material the price for electrical energy to ordinary consumers was raised as from the June quarter meter readings. The total receipts showed an increase of £9,301 over 1914. It was estimated that the loss due to the lighting restrictions was £3,700, but that had been compensated for by the increased demand for power. The net profit was £15,965, an increase of £555. With regard to the payment of a dividend, he said in view of the exceptional circumstances which had arisen due to the war, and the uncertainty of what was before them, the directors decided that it would not be wise to recommend the payment of a dividend, believing that a cautious and conservative policy of finance was essential.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—The gross receipts for 1915 were £54,782 and expenditure was £27,553, leaving £27,229 and making with amount brought forward (£2,898) an available total of £30,127. 8s. 9d. After placing to depreciation account £6,248 (making the balance standing to credit of this fund £55,500), also making provision for dividend on 6 per cent. cumulative preference shares paid and accrued to the end of the year, debenture and other interest, &c. (£14,117. 10s. 1d.), the balance is £16,009. 18s. 8d. Out of this the board recommend payment of a dividend on the ordinary shares at rate of 5 per cent. for the year (£13,000), carrying forward a balance of £3,009. 18s. 8d. During the year new connections representing the equivalent of 25,652 (35 watt) lamps, or 900 kw., were added to the company's system, making a total connection at the end of the year of 366,518 (35 watt) lamps, the equivalent of 12,820 kw. The units sold during the year amount to 6,318,140, an increase of 164,899 over 1914.

TRAMWAYS, LIGHT & POWER CO. (LTD.)—The receipts for 1915 were £32,213 (including £1,712 brought forward), and after providing for administration, loan and debenture interest, the profit was £19,324. The directors propose a dividend on the preference shares at rate of 6 per cent., leaving to be carried forward £3,348. The whole interest in the Cheltenham & District Light Railway Co. was acquired in October last.

TYNESIDE ELECTRICAL DEVELOPMENT CO. (LTD.)—The profit for year ended Jan. 31 was £2,602, and with £3,427 brought forward, dividends at rate of 6 per cent. per annum on preferred ordinary shares and of 10 per cent. on the deferred (less interim dividends) have been declared, £1,000 has been placed to general reserve and £3,654 carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES

BAUGHAN & CO. (LTD.) (143,116)—Reg. Feb. 25, capital £2,500 in £1 shares, to carryon business of electrical, general and consulting engineers formerly carried on at Reading as Baughan & Co. Private company. A. H. V. Baughan is first permanent governing director. Reg. office: 8 and 10, London-street, Reading.

CHARLES BRUCE & CO. (LTD.) (143,119)—Reg. Feb. 25, capital £15,000 in £1 shares, to carry on the business of ironfounders, mechanical and marine engineers, manufacturers of propellers and other machinery, aeroplanes, motor cars and boats, metal workers, manufacturers of and dealers in motors, dynamos, pumps, &c. Private company. Sec. (pro tem.): J. H. Morton. Reg. office: Pinner's Hall, Old Broad-street, E.C.

DOMESTIC ENGINEERING CO. (LTD.) (143,040)—Reg. Feb. 17, capital £3,000 in £1 shares, to carry on in any part of the world the business of domestic, agricultural, electrical, gas, mechanical, motor, marine and general engineers, founders, &c. Private company. First directors are A. D. Wire, F. J. Gordon, C. W. Gordon and A. S. F. Morris. Reg. office: 112, Tower Hamlets-road, Forest Gate, E.

FRANCIS THEAKSTON (LTD.) (143,057)—Reg. Feb. 18, capital £1,505 in 1,500 A shares of £1 each and 100 B shares of 1s. each, to carry on the business of railway, mechanical, mining and electrical engineers, manufacturers of and dealers in railway permanent way materials, &c. Private company. First directors are F. Theakston (chairman and permanent directer) and S. Gosman. Reg. office: 57, Moorgate-street, E.C.

LUBY-LOWE ENGINEERING CO. (LTD.) (143,018)—Reg. Feb. 15, capital £6,000 in £1 shares (3,000 7 per cent. participating preferred), to take over the business carried on at Bristol as the Luby-Lowe Engineering Co., to carry on the business of general, marine and electrical engineers, importers and exporters of machinery, &c., and to adopt an agreement. Private company. First directors are C. J. M. Lowe and J. H. Luby (both permanent managing directors). Reg. office: 81, Queen's-road, Bristol.

OXYGEN PRODUCERS (LTD.) (143,049)—Reg. Feb. 17, capital £6,000 in 5,500 preferred shares of £1 each and 10,000 ordinary shares of 1s. each, to carry on the business of manufacturers of and dealers in chemical, industrial and other preparations, gases, acids, electrical and scientific apparatus, &c. Private company. Reg. office: 17, Victoria-street, S.W.

SCOTT, KIRK & CO. (LTD.) (143,081)—Reg. Feb. 21, capital £1,000 in £1 shares, to carry on the business of general, mechanical and electrical engineers, machinists, founders, &c. Private company. First directors are M. Scott and H. H. Green. Reg. office: Montgomery Works, Rockingham-street, Sheffield.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The net revenue for 1915 from investments, &c., after deducting general expenses, and including balance brought forward, amounted to £707,370, the service of the 4½ per cent. bonds, due 1933, required £95,251, and the service of the 4½ per cent. three-year secured notes £31,500, leaving £580,618. This is applicable as follows: Payment under guarantee on Central London Railway Co. assented stocks, £26,931; interest at rate of 6 per cent. on £1,273,000 first cumulative income debenture stock, £76,380; and interest on £6,330,050 6 per cent. income bonds, £438,731, leaving £38,575.

WESTMINSTER GLASS & FURNACE CO. (LTD.) (143,100)—Reg. Feb. 23, capital £6,000 in 2,000 ordinary shares of £1 each and 800 10 per cent. preference shares of £5 each, to carry on business as manufacturers of and dealers in glassware of all kinds, to execute contracts for erection of glass or other furnaces, &c. Private company. First directors are F. Shelford and W. T. Cunningham. Sec.: W. T. Cunningham. Reg. office: 39, Victoria-street, S.W.

STATUTORY RETURNS.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.) (99,640).—Capital at Dec. 30, 1915, £1,000,000 in £1 shares (300,000 preference, 600,000 ordinary and 100,000 preference or ordinary). 300,000 preference and 600,000 ordinary shares taken up. £1 per share called up on 300,000. preference and 170,100 ordinary. £470,100 paid. £429,900 considered as paid on 429,900 ordinary shares. Mortgages and charges: £482,700.

ELLIS & WARD (LTD.)—In return to Sept. 28 gives capital as £10,000 in £1 shares. 6,703 shares taken up. £703 paid. £6,000 considered as paid. Mortgages and charges, nil.

HEXHAM & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—In return to May 17 capital is £30,000 in £5 shares. 1,521 shares taken up and £7,605 paid. Mortgages and charges: £7,350.

LARNE ELECTRIC LIGHT WORKS (LTD.)—The capital in return to Nov. 24, 1915, is £4,000 in £1 shares (500 5 per cent. cumulative preference). All shares taken up. £500 paid on the preference. £3,500 considered as paid on the ordinary. Mortgages and charges, £2,700.

RAILLESS ELECTRIC TRACTION CO. (LTD.)—Return to Jan. 6 gives capital as £5,000 in 4,750 ordinary shares of £1 each, and 5,000 deferred shares of 1s. each. 2,571 ordinary and 5,000 deferred shares taken up. £1 per share called up on 2,056 ordinary shares. £1,916 paid, leaving £140 in arrears. £765 considered as paid on 515 ordinary and 5,000 deferred. Mortgages and charges: Nil.

CITY NOTES.

MEMORANDA (March 1).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57⅞. Consols Pay Day, April 5. Stocks and Shares Ticket Days, March 9 and 26. Pay Days, March 10 and 27. Price of silver, 26 15/16d.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—A dividend of 4 per cent. has been declared on the ordinary shares for the past year.

CENTRAL LONDON RAILWAY CO.—At the meeting last week the chairman, Lord George Hamilton, said the improved financial position justified the increase of the dividends on the ordinary and deferred ordinary stocks. The Ealing extension had been delayed through the war.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have decided, subject to audit, to place £50,000 to reserve, and to recommend the following dividends: On preference shares 12s. per share, being at full rate of 6 per cent. per annum; on ordinary shares 16s. per share, being at rate of 8 per cent. per annum. On account of these shares 6s. per preference share and 6s. per ordinary share were paid in Sept., 1915, and the balance remains to be paid. About £17,500 will be carried forward. For 1914 the same amount was placed to reserve, the distribution was 18s. per share, or 9 per cent. per annum, and the carry forward about £23,500.

CLONTARF & HILL-OF-HOWTH TRAMROAD CO.—At the recent meeting a dividend of 6 per cent. was declared for the past year.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—A final dividend on the ordinary at the rate of 9 per cent. per annum (less tax) has been declared for the half-year ended Dec. 31, making 7 per cent. for the year 1915. £40,000 has been placed to reserve for depreciation, leaving about £14,000 to carry forward.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The directors have declared a quarterly interim dividend of 3s. per share on the preference shares (less tax) and of 2s. per share on the ordinary shares (income tax having already been deducted).

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—A dividend of 5½ per cent. has been declared on the preference shares.

MANSFIELD & DISTRICT TRAMWAYS CO.—The accounts for 1915 show £14,148 for appropriation. A dividend of 7 per cent. is proposed on the ordinary shares, adding £2,500 to reserve and carrying forward £1,545.

At the meeting the chairman (Mr. A. R. Holland), said the business had increased steadily. The collieries in the district were working full time and other collieries were in process of development. The directors were considering the matter of possible extensions. During the year they carried 5,600,000 passengers, and more than 500,000 car-miles were run.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—A dividend for the half-year ended Dec. 31 has been declared at the rate of 2 per cent., making 3 per cent. for the year 1915, against 3½ per cent. for 1914. £27,000 has been placed to reserve, against £22,000, and £4,978 carried forward, against £3,795.

WADEBRIDGE ELECTRIC SUPPLY CO. (LTD.)—A dividend of 6 per cent. has been declared for the past year.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date Feb. 29, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	17d.
Solid Drawn Copper Tubes	18¼d.
Brazed Copper Tubes	12½d.
Brazed Brass Tubes	19d.
Brass Wire	16¾d.
Copper Wire	18d.
Rolled Brass	16½d.
Brass Sheets	16¾d.

	per ton.
Copper Sheets	£148 0 0
Spelter	£110 0 0

	per ton.
English Lead	£34 0 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Scrap Copper	£96 0 0
Braziery Copper Scrap	£87 0 0
Clean Scrap Brass	£66 10 0
Old Lead	£27 0 0
Old Zinc	£70 0 0
Hollow Pewter	£120 0 0
Black Pewter	£90 0 0
Gun Metal	£83 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date Feb. 29 the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£150 0 0
Clean Mixed Brass	£70 0 0
Clean Copper	£98 0 0
Braziery Copper	£92 0 0
Gun Metal	£84 0 0

	per ton.
Old Lead	£28 0 0
Tea Lead	£26 0 0
Old Zinc	£76 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £110; Blowpipe Solder, £120.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, Feb. 29. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues., Feb. 29	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 5 5	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	Do. 6% Cum. 2nd Pref.	10⅜	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St.	83½	4 19 ..	..
St.	4%	Charing Cross West End & City Debs.	80	5 0 0	Jan, July
5	2/3	Do. 4½% Pref.	31⅝	6 9 9	..
5	5%	Do. Ord.	34	7 2 10	Aug, Feb
..	4½%	Do. City Pref.	21½	8 9 5	Jun, Dec
5	5%	Croydon Elec. Supp. Co. Ord.	41	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	11⅞	7 11 7	Feb, Aug
10	6%	Do. 6% Pref.	10⅛	5 10 4	Mar, July
St.	5%	Do. 5% Deb. St.	97½	5 2 6	Jun, Dec
..	4½%	Do. 4½% Debs.	90½	5 12 11	Jan, Dec
10	7%	County of London Ord.	13½	6 14 11	Mar, Sept
10	6%	Do. 6% Pref.	12½	5 18 4	Feb, Aug
St.	4½%	Do. 1st Debs.	89½	5 4 1	Jan, July
St.	4½%	Do. 2nd Debs.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	9%	Kensington and Knightsbridge Ord.	7⅛	7 5 5	Feb, Aug
St.	4%	(Do. Deb. St.)	77½	5 0 11	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4⅛	7 1 2	..
St.	4%	Do. 4% Mort. Debs.	75½	5 4 6	Jan, July
5	4½	Metropolitan E. Supp. Ord.	7⅛	8 7 3	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	89	5 11 6	Jan, July
St.	5%	Metropolitan Elec. Supply 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Deb.	99½	6 0 6	Mar, Sept
St.	5%	Newcastle Electric Supply 2½% Mt. Db. St.	100	5 0 0	Mar, Sept
..	6%	North Metropolitan E.P. Supp. 6% Pref.	6	6 ..	Apl, Oct
4	5%	South London E.S. Corp.	3⅜	6 10 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., Feb. 29.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	10%	St. James' & Pall Mall Ord.	5⅞†	8 10 3	Feb, Aug
5	7%	Do. do. Pref.	5⅛†	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅜	7 6 3	Mar, Aug
5	9%	Westminster E.S. Corp. Ord.	5⅛†	7 6 11	Mar, Sept
5	4½%	Do 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	82⅞	6 0 10	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	73½	8 3 3	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	69½	5 15 4	..
St.	4%	Do. do. Assented Def. Ord.	68	5 17 8	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½	8 0 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1⅛	3 4 7	Jan, July
St.	4%	Do. 4% Pref.	64½	6 4 0	Mar, Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22½	4 10 1	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan, July
St.	4%	Do. 4% Guar. Stock	68	5 18 6	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅛	5 4 5	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	4 11 5	Mar
100	5%	Do. Prior Lien Debs.	89½	5 12 0	Jan, July
1	6%	Do. 6% Pref.	⅞	6 15 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛	6 19 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅜	5 15 8	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm. 6% Pref.	⅞	6 15 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91†	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅜	6 15 2	April
100	6%	Do. 6% Prior Lien Debs.	102	5 17 11	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	63½	6 5 8	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅛	6 9 0	Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅝	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅝	8 6 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	71	5 12 8	Jan, July
..	10%	General Electric Ord.	10⅜	9 6 7	July
10	6%	Do. 6% Pref.	9⅛	6 5 6	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14	7 2 10	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9½	10 16 3	Feb, Aug
10	5%	Do. Pref.	7⅛	6 11 2	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	37	6 9 9	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅛	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 14 3	May, Aug
St.	4%	Do. 1st Debs.	79½	5 0 8	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	100½	5 19 10	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21½	6 18 9	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70	5 14 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 11 2	May, Nov
10	10%	Do. 10% Pref.	12	8 6 8	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	†Direct United States	5⅜	6 16 2	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127½	5 9 10	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77½	5 3 3	May, Nov
St.	4%	†Eastern Extension Tel. Co., 4% Debs.	78½	5 2 3	Feb, Aug
10	7%	Do. Ord.	12⅜	5 13 2	Ja, Ab,Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	34	6 9 5	Ja. My, Jly
25	13%	Indo-European	50½	6 8 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅞	5 6 8	April
1	7%	Do. 7% Pref.	1⅝	4 2 4	July
10	1%	West India & Panama Ord.	1⅜	9 15 1	May, Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12⅜	5 5 11	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	75½	5 6 0	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99½	4 10 3	May, Nov.
		Telephones.			
1	7½d.	* Monte Video Telephn. Ord	⅞	6 12 5	Nov.
1	10%	Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅛	6 16 2	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅝	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	84½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10½	5 17 1	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	10	6 0 0	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80½	6 4 7	Ja,Apl,Jly,O
..	4%	Do $100 Pref	67½	5 18 11	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 16 9	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5⅜	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs.	95½	5 4 9	Jun, Dec
10	6%	Bombay E. S. & T 6% Pref.	10	6 0 0	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	6	7 10 0	May, Nov
5	5%	Do. 5% Pref.	4⅝†	5 11 11	Mar, Sept

* And 13½% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 793
Arrangements for the Week .. 797
Some Recent Developments in the Audion Receiver. By Edwin H. Armstrong. Illustrated 798
Institution of Electrical Engineers 801 815
Uniformity in Drawing Electrical Diagrams. By Gisbert Kapp. Illustrated 802
Arc Phenomena. By A. G. Collis. Illustrated 806
Julian Train Control and Automatic Stop. Illustrated .. 807
Diesel Engine Users' Association.—*Discussion* 808
Recent Progress in Industrial Lighting. By L. Gaster 809
DIAGRAMS, RULES AND SYMBOLS 810
REVIEWS 811
An Elementary Manual of Radiotelegraphy and Radiotelephony [Fleming].
Handbook of Technical Instructions for Wireless Telegraphists [Hawkhead and Dowsett].
Industrial Development. By Harold Cox 812
Efficiency Progress of the Metal Filament Lamps. Illustrated 814
CORRESPONDENCE 814
The Rating of Incandescent Lamps (F. W. Willcox).
"Rapid Reckoning Chart" (F. M. Denton).
The "Electrician" Commercial and Industrial Section .. 817-826

NOTES.

"The Stranger That is Within Thy Gates."

We give elsewhere an account of the special general meeting of the Institution of Electrical Engineers that was held on the 1st inst. for the purpose of considering, and, if thought fit, of passing a resolution dealing with the modification of the articles of association. The ambiguity in the wording of the resolution, to which we referred in our issue of the 18th ult., resulted in a certain amount of "liveliness" at the meeting, and we venture to think that the happy (and rare) combination of firmness, tact and amiability of the President will long be gratefully remembered by most of those present. A notable feature of the meeting was the ignorance, real or assumed, of many of the speakers of the elementary principles of the Law of Public Companies, and it was largely due to such "ignorance" that the meeting was adjourned.

IF it be the intention to regard as subjects of an enemy country all those who, although naturalised in this country, are not de-naturalised in the country of their birth, in addition to those who are not naturalised in this country, then we think it will be difficult to frame such a resolution as would be upheld in the Courts. Apart from this, the necessary evidence would seldom be available. Moreover, we understand that the law in regard to denaturalisation was only introduced in Germany in 1913. Assuming that the resolution were altered so as to have the extreme meaning desired by some members, thus embracing all naturalised members as well as aliens, the immediate effect would be the removal from the roll of the Institution of names which are honoured, and rightly honoured, not only within the Institution itself, but throughout the entire electrical industry. We cannot believe that such was the intention of those who sought to give to the resolution a meaning which, evidently, was not intended by the Council. But if such was their intention we are inclined to doubt whether they will secure a unanimous vote at the next meeting.

THERE is much to be said both for and against naturalisation, but our columns are not adapted for the purpose, nor do we look upon the Institution as a suitable place for holding such a discussion. It is within the power of the Council to frame their constitution and by-laws so as to exclude naturalised citizens in future; but according to the Naturalisation Act, naturalised citizens have substantially the same rights and duties as natural born citizens, and this is so in every State which allows naturalisation. Therefore it will be, as we have said before, difficult, if not impossible, to frame a resolution for expulsion which would successfully stand the test of a Chancery action. The War Office has only this week recognised the rights of naturalised citizens further by permitting their sons to join the Colours. Although for purposes of trade, naturalisation may be undesirable from our point of view, it must not be forgotten that the Institution was founded with the object of promoting the general advancement of electrical science and its applications, and of facilitating the exchange of information and ideas on these subjects. In a word, the Institution is concerned more with the technical side than with the commercial side. This is a point that is liable to be overlooked. Were the Institution a trade association we should hold the view that its membership should be exclusively British. If it were possible we would much rather see members of the Institution pledged to buy and recommend machinery of British manufacture instead of filling their power stations and works with machines manufactured either on the Continent or in America, as many of them have done in the past. It is, of course difficult to act temperately in these matters at the present time, because Germany has broken away from all honourable methods and can no longer be numbered among civilised nations. Her methods are abhorrent to us. But this is all the more reason for acting with deliberation, and for avoiding even the semblance of injustice. It is said there are traitors among the naturalised members. This is not unlikely; but if so, they should be dealt with individually. To turn out members whose sons are fighting for us, to punish the just, whom we know, for the unjust who are unknown, is surely a parody of those laws of justice which we have rightly held sacred for generations.

THAT relatively few members should be able to carry a resolution of vital importance to the well-being of the Institution without consulting the total membership is a matter to which the immediate attention of the Council should be given. Furthermore, a list, not merely numbers, but names, status and date of election of the members affected by such a resolution should be sent, in confidence, to every member, so as to enable such member to form an opinion as to the desirability

or otherwise, of removing names, even if it were legal so to do, from the roll of the Institution. Finally, we believe that a statement by the President as to why the Institution of Civil and Mechanical Engineers decided to do nothing would be welcomed by many at the next meeting. In dealing with such a broad question collective action would be much more satisfactory than action by a single institution.

An account of the further informal meeting held last Wednesday will be found near the end of our present issue. In opening the proceedings the President announced that any resolution supported by a majority that afternoon would be submitted to the whole membership for an expression of opinion by a postal vote. After a lengthy discussion the following alternative courses of action were accepted by the meeting for submission to the membership: (*a*) Expulsion of members who are subjects of enemy states, as proposed in the original resolution of the Council; (*b*) expulsion of naturalised British subjects who have retained enemy nationality; (*c*) rendering ineligible for membership the subjects of enemy states after the war. The expulsion of naturalised members who are not de-naturalised in their own country raises the legal difficulty to which we have already referred. In this connection it must be remembered that the Institution is not a club but a public company, and unless certain rules of conduct are infringed, members cannot be expelled. The suggested regulation draws a distinction between British subjects quite irrespective of conduct. The rights of British naturalised subjects were strongly supported by Mr. Gill, Mr. J. E. Kingsbury, Mr. W. L. Madgen, Mr. W. Rutherford and Prof. S. P. Thompson. Mr. Gill read the clause in a naturalisation paper, setting out the rights that were so conferred, and pointed out that the treating of such a document as a "scrap of paper" would not be to our credit. A resolution to expel all naturalised members of enemy origin finally received but scanty support, and will, therefore, not be included among the above alternatives.

In a matter of this kind it is the duty of every member in supporting any resolution or course of action to be convinced:

1. That the proposed action is in the best interests of the Institution as a whole.
2. That the resolution is not dictated by any trade interests, instead of considering the welfare of the Institution.
3. That the action will not be detrimental to the interests of members engaged in enemy or neutral countries after the war.
4. That the action will be endorsed by the members generally 10 years hence.
5. That the resolution cannot be described by neutrals as what might have been expected from Germans, but not from Britons.
6. That the course of action is in accordance with British standards of justice, which, even in our hours of greatest provocation, we trust will never be lowered.

We hope that every corporate member will look at the question in all its aspects, considering the points enumerated above, and will not merely take the easy course of letting any action go by default.

The "Dead Man's Hand."

In common with many of our readers we have long regarded the knob in the top of the handle of the master controller used in electrically-operated trains as an absolute safeguard. That this is not so was made evident at an inquest held at Penge last Saturday. It was explained that when the driver releases his grip on this knob, which is known as the "dead man's hand," the train stops automatically. From the evidence it appears that a train, that should have stopped at Norwood, failed to do so, and the guard cut off the current and applied the brakes. Investigation showed that the motorman's cabin was unoccupied, and on the floor of the compartment was found a wedge which, if used, would put the safety device out of action, thereby enabling the driver to walk about or read a book. It is not unlikely that those guilty of such foolhardiness would find it more profitable to exercise their ingenuity in devising something superior to the existing appliance. The matter is one that should be inquired into by the railway companies, as the practice of drivers in charge of trains in motion "walking about and reading books" is not one to be encouraged. Makers of train-control equipment would do well not to underrate the capacity of those whom they endeavour to protect.

Coal and Coke Supplies.

There is something a little humorous in the announcement of the Board of Trade which we give in another column, that "owing to the increasing demand of industries connected with the war, difficulties with regard to fuel supplies have become more pressing in certain districts." To the average individual this fact became apparent in the spring of last year, but no action was taken for many months after that time; in fact, not until the winter demand was well in sight and when most valuable time had been lost. As it is, the stock of coal at many electricity works has been seriously depleted. In other directions also the deficiency is very marked. Thus, we learn that the Council's Schools at Birmingham are being closed because coal is not obtainable for warming them. When it comes to such institutions as schools, it may be that the net result is not much more than what may be classed as personal discomfort and a certain loss in education, but with electricity works the case is far different. It is high time it was realised how largely the output of munitions depends upon electric power, and it is to be hoped that the steps which have at length been taken by the Board of Trade in appointing certain committees may have a beneficial effect.

Edison's Birthday.—"The Electrical Review and Western Electrician" states that the 69th birthday of Thomas A. Edison was celebrated with a banquet at Newark, N.J., on the 5th ult. Six hundred of his employés were present.

Russian Central Station Statistics.—According to published statistics of Russian electric light stations, in which particulars of about 80 of the 225 stations are given, 47 stations possess steam plant of a total rating of 221,000 kw. Sixteen stations have oil or gas engines of a total rating of 9,570 kw., and 16 stations with a rating of 9,690 kw. have both steam engines and internal combustion engines. It appears that only one station uses water power.

American Electro-Chemical Society.—Volume XXVIII. of the "Transactions" of this Society contains some 20 Papers on metallurgical subjects. Amongst these we notice "Heat Losses from an Electric Furnace," "Electric Steel Costs," "Electric Furnace Melting of Ferro Alloys," "Electrolytic Precipitation of Gold, Silver and Copper from Cyanide Solutions," "Electro-deposition of Nickel," and the "Use of the Flame Arc in Paint and Dye Testing."

Energy Required by the Panama Pacific Exposition. According to the "Electrical World," the electrical energy which was consumed by the above amounted to 2,334,953 kw.-hours during the pre-Exposition and post-Exposition periods, and to 15,876,085 kw. hours during the Exposition period

proper, making a total of 18,321,038 kw.-hours. Excluding the State and Foreign section, the illumination produced a load of 5,216 kw., of which 1,700 kw. was for searchlights, 450 kw. for arc lamps, and 3,066 kw. for incandescent lamps.

Water Powers of Europe.—Statistics of the Imperial Russian Technical Society show the available water-power in European Russia, including Finland, the Urals and Caucasia, to be roughly 30,000,000 H.P. The potential water-power of Germany is about 1,000,000 H.P., that of Switzerland 2,500,000 H.P., and that of Sweden more than 6,000,000 H.P. Of the latter about 3,500,000 H.P. is not yet utilised. In Switzerland 300,000 H.P. and in Italy more than 400,000 H.P. is utilised, whereas hardly 250,000 H.P. is utilised in Russia.

Royal Society Candidates.—Among the candidates selected by the Council for nomination we notice the following :—E. H. Barton, Professor of Experimental Physics, University College, Nottingham; W. R. Bousfield, K.C., well known for his physical chemical work and as counsel in patent litigation; S. G. Brown, who has done much work in cable telegraphy; E. G. Coker, Professor of Engineering and Applied Mathematics at University College; and J. A. Pollock, Professor of Physics, Sydney University, N.S.W.

Boiler Fuels.—In the "Colliery Guardian" recently, Mr. E. Gevers-Orban contributed an article entitled "Coke, Anthracite Slime and Anthracite Duff as Boiler Fuel." A low refractory vault above the grate forces the burning gases upwards and brings them in contact with the coal entering the furnace from a hopper. In this way coke dust ignites easily as also does anthracite slime and duff. Wet anthracite slime burns regularly with 30 per cent. ashes, and 18 per cent. water without additional fuel, and raises steam for electrical purposes. Each pound of slime raises 3 lb. of steam at 120 lb. pressure.

Telephone Development.—According to the "Electrical World," the latest statistics compiled by the Bell Telephone Company, giving the average number of people to every Bell telephone in some of the largest cities in the United States, places Chicago and Albany first with 6·1 people per telephone, Los Angeles is next with 6·8, followed by Washington with 7·2 and Detroit with 7·8, Boston has 8·4, New York 8·5, and Philadelphia 11·5. Other cities were as follows : St. Louis 12·7, Pittsburgh 11·5, Cleveland 11·9, Newark 15·6, Buffalo 12·3, Providence 10·1, and Rochester 16·1, while the average of all these cities was 11·2.

Electric Railway Signals at Adelaide.—The "Commonwealth Engineer" referred recently to the system adopted at Adelaide, where the platform accommodation has been extended. The system of signals introduced is of the three-position type, and the operating machine has 43 levers and 13 square spaces. The power is furnished from duplicate sets of 200–100 volt direct-current motor-generators, which charge various storage batteries. It is stated that the total power required to operate the points and signals for their requirements was less than that required for six 16 c.p. lamps burning continuously.

Chimney Design.—Mr. R. Trautschold, writing in the "Coal Age" on "Power House Chimney Design for Bituminous Coal," refers to the progress made in the smokeless combustion of soft coal. If induced draught is not employed the chimney must exceed 65 ft. in height, and if fuel economisers are used the height must exceed 85 ft. A few figures taken from one of his curves for the height of chimney with different rates of combustion in a case where there is no fuel economiser are as follows :—

Lbs. per sq. ft. of grate.	Height in ft.	Lbs. per sq. ft. of grate.	Height in ft.
10	70	40	135
25	98	50	172

Fixation of Atmospheric Nitrogen.—The "Iron Age" has an interesting article on this subject by Mr. R. G. Skeratt. Referring to Germany, he states that with her imports of nitrate cut off, and making allowance for the stock in hand worth £6,000,000, she could not have kept up the struggle, since her use of explosives amounts to £200,000 every 24 hours. In August, 1914, Germany had three electrochemical establishments engaged in the fixation of nitrogen, and since then has increased this industry enormously. In Scandinavia, where the arc method is used, the cost per horse-power year is about 10s. to 15s. In Germany there is no water-power, but she has found a way to fix atmospheric nitrogen at a cost that bids fair to make her independent of Chili in the course of a decade.

What is an Engineer?—"Engineering Record" refers to 1,500 replies to this question received by the Chairman of the Carnegie Foundation from practising engineers. The following is an analysis of the attributes :—

Character and initiative	41 per cent.
Judgment and common sense	17·5 ,,
Efficiency and industry	14·5 ,,
Executive ability	14 ,,
Knowledge of fundamentals of engineering science	7 ,,
Technique of business	6 ,,
	100 ,,

This is not considered satisfactory, and another set of questions is to be sent out. The idea is that if practical men will specify what they want the colleges will turn it out.

Plant at Kananaskis Falls, Alberta.—In "Engineering Record" there is an interesting article by Mr. Harold S. Johnston on "Five Schemes considered for Power Development at Kananaskis Falls, Alberta." The two main turbines in the power house are of the vertical shaft, single-runner type, giving 5,800 H.P. at 164 revs. per min. The effective head is 68 ft. and the efficiency at three-quarters gate is 85 per cent., with a guarantee as to normal speed and capacity under heads varying from 65 ft. to 72 ft. At full gate and no-load the runaway speed is not to exceed 280 revs. per min. The exciter turbine is a 150 H.P. vertical shaft machine of 82 per cent. efficiency. The flywheel action of the rotor is such that no flywheels are required on the main units. The generators are designed to carry a 25 per cent. overload continuously, and momentary overloads of 100 per cent. They are also to be capable of being short-circuited for two minutes without injury and to operate successfully in parallel with the generators at the Horseshoe Falls plant.

Corona and Other Forms of Electrical Discharge.—Last Friday Prof. S. P. Thompson gave a discourse at the Royal Institution on this subject. Reference was first made to the three types of discharge—namely, spark, brush and glow, and then to the character of insulator that is necessary for transmission at high voltages. It was pointed out that there was a lack of experimental work on breakdown voltages, and that Manchester was the only city in this country which had a high-tension laboratory suitable for dealing with such work. Passing on to experiments on electric wind, Prof. Thompson pointed out that a jet of electric wind was capable of passing through an ordinary air jet without causing much displacement, and showed some interesting experiments on the subject. At the end of the discourse experiments were shown upon dust figures, the pattern of which depended upon whether the electrification was positive or negative, a round spot being characteristic of negative electrification or glow discharge, and a branching pattern characteristic of positive electrification or brush discharge. By suitable means (using a wooden discharge point instead of a metal point) it was possible to obtain a round spot with positive electrification. Breath figures were also shown, and finally the patterns obtained by discharge upon photographic plates.

Coal and Coke Supplies.—The Board of Trade announce that, owing to the increasing demands of industries connected with the war, the difficulties with regard to fuel supplies have become more pressing in certain districts.

On the nomination of the various coalowners' associations, District Coal and Coke Supplies Committees have been formed in order to ensure that munition firms and other important consumers obtain the supplies they need with as little delay and friction as possible. Committees have been formed, or are in course of formation, in the following districts :—

Scotland (secretary, Mr. Robt. Baird, 105, St. Vincent-street, Glasgow); Northumberland (secretary, Mr. R. Guthrie, Coal Trade Offices, Newcastle-on-Tyne); Durham (secretary, Mr. R. Guthrie, Coal Trade

Offices, Newcastle-on-Tyne); Cumberland (secretary, Mr. Tom P. Martin, 19, Falcon-street, Workington); Lancashire, Cheshire and North Wales (secretary, Sir T. R. Ratcliffe Ellis, 18, King-street, Wigan); W. Yorkshire (secretary, Mr. A. B. Smith, Central Bank Chambers, Leeds); S. Yorkshire (secretary, Messrs. Parker Rhodes & Co., 14, Moorgate-street, Rotherham); Nottingham, Derby and Leicester (secretary, Mr. Wm. Saunders, Bank Chambers, London-road, Derby); Staffordshire, Warwickshire and Shropshire (secretary, Mr. S. J. Keeling, New-road, Netherton, Worcestershire); S. Wales (secretary, Mr. Finlay A. Gibson, Park-place, Cardiff); and Somersetshire and Gloucestershire (secretary, Mr. J. G. Dennehy, Albion Chambers, Bristol).

It will be the business of these Committees to see that the resources of their districts are utilised to the best advantage and that the requirements of important industries are fully met. The question whether licences for the export of coal and coke can be issued will necessarily depend largely upon the home demand being satisfactorily supplied. Any recommendations that the Committees may be able to make with a view to greater economy in the use of coal will be carefully considered. It is hoped that both coalowners and consumers will realise that the industries connected with the war must have precedence, and that some interference with the normal distribution of coal at the present time cannot be altogether avoided. It will probably be necessary for the Committees from time to time to ask for information, in the form of returns or otherwise, as to the distribution of the output or portions of the output of mines in their districts. Should serious objection be felt by coalowners to furnishing any particular informatoin the matter should be submitted at once to the Board of Trade, who will consult the Central Committee if necessary. The Board of Trade have appointed the following committee to consider all questions relating to the distribution of coal and coke that may be referred to them from time to time by the Board or submitted by the District Coal and Coke Supplies Committees :—

Mr. W. F. Marwood, C.B. (Board of Trade) (*Chairman*), Sir Richard A. S. Redmayne, K.C.B. (H.M. Chief Inspector of Mines) (*Vice-Chairman*), Messrs. H. F. Carlill (Board of Trade), Commander T. Fisher, R.N. (Admiralty), J. C. Hamilton Greig, F. J. Jones, Leonard W. Llewelyn, Arthur F. Pease, K. W. Price (Ministry of Munitions), F. Tatlow (Railway Executive Committee), and W. Walker (Deputy Chief Inspector of Mines), with Mr. W. A. Lee (Board of Trade) and Capt. C. E. Williams (Ministry of Munitions) as secretaries.

OBITUARY.

R. A. Dawbarn.—We regret to record the death of Mr. Robert Arthur Dawbarn, M.I.C.E., M.I.E.E., which occurred on Monday, at the age of 55.

Mr. Dawbarn was born in 1860 and served his apprenticeship with Messrs. Neilson & Co., locomotive engineers, of Glasgow. In 1881 he obtained an appointment with the British Electric Light Co., which held the Gramme patents, and for three years he was the company's representative at its Stockport works where the dynamos were made. In 1884 he joined Mr. Raworth's staff in Manchester and became identified with ship lighting. From 1885 to 1887 he was assistant engineer on the electric lighting staff of Messrs. Siemens Bros. & Co. at Woolwich, but in the latter year he again took up a post under Mr. Raworth, who was at that time superintending engineer of the Brush Company. In 1888 he became chief assistant engineer of the company and had entire charge of the estimating department, being responsible for the many schemes which emanated from the Brush Company in the early days of municipal lighting. Among the projects which originated from Mr. Dawbarn were the Hanley, Worcester, Leicester and Stockton-on-Tees schemes. In 1893 he secured the premium for the best electric lighting scheme for Winchester Corporation, and in 1895 a similar premium offered by Battersea (London) Vestry. In 1897 he visited Australia, and as the outcome of his work the Electric Lighting & Traction Co. of Australia (Ltd.) with a capital of £300,000 was formed. On his return from Australia he became superintending engineer to the Brush Company, with the control also of the traction department, but in 1900 he resigned in order to enter into a partnership with Mr. W. M. Mordey, which continued until 1915.

PERSONAL.

It is announced that a marriage has been arranged and will take place shortly between Major F. H. Masters, R.E. (T.), and Dorothy, third daughter of Mr. Walter Fox, J.P., of Upton St. Leonards. Many of our readers will know Major Masters as Assistant Editor of The Electrician up to the time when war broke out.

Mr. T. Gladdy, who for the past eight or nine years has had charge of the accessories section of the supplies department of Messrs. Siemens Bros. Dynamo Works (Ltd.), 39, Upper Thames-street, E.C., is shortly leaving this firm to take up an appointment as commercial manager with Messrs. Trevelyan & Co., who are manufacturers of accessories &c., for the electric and general engineering trades, at 155, Bracebridge street, Birmingham.

Royal Engineers (T.F.).—The following appointments have been made:

London Electrical Engineers.—Lieut. (temp. captain) F. H. Masters is seconded and promoted to temp. major (to remain seconded). Capt. T. S. Wallis from R.N. Divisional Engineers, Corpl. H. C. Durant and Spr. Corpl. H. K. B. Reed to be second lieutenants on probation.

APPOINTMENTS VACANT.

Wallasey Electricity Committee require a chief assistant engineer. Commencing salary £200 per annum. Applications to Town Clerk by March 11.

A firm of electrical engineers is advertising for an experienced technical assistant.

Hammersmith (London) Council require an engineer-in-charge (salary £3 per week) for period of the war: and a stoker (38s. per week and 2s. 6d. war bonus). Applications to Mr. G. G. Bell, engineer and manager of the Electricity Department, 85, Fulham Palace-road, London, W.

INSTITUTIONS AND SOCIETIES.

Junior Institution of Engineers.—A Bohemian Concert "in aid of the funds of the Red Cross Hospital of the City of London branch of the British Red Cross Society" was held in the King's Hall of Holborn Restaurant last Saturday by this Society. Sir Boverton Redwood, in the chair, was as ready as ever to help the Institution, in spite of the demands made upon his time and energies by his work for the Ministry of Munitions. The Lord Mayor made a brief but eloquent speech. In thanking the audience, the chairman included a reference to Mr. Bullock, the hon. musical director. The audience numbered 646.

The Royal Society.—Amongst the Papers read last Thursday we notice the following: "On the Distribution of Intensity in Broadened Spectrum Lines," by Prof. J. W. Nicholson and T. R. Merton; "On Prof. Joly's Method of Avoiding Collision at Sea," by Prof. H. C. Plummer.

Last Tuesday Sir John Wolfe-Barry was elected an honorary member of the Institution of Civil Engineers.

Electric Vehicle Committee.—A meeting of this Committee was held in London on the 18th ult.

They had before them favourable figures regarding the increasing circulation of their official publication, "The Electric Vehicle," subscribers being now numbered in all parts of the world.

They had received a letter from the Secretary of the Electric Vehicle Association of America, congratulating them on tangible progress.

Some time ago, the Committee asked the Accumulator Manufacturers' section of the British Electrical and Allied Manufacturers' Association, through their representatives on the Committee, to consider the possibility of further standardisation of lead-acid accumulators for electric vehicles, particularly in regard to rating and the overall sizes of cells. The Committee at this meeting considered a communication from the Accumulator Manufacturers' section of the B.E.A.M. Association, stating that they were prepared to agree to the standard sizes and rating as set forth below, which the Committee consider satisfactory, and as meeting present requirements. These, as well as the other matters in connection with lead-acid accumulators that have, with the co-operation and assistance of the Manufacturers, been standardised, will be known as E.V.C. standards, but it is hoped that, in due course, the British Engineering Standards Committee may give them the mark of approval.

Standard Rating. If a battery is specified to have an "E.V.C." standard rating of 180 ampere-hours, it means that the battery will give this capacity when discharged at a continuous rate of 36 amperes for a period of five hours, at the end of which time the voltage per cell shall not have fallen below 1·7 volts.

Standard Plates. Height, $8\frac{5}{8}$ in.; width, $5\frac{1}{4}$ in.; lug centres, $4\frac{3}{4}$ in.

Standard Overall Sizes. For all sizes the width of the cell shall be $6\frac{5}{16}$ in., and the overall height, including connector, $14\frac{7}{8}$ in. The length of the smallest size, *i.e.*, that with seven plates, shall be $2\frac{5}{16}$ in., with the addition of $\frac{1}{4}$ in. for each pair of plates above seven plates.

Standard Inspection Plug. Shall be that which will fit a hole in the cover of the cell 1 in. in diameter.

Standard Charging Voltage.—Shall be that which is suitable for charging 44 lead-acid cells, *i.e.*, 85 to 120 volts.

The secretary reported that since Oct. 1, subscriptions and donations amounting to £56, 14s. had been received. The Committee have again undertaken to award money prizes amounting in all to a sum of £10 at this year's annual parade and inspection of motor vehicles, to be held under the auspices of the Commercial Motor Users' Association.

The Committee have had brought to their notice difficulties which are being experienced in a few of the districts bordering upon the London area by electric delivery vehicles, operating from London on long delivery routes, in getting boosting charges. The difficulties consist in either delay in getting connected up for charging owing to there being no permanent connection for the purpose, or, on the other hand, the exorbitant price charged for the service. The Committee appeal to all central station engineers to adopt, where they have not already done so, the Committee's standard tariff of 1d. per unit for "off peak" charging with a minimum of 2s. per lamp (24 units at 1d.) to include all connecting up and disconnecting.

Institute of Chemistry.—Speaking at the annual general meeting of the Institute of Chemistry on March 1, Sir James Dobbie, the president, referred to the work of the Institute during the war and the importance of the services of professional chemists to the nation, particularly in the production of munitions and other material of war. The Institute had fulfilled a useful function, which e knew was fully appreciated by the authorities. Both in the interests of the profession and of the industries of the country, the Institute had encouraged by every means possible the production of laboratory requirements of all kinds hitherto obtained almost entirely from Germany and Austria. The President than gave some details of the work of the Institute, to which we referred in our issue of the 25th ult. Referring to the necessity for equipping ourselves for the economical struggle which must ensue when peace is restored, he said that the discussions which had taken place on the subject revealed a wide divergence of views, both as to the cause of the unsatisfactory position in which we found ourselves and the steps required to remedy it. In chemical industries, however, it was generally agreed that the relations between chemical science and chemical manufactures should be more intimate in the future. That condition could only be fulfilled if the country possessed an ample supply of highly-trained chemists. He agreed with Dr. Beilby in the belief that the phenomenal development of chemical industry in Germany had resulted much more from the large command of chemists and engineers of sound professional training than from the possession of an even larger supply of research chemists of mediocre ability. That opinion should not be taken as giving the impression that the value of research was to be underrated. It had to be admitted, however, that the great public schools were, for the most part, unsympathetic towards the study of science, and, even when they were excellently equipped for the purpose, the results were meagre and unsatisfactory. The progress made by the older universities was then referred to, and general education on broad lines up to a certain age was advocated. Sir James Dobbie intimated that the Council of the Institute were about to give further consideration to the problem of promoting a more complete organisation of professional chemistry in the interests of the industries of the country. He then dealt with chemical education, and thought the Institute should act as an attesting rather than examining body. Chemistry was a comparatively young profession, which was gradually establishing itself in the knowledge and, he hoped, the good opinion of the community.

National Association of Colliery Managers.—At a meeting of the Scottish Branch in Glasgow on the 26th ult., Mr. John George, Cambuslang, replied at considerable length to the criticism passed on his Paper "The Electric Safety Lamp" at recent meetings of the Branch.

His advice to those members of the Association who still doubted the superiority of the light given by the average electric lamp as compared to that of the flame safety oil lamp was to visit some colliery where there was an installation of electric lamps. On the occasion of such a visit they ought not to omit asking the miner which lamp he preferred and which he thought gave better light. After all, there was no question that the miner could be considered both a competent and a good judge. Mr. J. Balfour Sneddon of Mid-Calder had asked, in the course of discussion, to be supplied with an estimate of the probable cost of working an installation of electric lamps. It was difficult to give such an estimate because circumstances altered cases, and while one installation might cost a certain figure, another, of similar size, might involve heavier maintenance charges. The undernoted were factors, one or all of which materially affected the cost: (1) The instructions as supplied b they electric lamp manufacturers were not always carried out; (2) the lampman might not be altogether capable; (3) colliery companies might be trying to work lamps without being in possession of the proper accessories; (4) a cabin where space was limited had invariably the effect of increasing costs of upkeep and (5) the accumulator acid in use might not always be of the desired quality. Again, much depended on how the miners used or abused the electrical lamps, while the underground conditions in each case had to be separately considered. There was no question of this, that the brighter and better-diffused light afforded by the electric lamp had considerably reduced the number of accidents from falls from roof or sides. Even in the isolated instances where men had been overcome by gas it was by no means certain that the oil lamp had any advantage over the electric lamp. An oil lamp might warn a miner of the presence of gas, but if the light was extinguished that workman had a worse chance of finding his way out before being overcome than he would have if he remained in possession of an electric lamp, the light of which would continue unaffected.

Circle of Scientific, Technical and Trade Journalists.—A discussion on "The Sphere of the Scientific and Technical Press in relation to Technical Education and Industrial Research" will take place at the next meeting of the Circle, to be held at 8 p.m. on Tuesday, March 14, in the hall of the Institute of Journalists (Tudor-street, Blackfriars, London, E.C.). Dr. William Garnett (late educational adviser to the L.C.C.) will open the discussion by an introductory Paper. Some of the conclusions arrived at by the author may be summarised as follows: Education in elementary and secondary schools must be more directly associated with things so as to develop self-reliance and resourcefulness, and a considerable proportion of teachers should devote a third year of training largely to practical work under conditions enabling them to become acquainted with the practice of some trades. Some alterations must be made in the patent law. Trades should be organised for the purpose of superintending the research work in which they are interested, and the trade associations should be in close touch with the Advisory Council for Research. The National Physical Laboratory should be the central institution for all physical measurements and standardisation.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 10th (to-day).

PHYSICAL SOCIETY.

5 p.m. Meeting at Imperial College of Science, Exhibition-road, S.W. Paper on "Experiments Illustrating the Flow of Heat in Conducting Sheets," by S. Skinner, M.A., and "The Absorption of Gas by a Quartz Vacuum Tube," by R. S. Willows, M.A., D.Sc., and H. T. George, M.A.

ROYAL INSTITUTION.

5:30 p.m. At Albemarle-street, W. Discourse on "Illusions of the Upper Air," by Sir Napier Shaw, M.A., LL.D., D.Sc., F.R.S.

SATURDAY, March 11th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, W. "Radiations from Atoms and Electrons," Lecture I., by Prof. Sir J. J. Thomson, F.R.S.

TUESDAY, March 14th.

SCOTTISH SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at 207, Bath-street, Glasgow. Kelvin Lecture on "Terrestrial Magnetism," by Dr. C. Chree, F.R.S.

WEDNESDAY, March 15th.

BIRMINGHAM SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Meeting at the University, Edmund-street. Paper on "The Use of Continuous Current for Terminal and Trunk Line Electrification," by Mr. N. W. Storer.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Meeting at the Surveyors' Institution, 12, Great George-street, Westminster. Lecture on "The Meteorology of the Globe in 1911," by Sir Napier Shaw, F.R.S.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, Victoria Embankment, W.C. Informal Discussion on "Methods and Appliances for the Attainment of High Temperatures in the Laboratory."

STUDENTS' SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7:45 p.m. Adjourned Discussion on "Suggested Applications of Science in Warfare."

THURSDAY, March 16th

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Victoria Embankment, W.C. Paper on "The Use of Direct Current for Terminal and Trunk Line Electrification," by Mr. N. W. Storer.

FRIDAY, March 17th.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. Meeting at the Institution of Civil Engineers, Great George-street. Paper on "The Composition of the Exhaust from Liquid-fuel Engines," by Second-Lieut. R. W. Fenning, R.E., B.Sc.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding: Lieut.-Col. CLAY, V.D.

Orders for week commencing March 13, 1916.

Drills 6:25 to 7:25.; 7:25 to 8:25 p.m.

Saturday, March 11th, Parade, Putney Bridge Station, 3 p.m.

Monday, March 13th.—Sections 1 and 2, Technical; Sections 3 and 4, Lashings and Trestle Bridging. Signalling Class and Recruits.

Tuesday, March 14th.—School of Arms, 6 p.m. to 7 p.m.

Thursday, March 16th.—Shooting for Sections 3 and 4.

Friday, March 17th.—Sections 3 and 4, Technical; Sections 1 and 2, Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, March 18th.—Adjutant's Instruction Class at 2:30 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 46, Regent-street, W.

Sections for Shooting Parade at Miniature Ranges.

Unless otherwise ordered, all Parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate-hill, as soon as possible.

Payment for uniform to be made to the Adjutant.

SOME RECENT DEVELOPMENTS IN THE AUDION RECEIVER.*

BY EDWIN H. ARMSTRONG.

Summary.—The action of the audion as a detector and simple amplifier is explained, with the method of verification of the theory by means of oscillograms. Various methods of coupling grid and wing circuits are shown. The audion, being a generator of alternating current of any desired frequency, can be used as a beat receiver. By the use of two audions in cascade, amplifications as high as 1,000 are attainable. It is found that a static of large amplitude nearly always decreases the wing current, while a signal (with beat reception) alternately increases and decreases it.

The Audion as Detector and Amplifier

The fundamental operating characteristic of the audion is the relation between the wing current and the potential of the grid with respect to the filament—say, the negative terminals of the filament.

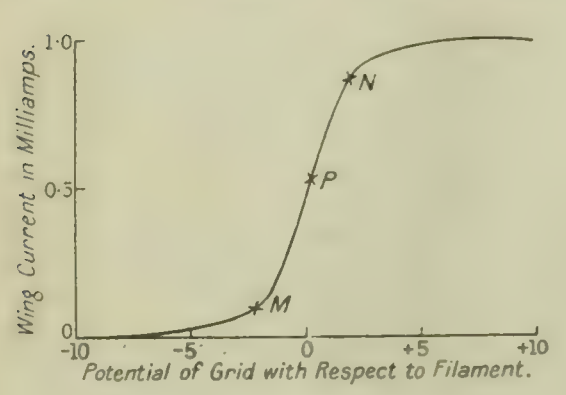


Fig. 1.

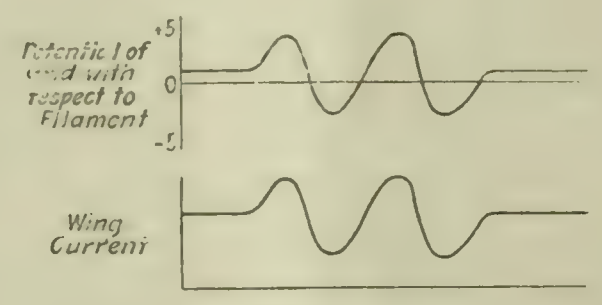


Fig. 2.

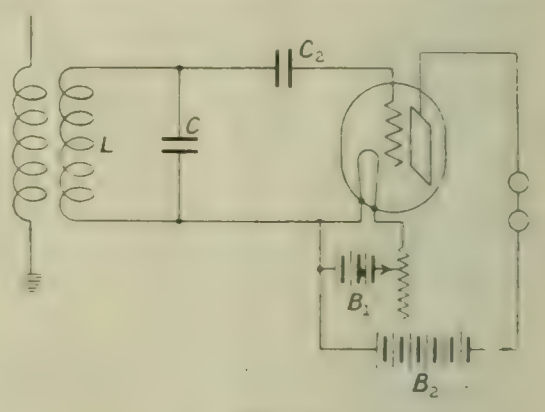


Fig. 3.

Such a characteristic is shown in Fig. 1, and from it we see that a positive charge placed on the grid produces an increase in the wing current, and that a negative charge placed on the grid produces a decrease in the wing current. When the audion is used as an amplifier, and an alternating E.M.F. is impressed between the grid and the filament, the continuous current of the wing circuit will be varied in accordance with the characteristic of Fig. 1, producing on the continuous current a superimposed alternating-current wave in phase with and of the same frequency as the impressed E.M.F. Diagrammatically this action is shown in Fig. 2.

The action of the audion as a detector of radio-frequency oscillations is very different from its action as a simple amplifier. Some form of connection must be used, such that the effect of a group of radio-frequency oscillations in the grid circuit of the audion is translated into a single aduio-frequency variation of the current in the telephones. The usual method is to make use of the valve action between the hot and cold electrodes at low pressures, and the connection used to do this is shown in Fig. 3. In this method of connection there are two distinct actions: one rectifying and the other amplifying. The closed oscillation circuit LC, filament, grid and condenser C_2, behaves exacty as a Fleming valve receiver, the incoming oscillations being rectified between the grid and filament and the rectified current being used to charge the condenser C_2 (the side connected to the grid being, of course, negative). The negatively charged grid then exerts a relay action on the wing current, decreasing it; the wing current returning to its normal value as the charge in the grid condenser leaks off by way of the grid and the grid resistance its normal potential. If the audion is properly constructed, the relay action results in an amplification of the energy available for use in the telephones over that which would be available in a simple rectifier. Fig. 4 indicates the features of the valve method of detection.

Working in conjunction with Prof. Morecroft, I have recently secured oscillograms (given in the original Paper) which confirm the explanation already advanced.

It will be seen, therefore, that using the audion as a detector of radio-frequency oscillations, it has been shown that, in addition to operating as a rectifier, it simultaneously acts as a repeater of the radio frequencies; so that oscillations in the grid circuit set up oscillations of similar character in the wing circuit of the audion. In the ordinary detector system no use is made of the repeating action, and it is the purpose of the present Paper to show that it may be turned to account to produce improvements in the reception of signals which completely overshadow any of the particular advantages of the audion when used as a simple detector. The ordinary detector circuit is illustrated by Fig. 3 and the phenomena present therein may be summed up diagrammatically by the curves of Fig. 4. It will be seen from these that the radio-frequency oscillations present in the wing circuit of Fig. 3 with the ordinary audion are necessarily small and also that they are of no value in producing a response in the telephones; but by providing means for increasing their amplitude and means for utilising them to reinforce the oscillations of the grid circuit it becomes possible to produce some very remarkable results.

Reinforcement of Radio-frequency Oscillations by the Audion.

There are two ways of reinforcing the oscillations of the grid circuit by means of those in the wing circuit. The simplest way perhaps is to couple the two circuits together in the manner shown in Fig. 5. This is essentially the same as Fig. 3, but modified by the introduction of the inductively-coupled coils L_2 and L_3 in the grid and wing circuits respectively, and by the condenser C_2 which forms a path of low impedance across the telephones for the radio-frequencies.

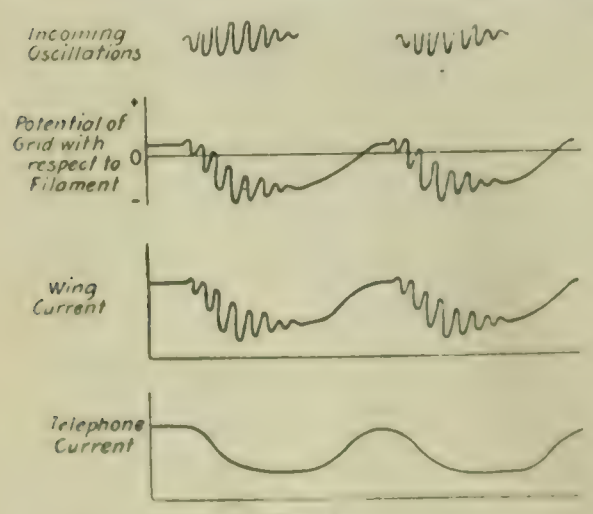


Fig. 4.

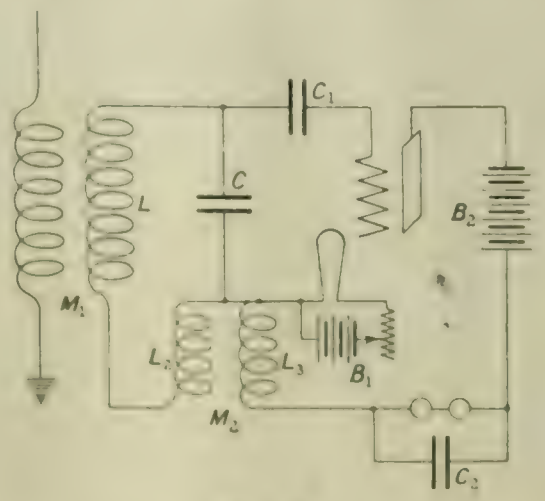


Fig. 5.

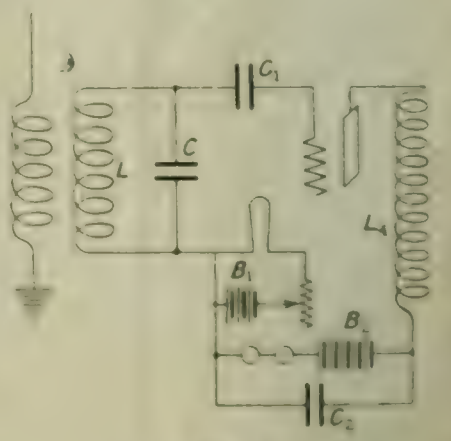


Fig. 6.

In such a system incoming signals set up oscillations in the grid circuit which repeat into the wing circuit producing variations in the continuous current, the energy of which is supplied by the battery B_2. By means of the coupling M_2 some of this energy of the wing oscillations is transferred back to the grid circuit, and the amplitude of the grid oscillations thereby increased. The amplified grid oscillations then react on the wing circuit by means of the grid to produce larger variations in the wing current, thus still further reinforcing the oscillations of the system. Simultaneously with this procedure the regular detecting action goes on: the condenser C_1 is charged in the usual way, but accumulates a charge which is proportional, not to the original signal strength but to the final amplitude of the

* Paper read before the Institute of Radio Engineers of New York. Somewhat abbreviated.

oscillations in the grid circuit. The result is an increased response in the telephone proportional to the energy amplification of the original oscillations in the grid circuit. It will be observed from the operating characteristics (the relation between grid potential and wing current) that the amplitude of the variation in the wing current is directly dependent on the variation of the grid potential. This indicates that the grid circuit should be made up of large inductance and small capacity to obtain the maximum voltage which it is possible to impress on the grid. For moderate wave-lengths the tuning condenser C of the grid circuit may be omitted altogether and the capacity of the audion alone used to tune the circuit. For long wave-lengths the distributed capacity of the grid circuit inductance becomes so high with respect to the capacity of the audion that better results are obtained by the use of a tuning condenser to fix definitely the points of maximum P.D. across the grid and filament of the audion.

In the second method of reinforcing the oscillations of the grid circuit the wing circuit of the audion is tuned by means of an inductance introduced as shown by Fig. 6. This differs from the ordinary detector circuit of Fig. 3 by the addition of the coil L_4 and the condenser C_2. The manner in which the grid oscillations are amplified may best be understood by the following analysis. With no oscillations in the system the P.D. between filament and wing will be approximately the voltage of the battery B_2, but when oscillations are set up in the grid circuit, causing radio-frequency variations of the wing current, the potential of the wing with respect to the filament varies as the reactance voltage of the wing inductance alternately adds to and substracts from the voltage of the battery. When a negative capacity charge is placed on the grid the wing current will be reduced and the direction of the reactance voltage of the wing inductance will, therefore, be the same as the voltage of the battery B_2. The reactance voltage will, therefore, add to the battery voltage and the difference of potential between wing and filament and also between wing and grid will be increased. Similarly, when a positive charge is placed on the grid the wing current is increased and the reactance voltage of the wing inductance opposes the battery voltage, producing a decrease in the P.D. between grid and wing. Hence, supposing a negative capacity charge is placed on the grid, the tendency of the corresponding increase in the potential of the wing with respect to the grid will be to draw more electrons out on the grid, thereby increasing the charge in the condenser formed by the wing and grid, the energy for supplying this charge being drawn from the wing inductance as the wing current decreases. The increased negative charge on the grid tends to produce a still further decrease in the wing current and a further discharge of energy from the wing inductance into the grid circuit. On the other hand, when a positive charge is placed on the grid, the P.D. between grid and wing is reduced and some of the energy stored in the capacity formed by them is given back to the wing inductance. During this part of the cycle, electrons are being drawn into the grid from the surrounding space to charge the grid condenser in accordance with the well-known valve action, and this, in effect, is a conduction current, so that a withdrawal of energy from the circuit takes place. In spite of this withdrawal of energy, however, a well-defined resonance phenomenon between the audion capacity and the wing inductance is to be expected and in the reception of signals such is found to be the case. When the wing inductance is properly adjusted at the resonance frequency, energy from the wing circuit is transferred freely to the grid circuit and oscillations built up therein and are rectified in the usual way.

A curve showing the general relation between signal strength and value of wing inductance is shown in Fig. 7, the circuits used being those of Fig. 6. As the capacity of the audion is the main means of transferring energy from the wing to the grid circuit best results are obtained when the condenser C is very small. On account of the very small capacity of the audion the effectiveness of this method of tuning is more pronounced at the higher frequencies, but by the use of a shunt condenser across the inductance of the wing circuit very good amplification is secured on frequencies as low as 30,000 cycles (10,000 meters wave-length). The best results, however, are obtained with some combination of coupling and wing circuit tuning. Other methods of coupling may be employed between the grid and wing circuits.

Audio-frequency Amplification.—It is possible to combine with any of these systems a system of audio-frequency circuits which amplify the telephone current in exactly the same manner as the radio-frequency oscillations are amplified, and such a system is shown in Fig. 8. Here M_2 represents the coupling for the radio-frequencies and the coils are of relatively small inductance. M_3 is the coupling for the audio-frequencies, and the transformer is made up of coils having an inductance of the order of a henry or more. The condensers C_3 and C_4 have the double purpose of tuning M_3 to the audio-frequency, and of by-passing the radio-frequencies. The total amplification of weak signals by this combination is about 100 times, with the ordinary audion bulb. On stronger signals, the amplification becomes smaller as the limit of the audion's response is reached.

The Audion as a Generator and Beat Receiver.

Any repeater which is also an energy amplifier may be used to produce continuous oscillations by transferring part of the energy in the circuit containing the battery back to the controlling circuit to keep the latter continuously excited. By providing a close enough coupling between the grid and wing circuits sufficient energy is supplied to the grid circuit to keep it in continuous oscillation, and as a consequence thereof oscillations of similar frequency exist in all parts of the system. The frequency of these oscillations is approximately that of the closed grid circuit if the tuning condenser of that circuit is large with respect to the capacity of the audion. If this capacity is small, then the wing circuit will exert a greater influence on the frequency of the system, and it will not approach that of the grid circuit so closely. When such a system of circuits is in oscillation it has been found possible not only to receive continuous waves by means of the beat method but also very greatly to amplify them as well.

When the audion begins generating, the grid oscillations are continuously rectified to charge the grid condenser, and this charge continuously leaks off either by way of the grid or by means of a special high resistance placed in shunt with the condenser. As the negative charge builds up in the grid condenser it decreases the average value of the continuous-current component of the wing current, and, therefore, limits the amplitude of the oscillations of the grid circuit until a point is finally reached where the rate at which electricity is supplied to the grid condenser is justequal to the rate at which it leaks off. Consider, now, the effect on the system of an incoming continuous wave having a frequency slightly different from the frequency of the local oscillations. The presence of the local oscillations will not in any way interfere with the amplifying powers of the system and the incoming oscillations will build up in exactly the same manner as for the non-oscillating state but to a greater degree because of the closer grid and wing coupling. Simultaneously with the amplifying of the incoming wave beats are produced between the local and the signalling currents, the effect being alter-

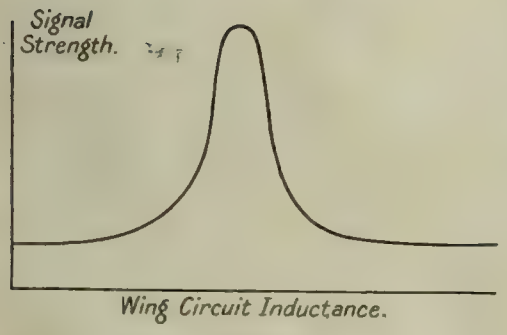


Fig. 7.

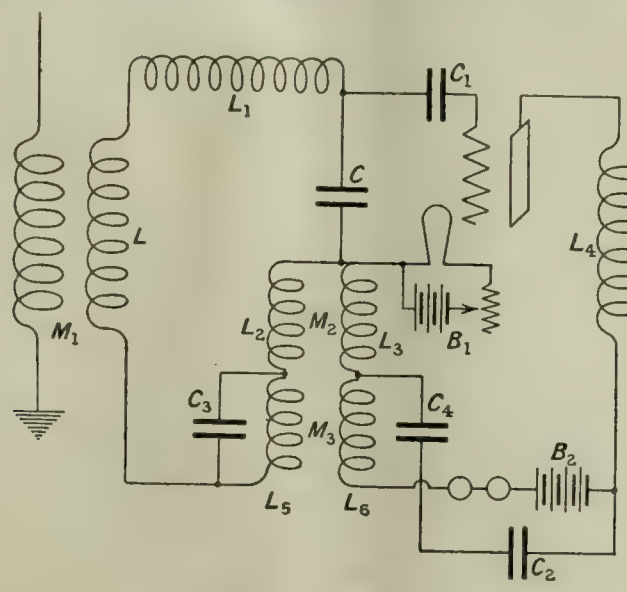


Fig. 8.

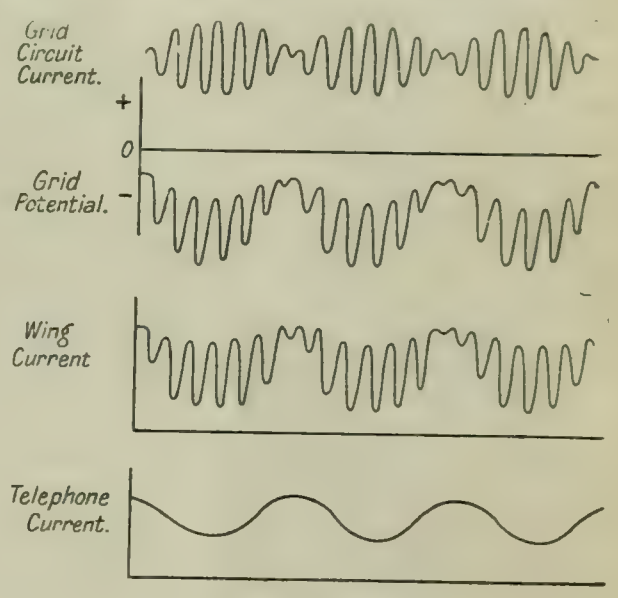


Fig. 9.

nately to increase and decrease the amplitude of the oscillations in the system. From Fig. 9 it will be apparent that when this steady state is reached an increase in the amplitude of the grid oscillations by any means whatever will increase the negative charge in the grid condenser, producing a decrease in the average value of the wing current and hence a decrease in the telephone current. On the other hand, a decrease in the amplitude of the oscillations will allow some of the negative charge in the grid condenser to leak off and thereby permit an increase in the telephone current. Hence, when incoming and local oscillations add up, the negative charge in the grid condenser is increased and a decrease in the telephone current results. When the two ferquencies are opposed some of the charge in the grid condenser leaks off and an increase in the telephone current occurs. The result is the production in the telephones of an alternating current having a frequency equal to the difference in the frequencies of the local and incoming oscillations and having the very important property of being almost simple harmonic. Fig. 9 illustrates the characteristics of this method of reception. The complete phenomenon may be summed up as follows: Incoming oscillations are simultaneously amplified and combined in the system to produce beats with a local oscillation continuously maintained by the audion. The radio frequency beats are then rectified by the audion to charge the grid and the grid condenser, and this charge varies the electron current to produce an amplifying action on the current in the telephones.

Peculiar Features of Oscillation.

Some very interesting features of operation accompany the production of oscillations in the system. Suppose the audion is not oscillating, and the grid and wing coupling is fairly weak. As this coupling is increased the point at which oscillations begin is indicated by a faint click in the telephones accompanied by a slight change in the character of the static. The oscillations produced are usually so high in frequency and constant in amplitude that they are entirely inaudible. As the coupling is still further increased, a rough note is heard in the telephones, the pitch decreasing with increase of coupling. This note is produced by the breaking up of the oscillations into groups, and it occurs whenever electricity is supplied to the grid condenser at a greater rate than that at which it can leak off. The result is that the grid is periodically charged to a negative potential sufficient to cut off entirely the wing current, causing a stoppage of the local oscillations until the grid charge leaks off and the wing current re-establishes itself. The frequency of this interruption depends largely on the capacity of the grid condenser, the resistance of its leakage path and the amplitude of the local oscillations; and it may be varied from several hundred down to one or less per second. This effect is sometimes troublesome in the reception of signals, especially with high vacuum tubes. It may be eliminated, however, by increasing the leak of the grid condenser by means of a high resistance shunt. The best coupling for receiving continuous waves lies somewhere between the point at which oscillations start and the point at which interruption begins, and can only be determined by trial. The foregoing explanations refer to the audion only when it is used as an electron relay. When there is an appreciable amount of gas in the tube in the ionised state disturbances of an entirely different character occur.

Audio-frequency Tuning.

One of the very important advantages of the receiver when used for continuous waves is that the alternating current produced in the telephones is almost a pure sine wave. Only when the audio frequency is simple harmonic can selectivity be obtained by tuning the telephone circuit. A distorted wave such as that produced by spark signals possesses many harmonics, and as each may be picked out by the tuned telephone circuit there is little chance of separating two spark signals by audio frequency tuning. With continuous waves, however, the pure wave produced by the beat method of reception makes it possible to obtain selectivity by the audio frequency tuning, resonance being fully as sharp as in the radio frequency circuits. Two methods of audio frequency tuning are described. In the first the telephone is inductively connected to the wing circuit of the audion by means of a transformer, the secondary of which includes besides the telephone a tuning condenser. In this connection the telephone, with a resistance of many thousand ohms, is placed directly in the tuned audio frequency circuit, and hence for good tuning the inductance of the secondary of the transformer must be made extremely large to secure the necessary ratio of the reactance of the primary to the resistance of the circuit. This disadvantage is overcome in the system by removing the telephones from the audio frequency circuit, and using the latter to operate a second audion. The telephones may then be placed in the wing circuit of this audion without adding appreciably to the damping of the circuit. The tuning of the circuit may, therefore, be made very sharp with reasonable values of inductance simply by keeping the resistance low. In this case considerable amplification is obtained by the use of resonance to increase the voltage impressed on the grid of the second audion. The great advantage of this kind of tuning is shown by the following example: Suppose the incoming signal has a frequency of 50,000 cycles, and the local frequency is 49,000 cycles. The differential frequency is 1,000 and the audio frequency circuit is tuned accordingly. An interfering wave of 1 per cent. shorter than the signalling wave, or 49,500 cycles, will produce an audio frequency of 500 cycles per second, which will not appear at all in the wing circuit of the second audion unless it is many times stronger than the 1,000 cycle signal. This combination of radio and audio frequency tuning is too selective for use at the present time even when the sending station is equipped with an alternator, as the slight changes in frequency of the radiated wave produce changes in the beat frequency of the receiver which carry it out of range for the sharply tuned audio-frequency circuit. A disadvantage of this method of tuning is that atmospheric disturbances produce a musical note due to shock excitation of the audio-frequency system. Very loose coupling with the wing circuit of the first audion is a partial remedy for this. There are times, however, when interference is more troublesome than static, and in such cases the method may be used to great advantages.

Cascade Systems.

For the reception of spark signals by cascade working with two audions considerable adjustment is required to get the best results without causing one or the other or both of the systems to generate oscillations. It will be found that after the first circuit is adjusted to the point of oscillation and the second is coupled with it, the strength of signal in the first system will be reduced owing to the withdrawal of energy from it by the second system. The signals may then be again brought up in strength by increasing the coupling between the grid and wing circuits of the first audion until the appearance of the local oscillations indicates that the limit of amplification has been reached. By careful adjustment about a thousand times amplification and very sharp tuning can be obtained with two steps.

For continuous wave reception there are several methods of operating cascade systems. It is possible to have either system generate oscillations, the other system acting simply as an amplifier, or both systems may be made to generate in synchronism. It will generally be found that when both systems produce oscillations beats will be produced, so that a continuous note is heard in the telephones; but by adjusting the frequency of one of the systems the pitch of this note will be reduced as the two systems approach synchronism, until finally at one or two hundred beats per second the two systems pull into step in much the same way as two alternators. The ability of the two systems to keep in step depends mainly on the value of the coupling between them, and the closer this is the better the two hold together. There is still another way of working this combination, and that is asynchronously In this case beats are continuously produced in the system so that a continuous note is heard in the telephone, but the circuits may be so adjusted that the note is not loud enough to be troublesome or it may be tuned out of the telephone in the manner previously described. Incoming oscillations are combined in the system to produce beats with the beats already present, so that a rather curious note is heard. Very good amplification is secured by this method, though naturally the system is troublesome to operate.

There is a second method of receiving continuous oscillations which make use of the generating feature of the audion, but does not employ the beat phenomenon. The amplifying ratio of the audion depends more or less directly on the value of the wing current, and by varying this current periodically there will be a corresponding periodic change in the amplifying power of the audion. Hence an audion arranged to repeat a continuous wave under such conditions will produce in its wing circuit oscillations which vary periodically in amplitude, and which may, therefore, be received by a simple audion system.

Effects of Atmospheric Disturbances.

A very interesting feature of these receiving systems is their behaviour under conditions of severe atmospheric disturbances, particularly when used for receiving continuous waves. Their success under such conditions is due to the fact that they combine in addition to their inherent property of responding more readily to a sustained wave than to a strongly damped one, the characteristics of the two most effective static eliminators known, the balanced valve and the heterodyne receiver. The effect of the static on an audion is to build up a negative charge on the grid, reducing the wing current, and the limit of the response which can be produced in the telephones is reached when the wing current is reduced to zero. Under ordinary conditions this limit is too great to do much good:

but when the audion is generating it is possible, by proper adjustment of the amplitude of the local oscillations, to reduce the wing current to a point just above the lower bend in the operating characteristic so that the audion is rendered insensitive to a further increase in the negative charge on the grid. The strays which cause serious interference are of a much greater amplitude than the local frequency, so that no appreciable interaction between the two takes place, and the wing current is invariably decreased. Since the decrease in the wing current is not in proportion to the change in the grid potential the response in the telephone and the effect on the ear of the operator are correspondingly reduced. Static of smaller amplitude than the local oscillations may interact with them to produce either an increase or a decrease in amplitude of the oscillations in the grid circuit, and may, therefore, cause either a decrease or an increase in the wing current. The wing current can, of course increase to a relatively large value, but as it is impossible for the wing current to increase faster than the charge in the grid condenser can leak off the rate of increase is necessarily slow. The response in the telephones is, therefore, not so disturbing as would be caused by a decrease of similar value where the rate of change of current is usually large.

When the system is operated without an auxiliary leak around the grid condenser a peculiar paralysis of the audion is frequently caused by heavy static, no sound of any kind being heard in the telephones for a considerable length of time. If the apparatus is not touched the paralysis may last for many minutes and then suddenly disappear and the former sensitiveness be restored. The effect is primarily caused by the charging of the grid condenser to a sufficient potential to cut off entirely the flow of electrons to the wing, thereby decreasing the wing current to zero. Now the way in which the negative charge in the grid condenser leaks off is chiefly by means of the positive ions in the tube, which are drawn into contact with the grid when it becomes negatively charged. These positive ions are the result of ionisation by impact, and when the voltage of the wing battery is properly adjusted, they can be produced only in the region between the grid and the wing, since the velocity attained by the electrons between the filament and grid is very low. When the grid is charged to a high negative potential it keeps all the electrons between the grid and filament, thereby barring them from the region between grid and wing. Hence the production of positive ions must cease and the usual means of removing the negative charge from the grid vanishes. The resistance of the leakage path of the grid condenser must then be almost infinite, as is shown by the very long time taken for the charge to leak from a condenser of approximately 0·0001mfd. capacity. The effect is naturally the more pronounced the higher the vacuum, as the number of positive ions present is correspondingly reduced. A resistance of several hundred thousand ohms placed across the grid condenser gives a leak which is independent of the value of the wing current and which effectually prevents trouble of this kind. With the very high vacua now obtainable by the use of a molecular pump there are practically no positive ions present, so that the auxiliary leak is always necessary. Under these conditions it not only prevents paralysis by the static but it also removes from the grid condenser the excess of negative electricity which accumulates in it, thereby increasing the sensitiveness of the audion and the sharpness of the signals in the telephones. The very high potentials to which the grid condenser may be charged by the static when it is not provided with an auxiliary leak are surprising. These potentials may be measured in a very simple and accurate way, here described. After a stray has cut off the wing current, if we continuously increase the capacity of the grid condenser the potential across it and hence the potential of the grid, with respect to the filament, will be decreased inversely as the capacity. A point will finally be reached where the grid potential is sufficiently reduced to allow the wing current to flow. When this occurs it indicates that the potential of the grid condenser is slightly less than that shown by the operating characreristic as necessary to reduce the wing current to zero. The potential to which the grid condenser was originally charged is equal to this voltage times the ratio of the capacity of the condenser at which the wing current began to flow to the original capacity. Voltages of over 100 are not uncommonly reached by the grid ; and as one volt represents a very strong signal the difficulties of the static problem are very forcibly presented.

The fact that static of large amplitude produces almost invariably a decrease in the wing current while a signal (with heat reception) produces alternately an increase and decrease in the wing current is a circumstance of which it should be possible to take advantage. Methods to this end are described.

In conclusion, the author points out that none of the methods of producing amplification or oscillation depend on a critical gas action ; they depend solely on the relay action of the tube employed (electron or gas relay) and the proper arrangement of its controlling circuits.

INSTITUTION OF ELECTRICAL ENGINEERS.

Expulsion of Enemy Members.

As we stated briefly in our last issue, a special meeting of this Institution was held on Wednesday, March 1, to consider the resolution which has been circulated amongst the members regarding the expulsion of members who are subjects of enemy States. In what follows we give an account of the proceedings.

The President (Mr. C. P. Sparks) said if 10 members had cited any one or more members who appeared to be undesirable the Council could have taken definite action under the existing articles of association, but in the absence of such action on the part of the members the Council appointed a Committee of the vice-presidents to report on the subject. When the Committee met it had before it a communication signed by 17 members calling upon the Council to take action on certain lines. The Committee reported to the Council, after which he met representatives of the 17 members who had sent the petition, and submitted to them the Council's proposal, which was now before the meeting. On the advice of their honorary solicitor, he informed the meeting that, unless very carefully framed, amendments could not be moved, as under Article 81 no business could be transacted at a special meeting except the business specified in the notice of the meeting. He moved—

> "That the following words be added to Article 41 in the articles of association : (*a*) In the event of a state of war arising between Great Britain and any other country or State, any member of any class who at any time during such war shall be a subject of such enemy country or State shall forthwith cease to be a member of the Institution, and in the case of the European War of 1914 all such members shall cease to be members of the Institution on or after March 16, 1916."

Mr. C. A. Baker, in seconding the motion, said some of the members thought there had been too much hesitation in bringing the matter to the present point. A paragraph in the "Journal" of December 15th last stated that the Council could not do anything except under Article 41. In the case of war this did not seem sufficient. In a letter to the "Electrical Review," which was published on December 31st, he (Mr. Baker) called the attention of the Council to Article 80, which also gave them power to act. He was strongly opposed to allowing alien enemies to continue to share the privileges of membership of that Institution. He had no difficulty in getting the 17 members to sign the petition, and he was confident 170 or 1,700 could have been obtained. The Council placed certain alternatives before the petitioners, but they did not seem to hit the nail on the head. The resolution now before them was on the lines of one adopted by the Iron and Steel Institute, and the petitioners accepted it and decided to try and get their friends to accept it also. The President met the Manchester Local Section of the Institution recently, and pointed out to them that members could act under Article 41, but that nothing had been done. It was a little misleading to the members not to be informed that the petition under Article 80 had been received. The announcement in the "Journal" of February 15th did not say the special meeting was to be held in consequence of the petition, which he took it was the fact. It was felt by most of the petitioners that the subject of naturalised aliens was one that could not be dealt with in the petition, as it was felt that the naturalised people had a status in this country, and that they were amenable to the laws of the land, and were get-at-able. Amongst them were men whose sons were fighting for us, and one would not like to include them. Under the resolution proposed, however, a man who was naturalised here, even 10 years ago, would be excluded if he was not denaturalised in his own country. They did not want any of the Germans there. No man had a right there unless he was a patriot, or at least a friendly alien. The feeling of the majority of the petitioners was that they should have a rule to exclude enemy aliens.

Mr. Albert Gay said he had sent in a letter (which the President read) asking whether the recognised rules of debate would be followed at that meeting, and stating that he proposed an amendment to insert after the word "State" in the fourth line of the printed resolution the words "or who shall be of enemy origin, although he may be a naturalised subject of the British Empire." A further amendment would be moved by another member "that a ballot be taken by post of all the members upon the motion and upon the amendment."

The President declined to put the amendments to the meeting, and said 14 days' notice must be given before any such motion could be brought before the members. The articles of association only permitted a ballot to be taken for the election of a president. The addition of the amendment to the resolution would be *ultra vires*, and the Courts would restrain the confirmation of it. They must proceed in accordance with the Companies Acts.

Mr. Gay then withdrew the amendment under protest.

Mr. Joseph said he agreed with the motion, but there was nothing in it to say that a member turned out now could not be re-elected at the end of the war. He thought the idea of the meeting was that they should be exiled permanently from the Institution.

Mr. A. H. Walton said if the law gave a man naturalisation it was not for them to say they were going to do something else. They had some good friends in the Institution who had been aliens and were naturalised, and it would be a great injustice to expel them. They knew several who were, no doubt, as good as any British born man. They had allowed alien enemies to come here and exploit them, and they had only themselves to blame. The unnaturalised aliens should be expelled, but it was

unfair to quarrel with men who were known to be straight and upright British subjects.

Mr. C. C. Atchison (Rochdale) said it appeared that no alternative to the resolution could be submitted, which was a farce, and, moreover, the meeting was not fairly representative of the whole of the members. In October last he brought this subject before the Committee of the Manchester Section, and a recommendation was sent to the Council in London. Whatever was done by the Council on this matter should be representative of the majority of the members, and every member should have an opportunity of giving his vote. He suggested that it was not for members to make suggestions to the Council. The Council were there to represent the members, and it was their duty to find out the members' feeling before putting a resolution before them. He thought the resolution did not go far enough. It did not say what would be the position after the war. They did not want the Germans back there.

The President said they could not come back unless they were re-elected.

Mr. Atchison said applications for membership were only submitted to the members in London, so that the whole body of the members would not have an opportunity of saying whether they would have them back. There were a large number of members who would no longer be members if Germans came back. He was in favour of keeping out Germans, naturalised or not, or men born of German parents on either side, whether the parents were naturalised or not.

Mr. Gay then proposed an amendment "that this meeting do adjourn, and that a vote be taken by ballot of the whole of the corporate members of the Institution by post, both upon the principal motion and upon the amendment," or, if the President would not accept that, to finish at the words "principal motion."

The President said that could not be dealt with. Mr. Gay would have to give notice.

Mr. F. C. Raphael said it would be a waste of time if Mr. Gay's amendment were put and passed and afterwards found to be irregular, and as everybody present agreed with the main resolution it would be a pity if the resolution were not carried unanimously. In the articles of association there was a simple solution of the difficulty in giving Mr. Gay and his friends and Mr. Atchison a free hand to endeavour to enlarge the resolution. After the resolution had been put and passed, Mr. Gay and 10 of his friends or Mr. Atchison and 10 of his friends, should put in their resolutions under Article 80 and their request for another special meeting to consider their resolutions and they could come up with the present resolution at the subsequent confirmatory meeting. In the meantime the Council could decide whether it was expedient to take the postal vote.

The President said the hon. solicitor advised him that that course would be in order, but the Board of Trade required that alterations of the articles of association should be submitted to them before being passed.

Mr. Gay thought Mr. Raphael's suggestion would clear the ground considerably. Would the President promise that in the event of the resolution going through he would accept an amendment or another resolution?

The President said he would call another meeting at which the further resolution should be discussed, and then adjourn the March 16th meeting so as to deal with the additional resolution as well as the one now before the meeting.

Mr. Berkeley said he agreed with Mr. Atchison. He was led to believe they would have had an opportunity of threshing out the question as to alien enemies, naturalised Germans, &c. They were hedged round by technicalities. This was war time, and they ought not to allow themselves to be fettered by legal technicalities. Let them go ahead and thresh out the question, and if anyone wanted to object afterwards let them do so.

The President said he did not wish to burke discussion, but they must take it in a proper manner.

Mr. W. B. Woodhouse said he would vote for the resolution. He did not agree that they should specify now that alien enemies were excluded for ever. They must look forward to after the war. If they blotted out people for ever without having a chance to reconsider it they might get into trouble. As long as people owed any allegiance to an enemy country they would be automatically cast out of the Institution until after the war, and they could not come back unless they were re-elected.

Mr. McGregor Duncan said he felt that the only way they should exclude members must be personally—by taking each member and considering his behaviour. The London Stock Exchange had been content with requesting enemy members to refrain from attending. He believed the Institutions of Civil and Mechanical Engineers had decided to do nothing in the matter. He suggested that they should consider whether it was not advisable to wait. (Cries of "No, no.") It would have been better if the resolution had referred to Germans (to whom they objected), as they meant Germans all the time. If it had referred to Germans he would not have objected to the resolution to the same extent. He thought they were going too far and too fast.

The President said they did not want to be guided by what other bodies had done. When he was at Manchester he tried to tell members what had been done without opening up the inner matters that had been dealt with by the Council until the Council could come forward and announce what had been done. Many points were taken before a final decision was come to. The petition referred to by Mr. Baker left it to the Council to take action, and indicated the lines on which it was suggested the Council should act. The form of words in the resolution was accepted by the 17 petitioners and loyally supported by Mr. Baker. With regard to the question of the naturalised alien, he understood he would not be automatically struck off if he had naturalisation papers. Any 10 members could cite any naturalised person, and if he were undesirable the Institution could get rid of him. They could deal with cases individually or collectively. It was suggested that the Local Sections should be brought into closer touch. If a naturalised German came up for election from Manchester, the Council would ask the Manchester Section, and it would be their duty to tell them if he were undesirable, in which case the Council would not put his name forward. In reference to Mr. Joseph's amendment which had been handed in, it could not be accepted at that meeting.

Mr. A. A. Campbell Swinton said he was one of the 17 members who sent the petition. He thought the President's interpretation of the effect of the resolution put a very different complexion upon the resolution to what he had expected. It was not satisfactory to him, and he doubted whether it would be to the other 16.

Mr. Woodhouse said if the resolution took the meaning the President had put upon it he would not vote for it.

Mr. Campbell Swinton thought the President's explanation was correct, and that the resolution would not cut out Germans who remained Germans under German law. That was not what the signatories to the petition intended.

Mr. L. L. Atkinson suggested that instead of "during such war shall be a subject of such enemy country or State," they should substitute "during such war has not divested himself of his nationality of such enemy country or State."

The President said that amendment could not be accepted at the present meeting.

Mr. W. R. Cooper said there was no good in passing a resolution they did not understand. Most of the confusion that afternoon was due to ignorance of company law on the part of members. Was it not possible to adjourn that meeting and call it again later on, and then the various resolutions could be considered at the same time after formal notice.

Mr. J. H. Rider said after the President's explanation he was bound to vote against the resolution, and he hoped most of the members would.

Mr. L. L. Robinson said it was clear they could not agree to the resolution unanimously. He wished to move that it be referred back to the Council, after which the Council might prepare a resolution which could be discussed and, if necessary, amended by the members.

The President said they could have an informal discussion by calling an informal meeting, and after agreeing to the wording of a resolution send out a notice giving 14 days' notice of a special meeting, afterwards giving notice of the confirmatory meeting.

Mr. T. Petersen said he was going to make a similar suggestion. If the present resolution were put to the vote he was afraid it would be inactive, and would be misunderstood by the public. Therefore, a vote should not be taken until the whole matter had been discussed.

The President said he had decided not to put the resolution, but to call another meeting to discuss the whole question. The Council would be glad to receive suggestions from any members. He would try and keep the country members informed of what was taking place.

A vote of thanks to the President and Council, moved by Mr. Madgen and seconded by Mr. Gay, was carried unanimously.

UNIFORMITY IN DRAWING ELECTRICAL DIAGRAMS.

BY GISBERT KAPP.

Summary.—The author advocates the use of certain symbols and methods in diagrams, so that they become more self-explanatory than is usually the case.

The old saying that drawing is the language of the engineer requires modification if it is to apply to such drawing as electrical engineers use to represent diagrammatically the essential parts of machinery and their connections. We must substitute for the word language the word dialect; but the necessity of having to master each author's special dialect in graphics before we can grasp the meaning of his diagrams at a glance takes away a good deal of the benefit which graphic methods of conveying information are supposed to confer, as contrasted with the written explanation. The same thing is represented by different writers differently, and very often different things by the same graphic symbol. If in a diagram we find a long drawn out spiral it may mean with one author merely a flexible connection in the manner of the old physics text book, but it may also mean a resistance, or it may mean an inductance. Whether it means one thing or the other may only be decided after we have made ourselves familiar with the custom in drawing adopted by the author we are studying at the time. Even then we may find that the long drawn out spiral is used by one and the same author to represent any of the things mentioned. If we find an arrow it may mean the direction of an E.M.F., or a current, or a flux; there is no distinctive mark to say which. A circle is often used to represent an amperemeter, but also the armature of a dynamo, or may be the whole machine. It is true that in many cases the exact

meaning of a symbol can be gathered from the general appearance of the diagram, just as the meaning of some obscure expression in a speech can be unravelled by carefully reading the context in which it is used ; but the necessity of having to puzzle out the meaning of many of the parts of a diagram before one can approach the study of the thing itself is an increase of mental labour one would gladly avoid. When I come across what I call a diagram in another man's dialect I generally find it easiest and quickest in the end to re-draw it in my own dialect before I begin to study the thing itself. This irksome labour of translating from one graphic dialect into

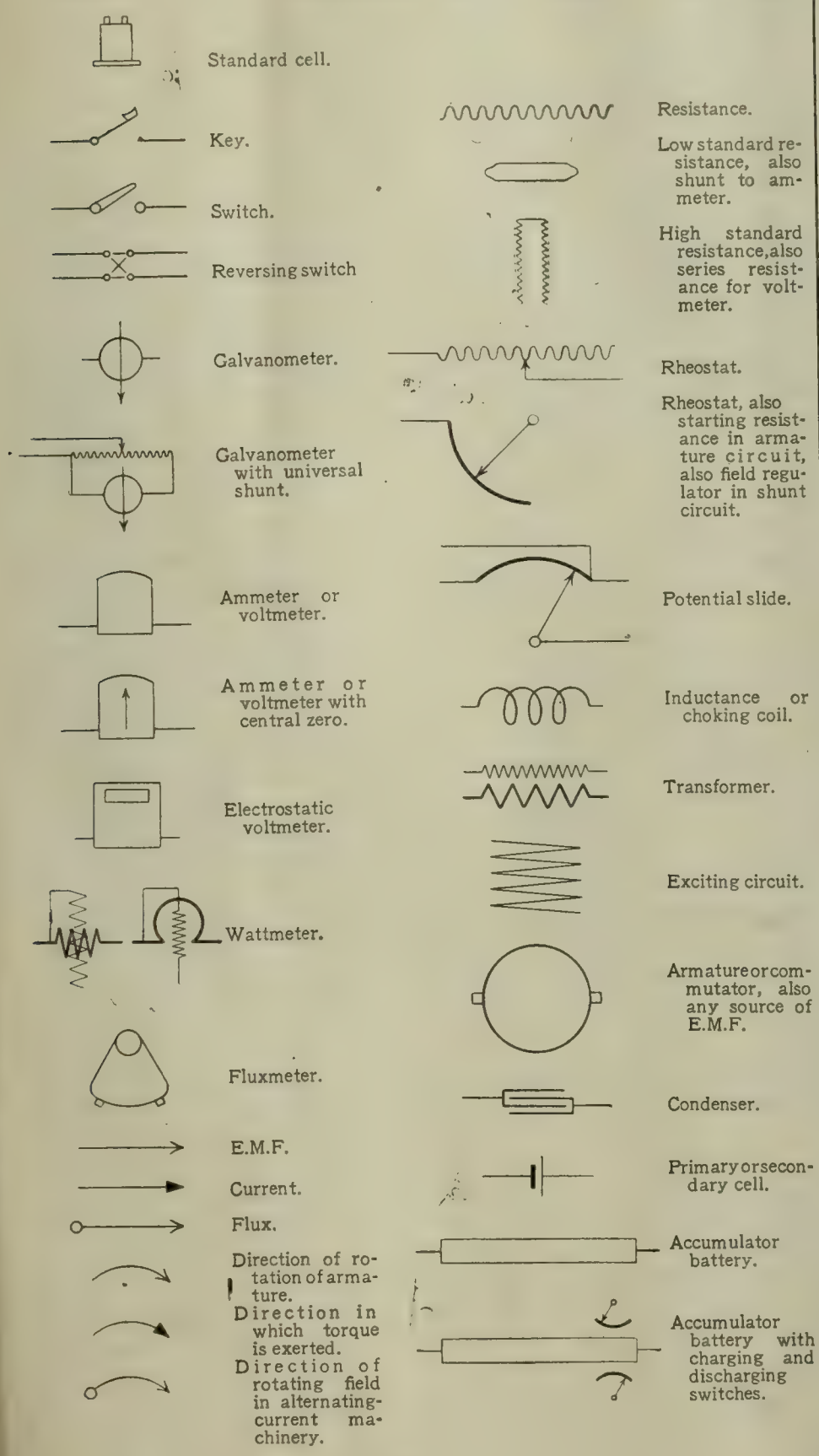


FIG. 1.

another might be saved if we all had the same graphic language ; in other words, a universally accepted method of drawing electrical diagrams This article is a plea for uniformity, but, as the mere expression of a pious wish, will not carry us very far in this direction, and as a beginning in a definite way must be made by someone (even if it be only regarded as a basis for discussion), I make in what follows some suggestions for a uniform system of symbols. This system has been evolved gradually during my work as a teacher, and I found that it is readily accepted by students, and that they find it useful in the sense that mistakes in the interpretation of a diagram are very unlikely to occur.

The avoidance of mistakes in the interpretation of an electrical diagram is, however, only a negative kind of merit ; what we must aim at is to draw the diagram in such a manner that it also becomes self-explanatory as regards the way a machine works. Thus, in the case of the diagram of a dynamo, it must show at a glance which is the sense of rotation if the machine is to work as a generator, which brush will be positive and which negative ; or, in the case of a motor, which will be the sense in which torque is developed. In alternating-current machinery the diagram should not only contain the essential details and their connections, but it should also serve as a space diagram as regards the working, and thus supplement, or rather make more clear, the interpretation of the usual time diagram.

Fig. 1 is a table containing the most important symbols, and Fig. 2 shows by way of example how these symbols may be used to indicate apparatus and connections for making a particular test—namely, the mapping out of the induction under the pole of a dynamo by means of a flux meter. In this well-known test the armature is rotated step by step through an angle corresponding to a commutator section, and the deflection on the fluxmeter is noted when reversing the exciting current after each step. The deflection plotted against angular position of the armature gives a curve, the tangent to which at any point is proportional to the induction at that point. It will be seen that this diagram is self-explanatory, no description being required to enable anyone to set up the apparatus required for this test.

The last six symbols in Fig. 1 do not refer to apparatus, but are the conventional means for indicating a direction. In using an arrow with an open head for E.M.F., and one with a

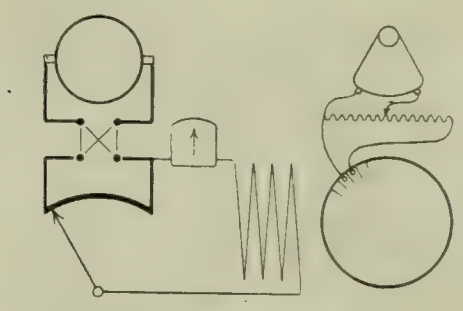


FIG. 2.

solid head for current, I follow a lead given by Messrs. Cramp and Smith in their book on vectors ; but I do not follow them in their suggestion to indicate a flux by an arrow with a double head. Instead of this I use a little circle at the tail of the arrow. The curved arrows indicate sense of rotation, open head for mechanical movement or speed, solid head for direction of torque, and open head with circle at tail end for direction of rotating field. Leads intended to carry working currents are shown by thicker lines than those intended for shunt exciting currents or voltmeter connections.

In order that a diagram made up of the symbols of Fig. 1 shall not only show the different parts in their correct relation, but also explain the working of a machine, some conventional rules must be observed. These are :—

1. All dynamos, whether continuous or alternating current, are to be considered as two-pole machines.

2. The sense in which the armature is wound is such that the current passing through the armature produces north polarity under the positive brush ; or, to put it in another way, the direction of the flux produced by a current through the armature coincides with the direction of the current internally from brush to brush.

3. The same rule applies to a distributed winding in a fixed position and surrounding the armature. Such a winding is called a compensating or a neutralising winding, and is shown by a circle concentric with, and very little larger than, the armature circle. The brushes may be placed inside or outside the armature circle as convenient.

4. All salient pole windings are shown by a zigzag line, as in Fig. 1, but with this difference, that those producing a main

field are drawn with wider zigzags than those used for commutating poles.

5. The sense in which the winding is put on a core is supposed to be such that the direction of the flux produced is the same as the axial progression of the current.

6. Series coils are shown by stouter lines than shunt coils.

7. The direction of the E.M.F. due to rotation is found by rotating the flux vector through 90 deg. in the direction in which the armature is driven.

8. The direction in which the torque acts is found by supposing the vector of armature current to be a lever fixed at its tail and weighted at the head by the flux (as an aid to memory, substitute for flux or field a clod of earth from a field).

As examples for the application of these rules, I take in Fig. 3 a compounded generator with commutating poles, and

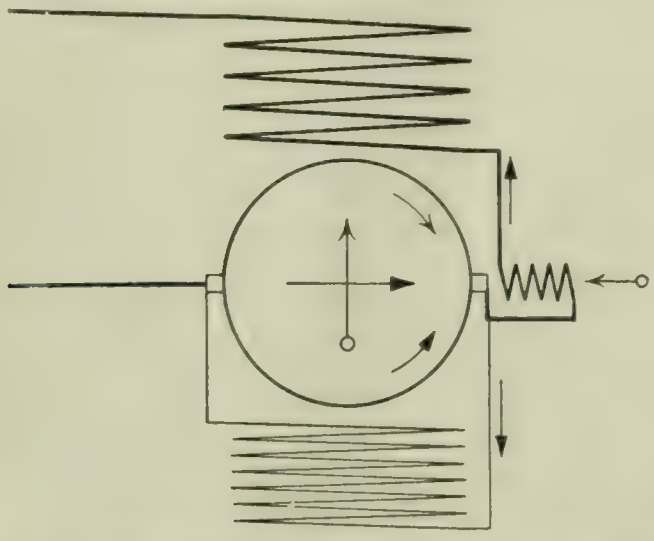


Fig. 3.—Compound Excited Generator with Interpoles.

in Fig. 4 a shunt motor with compensating winding and commutating poles. That the machine represented by Fig. 3 is working as a generator is seen at a glance by the direction of the curved arrows, that representing direction of rotation being in opposition to the torque arrow. If the machine were working as a motor the main current would be shown by a current arrow in the brush axis pointing to the left. The torque arrow must be shown pointing clockwise and the flux arrows of main and shunt coils pointing in opposite directions. The flux due to the shunt field would remain as before, but that due to the series winding would be opposed, the resultant being still directed upwards, but reduced in magnitude. The reduction will be the greater the greater the mechanical load. The

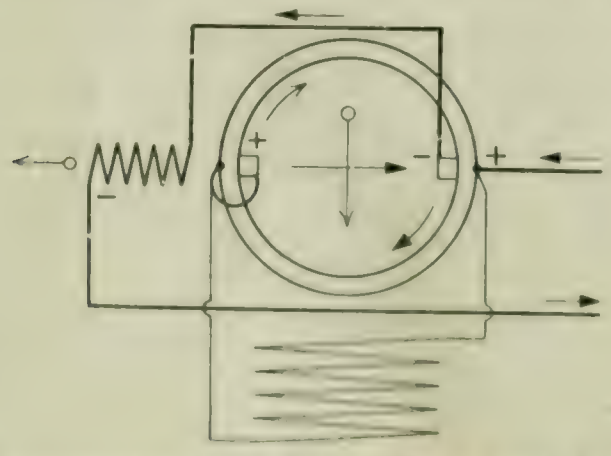


Fig. 4.—Continuous Current Shunt Motor with Compensating Winding and Interpoles.

diagram therefore, shows at a glance that a compound excited dynamo, if designed to give at constant speed constant terminal voltage if used as a generator, will, if used as a motor with constant impressed voltage, run at constant speed at variable mechanical load. In Fig. 4 the coincidence of direction of the flux and speed arrows shows that the machine is working as a motor. The opposition in the direction of the arrow showing current through the armature, and that showing the flux produced by the interpoles shows that the latter act in the proper way to produce sparkless commutation. The same remark applies to Fig. 3.

When dealing with alternating-current apparatus and machinery, the above conventions as to the meaning of vectors in a space diagram must be supplemented by a convention as to sign. In the time diagram we consider a vector positive if its projection on the vertical is directed upwards. Whether the vector is growing or waning at the moment is shown by the quadrant in which it lies. With counterclockwise rotation of vectors (or clockwise rotation of the time line), which has been accepted as the standard practice at the Turin meeting of the International Electrotechnical Commission, a vector in the upper right-hand quadrant and one in the lower left-hand quadrant is growing, the former being positive, the latter negative. The time diagram gives, therefore, not only the actual magnitude of the vector and its sign, but also information whether the vector is growing or waning at any given moment. If the same information is to be given in the space diagram, we must agree on two things—namely, which direction is to be considered positive, and also how the momentary condition of the quantity represented by the vector shall be indicated. We have to distinguish between crest value, zero value, growing and waning, and also whether in passing through zero the vector is going to be positive or negative.

As regards any vector which must be drawn vertically in a space diagram, the rule had best be made in conformity with that obtaining in the time diagram—namely, any vector with the arrow pointing upwards represents a positive value. For

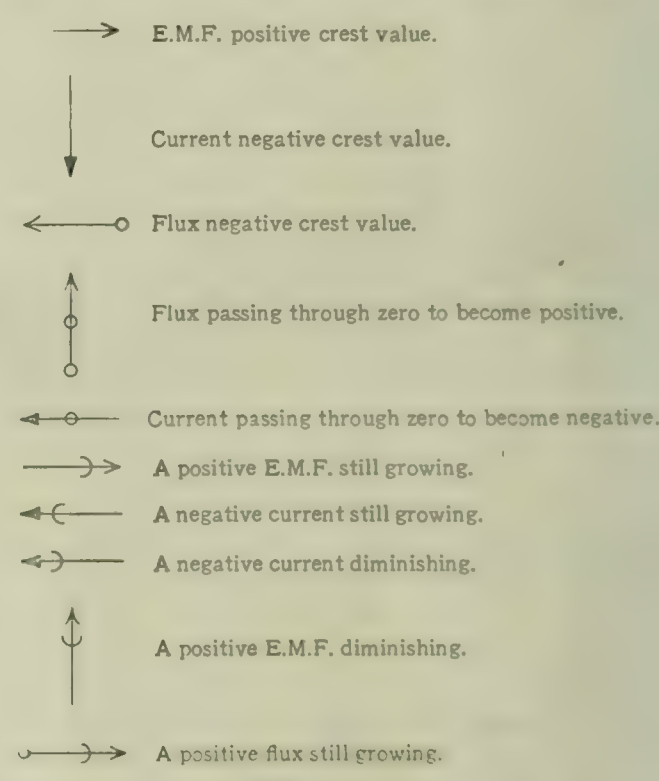


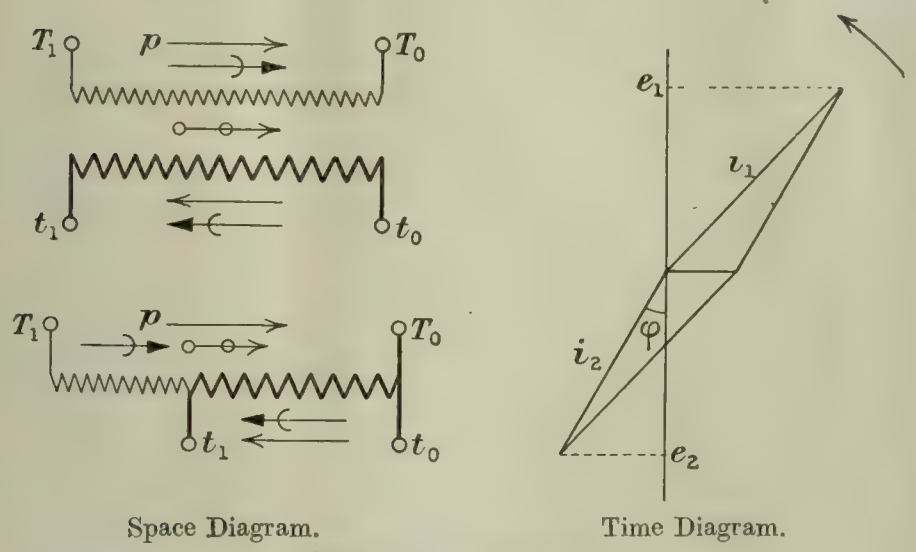
Fig. 5.

horizontal vectors we agree that the arrow pointing to the right shall mean a positive vector. If, therefore, in the time diagram, a vector lies in either of the two lower quadrants, the corresponding arrow in the space diagram must point to the left or downwards, accordingly as it is a horizontal or a vertical vector. The change in magnitude is represented by additional symbols added to the vector. Where the rate of change is zero, as in crest values, no additional symbols are used. Fig. 5 gives some examples of these symbols.

To show the use of these symbols, I take as a first and very simple example the case of a single-phase transformer. Here the space diagram has only one axis, which is parallel to the axis of the windings. The terminals are marked in accordance with the rule established by the Engineering Standards Committee (October, 1915, No. 72, p. 41). At the tail of the primary E.M.F. arrow we put the letter p to show that this is an impressed E.M.F., not an induced, as in the secondary. The space diagram refers to the moment when the magnetisation of the core passes through zero to become positive, and when, therefore, the impressed E.M.F. has positive crest value and the induced E.M.F. in the secondary has negative crest value. The magnetisation of the core is at that time passing through zero to become positive. Primary and secondary

currents are near crest value, but are still growing ; hence the distinctive marks to indicate growth have to be added to their arrows. The lower part of the figure shows the application of the same symbols to an auto-transformer. In drawing the space diagram I started from the time diagram, but it will be seen that if only the space diagram were given the time diagram could be reconstructed from it.

As a second example, to show how a space diagram may be used to explain the working of a machine, I take the case of a single-phase series commutator motor with salient poles, compensating winding and the usual provision for sparkless commutation, consisting of an inductionless shunt across the terminals of the compensating winding. The space diagram is shown on the left of Fig. 7, the time diagram as far as it refers to commutation on the right. Both are drawn for the moment



Space Diagram. Time Diagram.

FIG. 6.—TRANSFORMER.

that the working current goes through zero to become positive. In the time diagram *cb* is the vector of current, and also, to a suitable scale, that of the ampere-turns in the field system, and therefore also that of the main or working flux. The ampere-turns in the circular compensating coil are given to the same scale by *ab*, which is also the direction in which they act, so that *ca* is the resultant flux through the armature both in direction and magnitude. If it were not for the shunt resistance, *c* and *a* would coincide, and we should have no flux at all in the brush axis ; but the effect of the resistance is to make the current in the compensating winding lag by the angle *cba* behind the current in the armature winding, and thereby produce the resultant ampere-turns *ca*. Since the direction

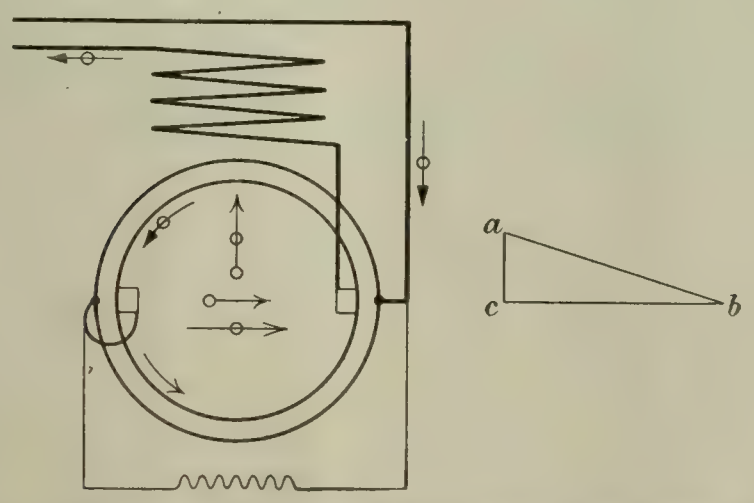
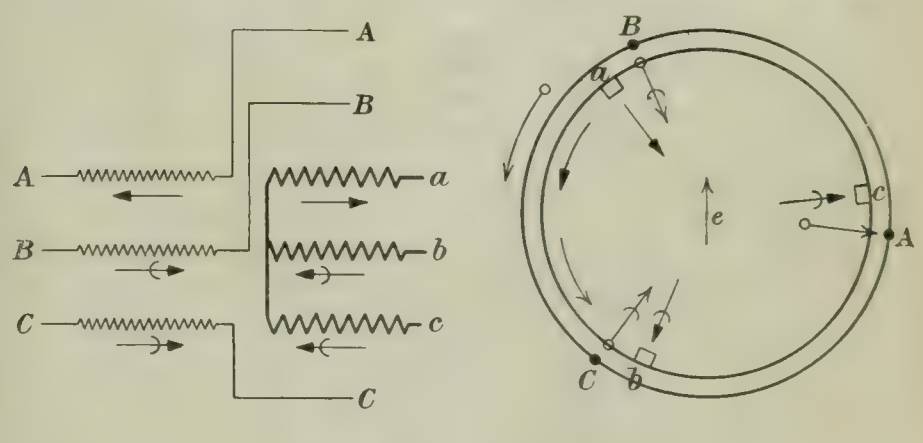


FIG. 7.—ALTERNATING-CURRENT SINGLE-PHASE COMMUTATOR MOTOR WITH COMPENSATING WINDING AND COMMUTATING FIELD.

is upwards—that is, positive in the time diagram—the corresponding vector in the brush axis must point to the right. The corresponding flux is the only flux acting in the brush axis, and it is obviously possible to so select the number of turns in the compensating coil that *ca* shall be at right angles to *cb*—that is to say, that the flux corresponding to *ca* shall have crest value at the moment to which the space diagram refers. This is shown by the horizontal flux arrow. The condition of sparkless commutation can also be deduced from the diagram. At the moment of zero current the transformer E.M.F. in the coils short-circuited by the brushes is a maximum. By Lenz's law it must tend to produce a current which will retard the growth of flux in the axis of the field coils, which is vertical. Flux and current want to become positive ; the transformer E.M.F. must, therefore, act in an upward direction under the right hand and in a downward direction under the left-hand brush. This must be balanced by the E.M.F. of rotation due to the flux of the commutating field, which at the moment is positive and has crest value. By applying the right-hand rule we find that, with the counterclockwise motion produced by the torque, the E.M.F. of rotation is downwards under the right-hand brush—that is, in opposition to the transformer E.M.F.—and this is the condition for sparkless commutation.

A little circle is shown in the stem of the torque arrow in order to indicate that at the moment the torque is zero ; the speed arrow has no special mark, since, notwithstanding the pulsating torque, the speed is practically constant—that is, it has crest value all the time.

When we have to deal with three-phase machinery a new convention as regards the sign of vectors is necessary. In single-phase work we have only to do with two axes, both fixed in space and in quadrature, one belonging to the stator and the other to the rotor. It is the brush axis of the rotor. In a three-phase machine we have three stator axes, displaced relatively to each other by 120 deg., and three rotor axes with the same relative displacement, but not coincident with the



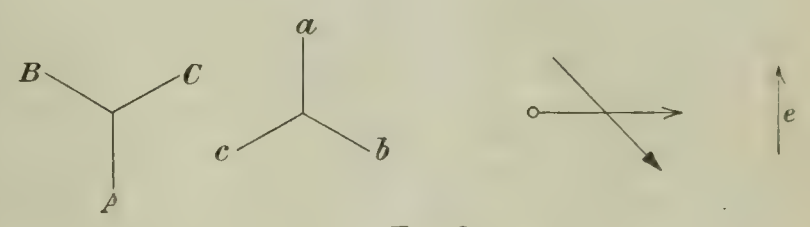


FIG. 8.

stator axes. Moreover, resultant vectors have not a fixed direction in space, but revolve with the frequency of supply. For these reasons we cannot use the same rules as to sign which we adopted for single-phase work. The most natural way for the establishment of the new convention required to represent three-phase machinery is to adhere to the conception of positive and negative as usual in continuous-current machinery. In a generator the brush where the current leaves the armature is positive ; in a motor the positive brush is that at which the current enters. Restricting the investigation to motors, we call that current positive which at the moment flows towards the machine, and we call that E.M.F. positive which, if only opposed by ohmic resistance, would produce a current flowing towards the machine. Whether the current flows into an armature brush or into the terminal of a distributed winding is immaterial, since both windings are of the same character, which is not altered by the fact that one is rotating and the other fixed in space.

Fig. 8 shows the space diagram of a three-phase series commutator motor. The machine has no salient poles, but the exciting or stator winding is distributed in the same way as a compensating winding. Since both stator and rotor are mesh connected they cannot be put into series connection directly, but only through the intervention of a series transformer. This is shown on the left. The primaries ABC are joined to the correspondingly marked terminals on the stator, and the

secondary transformer terminals *abc* are connected to the correspondingly marked brushes. The connecting wires are not shown on the diagram. The time diagrams for primary and secondary of the transformer are shown below it. The moment chosen is that when the current in the *a* phase has crest value. The current in the *b* phase is negative and approaching zero, that in the *c* phase is also negative but growing. These conditions are marked in the space diagram. The little diagram below shows the resultant vectors of flux through armature, due to the stator winding and current through armature put in by the brushes. The direction of rotation of the resultant field is shown by the arrow outside the stator winding, that of torque and motion inside the rotor winding. The speed of the field corresponds to the frequency, and the angular distance between field and resultant armature current remains constant. If the brushes were set in quadrature with the stator terminals this angle would be 90 deg., and the E.M.F. of rotation *e* would be in exact opposition to the resultant current, obviously the condition for maximum torque. But the brushes have been set at a greater angular distance than 90 deg., and the result is that the E.M.F. of rotation has a component leading by 90 deg. over the current. The E.M.F. of self-induction lags by 90 deg. behind the current. By advancing the brushes beyond quadrature position it is, therefore, possible to compensate for self-induction—that is, obtain unity power factor or even a leading current. This, however, at the disadvantage of a reduced torque. By setting the brushes at 180 deg. from the terminals the torque vanishes altogether, and the machine, if driven by external power at a speed considerably above that corresponding to the frequency, acts as a phase advancer.

Other examples of alternating-current machinery might be given, but as this article is not intended to be a treatise on such machinery, but merely a suggestion for uniformity in the drawing of electrical diagrams, the few examples above given will suffice to show how a space diagram may be made to show not only the essential parts of a machine and their electrical connections, but also the way it works.

ARC PHENOMENA.*

BY A. G. COLLIS.

Summary.—The author describes a number of experiments made to determine the influence of differently shaped arcing contacts upon the disturbances following rupture of an alternating-current circuit, and various theoretical considerations are discussed with a view to modifying the design of oil switches so as to increase their rupturing capacity and thereby eliminate auxiliary devices with their added complications and expense.

As the formation of the arc in oil switches becomes the critical point of an oil switch, the first portion of this Paper contains some research work which is submitted as an introductory for further unexplained phenomena on this important question.

Arcs in Alternating current Oil Switches.

Photographs are reproduced in the original Paper showing arcs in alternating current oil switches. In the first case the arc was formed by rupturing a non-inductive three-phase circuit, 6,600 volts, 200 amperes, (r.m.s.) at unity power-factor. The oil-switch contacts (Fig. 1) operated in a vertical plane, the total length of break being $10\frac{1}{4}$ in. per phase. The shape of the arc is an ellipse, its greater diameter being directed horizontally towards the sides of the tank. In nearly all the cases of switch bursts that have come under the author's observation, the damage is more apparent on the sides of the oil tank, in the direction of the flow of the current. Front or back explosions are not so prominent. The shape of the arc follows the shape of the arcing contacts, and there is no doubt that the disturbances following rupture are directly related to the shape of arc contacts as will be commented upon later.

In the next case the arc was obtained by rupturing a three-phase, 6,600-volt, 220-ampere (r.m.s.) inductive circuit at 0·9 power-factor. The contacts here used were of the well-known "wedge" form, Fig. 2. The rupture in this case is slightly more severe than in the case of Fig. 1, and the arc slightly larger. Several designers, in order to quench the arc more effectively, have used artificial "arc dampers." On the other hand, some engineers appear to consider that the arc damping fluid should be forced on the rupture zone from the vertical position.

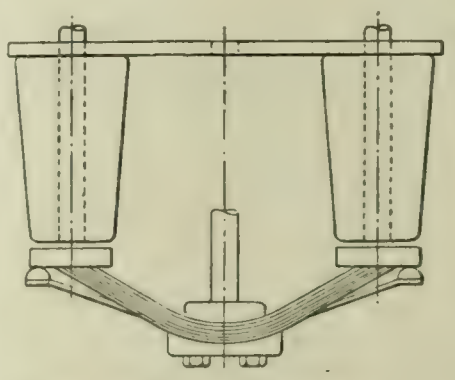


Fig. 1.—Brush Laminated.

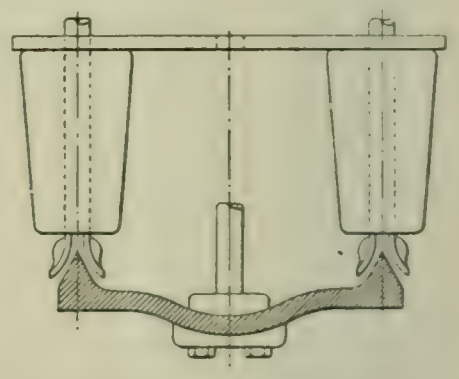


Fig. 2.—Solid Wedge Form of Contact.

The next form of contact used (*see* Fig. 3) is the brush form as in Fig. 1, but fitted with vertical trailing arc pieces. It will be observed that the arc pieces were fixed at the side of the main contact one inside and the other outside. These arcing pieces were placed in this position for the purpose of observing whether the arc phenomena were affected by the individual shape and character of the contacts. It would appear that the arc is influenced by the construction of the trailing pieces. The formation of an arc can be artificially directed and modified by contact design, considerably increasing or decreasing the capacity of switches of limited rupturing capacity. Thus a switch with one form of contact and a rupturing capacity of, say, "10,000 k.v.a." might be so reconstructed and modified as to have its capacity increased to 15,000 k.v.a.

The class of contact shown in Fig. 4 is not in such common use as those shown in Figs. 1 and 2. But the shape of the arc is more ideal and the rupturing capacity of the switch increased by this form. Auxiliary arc dampers were provided with this switch, forcing the oil in a downward direction towards the seat of the explosion. For very heavy rupturing capacities, "arc dampers" are considered necessary, and will be commented upon later.

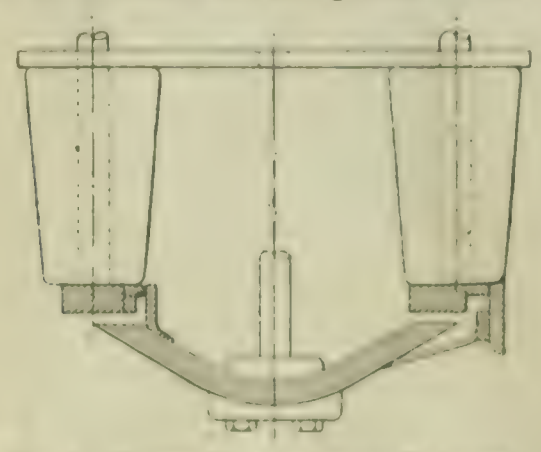


Fig. 3.—Brush Contact with Trailing Pieces Inside and Outside.

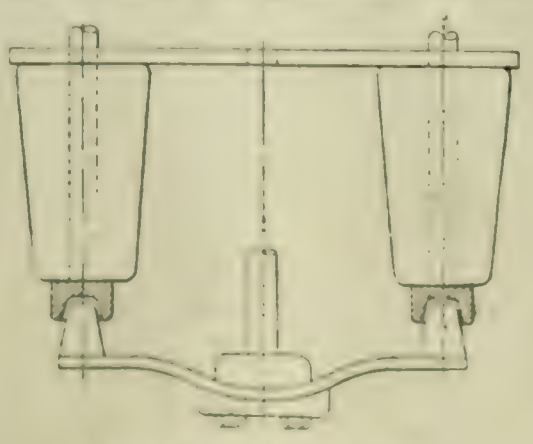


Fig. 4.—Cone Contacts.

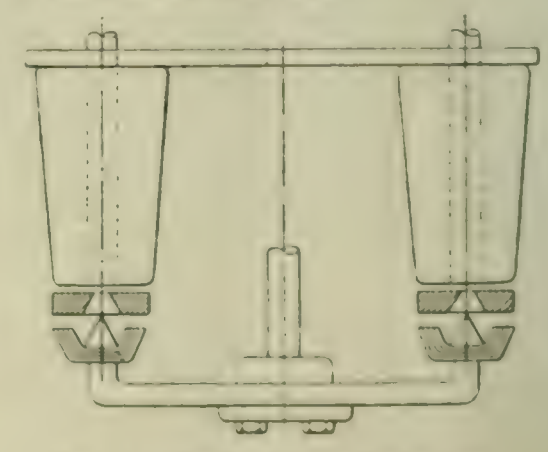


Fig. 5.—Hollow Conductor for Oil Brush Contacts.

The arcing contacts shown in Fig. 5 are known as the double-brush type, the oil being forced over the centre of the arc zone. This type of contact was introduced very successfully on a 20,000-volt transmission, but the tendency is now to use an entirely different form of design for high-tension electrical transmissions.

The pressures in pounds per square inch surrounding the arc area are given in Table I. for various currents at 6,600 volts. These pressures were obtained by inserting in the tank an operating cam,

* Abstract of a Paper presented at the Panama-Pacific Convention of the American Institute of Electrical Engineers, San Francisco.

Table I.

Amperes.	Lb. per sq. in. near arc.	Lb. per sq. in. 2½ in. from contacts.
200	74	70
220	75	63
180	68	65
125	54	32
300	78	71

directly connected to an external indicating instrument, as used for hydraulic testing (*see* Fig. 6), the instrument being specially calibrated to record pressures in the oil tank.

There exists a hypothesis that an arc ruptured in oil is immediately damped out by the oil rushing between the contacts, and intercepting the current flow at the zero point. An analysis of the above proves that this is not the case. The formation of the arc

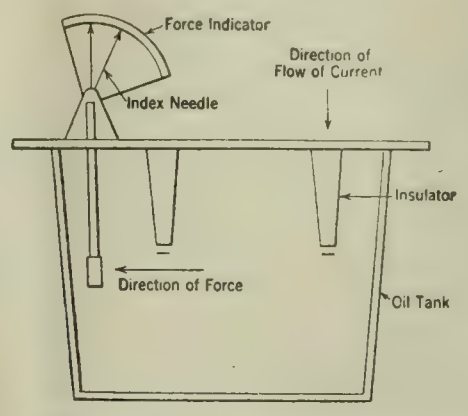


Fig. 6.—Method of Force Measurement.

sets up a vaporised space around the contacts. This prevents the oil (which is of a somewhat sluggish character) entering the space around the contacts.

In comparison, a quick-acting switch must have a greater rupturing capacity than those of the slow type, their rates being, within limits, proportional to their time elements. The time taken by a positive relay for automatically tripping the switch from a power supply averages 0·4 second. The time occupied by a gravity oil switch with a 5-in. break per pole per phase averages 0·6 second. So that, in all, the switch reaches off position in a second. The time elapsed between the parting of the main and auxiliary contacts (assuming brush contacts) averages 0·2 of a second; thus, by multiple breaks the rapidity of a circuit may be correspondingly

Fig. 8.—Oil Switch Tests, Direct-current.

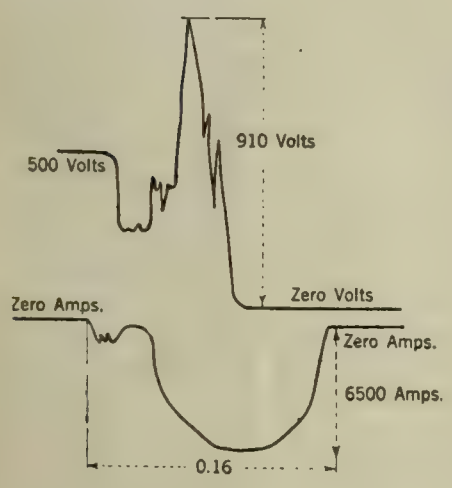


Fig. 7.—Magnetic Blow-out Circuit Breaker Tests, Direct-current Short Circuit.

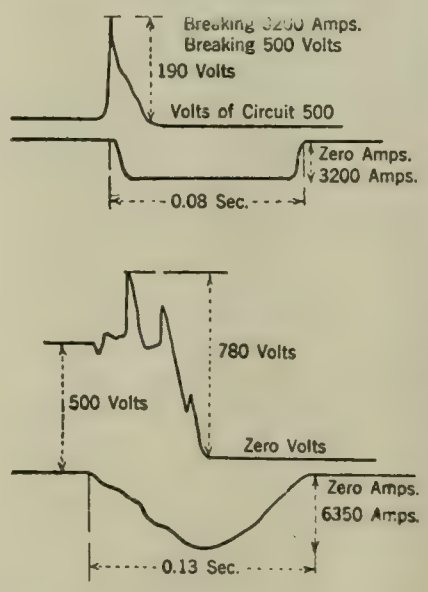


Fig. 9.

increased, and for heavy duty at high pressures the multiple break is becoming a necessity. There is a mechanical difficulty in making a multi-break gravity switch where all the contacts should make or break at the same time. A number of oscillograms are given in the original Paper, illustrating the opening of oil switches under short circuit.

Engineers have experienced considerable inconvenience by the appearance of surges when closing high-potential circuits. A series of experiments were carried out on a large power supply system in the Midlands by installing a series of earthed spark gaps on the end turns of a 500 kw. 6,600-volt slow-speed motor. These spark-gaps were adjusted to flash over at definite voltages. When the results were plotted, a pressure of 27,000 volts was recorded by closing the overhead mains 4 miles long, while connecting this machine on to the circuit before starting up.

An oil switch in itself by the nature of its construction does not introduce distortion in the E.M.F. wave, the rate of change of current being its chief contribution. The manufacture of arc-dispelling fields introduced into some designs will, however, considerably and artificially alter the circuit phenomena. Figs. 7-9 illustrate the nature of the arcing and the rises obtained when opening a heavy direct-current short circuit.

The author then discusses the effect of the magnetic blow-out field on the pressure rises obtained.

The meaning of the term "kilowatt capacity" is contentious. The conditions affecting the capacity of a switch are as follows: (1) Power factor, (2) time taken in opening the circuit, (3) amount of current generated on short circuit, (4) position of the wave at the time of rupture, (5) impedance and reactance of the circuit.

The question of power factor materially modifies the rupturing capacity of a switch; the greater the phase displacement, the larger must be its rupturing value, for the reason that a potential exists tending to restore the circuit when the current is zero. This relationship between the voltage and current waves differs between the point of disturbance and its generated source, and the simultaneous value on opening the circuit depends upon the position of the switch relative to the cause of rupture and the known impedance of the circuit.

To limit the instantaneous rise of current on the development of a short circuit, reactors have been advised; their use, however, has been confined to stations of very high ratings. There is much that may be said for their use and introduction, but it is contended that these additional links indicate the ineffectiveness of switches, and, as this is so, a development for improving the rupturing value of the switch would be more consistent engineering practice. The insertion of 5 per cent. internal reactance limits the short-circuit rise according to the characteristic of the generator, to, say, 15 times normal, and 10 per cent. reactance reduces the original capacity to half, such reactances being designed at percentage voltage drop at normal current and frequency.

The question of external reactors forms a problem in itself, inasmuch as their situation on the system requires separate treatment. External reactors on the machine side of the system only limit the current that can pass into or out of it; thus several units could contribute a total rise in excess of such calculations, based on individual reactors. In the same way, feeder reactors might lead to some incorrect conclusions, as the total rise on short circuit might be considerably above those permitted by each reactor. Sectionalised reactors in groups offer the same possibilities and may prove to be of little value whatever under any eventful conditions of disturbance.

JULIAN TRAIN CONTROL AND AUTOMATIC STOP.

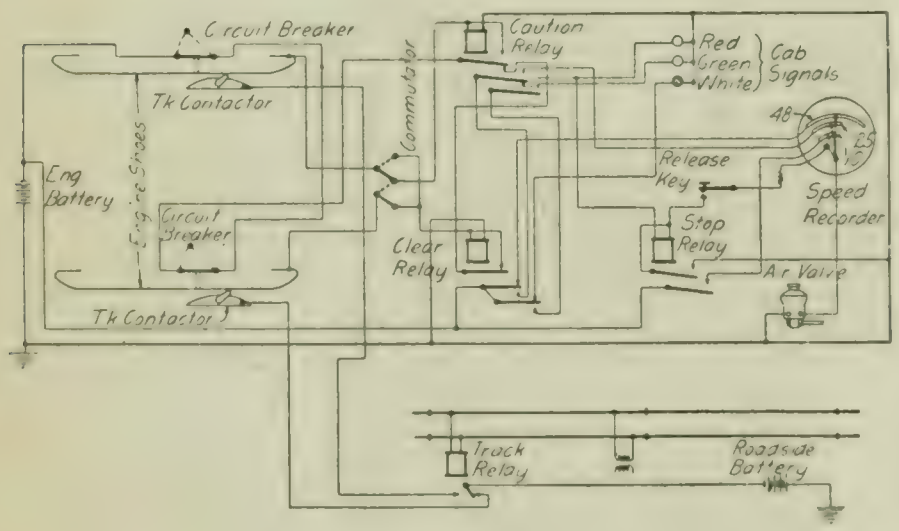
The automatic train control and cab signal system of the Julian-Beggs Signal Co. is being tried on the Queen and Crescent route of the Cincinnati, New Orleans & Texas Pacific. The working has been described recently in the "Railway Gazette." The speed control instrument is belt-connected to an axle. It has a series of contact segments arranged for any desired series of predetermined speeds, and a dial switch, on which is set the desired limiting speed. A series of platinum points are moved up and down over the contact segments by the piston of the recorder, which is raised as the speed increases. As these platinum points rise above the segment corresponding to the speed indicated on the dial switch, the normally closed circuit, through a solenoid magnet, holding closed a valve in the air-brake train line or in a connection from the equalising tank, is broken, allowing this valve to open and the air to escape to the atmosphere, thereby setting the brakes. As the speed of the train is reduced the platinum points again make contact with the segments, completing the circuit, energising the magnet and closing the air valve.

The train control and cab signal system utilises a similar speed recorder and air valve in connection with a roadside contactor and a third rail to control the speed of the train automatically, and to give the enginemen distinctive "clear," "caution" and "stop" signals in the cab. This system requires on the locomotive a 12-volt storage battery for the relays and lamps and two curved shoes are attached to the journal boxes of the forward truck on each side, where are also mechanical circuit-breakers with horizontal arms. Track contactors are located about 600 ft. in the rear of the signals,

in order to allow an engine running at the caution speed to be stopped automatically by the device before passing a stop signal.

The complete circuits on the roadside and of the engine and tender are shown in the accompanying diagram. In the position shown, the engine is approaching a " proceed " signal, two blocks in advance being unoccupied. When the engine shoe strikes the track contactor the circuit is completed from the roadside battery through the front contact of the track relay, the track contactor, engine shoe and coil of the clear relay, to earth. This picks up the " clear " relay, completing a " stick " circuit from the engine battery through the two circuit-breakers, the first back contact on the " caution " relay, the first front contact on the " clear " relay and the coils of this relay, to earth. Current can then flow from the engine battery through the second front contact of the " clear " relay, the upper contact segment on the speed recorder, the dial finger moving over this segment, the solenoid actuating the air valve, and back to ground.

The length of the contact segment can be adjusted for any desired speed, 48 miles being used on this installation. As soon as the speed exceeds this rate the dial finger passes off the end of the segment, the circuit is broken and the brakes are applied through the de-energising of the air-valve magnet. As soon as the speed has been decreased to a point below a specified limit the circuit is again completed and the brakes released. After passing a " clear " signal and until the next track location is reached, the white light burns, as it is included in a circuit from the engine battery through the third front contact of the " clear " relay, to ground. The third rails are not shown in the wiring diagram. A length of about 6ft. outside the running rails is used to break the holding circuit on the engine by engaging the horizontal arm of one of the circuit-breakers, shown above the engine shoes. The breaking of this circuit de-energises any relay that may be energised at the time, and puts out any of the



lights that may be burning. This prevents any indication from being carried improperly into the next block without proper control from that block. If the next two blocks are clear after the circuit is broken, the circuits previously described are again established and the train continues at full speed. If, however, only one block in advance is clear and the signal 600 ft. ahead is at " caution," the polarised track relay will be reversed, allowing current from the roadside battery to flow through the back contact of the track relay, the track contactor on the opposite side, the engine shoe, the coils of the " caution " relay, and back to ground. The pick-up of the " caution " relay closes a " stick " circuit from the engine battery, through the two circuit-breakers, the first front contact and the coils of the " caution " relay and back to ground. Until this circuit is broken by the next third rail, therefore, current flows from the engine battery through the second back contact of the " clear " relay, the second front contact of the " caution " relay, the second contact segment on the speed recorder, the dial finger, air valve solenoid, and to ground. The length of this contact segment is adjusted for the desired " caution " speed, which in this installation is 25 m.p.h. If that speed be exceeded, the brakes are automatically set, and again released as soon as the speed has decreased below that rate. Also, throughout this block the green light burns, being in a circuit from the engine battery through the third back contact of the " clear " relay and the third front contact of the " caution " relay.

When the train approaches a " stop " signal the block ahead being occupied, the engine circuits are broken by the circuit-breaker as described above, and as the track relay is de-energised, the circuit from the roadside battery to engine cannot be completed when the engine shoes pass over the track contactors. This de-energises the solenoid holding the air valve closed, exhausts air and applies the brakes; and as there is no circuit through the speed recorder the train is brought to a stop. When it has stopped, the dial hands on the speed recorder will have made contact with the fourth segment, allowing the circuit through the air-valve solenoid to be closed by operating the release key. In this case the current flows from the engine battery through the second back contact of the " clear " relay and the second back contact of the " caution " relay, the coils of the " stop " relay, release key, speed recorder, air-valve magnet, and to ground. As soon as the " stop " relay is picked up by closing the release key the " stick " circuit through the coils and the first front contact of this relay is completed, and also the circuit from battery through second front contact of the " stop " relay and the third contact segment on the speed recorder. This segment is arranged to allow a speed of 10 m.p.h. until the next indication is received.

DIESEL ENGINE USERS' ASSOCIATION.

At the February meeting of this Association the president (Mr. Geoffrey Porter), in opening the further discussion on the subject of the use of tar oils as fuel for Diesel engines, announced that Mr. W. Batho, of Messrs. Sulzer Bros., and Mr. L. W. Johnson, of Messrs. Banks, Warner & Co. (Ltd.), had been specially asked to attend the meeting, and he trusted they would be good enough to let the members have the benefit of the information they had on this subject.

Mr. W. BATHO remarked that for years past the Continental journals had contained a large amount of information on the subject, and the late Dr. Diesel, in the Paper he read in March, 1912, before the Institution of Mechanical Engineers, gave the specification for a tar oil suitable for Diesel engines, which were then in use in Germany. It was interesting to note that at this lecture he made the statement that the tar production of Germany was sufficient for more than 5,000,000,000 H.P. per annum, and that in case of war cutting off the supply of imported fuel this quantity would be sufficient to run the whole Fleet, war and mercantile, and also to provide the power for inland industries as well. In Switzerland about 140 Diesel engines, of a total output of 24,000 B.H.P., installed by Messrs. Sulzer Bros., were nearly all running on tar oil prior to the outbreak of war, the units varying from 20 B.H.P. to 1,000 B.H.P. This tar oil was all imported, and not only did the supply immediately fail, but also the supply of mineral oil, with the result that the prices increased enormously, and at one time fuel oil was almost unobtainable. Fortunately there was a considerable quantity of vertical retort tar available, and as Messrs. Sulzer Bros. had carried out in their testing laboratory long experiments with this fuel and had designed a special method of burning it they were in a position to help their clients out of what might otherwise have been a disaster by fitting a number of the engines with this arrangement for burning tar. It proved to be of particular service to the contractor building the Hauenstein Tunnel on the Swiss Federal Railways. He had two Diesel engines of 500 H.P. which had to run two and three weeks continuously without stopping. They were used for driving compressors with very variable loads, or, in other words, about the most difficult conditions to contend with. The results were extremely satisfactory, and the contractor, thanks to being able to use tar as fuel, was able to keep his plant running and to complete his contract in the specified time. He had reported since that, with one year's running with tar and several years with tar oil, the engines were still in the best condition. As far as Messrs. Sulzer Bros.' own position was concerned, soon after the outbreak of war they found that steps would have to be taken to keep up their supply of fuel, as otherwise their testing station would come to a standstill. They therefore installed their own tar distillation plant according to designs of their own. The reason why they installed this plant instead of using ordinary tar was that, although the latter gave fairly good results, it was not such a clean and satisfactory fuel as tar oil. It was also more economical to use tar oil, as it was well known that from the distillation of tar valuable by-products were obtained, such as benzol, toluol, ammoniacal liquors and anthracene, which would otherwise be lost if the tar were used direct in the Diesel engine. In France, where they had installed some 50 engines of a total output of 30,000 B.H.P., tar oil was almost universally in use. The units varied from 20 B.H.P. to 3,500 B.H.P., and the tar oil in that case also was imported, the supply of which failed when war broke out. On the other hand, in France the Government have taken over the whole production of tar, so that at the present time tar oil was almost unobtainable, and in France most of the Diesel engine users have been compelled to fall back on mineral oil. The greater part of Messrs. Sulzer Bros.' engines run with tar oil without any auxiliary fuel pump, and this refers particularly to their two-stroke engines. They have found in the course of their experiments that it was not sufficient to inject a drop of oil in a solid state, so to speak, in advance of the main fuel charge, but this ignition drop requires to be properly pulverised in the same way as the main fuel supply. Unless this was done the initial combustion is impaired, and it also considerably increased the consumption of the ignition fuel. They have found various solutions for this, for which patents have been taken out in this country. There seems to be a difference of opinion between experts in this country as to the amount of ignition oil necessary, and in

one case the quantity is stated to be 3 per cent. of the tar oil, whereas in the "Engineer" of February 18th the quantity was given as 6 per cent. An analysis of coal tar and tar oils then followed.

Mr. L. W. JOHNSON referred to the entirely successful manner in which tar and tar oils had been used in Diesel engines in Germany. In that country the approximate total brake-horse-power developed by Diesel engines was 850,000, of which about 150,000 was obtained from tar or tar oils, the corresponding figures for Great Britain being about 80,000 and 1,000 respectively. The lowest import duty on petroleum oils brought into Germany was 36s. a ton, which naturally was a great encouragement to the use of the home product. Referring to the subject of the saving of national wealth which might be effected by the use in internal combustion engines of fuel oil distilled from the coal produced in our own country, as compared with the burning of coal in boiler furnaces, it might be taken that out of a total of 11,000,000 B.H.P. necessary for industrial purposes 10,000,000 B.H.P. are developed by steam engines. Assuming 6 lb. of coal per indicated horse-power, working for 2,500 hours per annum, we use 67,000,000 tons of coal, costing £50,000,000 sterling, if the cost of coal be taken at 15s. per ton. With the internal combustion engine the corresponding power would be represented by, say, 9,500,000 B.H.P., and assuming 0·6 lb. per brake-horse-power, we should consume in the same period 6,500,000 tons of oil. If oil cost £3 per ton, the total consumption would represent £19,500,000 sterling, or a saving of £30,000,000 sterling to the consumer per annum. In addition, the national wealth would also be augmented by the coal being subjected to a distillation treatment, as then the value of the coal is increased by fully 75 per cent. The questions to be considered are: How much tar oil is available for possible use in engines? What is its market value, and how will this be affected if tar oil becomes generally used? The first question resolves itself into a consideration of the various distillation processes, and a fairly accurate estimate of the total output from all existing plants can be made. At the present time, however, such an estimate would serve no very good purpose. Regarding the second question, tar oils have so far chiefly been used for creosoting timber, and most of the available supplies are now sent to the United States. In fact, in 1913 40 per cent. of our total production of tar was exported to America, the approximate amount being 200,000 tons, which would provide nearly 250,000 B.H.P. working 3,600 hours per year. A further large percentage was exported to Germany, and this now also goes to the United States. Lately considerable interest has, however, been taken by America in the possibilities of tar, and a number of tar distilling plants are being installed, which fact was of much importance to us, remembering the extent of our export trade with that country. The speaker stated that since the beginning of this year he had been in touch with most of the sources of supply of tar oils in this country, and that out of some 50 firms approached only about a dozen had been able to make any offers at all. Of this latter number about one-half could supply products which would in any way be suitable for use in Diesel engines, and the total quantity would amount to about 5,000 to 8,000 tons per annum. The prices quoted by these firms ranged from 2½d. to 6d. a gallon, or, say, £2. 10s. to £7 a ton at their works. From further information quite lately received it seemed probable that a further 1,000,000 gallons of suitable fuel oils could be supplied from other sources. He next referred to the question of the present high prices of petroleum fuel oils. The result of the tax on imported oils had been that in Germany tar oil has been cheaper to use than even Galician fuel, notwithstanding the fact that the calorific value of the tar oil is 10 per cent. lower than that of gas oil. The value of creating a home product lies in the fact that thereby competition is established with the foreign product, and prices are kept within reasonable limits. A process for distilling tars obtained from gasworks where vertical retorts were used has already been set to work in a neutral country, and the distilled oils are being used on Diesel engines of all sizes, and of both slow and high speeds, with every success, and without the engines being altered for pilot ignition. Continental engineers have for many years past given attention to the question of using suitable tar oils in existing Diesel engines without the necessity of making costly modifications. In 1909 experiments were made by Messrs. Korting Bros., the M.A.N. Co. and Messrs. Sulzer Bros., who succeeded in burning satisfactorily tar which emanated from several gasworks, and some of which was obtained from the gasification of English coal, the rest from Westphalian and Silesian coals. In most cases, however, pilot ignition has been resorted to in one form or another, and it was only quite recently that any measure of success has attended the experiments made to use the oils without pilot ignition. The chief trouble experienced is that at lighter loads—*i.e.*, below three-quarter loads—the temperature inside the cylinder at the time of opening the fuel valve is not high enough to start and complete the perfect combustion of the main charge. The various methods that have been tried for burning tar oils were mentioned. Most of these are impracticable, except the one in which a pilot charge is used. What appears to be required was that quite a small quantity of tar oil should enter the cylinder before and distinct from the main charge. This quantity was readily converted into the oil gas formation necessary to raise the temperature in the combustion space sufficiently to permit of the smooth and complete burning of the main charge. It should be noted that copper, zinc or any alloys of these metals cannot be employed in the manufacture of parts in contact with tar oils. Hence steel pipework must be adopted, and the parts of engines which were generally made of gunmetal or phospho-bronze have to be made of pure nickel or 25 per cent. nickel steel, while good joints can be made of sheet asbestos after soaking it in goldsize or some like substance. Actual results obtained on various engines showed that when using a pilot charge the consumption of oil per brake-horse-power-hour was at full load 0·43 lb., half load 0·47 lb., the calorific value of the tar oil being 16,300 B.Th.U. per lb.

In the discussion which followed much stress was laid on the advantage which would accrue to users of Diesel engines in this country if they were not in future to be left entirely dependent upon the use of imported petroleum fuel oils.

RECENT PROGRESS IN INDUSTRIAL LIGHTING.*

BY L. GASTER.

Referring to the progress recently made, the increased range of candle-powers and intrinsic brilliancy was mentioned. The watts per candle has diminished from 5 for carbon filaments to 1·25 for tungsten to 0·65 for tungsten "arc incandescent," the "intrinsic brilliancy" or candle-power per square inch has increased from 381 for carbon to 12,900 for tungsten arc. The method of rating lamps was dealt with and it was suggested that mean spherical candle-power should be indicated by lamp makers.

By means of the "Holophane Lumeter" measurements can be easily made, and by adopting the data given by makers, and specified spacing between the lamps, satisfactory results can be obtained. There is to-day no need for "rule of thumb" in illumination. With modern lamps roughly 1 c.p. per square foot produces an effective illumination of 3 ft. candles, when the lamps are arranged according to the uniformly distributed overhead system, with mounting heights ranging from 12 ft. to 16 ft. above the floor, and when the light is directed from the lamps in an efficient manner. Reflectors should screen the source of light from the workers' eyes, distribute the light where it is most needed and diffuse the light.

Referring to the Home Office Departmental Committee on Lighting in Factories and Workshops, it was pointed out that the accident rate is invariably greater by artificial light than by daylight. The accidents in winter exceed by 50 per cent. those in summer. There appears, therefore, to be a strong connection between accidents and lighting. Of 1,287 fatal accidents reported by H.M. Chief Inspector of Factories for 1914, 401 were caused by people falling, and over 10 per cent. of the non-fatal cases were due to the same cause. It was pointed out that inadequate illumination restricts the output and leads to spoiled work, and where expensive labour is employed it pays to illuminate well.

Referring to general illumination, it is cheaper to instal, as a rule, local lighting being necessarily used where the work is of a specially delicate or complicated character. Formerly in offices and banks every clerk had his own specially shaded lamp; now more general diffused illumination is being introduced.

The present tendency seems to be towards using incandescent lamps of moderate candle-power, 300 or so, instead of 1,000, and in this way the lighting is sub-divided and better conditions regarding shadows are obtained. Special attention should also be paid to the provision of light walls and ceilings. Dust deposits on lamps and reflectors may reduce the illumination in a factory by as much as 50 per cent., and in America supply companies make contracts for lamp renewals and cleaning of lamps and reflectors.

Reports on the lighting of schools and interiors have been issued by Joint Committees initiated by the Illuminating Engineering Society, and in these directions there has been a steady improvement during recent years.

Electric Furnaces.—The Canadian Department of Mines has issued a report of the investigations made by Mr. A. Stansfield in Norway and Sweden on behalf of the Department. In Sweden the Electro-Metals furnace is specially favoured. This furnace has a shaft in which the iron ore is first heated by the furnace gases and partly reduced before the ore reaches the furnace proper. Another type of furnace is the Rennerfelt, which is used for smelting and refining. Three electrodes are used supplied with two-phase current, one being arranged vertically and two horizontally. The vertical electrode has an arc extending on to the material being heated, and the furnace shell is mounted on trunnions, so that it can be tilted when it is required to pour off the metal. It is stated that small Rennerfelt furnaces of 1,320 lb. capacity will produce molten steel for castings from a cold charge with an expenditure of 700 to 800 kw.-hours per ton when in regular operation.

* Abstract of a Paper read before the Association of Supervising Electricians.

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DIAGRAMS, RULES AND SYMBOLS.

In an article in our last issue it was stated that the hollow circles and the black circles distinguish the directions in which the currents flow. We are inclined to question whether many of our readers are familiar with this method of distinguishing the direction of current flow. Nor would we have them familiar with the method till very good reasons are given for abolishing the "dot and cross method" of denoting come-out and go-in currents, for every system should, as far as possible, be self-explanatory. The adoption of a standard system in the drawing of electrical diagrams would be welcomed by many electrical engineers and by most students of electrical engineering. The draughting of such a system is work for a committee appointed by the several electrical engineering institutions and societies, or, alternatively, for the International Electrotechnical Commission.

We favour the latter course, because the machinery already exists for giving authoritative expression to the work. At the same time, so as to secure the wide adoption of a uniform system, it would be necessary for the various institutions to contribute towards the cost in order that the recommendations could be distributed through the medium of recognised channels without cost, or at negligibly small cost, to the recipients. There can be no question as to the desirability of adopting a uniform system of diagrams and symbols. These form the alphabet of the language spoken by electrical engineers, and it will be generally conceded that, in order to master the language, it is necessary in the first place to become familiar with the alphabet.

That the electrical symbols recommended by the International Electrotechnical Commission are neither well known nor widely used in this country can only be attributed

to the fact that, up to the present, writers and others have not been allowed to publish them, as the copyright is the property of the Commission. Those responsible for the training of electrical engineering students would like to see the international symbols in every student's notebook, irrespective of the cost of the book, just as one finds tables of atomic weights, logarithms and trigonometric functions in such books. To popularise these symbols we should like to hear of permission being granted to our colleges and schools to have them printed for free distribution to their students. Prior to the war certain of the makers of chemical reagents in Germany used to send out in large numbers tables of international atomic weights. These were nicely printed on thin card, and could conveniently be carried in the pocket. If this can be done in the one case, we see no insuperable objection to doing it in the other.

In exactly the same way we should like to see provision made for the publication, in the "Journal" of the Institution of Electrical Engineers, of all reports and recommendations of the Engineering Standards Committee dealing with electrical machinery and apparatus. It is the misfortune of the latter Committee to be dependent upon subscriptions for carrying on their work, and although the work is of inestimable value to the engineering industry it is necessary, under existing conditions, to make a fairly heavy charge for the publications issued by the Committee. The attempt to make unproductive work pay necessitates a charge of half-a-crown being made by the International Electrotechnical Commission for a copy of the symbols, with the result that relatively few people are familiar with them. We look upon this as discreditable to the industry, not of this country alone, but of all countries, since the work is international in character.

Elsewhere we give an article by Prof. GISBERT KAPP on "Uniformity in Drawing Electrical Diagrams." In this article the author makes out a strong case in favour of such uniformity, and advocates the use of certain symbols and methods in diagrams, so that the latter become more self-explanatory than is usually the case. Prof. KAPP's article may be regarded as a basis for discussion. As we desire to secure uniformity (and this includes uniformity of excellence) in the drawing of diagrams, we shall be pleased to consider any other contributions on the subject that may be sent to us.

Graphical symbols can be looked upon as the alphabet of the *picture language* used by the electrical engineer. Knowledge of the shortcomings, as draughtsmen, of many authors and students, to say nothing of the callous indifference of many publishers to the appearance of the printed page, compels us to suggest that the alphabet should be kept as simple as possible. To make our meaning clear, we will take a few of the signs given by Prof. KAPP. It will be noticed that a resistance takes the form of the section of a Whitworth screw thread. Now, as everybody knows, it requires considerable skill to make a creditable drawing of a screw thread of small pitch. Each element of the resistance consists of two circular arcs joined together by a pair of tangents, and it is difficult to get invisible joints. In order to represent a shunt, a figure composed of no less than 12 lines is used, and here again we have laborious geometrical construction to secure accuracy comparable with the accuracy of the type. There is no need to adopt any complicated shape to represent these things.

The symbols proposed for instruments are also difficult from the point of view of ease of construction. Take, for example, the fluxmeter, which is petal-shaped. The symbol suggested is a complicated geometrical figure composed of 12 lines. It cannot be that the author is endeavouring to use the outline of the instrument as the symbol. If it were so the wattmeter would have the same outline as the ammeter and voltmeter. The fact of the matter is that practically every instrument used in electrical engineering can, without any ambiguity whatever and without reference to the text, be represented by a circle, and, in order completely to define an instrument, a letter may be placed within the circle. Thus, the letter F would denote a fluxmeter, V a voltmeter, and so on. If it be desired to state the type of instrument subscripts may be used. Thus, A_i within a circle could very well stand for an ammeter of the induction type, and for a V_{hw} hot-wire voltmeter. The accepted sign for a battery placed within a circle could represent a standard cell. These are matters of detail, but they are, nevertheless, important in so far as the simpler the characters of the alphabet the better is the writing likely to be.

We believe that the author would like the diagrams to be well-drawn both in students' notebooks and in text books. If such be the case, we are certain that he will welcome suggestions which, without in any way disturbing the uniformity of the diagrams, will result in material simplification of the system. The many excellent illustrations given by Prof. Kapp of the use of symbols and method in diagrams speak for themselves, and the subject is one which, as we have said, could well be undertaken by the International Electrotechnical Commission.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

An Elementary Manual of Radiotelegraphy and Radiotelephony. By J. A. FLEMING, D.Sc., F.R.S. (London: Longmans, Green & Co.) Pp. xiv.+358. 7s. 6d. net.

This is the third edition of a book known to many of our readers and to most students of radiotelegraphy familiar with the English language. The author has a happy manner of presenting the facts of science in such a way as to make them interesting. This is highly desirable in books for beginners.

New matter has been added so as to bring the information up to date, but the general purpose of the book has not been otherwise altered or its scope as an elementary manual enlarged. The new matter includes a section on quenched spark methods, and notes on the Goldschmidt alternator, arc generators and dischargers. To the section on earthed and non-earthed antennæ a note has been added, and in the chapter on oscillation detectors is given an account of rectifying contact detectors, as well as a brief reference to the methods for the quantitative measurement of electric waves. Other alterations and additions of a minor character call for no special mention.

The appearance of the new edition is more pleasing than that of the previous edition. The book will continue to be popular with those students who desire to be well-grounded in the elementary principles underlying radiotelegraphy before attempting to read larger treatises, and who wish to read with understanding the many and valuable original Papers on the subject.

Handbook of Technical Instructions for Wireless Telegraphists. By J. C. HAWKHEAD and H. M. DOWSETT. (London: The Wireless Press.) Pp. xvi. 310. 3s. 6d.

Although it is little more than a year ago that this book was first reviewed in these columns, it is stated that the constant demand has exhausted several reprints of the first edition. The large amount of new matter which has been added in the second edition includes 47 new illustrations, and no less than 88 of the original diagrams have been redrawn. The book is divided into three parts, of which the first, consisting of 10 chapters, deals with elementary principles, and in the second

part an account is given of electromagnetic waves and the receiving circuit.

A notable improvement over the first edition is in the third part, which has been completely recast, and the book is now up to date as regards Marconi wireless practice for installations up to 5 kw. capacity. The requirements of the operator have made it necessary to give full descriptions of both old and new apparatus, as the many ships now equipped have been fitted at different dates, and apparatus of every type is, therefore, to be found on them. The student is thus provided with a good illustration of the progress that has been made in one system of radiotelegraphy.

Part III. consists of eight chapters, in which the 0·5 kw., 1·5 kw. and 5 kw. sets are described in considerable detail, and space is given to the description of emergency transmitting apparatus and portable sets, and to the localisation of faults. As the book will undoubtedly be used by and be of service to operators working "on their own," we think it would be a good plan to make all the diagrams of connections as distinct as possible and of good appearance. One or two minor errors have crept in. Thus, the cartridge fuse, Fig. 104, is said to be enclosed in a cardboard tube, whereas fibre is surely intended by the construction of the fuse, and the angle in Fig. 214 is shown as $\pi/2$, whereas π is intended. The authors are to be complimented upon the many excellent elementary diagrams which accompany the main diagrams of connections. The book, which is well printed and inexpensive, can be recommended to those who possess an elementary knowledge of electrical principles and who desire to become acquainted with the practical side of radiotelegraphy.

INDUSTRIAL DEVELOPMENT.

BY HAROLD COX.

At the Institution of Civil Engineers on Tuesday evening Mr. Harold Cox delivered an address on the above subject, the President of the Institution, Mr. Alexander Ross, occupying the chair.

Mr. HAROLD COX said the subject of Industrial Development must, by its nature, have reference to problems that came after the war. In peace it was necessary to prepare for the possibility of war, and in time of war it was our duty to prepare for the certainty of peace. When peace was declared hundreds of thousands of soldiers would return, large numbers of munition workers would be discharged, and an enormous number of separation allowances would be discontinued. This would have so serious an effect on our social life that even those who had thought deeply about the subject feared the possibility of industrial revolution. We had made no provision for these difficulties beyond vague talk. The problem was one with which that Institution was eminently fitted to deal. Engineers were engaged in planning great enterprises, and most of them had had experience of manual work side by side with men who were now merely wage-earners. The Institution had built up a world-wide connection, as was evident from its examinations, which were held in such widely separated cities as Alexandria, Auckland, Buenos Aires, Bulawayo, Colombo, Delhi, Dunedin, Havana, Hongkong, Shanghai, Sydney, Suva and Vancouver. At those examinations the Institution had its members to supervise them, which proved that there were members in these towns with whom they were in touch. They might be said to have tentacles which embraced the whole world. This was typical of the way in which British trade had been built up, and we might well be proud of the result. We were not only bearing a military burden 20 times as great as any we ever dreamed we would have to shoulder, and we were financing most of our Allies. We could not have done that if our system of working had not been sound at core. Individual enterprise could not be trusted to solve the industrial problems that would follow the war. There must be collective effort, but not necessarily Government action.

The aspects to be dealt with were both domestic and external. Without our external trade we could only maintain a small population in great discomfort. The extension of external trade was important from the economic and political points of view. The greatest danger we had experienced in German trade was due to the manner in which they had used their trade connections to build up political agencies in the British Empire and in neutral countries. German trade agencies were acting as spies for the German Government in various portions of the British Empire. Our recent experience did not encourage us to look for much more to be done by the Government. The Government did something for external trade—it maintained a consular service (laughter). A large number of our consuls were gentlemen who had been unsuccessful in the diplomatic service, and there were also some of foreign nationality—sometimes our trade and political rivals. Statistics in consular reports were generally published at least two years after date. Some consuls also persisted in repeating the parrot-cry that Englishmen and Scotchmen did not know their business. He remembered one report which stated that English manufacturers and merchants could not understand the needs of the people in the consular district in question. They wanted long credit and the Germans gave it. Three or four years later a report from the same place stated that one did not then hear so much of German trade there—the only Germans seen were a few seedy-looking individuals trying to collect bad debts. A report from Bahrel Benat Island, Persian Gulf, published March, 1916, stated that it was impossible to get reliable statistics, as such data were not kept, but it proceeded to give about 20 pages of statistics, not one of which was worth printing. It was a sheer waste of public money. No consular service controlled by the Government would ever be of practical use. Why should not business men organise their own consular service?

Mr. Cox then gave as an instance of what could be done by private effort, the important work done by the Engineering Standards Committee, the idea of which was started by Sir John Wolfe-Barry. The existence of these standards, which were recognised throughout the world, gave a foothold to British trade in foreign countries, and the Committee had received grants from the British and Colonial Governments, municipal bodies, gas and other companies and private manufacturers. If a private organisation could build up a system of standards of world-wide application, was it not possible to conceive a larger organisation, representing practically all the trades of the country, to deal with the problem of developing our trade abroad—an organisation for collecting trade information from agents abroad and systematising it and distributing it among the manufacturers primarily concerned? Mr. H. E. Morgan, whom he was glad to see present at the meeting, had developed that idea and had given it the very useful title of the National Trade Agency, which would do effectively the work which the consuls professed to do but did not; and, in addition, would do for our trades as a whole what each individual manufacturer was now trying himself to do.

Turning to what he described as the equally important and in many ways more difficult question of domestic problems, Mr. Cox said that the primary need was that of the men who returned from the war. If this question was not dealt with we should have chaos and, as some people thought, perhaps revolution. The problem was largely one of engineers, who had it in their power to prepare plans to put into application as soon as peace was declared. There would be the obvious work of repairing railways and roads, but it was also possible to prepare new schemes of public utility, new roads, and new streets that certainly ought to be planned in advance. In planning new streets they should think not merely of the needs of better locomotion, but also of better living. A town was not merely a place for motor 'buses to rush through, but primarily a place for people to live in in comfort and decency. The greater part of London was neither very attractive to live in nor beautiful to look upon, with its hundreds of miles of dreary streets and squalid houses: and there was no finer task than that of the reconstruction of the capital of the Empire. This task would not be finished in a day or a year, neither would the after-war problems end in a day or a year. They had not merely to think of the few months when men would be seeking work, but also of the future and to making permanent arrangements which would meet the difficulties created by the war itself.

The main point was that people had become accustomed, and rightly so, to a higher standard of wage, due to the increased demand for labour. How could that higher standard be maintained after the war? This was, he thought, the problem of problems, and he ventured to ask a series of questions to help to solve it. Why had the masses so long been condemned to live in poky houses and in mean streets, many of them having insufficient food? He was told it was the result of low wages. Was it necessary that wages should be so low? He was told that the work was worth very little, or, in other words, the worker produced so little. Was it necessary that the worker should produce so little? What were they doing now? There were nearly 4,000,000 men either fighting or training to fight, and large numbers of men and women producing materials for fighting, yet in spite of this enormous drain on the population, the whole of the people were being maintained in a much higher standard of comfort than ever before, and, in addition, our export trade was being kept up to what we should have regarded a few years ago as marvellous. In 1915 the value of our trade was as great as it was six years ago, in spite of all this deflection of industry. Part of the value was no doubt due to the rise in prices, but our export trade last year

was in volume equal to that of 12 or 13 years ago. This could only be explained by our enormous increase in productive power. There were those who argued that we could not expect to do so much in time of peace, because in war time the work was paid out of capital. The fact remained they were doing the work, producing the goods and maintaining the higher standard of comfort. Put the money question aside, and look at the bedrock facts of labour and goods; on the one hand labour was employed and on the other the comforts and luxuries created. Could they not achieve the same miracle in time of peace? Could they not secure universal employment and widespread enjoyment? If their tremendous productive power were used, a richer, fuller and happier life would be secured for our own population. The difficulties were no doubt serious, the workman was suspicious of his employer and restricted his output; the employer knew that the worker produced very little work and he therefore paid low wages; and thus it went on. This state of things had been partially suspended during the war, due to patriotic pressure, but after the war that suspension would cease. Indeed, the politicians, with that ephemeral view which seemed to be a necessary counterpart of politics, had actually promised the workmen that after the war the old conditions should be restored. He could imagine nothing more extraordinary than that politicians should hold that up as an ideal to the manual worker. Like most economic problems, it could not be solved by economic forces only; it must be solved by moral forces. The moral outlook on both sides must be changed. He suggested to employers that they would not overcome these difficulties until they demonstrated to their workmen that they looked to the well-being of those workmen as one of the primary objects of their business. As soon as the war work was organised, people woke up to the hardship of workmen travelling long distances and finding no provision for food at mid-day, and canteens were established. As a result there had been improvement in health, less broken time, and less drunkenness; yet this simple thing was not thought of before the war, and it would be disgraceful if it was not maintained. Most employers took care of their machines, and in future he hoped all would look after their men.

After all, the question of wages was a fundamental one, and as long as there was low output so long must there be low wages. In spite of the immense proportion of profit due to the activities of the machine rather than to the activities of the man, workmen still looked at machines with the same suspicion as in the beginning of the 19th century. Only the other day a new machine introduced into a munitions factory was damaged before it could be used. This was curious, as the first instinct of mankind was to make a tool, and a machine was only an elaborate tool. He ventured to lay down the proposition that so far as material comfort was concerned the progress of mankind was dependent upon the progress of machinery. Normally, however, we did not make full use of the machines we had got. He was aware that during the war there had been a greatly increased output because of the appeal to the men on the moral side, but after the war this increased output would cease unless the wages problem could be tackled and dealt with. There was no general way of deciding precisely what shares should go to capital, to management and to labour. Looking at the problem as a whole, he said they must admit that the worker's share of the profit was not adequate. The workman lived in tiny houses, the poorer people had insufficient food, and all workpeople got too short holidays. In many cases the work was horribly monotonous, and the man's position was uncertain. In this connection Mr. Cox instanced a notice which he had seen outside a London works, which read as follows: "Any workman employed here is liable to an hour's notice; the management does not want any notice from him." How could they expect a man to take an honest interest in his work or in his employer's prosperity under such conditions? It was asking too much of human nature. On the other hand, as contrasted with the mean and poor lives of the masses, in the upper classes there was ostentation and wealth, and in many cases deliberate flaunting of luxury in the faces of the poor. Was it surprising that Socialists found eager listeners when they preached the doctrine of class war? Nor had this class jealously vanished altogether now, and they had recently seen the carping way in which the middle class had referred to the increasing prosperity of the workmen. Why it was a crime for a workman to possess a piano and not for the middle classes he could not imagine. The manual worker needed just as much recreation as the brain worker. This could only be got by more efficient work, but the workman would only consent to become more efficient if it were proved that his interest and that of his class lay in that direction. If we could solve this moral problem he could see no limit to the progress of our country.

Great reform was possible in the hours of working. In this country the hours were much too long. Shorter hours would undoubtedly tend to increase the efficiency of the workmen and of the workwoman. The problem was that shorter hours meant a reduction in the efficiency of the machine, and the machine was becoming more and more an important factor in production. While workmen were eager for shorter hours, at the same pay, of course, the employer was making for longer hours to obtain greater output of the machines and a greater proportionate yield for establishment charges. But surely it merely meant the introduction of the shift system to ensure shorter hours for the men and longer hours for the machine. It had been done during the war, to destroy our enemies, Why not do it in peace time to build up our own people? He was in favour of the three-shift system, as this gave a period of working during which the individual was at his maximum efficiency. Eight hours might, however, be too much for some trades. Looked at from the point of view of employment, three people would be required for each machine or group of machines.

No doubt many gentlemen present had heard of what was called scientific management in the United States, which was started by Mr. F. W. Taylor, who published a book giving illustrations of the greater output to be secured with less exertion of the workman by scientifically directing his operations. The capacity of the workman or workwoman could be developed by scientific training. Mr. Taylor's idea had been taken up very largely in the United States, but it had not been altogether successful, because the employer had neglected the human side. Greater output, greater leisure for the worker, and higher wages for the worker were the three ideals for the industrial development of the future. Their realisation would be obstructed by class suspicion, resulting in class war. It was for us to plan and prepare so that after the war the same spirit of comradeship which prevailed amongst the men in the trenches might bind us together to work for the triumphs of peace. (Applause.)

Sir JOHN WOLFE BARRY, in proposing a vote of thanks to Mr. Harold Cox, said his address was thoughtful and suggestive. It was of extreme interest to engineers and to every man and woman in this industrial country. We should not forget that we lived by trade, and that it was vital to us to find out what was the proper way of conducting trade with the best results to the whole body politic. It was of vital consequence that there should be no misleading on this important point. Mr Cox drew attention to the possibility of remodelling our system which, up to now, had been based on the consular idea. He cordially agreed with him that that idea should be rooted out, root and branch. Their private efforts ought to be used to fill up the vacancies in the consular idea. He imagined the Government must have some kind of consular system, but if we were to have an efficient pushing of our trade it must be done by the voluntary efforts of the trades themselves. That Institution had its ramifications in every clime and every city, and they could use them to great advantage in some great voluntary effort. The success attained by the Standards Committee was most remarkable, and every step had been based upon voluntary effort. Every sacrifice had been made of time and money, without any *arriere pensee*, but merely to serve the great interests of the trades represented. The progress made could be extended and worked into our foreign trade for the benefit of all the great mercantile interests of Gt. Britain, and it would be of great benefit. He thought the time had come when they should look at the matter in a somewhat less altruistic way than had been the fashion of Gt. Britain. They had thrown open all their markets, and all the resources of the Empire to foreign competition in a way which had been in many cases extremely disastrous to this country. He trusted that we might, in alliance with those other nations that were fighting the battles in the war, see some mode of taking care of ourselves and those nations, by not throwing open to German enterprise so much of our foreign markets as had been the case up to now.

If they could make everybody see that the interests of capital were linked up with those of labour, and that they could not be dissolved without disaster, and if the working classes would learn that there was no real antagonism between their interests, the trade and prosperity of the country would be increased. Any one who would unite the interests of capital and labour in one indissoluble bond, and make everybody understand that their interests were dependent one on the other, would do the greatest good for this country. He thanked Mr. Cox sincerely for coming there and giving them his thoughts for consideration and pondering.

Sir ARCHIBALD DENNY, in seconding the vote of thanks, said he was an employer of labour, and to speak as one now upon so delicate a question as the relations of capital and labour was a difficult task. Many schemes for reconciling capital and labour, and proving that their interests were identical, had been suggested, but none of them appeared to have been quite successful. Co-operation and sharing of profits had been suggested In the case of the latter it was difficult to apportion the share of management and labour, and so far as he had seen no solution had been found for it. He thought the men would think they had been insulted if they were offered an equal share of profit. He had not had the extreme difficulties some of his colleagues in the same business had had, and he could not speak so well on the subject as those who had been through the "whins" of trouble. He agreed that the workmen should have good holidays. In Scotland they had about 10 days clean holiday in winter and 10 in summer, and autumn holidays founded on the old fast days. With regard to the question of increasing production, he had always understood the difficulties in dull times were due to over-production. If you produced you must have someone to consume. If you could not sell your goods in your own country you must export to some other

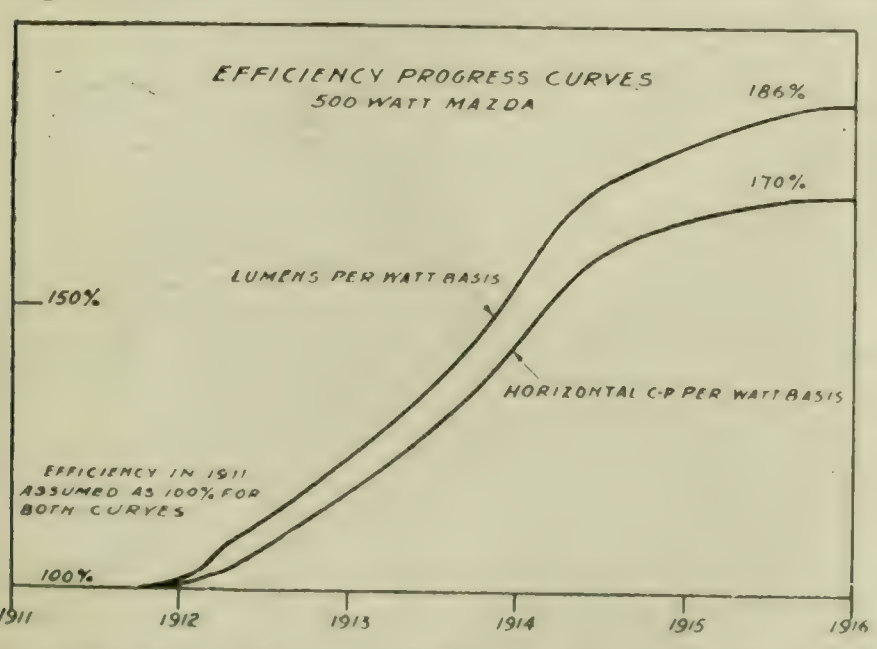
country, and import their goods in return. Whether they agreed entirely with Mr. Cox or not he had given them food for reflection, and he seconded heartily the vote of thanks.

Mr. HAROLD COX, in acknowledging the vote of thanks, said the idea in his mind was that if the demands of our own people for comforts and luxuries were extended, any additional output we could make could be used up. That was his main thesis. To use our productive power we must extend the ability of our own people to become purchasers.

EFFICIENCY PROGRESS OF THE METAL FILAMENT LAMPS.

A fortnight ago we commented upon the uncertainty in the terms "candle power" and "efficiency," caused by new methods of construction of metal filament lamps. These remarks are illustrated by the accompanying diagram which shows the approximate efficiency progress curve for a number of years of the 500-watt Mazda lamp. It will be noted that two curves are shown—one on the basis of the usual "watts per candle" efficiency and the other on the new efficiency basis "lumens per watt." There is a steadily growing tendency to speak of the efficiency of lamps in terms of lumens per watt rather than in watts per candle. The term lumens per watt is gaining currency because it is a measure of the quantity of light irrespective of direction, and therefore gives a true measure of efficiency for all types of electric light sources and shapes of filament.

It will be noted in the diagram that the two curves, the watts per candle basis curve and the lumens per watt curve, are parallel up to the point where the half-watt type of lamp was introduced. Here



EFFICIENCY CURVES ON THE BASIS OF (1) CANDLE POWER AND (2) LUMENS.

the curves diverge, and this divergence is due to the difference in distribution of light given by the half-watt type of lamp filament as compared to the standard vacuum type filament. For the same horizontal candle power the half-watt filament gives more light than the vacuum type in other directions than the horizontal. On the basis of efficiency expressed in watts per mean horizontal candle this increased light from the half-watt type is not given consideration. When, however, the lamps are rated in terms of lumens, *i.e.*, lumens per watt basis for efficiency, full justice is done to the new half-watt type lamp. The increase in efficiency of light production produced by the new half-watt type is therefore shown to be greater than what the watts per candle increase in efficiency indicates. As is well known, the maximum amount of light in the case of the ordinary vacuum type metal filament is given in a horizontal direction. In the case of the latest small sizes of half watt lamps with horizontal ring shape filament, the maximum candle power is given in the pip end direction, and the minimum in the horizontal direction. It will be seen, therefore, how important it is to have an expression for the efficiency on the lumen or spherical basis, which gives a true measure of the efficiency of the lamp and the actual amount of light emitted.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for postage of foreign books.]

"Examples in Magnetism," by Prof. F. E. Austin. (Hanover: F. E. Austin.) Pp. 90. $1.10.

"The Universe and the Atom," by Marion Erwin, C.E. (London: Constable & Co.) Pp. 314. 8s. 6d. net.

CORRESPONDENCE.

THE RATING OF INCANDESCENT LAMPS.

TO THE EDITORS OF THE ELECTRICIAN.

The Editorial article in your issue of February 25th on the above subject is of considerable interest as showing the extension of practice to Continental countries of the practical size-rating of lamps by even values of watts instead of candle-power. This method of rating by watts, while theoretically opposed from its very inception, has, by reason of its practical advantages, forced its own adoption in America, Canada, Great Britain and now in the Continental countries.

As the writer has repeatedly pointed out, however, it should be noted that this rating by watts is primarily a *size* rating to give a convenient, even and fixed set of values by which lamps can be sized and regularly listed and supplied uniform with the fixed sizing in total watts of other electrical appliances, such as heating appliances, transformers, meters, &c. It will not, of course, be possible to do without some expression for the luminous output of a lamp, but this will be a derived value representing the result of dividing the total watts for any fixed size (which will remain constant at values established such as 100, 60, 40, 30, 20 watts, &c.) by the efficiency at any time (expressed in watts per candle) which gives the candle-power value.

These derived candle-power values obtained in this way will always be available and be employed. They will, of course, be an increasing value in candle-power with every advance in efficiency (such an advance in candle-powers has occurred during the past year with the advances in the whole line of efficiencies in the vacuum type lamps).

A very important point, however, which is not touched on in your editorial is the growing tendency to advocate the use of the "lumen" for a measure of the luminous output as a better and more complete expression than candle-power. This new unit is based on the conception of light as a luminous flux, the lumen being the unit of luminous flux, and the American Illuminating Engineering Society has formally recommended its adoption. On this system the light output of a lamp is measured in lumens rather than in candle-power, the efficiency of the lamp is measured in lumens per watt, and the illumination results obtained are measured in lumens per square foot.

One reason for the adoption of the lumen arises out of the variety of shapes and arrangements of lamp filaments which makes it impossible for candle-power, as heretofore used, to properly express the relative luminous values of different lamps. This condition compels the resort to the mean spherical ratings of candle-powers, and the lumen is the most practical and concrete expression for such mean spherical values.

The ordinary vacuum types of metal filament lamps give about 10 lumens for each horizontal candle-power, and, therefore, have an efficiency of about 10 lumens per watt.

In the case of the half-watt type lamps (for the construction of filament used in the sizes of 300 watts and above in standard lighting voltages) the lumen value is given by $11\frac{1}{2}$ (about) times the mean horizontal candle-power, and the efficiency (for a lamp having a mean horizontal candle-power efficiency of 0·6 w.p.c.) would be slightly over 19 lumens per watt.

The total lumens of lamps are readily measured by means of the integrating sphere, and it is interesting to note that this system of photometry is rapidly displacing the previous measurements by mean horizontal candle-power.

It is not too much to say that the general adoption of the system of expressing luminous values by lumens will mean a great simplification of the practical units used by lighting men and all who have to do with lighting in any form. The leading lamp manufacturers of America are already rating their lamps in lumens and lumens per watt, and the British Thomson-Houston Company, in their latest complete lamp list, give a table showing the ratings of their lamps in "lumens" and the efficiencies in "lumens per watt." It is confidently expected that this terminology will come into general use in the course

of a few years, and its favourable consideration and adoption is earnestly recommended to the attention of all lighting men in Great Britain.

Mazda House, March 6. F. W. Willcox.

"RAPID RECKONING CHART."

TO THE EDITORS OF THE ELECTRICIAN.

I notice your review on page 778 of your issue of March 3rd of a "Rapid Reckoning Chart" which has been devised by Dr. Fournier d'Albe. So far as I can tell from the reproduction and brief description you give, this chart is identical, so far as it goes, with a chart which I devised early in 1914 and exhibited at the Royal Institution on January 29, 1915. In this chart I had, in addition to the special oblique lines for roots and powers, lines giving natural logarithms. I also added scales giving sines, tangents, &c.

I offered the chart for publication to a well-known firm, but they expressed the opinion that the chart would not commend itself to many people. I regret now that I did not go further with the matter.

In my own opinion, the chart has many advantages, more especially, perhaps, from the point of view of the technical student. Reproductions are inexpensive, and, provided they are distinct, have an accuracy depending only on that of the original chart, and not upon the precision of the methods or processes of reproduction. Having used this chart, a student finds no difficulty with a slide rule.

In working with the chart it is convenient to use two movable pointers, by which successive points may be marked in a series of multiplications. Each pointer can be made in the form of a small wire tripod with the pointing leg sharpened and standing vertically. A fairly long pin pushed through the end of an ordinary prism of india rubber is quite satisfactory; the india rubber forms an inclined plane with its lower end resting on the chart and its upper end supported by the pin which transfixes it and forms a vertical pointer.

In sending you this letter I have no desire to suggest that Dr. Fournier d'Albe may have in any sense borrowed ideas of which I was the originator. The chart represents what is really nothing more than a developed diagram of the ordinary slide rule. The slide rule is old, and the forms in which it has been made are very numerous; indeed, I suppose it is unlikely that any really new calculating device based upon the principle of the slide rule can be invented.

My object is to speak a good word for a good thing, and so try to soothe my own disappointment in having lacked the energy to push its publication at the time when, so far as I was aware, it was my own original design.

I enclose a photographic copy of my original chart made in 1914.

London, March 7. F. M. Denton.

INSTITUTION OF ELECTRICAL ENGINEERS.

INFORMAL MEETING TO DISCUSS THE EXPULSION OF ENEMY ALIEN MEMBERS.

An informal meeting of corporate members was held to discuss this subject further on Wednesday last.

The President said the Articles of Association could not be altered at this informal meeting, but they might arrive at a form of words for a resolution to be submitted to a formal meeting. He read letters from Mr. Evans and Major Risch expressing the hope that the movement would be extended to all members of enemy origin, whether naturalised or not. Mr. Pearce, of Manchester, Mr. Walker, Mr. Allcock and Mr. Wilkinson supported the proposed resolution. The Engineers' Club, Manchester, had included in their rules a provision that no one of German, Austrian, Turkish, Bulgarian or other alien enemy birth or nationality, either naturalised or not, should be permitted to be introduced in future into the Club, either as a member or visitor, and it was suggested that this might form the basis of a resolution of the Institution. Mr. Anderson (of W. T. Glover & Co.) wrote saying that many of the members in his district felt that nothing less than the exclusion of German and other alien enemies, either naturalised or unnaturalised, would meet the wishes of the members. Mr. Anderson expressed the view that the Council's resolution was drafted on wrong lines, and that although the Institution was safe from the intrusion of Germans during the war, they were not protected from their presence after the war. He suggested that a resolution should be passed making it impossible for any member of alien enemy races to join after the war. Mr. Atchison (Rochdale) wrote asking that any decision come to at an informal meeting should be submitted to the local sections. He suggested a resolution that in the event of a state of war arising between this country and any country or State, any member who was a subject of such country or State who had not been denaturalised in such enemy country or State, prior to the war, should forthwith cease to be a member, and in the case of the European war of 1914, all such members should cease to be members on and after . . . . . , and that no subject of such country or State should be eligible at any time for election. Mr. Farrer (Twickenham) sent a request signed by 10 members that words be added to the Council's resolution to the effect that no subject of an enemy country should be entitled to election after the termination of the war. Letters from several members expressed a desire that the resolution submitted to the meeting of March 1 should not be passed. These included Mr. Cramp, Mr. Frith and Capt. Creak. The last named thought foreign members elected for their scientific attainments should not be expelled unless they transgressed the statutes of the Institution. Mr. Lamb (Cambridge) said he would vote against the proposal, as did also Mr. Arnold Lupton. Mr. J. Hodgkin (Darlington) wrote saying that the passing of such a resolution would be an exhibition of petty meanness.

The President said that the object of the meeting was to hear the views of members, after which the Council would draw up one or more resolutions which the members, as a whole, would be asked to consider. It was not possible to ballot by postcard, because while they could take the views of the members so that the special meeting might be guided by the opinions expressed, they could only legally alter the Articles of Association at the special meeting, which must decide by a three-fourths majority whether the Articles be altered or not. The Council wished to take the views of the members as a whole on one or more resolutions that the meeting might determine on.

Col. R. E. Crompton said he was under the usual disadvantage of being the first speaker, but it was a subject with which he was rather well acquainted, having served on committees of the Royal Automobile Club dealing with the matter. He had heard a great deal of argument on both sides in regard to alien enemies, and their fitness for being members of clubs or scientific societies. A matter of principle arose, quite apart from the desirability of this question, and that was, were they prepared to take out of the hands of the Council the powers vested in them? If so, it showed they did not trust their Council, and that should be fought as strongly as possible. He did not like to see level-headed electrical engineers subject to fits of hysteria. The English qualities of level-headedness were proverbial; they kept their heads and did the right and just and fair thing. They were not timid or afraid of anybody in the world, and he hoped they never would be. All the "gas" about the Council, that they must expel every man whose ancestors for generations back were German, did savour of timidity. Englishmen could afford to take some slight risk of having Germans among them, but could not afford for it ever to be said that they were timid or hysterical.

The President said that in opening he had omitted one point. There were three classes to which they had to direct attention. First, there were the subjects of an enemy country. There was no question that these were fully dealt with by the notice of the meeting of March 1. In the second category were naturalised British subjects, who retained their enemy nationality. Many felt that this notice did cover these, but they were advised by their advisors that there was some doubt. The third class included naturalised British subjects formerly subjects of a state now at war with us, who had definitely lost their alien nationality. If the third class were discussed, he should like, as a corporate member, not as President, to say a few words on the subject later in the evening.

Mr. J. S. Highfield felt that the matter was one of intense importance to the Institution. Hasty action might be one of which in future they would be very much ashamed. They had to consider, first of all, what powers the Council had in the matter of expulsion of members. The Council could on their own initiative expel felons, bankrupts, &c.; they could not expel an enemy of this country. In his opinion they ought to have that power. (Hear, hear.) Next, there were members who were naturalised subjects, choosing to become British subjects and making this country their home, many of them having sons and relatives actually fighting for the country. Bona-fide British subjects of that class should be treated as British subjects, and we should have no right to expel them. In the German Naturalisation Law there was rather a curious point. The law was passed in 1913. The old German law provided that if a German left his country for a foreign country, and lived there continuously for 10 years, he automatically ceased to be a German. The new law was that a German leaving his own country for a foreign country did not lose his German nationality, but retained it. But suppose he should choose of his own volition and request to become the subject of the country he lived in, then he automatically ceased to be a German subject. But there was this further point: Supposing a German resided here, and for business purposes became naturalised, he was permitted by this new law to first of all apply to the German Government to retain his nationality as a German before he applied here for naturalisation papers. In that case he was the subject of both countries. It seemed to him (the speaker) that that was the worst sort of naturalised subject. (Hear, hear.) He thought the Council should have power to turn out that man, just as it ought to have power to turn out actual enemies. He agreed with Col. Crompton in not liking to take out of the hands of the Council the powers they had. He should like the Council to retain the power to turn out any undesirable person on 10 members signing a requisition. He believed that there were one or two Armenians, who were consequently

Turkish subjects, and he did not think they should want to turn them out; yet, if the resolution passed, there would be no alternative. He proposed that they should add to clause 41, "In the event of any member of any class being a subject of an enemy State, or being a naturalised British subject who is of his own volition also a subject of a foreign State, the Council may, without any such proposal or steps as aforesaid, remove his name from the register of the Institution." This would enable the Council to remove from the register in peace time the names of the peculiar type of naturalised subject to which he had referred.

Mr. C. H. WORDINGHAM said it was for them to say whether they chose to have people in their society whom they condemned and abhorred. It was offensive to him to associate with a German. He had no doubt as to the propriety of excluding all Germans from that Institution, and he thought it should also have effect after the war. Some naturalised Germans were English in sentiments and aspirations and had sons in the service of this country, and they ought to be ranked as Englishmen; but there were a great many not in that category. He did not care much whether a naturalised German had been denaturalised in his own country or not. They were naturalised solely for the benefit of their Fatherland. Most naturalised Germans were intimately connected with concerns with strong connections in Germany and should therefore be excluded.

Mr. W. RUTHERFORD said he was in sympathy with the expulsion of enemy aliens, but not altogether in sympathy with the suggestion that naturalised alien enemies should be dealt with in the same way. Men who had spent the majority of the years of their active life working for this country, of whom a number were members, could not be compared with "neutral" enemies who were members of the Institution and were working in Germany on armaments. Why not clear them out also? A naturalised German or Austrian was a British subject and the question of his guilt should be left in the hands of the Government.

Mr. ALBERT GAY said he wished to move the inclusion in the Council's resolution after the word "State" in the fourth line, of the words "or shall be of enemy origin although a naturalised subject of the British Empire." It would be a trivial injustice, at the worst, to exclude all members of alien birth or nation.

Mr. W. L. MADDEN said foreigners did not all come here for their own advantage; for example, the Huguenots, and the Dutch who settled in Lincolnshire and Yorkshire. On the whole we had benefited from the Germans here, as we had from the Huguenots, the Dutch and others. He wished to second Mr. Rider's resolutions. He thought the following words inserted in the resolution would be sufficient to meet the case:—"or having been born a subject of such enemy country or State has not completely divested himself of such nationality."

Mr. J. B. RIDER said, before making any remarks he would read a memorandum prepared by Sir John Snell, who was unable to be present. In the course of this memorandum Sir John Snell expressed the opinion that those members born in an enemy country who had taken out naturalisation papers here, provided they had not requested to also remain citizens of the country of their birth, should remain on the roll of the Institution. Mr. Rider said he should have been prepared at the last meeting to support the resolution drafted by the Council, if the literal meaning of certain words had been adhered to. He referred to the words "shall be the subject of such enemy country or State," and had hoped that they meant "whether a naturalised subject or not." When it was announced that the meaning was not as he hoped, he had to state that he should object to the resolution.

Mr. L. B. ATKINSON said he thought that the most hysterical remarks had come from his old friend, Col. Crompton. He thought that Col. Crompton was wrong in asking them not to take this matter out of the hands of the Council but to leave it to the Council to do as they think fit. The Council had run the thing for 18 months and had done nothing. The question was not one of confidence in the Council. They could not put on the Council the invidious task of trying to pick out who was and who was not an alien enemy, and of going into the whole of their characters. The members should arrive at a decision whether they wanted to get rid of any of the people in question, and, if so, let them have a rule which would make it an automatic process.

Mr. A. A. CAMPBELL SWINTON said he wrote some letters at the beginning of the war for which he was very severely called over the coals. He thought they could not expel naturalised British subjects, although originally Germans, provided always that they were properly naturalised and retained no allegiance to their original country.

Mr. LEONARD JOSEPH said mention had been made of neutrals who were working against us in Germany. Did any member know of a neutral member now working in Germany? A separate clause should be made to prohibit such from being members in future, and he hoped also that clause would be framed to keep out all enemy aliens after the war.

Mr. A. BECKETT said he thought he made the most hysterical speech at the previous meeting, but he did so quite knowingly and for a purpose. There seemed two alternatives: (1) To sweep out all Germans, naturalised and unnaturalised, and then find the means of putting back those justly entitled to be put back, some of whom had sacrificed their sons for this country; or (2) to leave things as they were in regard to naturalised Germans and then to turn out [illegible] one by one.

Mr. W. M. MORDEY suggested that, as it was not possible to get a large meeting to settle forms of words they should settle broadly what they wanted, and leave the Council or a committee appointed by the meeting, with the assistance of the hon. solicitor, to find appropriate words of expressing those views, to be put before the members later either by post and ballot or otherwise.

Mr. CHARLES WILSON protested against the whole procedure, which he characterised as puffing. Were they proposing that no German should ever belong to the Institution again? (Hear, hear.) Were they in their senses in imagining that the amity of Europe was never to be restored? Their duty was to win the war, and not to waste their time in so much talk.

Mr. IRWIN said that Germany felt that they were losing citizens, and for this reason had passed the new naturalisation law. A Britisher going abroad was not afraid to say he was a Briton, but the German wanted to disguise the fact that he was a German. He thought that every member of alien nationality should be asked to make a declaration that he supported the Allied cause. (Laughter.) In a crisis of this sort they ought to be broad-minded.

Mr. F. GILL supported Mr. Mordey's suggestion, and said they should try to indicate the broad lines on which the resolution should be framed, and then to leave it to the Council to find the words. Were they legislating for a specific case or laying down a fundamental p an which would apply to every war? Did they mean that for every war every alien citizen was to be thrown out? (Several members: Yes.) His own feeling was that it should be left that the Council had the power to act, and that it was not necessarily automatic for future wars. He would rather suffer some injury than that the Institution should go down as people who tore up the agreement made in naturalisation papers.

Mr. J. E. KINGSBURY said they should bring themselves within the letter and spirit of the law. The German nation was not a member of the Institution; they had to deal with individuals. There were three courses open: (1) To do nothing. When a member suggested that they should do nothing he was considering the interests of the State and the Institution. (2) At the other extreme it was suggested that members who were naturalised should be expelled. He agreed with Mr. Gill in thinking that an improper thing to do. They determined who were proper people to elect, and if they expelled any members they must be people they had a right to expel by law. (3) There was a mean in the resolution submitted at the last meeting, but there was a difficulty in regard to that because of some misapprehension as to its legal application. Following Mr. Mordey he suggested that they should submit the following alternatives: (1) "Are you going to do nothing?" (2) "Are you going to expel the German people practically in accordance with the resolution submitted by the Council?" or (3) "Are you going to try to expel the naturalised members?"

Prof. S. P. THOMPSON said it should be clearly decided who was an objectionable alien enemy. The Council should not have the power taken from them of exercising their right of discretion in such cases. It was not right to condemn men *en bloc*. Mr. Gay spoke of a trivial injustice, but they might do a great injustice unless the Council had reserved to it its duty of dealing with particular cases. The Council ought to be left with its powers of discrimination, because of the difficulties of defining "alien enemy" and "naturalised alien." There were something like 15 categories of persons to be considered, including actual alien subjects of enemy nations living abroad in their countries; actual aliens of enemy nations who were living in Great Britain; naturalised aliens of Germany, Austria, Turkey and Bulgaria: the laws of those countries as to what constituted citizenship were not alike; aliens who were naturalised before 1870, of whom some might be citizens of Hanover, then practically a British possession, and some of the city of Frankfort, which was then a free city and not subject to Germany; others naturalised between 1870 and January, 1914; others naturalised after January, 1914, but before the war, who were affected by the new German law, which enabled them to make an election as to reserving their German citizenship (he doubted, however, whether any members were included in that class); and aliens naturalised in other countries. If they turned them out they included Tesla and Steinmetz. He would be glad to have the whole thing shelved. It was petty and un-English. However, he was still prepared to support the Council's resolution if it preserved the Council's responsibility to determine who was an alien enemy.

Mr. T. O. CALLENDER thought Prof. Thompson's speech an unfortunate one. It was the wish of the members to have a clearly defined rule to bar certain nationalities from the membership. Naturalised members [illegible] prove that they are absolutely clear of their original nationality.

The PRESIDENT (at Mr. Gay's request) put the question to the meeting as to whether votes should be taken by ballot, and it was negatived by a large majority.

Taking extracts from the resolutions handed in, he put the following questions to the vote:—

"Those in favour of expelling members who are subjects of enemy countries." Carried by a large majority.

"Those in favour of expelling naturalised British subjects who have retained enemy nationality." Carried by a large majority.

"Those in favour of expelling naturalised British subjects who were formerly subjects of a state now at war with Great Britain and Ireland, but who have definitely lost their alien nationality, and are able to prove it to the satisfaction of the Council." Negatived by a large majority.

Mr. RIDER suggested a resolution that: "No person shall after [illegible] be eligible for election as a member of the Institution who is a subject of any country or state with which the United Kingdom of Great Britain and Ireland is or shall be at war." This was put to the vote and passed by 40 votes to 21.

The PRESIDENT said the provincial Sections would be informed of what had been done, and their opinions would be taken.

A committee, with the President as chairman, and including Messrs. Hedgcock, Roger Smith and Wordingham and Dr. Russell (vice-presidents), and Messrs. Atkinson, Swinton, Gill and Rider was appointed to draw up formal resolutions to be submitted to the Board of Trade and to a formal meeting of the Institution.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	817	The Round Table	153
Imports and Exports of Electrical Manufactures	818	Lighting a Shipyard Office. Illustrated	154
LEGAL INTELLIGENCE	818	A New Interphone. Illus.	156
Current Trade Literature	819	G.E.C. Electrical Plant for China	156
Business Notices	819	Firimine Switchboards for Mines. Illustrated	158
Bankruptcies, Liquidations, &c.	819		
Electricity Supply	819	Tenders Received & Accepted	822
Lighting and Power Notes	820	Companies' Meetings and Reports	822
Traction Notes	820	City Notes	825
Empire Notes	820	Electrical Companies' Share List	826
Foreign Notes	820		
Miscellaneous Notes	821		
Tenders Invited	821		

COMMERCIAL TOPICS.

Speculation in Metals.

Further regulations, issued under the Defence of the Realm Act, prohibit speculative transactions in the various metals required in the production of war material.

It shall not be lawful for any person on his own behalf or on behalf of any other person to sell or buy, or to offer to sell or buy (*a*) Any of the following metals: Iron (including pig-iron), steel of all kinds, copper, zinc, brass, lead, antimony, nickel, tungsten, molybdenum, ferro-alloys; or (*b*) any other metal which may be specified in an order of the Admiralty or Army Council or the Minister of Munitions as being a metal required for the production of any war material, unless in the case of a seller the metal to be sold is in the possession of the seller or is in the course of production for him, or in the case of a buyer, the purchase is made for or on behalf of a consumer.

It has been explained that the object of the new regulation is to prevent the undue inflation of prices which has been a feature of the markets for so long.

The new regulations came as a surprise to members of the Metal Exchanges, and business on the London Exchange was suspended on the 2nd inst. until further notice in copper, lead, spelter and iron, but tin was dealt in as usual. On Friday a deputation from the Exchange waited on the Minister of Munitions to discuss the situation, and on Monday the Ministry issued an announcement to the effect that the object of the regulation was to stop speculation in metals generally, and not to restrict legitimate trading. The following particulars were published for general information and guidance, and the regulation will not be enforced in case of purchases made outside the United Kingdom until the metal actually reaches this country. Export orders and sales to allied or neutral countries through authorised channels will be treated as consumers' orders. It is permissible for merchants, warehousemen and retailers to replace metals sold after March 1, 1916, by the purchase of an equivalent quantity of the same metal, but not more, although the metals purchased may not be the metal actually delivered against the sale. Transactions will not be permitted, except under special licence from the Ministry of Munitions, in scrap from high-speed steel, scrap from copper and scrap from brass. Transactions in other scrap metals do not require a licence. Consumers may buy for their own consumption only.

The London and Glasgow Metal Exchanges reopened for business in all metals on Monday.

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Business with Spain.

We desire to draw our readers' attention to a communication from the British Chamber of Commerce for Spain, which appears in our Foreign Notes column this week. Those who already have, or are likely to open up, commercial relations with firms in that country would do well to bear in mind the widespread and insidious German propaganda which is being carried on there at present. From the electrical, and especially from the hydro-electrical point of view, Spain is a country which has great possibilities, and British manufacturers and exporters would do well to take steps to protect their own interests and to counteract the measures of the wily Germans.

* * * *

Inter-communication Telephones.

The number of inter-communication telephones in use in proportion to the number of business and industrial establishments, even in this country, is still remarkably small. As a piece of commercial apparatus, the telephone ranks amongst the oldest of electrical inventions, and there must be some reason for the comparative lack of interest in this instrument as a time and labour saver in commerce and industry. We understand from those who are in a position to express an opinion that there are two principal reasons for progressive development in this direction; one is the prejudice created against inter-communication telephones by cheap, flimsy and unreliable instruments, and the other the comparatively high cost of efficient instruments. Telephone manufacturers appear to have been aware of these problems, and have steadily applied themselves to the task of solving them. An important step in the right direction has been made by the Western Electric Co., whose new interphone we describe in our Supplement pages this week. The chief feature of this instrument is the employment of a cradle for the microphone set, which can be turned so as to convert the complete instrument from a wall to a desk set, or vice versa. This feature will simplify the stocking of such instruments, and also simplify their use. From a production point of view this telephone is also of great interest, in that a standardised ringing and speaking key has been built up in group form and combined with the cradle mechanism, which greatly simplifies the use of the instrument. It is this simplicity and standardisation which must contribute towards the more extensive employment of instruments of this class. By producing on a quantity basis it is also possible for the instruments to be offered at a price which encourages their purchase outright rather than their employment on any form of rental basis. At the present time a good inter-communication telephone system is an investment for any business, when labour is at a premium, and even the largest establishments require to carry on with reduced staffs. We should like to see contractors and installation engineers heartily co-operate with telephone manufacturers in getting these instruments permanently installed.

* * * *

Safety in Mines.

The electrical industry generally will welcome the opinions expressed by Mr. H. Elliot, colliery engineer, Frickley, Yorks, at a meeting of the Yorkshire Branch of the Association of Mining Electrical Engineers. In the course of an excellent Paper on the use of electricity in mining, Mr. Elliot said that a high standard of construction and operating efficiency had been reached in the electrical equipment of mines and collieries. There had undoubtedly been a considerable increase in production, and, in the view of the speaker, "there were many mines which could only be successfully worked from a financial standpoint by the adoption of electricity. It was now possible by the aid of electrical machinery to work seams which either for financial or technical reasons had previously been unworkable." The foregoing is most encouraging, and we are particularly pleased to have an outspoken expression of opinion from a colliery engineer as to the safety of electrical appliances in mines. Mr. Elliot distinctly states that the number of lives lost in collieries in proportion to the output has greatly diminished since the introduction of electric power. Where accidents had happened they were attributable either to defective plant or faulty installation. It is absolutely necessary to install a high-grade plant and see that it is properly maintained. If this cannot be done the electrical installation should not be undertaken. Mr. Elliot also had sound views on the subject of the miner's lamp and the prejudice of the men regarding it. At one time men refused to use these lamps, and would rather have a holiday than take one down the pit; now this condition of things is exactly the reverse. We hope that the utmost publicity will be given to Mr. Elliot's views, as it is highly desirable that opinions expressed in certain quarters regarding the unreliability of electrical mining plant should be refuted, and preferably from the evidence of men who have had experience.

* * * *

Indian Government Finances.

The financial statement of the Government of India has been presented in the Viceroy's Legislative Council. It was stated that the revenue from the Post and Telegraph Department had not been affected to the extent anticipated. The Customs Duties have been increased on certain articles from 5 per cent. to 7½ per cent., including copper and brass, wrought and unwrought, other wrought metals and articles made of such metals, &c.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From Feb. 28, 1916, *to* March 4, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE. *France:* Unenumerated, 5 pkgs.
HULL. *U.S.A.:* Electrodes, 43 pkgs. *Denmark:* Elec. machinery, 5 pkgs.
LIVERPOOL.—*U.S.A.:* Unenumerated, 186 pkgs. *France:* Unenumerated, 7 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £1,745; carbon candles, £40; elec. lamps, £300; elec. motors, £44; telephone material, £67; switchboards and parts, £137; unenumerated, £1,556. *Holland:* Elec. lamps, £228—10 pkgs.; elec. wire and cable, £1,116. *France:* Elec. meters £88; elec. lamps, £20; unenumerated, £160—32 pkgs. *Switzerland:* Elec. lamps, £445; elec. meters, £499; unenumerated, £220. *Italy:* Elec. machinery, £158; elec. motors, £871. *Japan:* Unenumerated, £247.
MANCHESTER.—*U.S.A.:* Electrodes, 4 pkgs.; elec. carbons, 89 pkgs.

EXPORTS

TO AUSTRALASIA.—*Auckland:* Unenumerated, £663. *Melbourne:* Wire and cable, £1,984; elec. machinery, £522; elec. glow lamps, £288; telegraph material, £86; unenumerated, £4,372. *Sydney:* Elec. machinery, £1,521; wire and cable, £119; unenumerated, £1,521. *Wellington:* Wire and cable, £28; elec. machinery, £618; unenumerated, £914. *Adelaide:* Unenumerated, £413. *Perth:* Elec. machinery, £25; unenumerated, £183. *Christchurch:* Unenumerated, £94. *Dunedin:* Wire and cable, £341; unenumerated, £125. *Lyttelton:* Unenumerated, £66. *Townsville:* Wire and cable, £14. *Hobart:* Elec. machinery, £34; unenumerated, £118. *Fremantle:* Unenumerated, £527.
AFRICA.—*Durban:* Elec. machinery, £118; wire and cable, £23; unenumerated, £122. *Cape Town:* Elec. machinery, £44; unenumerated, £119. *Port Elizabeth:* Elec. machinery, £30; wire and cable, £90; unenumerated, £34. *East London:* Elec. machinery, £204; unenumerated, £12. *Zanzibar:* Unenumerated, £17. *Moji:* Unenumerated, £54. *Mauritius:* Wire and cable, £13; unenumerated, £86. *St. Helena:* Unenumerated, £36. *Balawan:* Unenumerated, £25.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £138; unenumerated, £373. *Santiago:* Elec. machinery, £83.
ASCENSION.—Telegraph material, £284; unenumerated, £52.
HOLLAND.—*Amsterdam:* Wire and cable, £226; unenumerated, £452. *Rotterdam:* Unenumerated, £206.
JAVA.—*Batavia:* Unenumerated, £19.
U.S.A.—*New York:* Unenumerated, £28.
EGYPT.—*Alexandria:* Unenumerated, £306. *Port Said:* Unenumerated, £139.
WEST INDIES.—*Barbados:* Unenumerated, £7.
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £227; unenumerated, £579. *Calcutta:* Elec. machinery, £744; unenumerated, £857. *Ceylon:* Wire and cable, £24; elec. machinery, £24; elec. lamps, 300 (No.); unenumerated £439. *Madras:* Elec. machinery, £532; telegraph material, £297; unenumerated, £273. *Karachi:* Unenumerated, £34. *Kilindini:* Telegraph material, £51; unenumerated, £138. *Sourabaya:* Wire and cable, £240; Unenumerated, £132. *Penang:* Unenumerated, £32.
CHINA.—*Shanghai:* Unenumerated, £80.
JAPAN.—*Kobe:* Unenumerated, £561. *Yokohama:* Unenumerated, £266.
FRANCE.—*Paris:* Elec. machinery, £60; wire and cable, £80; unenumerated, £253. *Boulogne:* Elec. machinery, £38; unenumerated, £266. *Marseilles:* Telegraph materials, £23; wire and cable, £73; unenumrated, £114; *Havre.* Unenumerated, £61. *Dunkirk:* Unenumerated, £15.
DUTCH EAST INDIES.—Submarine telegraph cable, 339 tons.
ITALY.—*Genoa:* Elec. machinery, £98; unenumerated, £785.
SPAIN.—*Huelva:* Unenumerated, £52.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £51. *Perth:* Unenumerated, £21. *Boulogne:* Unenumerated, £101. *Yokohama:* Unenumerated, £178. *Port Elizabeth:* Unenumerated, £168. *Sydney:* Unenumerated, £277. *Wellington:* Unenumerated, £949. *Adelaide:* Unenumerated, £26. *Calcutta:* Unenumerated, £132. *Paris:* Elec. machinery, £60; unenumerated, £342. *Saigon:* Unenumerated, £48. *Madras:* Unenumerated, £93. *Monte Video:* Unenumerated, £50. *Port Said:* Elec. lamps, £290. *Fremantle:* Elec. lamps, £197.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described a "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Electric Mining Regulations.

At Barnsley last week the owners of the Central Silkstone Colliery, Smithies, Barnsley (Messrs. Anderson & Son, Ltd.), appeared to two charges for contravening provisions of the Coal Mines Regulation Act; the certificated manager (Geo. Anderson) to eight charges; the under manager (John Cross) and the deputy (Sam Wilkinson) to two; and the electrician (Geo. Carr) to three charges. The more serious charges were those against the owners and manager of not sending notice forthwith of the accident; against the manager and under manager of not exercising daily supervision of the mine, and not countersigning the daily reports; and in the case of the manager and deputy of not keeping a record of the men to whom safety lamps were issued. The deputy was also charged with not leaving the place in the state it was immediately after the accident, and the rest of the charges were in respect of electrical appliances of the pit.

Mr. GUBARD (who prosecuted) said the explosion took place on Oct. 17 last, when on the electric coal cutting machine being started, there was a flash at or from the machine, with the result that four men—two workmen at the machine and two working about 12 yds. away—were more or less severely burned.

FRED D. ASQUITH, detailer, one of the men injured, said he did not see any test made for gas in the morning of the explosion.

HUGH DAVIES said he and Davis Badon were with the cutting machine. A shot was fired in a heading near by, and after the machine was started a flash came from the switch-box and there was an explosion.

Mr. JAMES MELLORS, Inspector of Mines, stated he visited the colliery to investigate the explosion. Mr. Cross said he was in Lancashire on the day of the explosion. Witness found the cutting machine close to the heading, but the cable and the plug had been detached from the machine. The switch-box door was slack, and in that state would permit of a flash coming from it. In such a state it could not prevent open sparking. The safety lamps in use at the time had been removed. In witness's opinion the explosion was due to the ignition of gas, caused by flame from the cutting machine. Witness tested for gas, and found rather more than 1¼ per cent.

Mr. H. Danby, Inspector of Mines, also gave evidence.

Mr. HEWITT (for the defence) submitted that the charges were not so serious as had been indicated. The owners had exercised every precaution. The accident occurred in a seam in which there was seldom if ever any trace of gas. He argued that the Act provided that, in the absence of the manager, the duties devolved on the under-manager. In regard to delay in giving notice, the man left in charge endeavoured to communicate with the under-manager, and eventually got in touch with the managing director, who was in London. He came immediately, and prepared the report, but it was too late to telephone it that night. As soon as a responsible person could be got to the pit notice was given. The Act had to be reasonably interpreted according to the circumstances. According to all human knowledge, the machinery was in good working order.

The Bench considered the cases proved, and that there had not been proper supervision of the pit. The manager and under-manager would be fined £10 and £5 and c2sts respectively for not exercising daily supervision of the mine. The owners and manager would be fined 40s. each for not sending notice of the accident forthwith, and on the other charges the defendants would have to pay the costs.

H. W. Lowe v. C. J. Weld Blundell.

On Tuesday before Mr. Justice Ridley and a special jury, Capt. H. Wm. Lowe sued defendant for an alleged libel. Defendant did not admit publishing the libel. The letter complained of was written on a privileged occasion, and was bona fide and without malice.

Mr. Lewis Thomas, K.C., and Mr. Kenelm Preedy represented plaintiff; Mr. Mitchell Innes, K.C., and Mr. T. Mathew were for defendant.

In opening the case Mr. LEWIS THOMAS, K.C., stated that plaintiff, who was an electrical engineer, was now a captain in the Warwickshire Regiment, and had been for 18 months in the trenches. In 1911 he was approached by a friend of defendant's to undertake the management of the Float Electric Co. (Ltd.), in which Mr. Blundell was the largest shareholder. The company was engaged in the manufacture of a patent safety electric lamp. According to the agreement defendant was to find sufficient capital to enable the business to be carried on. There was a difficulty owing to sufficient capital not being provided by defendant. Plaintiff eventually resigned his appointment, which was accepted. He received his commission in November, 1914. In July, 1915, on returning home plaintiff found that defendant had been making certain reflections on his character. After a new manager had been appointed defendant wrote a letter to Mr. Stephens, his accountant, and in this communication referred to the new manager, and stated: "But my experience with workmen is that they all follow exactly the tricks and rogueries of their predecessors, and his predecessor, Lowe, an ingenious thief, with the help of the rest of the gang —— managed by just the same manœuvres and pretext, to get £2,000 or £3,000, and —— sheltered him completely, and pretended that the money had been fairly used in trading transactions."

After plaintiff had given evidence, Mr. COMINS, C.A., was called to show that the balance-sheets and accounts of the company were accurate.

Mr. MITCHELL INNES, K.C. (for the defence), contended that there was no evidence of publication, and also that the letter was written on a privileged occasion. It was addressed to an accountant whom defendant had consulted for the purpose of guidance and information.

The jury returned a verdict for plaintiff, assessing the damages at £1,000.

Judgment was entered accordingly, with costs, but a stay of execution was granted with view to an appeal.

L. R. Morshead v. Quasi Arc Welding Co. (Ltd.)

Before Mr. Justice Darling and a special jury last week, plaintiff sought to recover damages for alleged wrongful dismissal from his position as technical representative. Defendants pleaded justification on the ground that they were dissatisfied and, in reply to that, Mr. Morshead, contended that such dissatisfaction was unreasonable. The jury eventually returned a verdict for defendants, and judgment was entered accordingly, with costs.

A stay of execution was refused.

Re J. Davis & Co. (Southampton) (Ltd.): Hands v. Company.—A receiver and manager has been appointed by Mr. Justice Neville on an application in a debenture holder's action, because Mr. Thos. Davis, the sole director, had died suddenly.

CURRENT TRADE LITERATURE.

G. St. John Day.—This company is issuing an eight-page brochure in an artistic cover describing its 1 part lamp-holders and adapters. We have described these from time to time in our columns, and the trade will doubtless welcome this little booklet as a complete catalogue of these accessories.

Holophane Limited.—This company has issued an 84-page catalogue, which describes and prices a considerable variety of fittings designed specially for use with Holophane glassware. In the section dealing with brackets there are a number of quite new and artistic designs. The same may be said for the ceiling fittings and the considerable section dealing with bowl pendants. The concluding pages are occupied with illustrations of a large variety of electroliers.

BUSINESS NOTICES.

Mr. W. H. Patchell, M.Inst.C.E., M.I.E.E., has removed his offices to 64, Victoria-street, S.W.

Frederic E. Good and Bernard V. Marriott (trading as Good, Marriott & Co.), electrical and mechanical engineers, 4, Chesterfield-street, Nottingham, have dissolved partnership. Debts by Mr. Marriott, who continues under the same style.

Patent Development.—The proprietor of patents Nos. 3,097/1912 and 3,098/1912, relating to "telephones," is prepared to sell the patents or to grant licences thereunder. He is also prepared to deal in the same way with patent No. 8,997/1912, relating to "party-line systems," and patent No. 12,547/1912, relating to "exchange systems." Particulars from Messrs. Boult, Wade & Tennant, 111 and 112, Hatton-garden, London, E.C.

Wood Blocks.—In view of the restricted imports of hard woods, the Electrical Supplies Co., 233, Tottenham Court-road, W., notify that they hold large and varied stocks of all kinds of wood blocks for electrical purposes, particularly in the larger sizes, circular, square and rectangular.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Wm. D. Birkett, factor of electrical goods, Arnside, Windsor-avenue, Whitley Bay, Northumberland. The first meeting of creditors will take place on March 16, at 30, Mosler-street, Newcastle-on-Tyne, and the public examination on March 23, at the County Court, Westgate-road, Newcastle-on-Tyne.

Claims against John Taylor Peddie, mechanical engineer, Exhibition-buildings, Aldwych Site, London, W.C., are to be sent by March 18th to Mr. F. S. Salaman, 142, Bucklersbury, London, E.C., preparatory to the payment of a dividend.

ELECTRICITY SUPPLY.

EXTENSIONS.

Accrington.—The electrical engineer (Mr. H. Gray) has been authorised to obtain tenders for an additional coal elevator and conveyor for the electricity works, estimated to cost £700.

Bo'ness.—At a special meeting of the Town Council last week the report of Mr. J. M. M. Munro, consulting engineer, on the proposed extension of the electricity works, was considered.

Mr. Munro approved of the scheme of extension as put forward, estimated to cost £14,161, but the National Electric Construction Co. had agreed to a reduction of £261, making the total £13,900, which he thought a fair and reasonable price for the work in the existing circumstances. He recommended that the Council should make application for powers to borrow £14,500. The report was approved by the casting vote of the chairman.

Burton-on-Trent.—Mains are to be extended at a cost of £100.

The L. G. Board is unable to accede to the Council's application for sanction to borrow £3,500 for work in connection with the electric supply undertaking as it is not a matter of pressing necessity on account of war requirements. The Board further stated that it appeared to them that the cost of such additional transformers and switchgear as might be necessary to meet the demands of manufacturers might be met out of revenue.

Hackney (London).—The Electricity Committee recommends the Borough Council to instal an auxiliary battery exciting plant, at a cost of £465, and to accept tenders for the supply of the plant.

London County Council.—On Tuesday loans of £3,000 and £2,000 respectively were sanctioned to the Hackney and Poplar Borough Councils for the cost of linking up the electricity undertakings of the authorities.

Sheffield.—Mains are to be extended at an estimated cost of £1,243.

The formal sanctions of the L.G. Board have been received to the borrowing of the following amounts for additional plant at Neepsend: £3,100 for reservoir, pipe work, &c.; £1,250 for cables for connection and auxiliary boards; £49,742 for combination of new plant and foundations, switchgear and accessories; £45,050 for three new boilers, sludge pump and pipe work, screens, motor pump and housing, boiler foundations, sub-station equipment and transformers; £12,500 for cooling towers and foundations, coal shoots.

GENERAL.

Birmingham.—Owing to the increased cost of coal and materials, &c., the Electric Supply Committee recommended the Council on Tuesday to increase the charges for electric current for lighting, power, high-tension supply and traction.

As regards lighting and power, the Committee are of opinion that it is undesirable to issue a fresh scale of charges. They consider that any increase made should be in the nature of a percentage addition to the total account, and the requirements of the department would be met by an increase of 15 per cent. on all charges in the scale under lighting and 20 per cent. on the charge for power, and they recommended that those increases be approved, to take effect from the March reading of the meters. The high-tension supply was given under special agreements, which now contain a coal clause advancing the price of current with the rise in price of coal, and the increased revenue derived from that source would compensate for the advance in costs. As opportunity arose, old agreements without the coal clause were being terminated and the new form substituted. The Committee propose to apply to the traction supply the terms of the coal clause in the high-tension agreement.

The report was adopted.

Blackburn.—Last week the Council decided to increase the salary of the borough electrical engineer, Mr. P. P. Wheelwright, from £700 to £800 per annum.

Burnley.—The charges for electricity and gas have been increased.

For ordinary electric lighting the charge has been increased from 3¼d. to 3½d. per unit, for heating and domestic purposes from 1¼ to 1½d., and traction from 1·20d. to 1·25d. On the old rates for power there will be an increase of 10 per cent., instead of 5 per cent. as hitherto.

Epsom.—Owing to the increased cost of coal, &c., the Council have increased the charges for electrical energy to all consumers, except those with contracts for a definite period.

For lighting private houses and business premises 7d. per unit will be charged; for power a flat rate of 3½d. per unit, and on the sliding scale with a minimum of 1½d. for 3,000 units; and for public lighting 4½d. per unit. For public and private lighting the increase is 25 per cent.

Halifax.—The Corporation have decided to ask the Minister of Munitions to declare the electricity works and the tramway undertaking controlled establishments.

Leeds.—At the meeting of the City Council last week it was decided to increase the charges for electric current by 10 per cent. as from April 1.

Manchester.—Last week the Electricity Committee reported to the Council that they had been unable to entertain a proposal to supply the amount of electric current required by certain very large works which it had been proposed to set up in Manchester. The Committee could not give the requisite supply without jeopardising the interests of the present users of electricity.

Municipal Contracts.—Manchester and Nottingham Corporations have decided to add clauses to their standing orders, providing that no contract shall be entered into with any person of German or Austrian nationality, or with any firm or company whose subscribed capital is held to the extent of one-third or upwards by persons of such nationality.

Ripon.—The Council have authorised the Electric Supply Committee to ascertain the terms upon which Harrogate Corporation would supply current in bulk at the city boundary, and also on what terms the War Office and also Thirsk would supply electric current.

Southampton.—The Council has adopted a scheme of the electrical engineer (Mr. H. F. Street) for removing the ashes, clinker, &c., from the boilers at the electricity works, by other means than that of the existing coal conveyor. The cost of the work is put at £500, which will be defrayed out of revenue.

Wigan.—The Council have appointed Mr. S. L. Pearce, of Manchester, to report upon the present position of the electricity undertaking.

Wimbledon.—The borough electrical engineer (Mr. H. Tomlinson Lee) has made arrangements with Messrs. E. Brook (Ltd.), of Huddersfield, for the hire-purchase of electric motors

The terms of the agreements for the supply of electric current of the Foster Engineering Co. and Hugh Stevenson & Sons are to be revised so that a basis price of 1¼d. per unit shall be charged for all current, the price to be governed by the cost of coal (at present fixed upon a cost of 22s. 6d. per ton), but under no circumstances is the price to be less than 1d. per unit

LIGHTING & POWER NOTES.

Electricity in Collieries.—The annual report of Mr. John Wadsworth, M.P., general secretary of the Yorkshire Miners' Association, for 1914-15 has been issued.

Referring to the use of electric coal-cutters, Mr. Wadsworth states that there are still men who advocate the use of electricity at the coal face. He reiterates his contention that no electricity should be taken into the coal face in any coal mine, because of the risk of explosion in the event of a defect developing in the machinery or in the pit itself.

At a recent meeting of workmen employed at the Blaenavon Colliery it was decided to accept the offer of 2½ per cent. advance to pieceworkers for using electric lamps, provided that the existing arrangement of payment for defective lamps be continued.

As that decision was tantamount to a rejection of the offer made by Mr. B. Nicholas (the colliery manager) to Mr. E. Manning (the miners' agent), the latter and Mr. W. L. Cook strongly urged the men to accept the offer without the proviso indicated in order not to defer a settlement indefinitely. They argued that the men should insist on defective lamps being replaced by proper lamps. A decision upon the matter was postponed.

TRACTION NOTES.

Gateshead Tramway Accident.—The Durham County Grand Jury have thrown out the bill against Leonard Geo. Jane, motorman, who was indicted for manslaughter in connection with the recent tramcar accident at Gateshead.

Glasgow.—The Tramways Committee recommend that powers be given to the tramways general manager to maintain the present service of cars and, if necessary, to employ women as car-drivers.

The experiment tried with 33 women as drivers has (the committee states) been found so satisfactory that they have agreed to the recommendation, which will come before the Council at the meeting on the 16th inst. The women car drivers are to be employed on the same terms and conditions as men drivers, and will receive 29s. per week.

Newcastle-on-Tyne.—The Corporation tramway route to Benton was opened for traffic last week.

Walsall.—The tramway service had to be temporarily suspended one day last week owing to the lack of coal at the electricity works.

EMPIRE NOTES.

Australasia.—Kempsey (N.S.W.) Electric Light & Power Co. (Ltd.) has been registered at Sydney, with a capital of £15,000, to acquire the rights undertaken by Kynoch (Ltd.) with regard to supplying electric current in the municipality.

The "Australian Mining Standard" says the Victorian Railway Commissioners recently reported on the progress of the scheme for electrifying the suburban railways of Melbourne.

The Commissioners are unable to give any idea as to when it will become possible to complete the plans, as, in addition to the control of British engineering works for military purposes, the position is complicated by the difficulty in securing ship room for plant and material. Steady progress is being made with the erection and equipment of the power station at Newport. Most of the material for No. 1 boiler house plant has been placed in position, and the 12 boilers, with automatic stoking and coal and ash handling apparatus, have either been completed or are expected to be completed during the next few months. A section of the condensing plant, which is being manufactured in Victoria, is practically finished, while the erection of the first two turbo-alternators is well in hand. The 20,000 volt high tension transmission cables will be laid underground within the more densely populated areas as far as Newport, Essendon, North Fitzroy, Westgarth, East Camberwell, Caulfield and Middle Brighton, and also to Port Melbourne and St. Kilda, and will then be carried overhead along the remaining sections of the lines. Considerable progress has been made with the work of laying underground cables. The car shed at Jolimont is practically completed, and the motors, &c., for the suburban rolling stock are reaching Melbourne periodically from England and the United States. A commencement has been made at Newmarket with the installation of the rotary converters. It is intended to complete the electrical equipment of the Flemington racecourse line as soon as possible, so that it may afford practical experience in the handling of the electric trains.

The accounts of Perth (W. Australia) Council's electric supply undertaking show profit of £31,767. 1s. for the past 12 months. After providing £10,500 for sinking fund and cost of street lighting (£8,507) the net profit was £12,760. The balance brought forward was £51.121. 13s. 8d., so that £63,882. 3s. 6d. now stands to credit of profit and loss account. About £50,000 has been spent on changing the system of supply.

"Tenders" (Melbourne and Sydney) says Burra (S. Australia) Council has written to Messrs. Bridger (Ltd.) asking on what terms they would instal electric lighting plant in the town.

The report of the engineer on the past year's working of the Subiaco (W. Australia) municipal electricity undertaking states that 114 new consumers were connected, the total now being 1,484. Private lighting increased by 14,344 units and street lighting by 528 units. Twenty-two new street lamps were erected.

Canada's Rural Telephone Service.—Until recently the rural telephone in Canada has largely served as a medium of exchange between farmers and for ordering supplies from dealers in town.

It has, however, been demonstrated that the rural telephone can easily perform other services of equal importance. There are now country districts where the telephone company has undertaken to supply a daily news service. At a certain hour the telephone bell rings five times. That is the news signal, and every interested subscriber along the line takes down his receiver. Then the central operator gives the weather report, a condensed market summary and important news. It takes only a short time to give this information to every subscriber and the line is tied up for only a few minutes. This idea may be carried still further. Where the telephone company is owned and operated by the farm subscribers themselves, the manager at the central office may act as a market agent. The subscribers advise him of the products they have for sale and those they wish to buy. Dealers near at hand and others who are "on the market" send him their wants. A complete list of the products demanded is made up and read over the 'phone. The subscriber then notifies the manager as to the business he is prepared to transact. Farmers are thus able to sell in 15 minutes products which might take half a day to dispose of if each buyer had to be personally visited. There are many other labour-saving schemes of a similar nature which can be operated equally well over the rural telephone.

Federated Malay States.—The report of the acting general manager (Mr. C. H. Fox) on the working of the F.M.S. Railways for 1914, states that the year was an exceptionally busy one for the electrical branch, and particulars are given of numerous extensions of electric lighting plant and lightning arresters at the stations, hotels, &c.

The electric plant at the central workshops and the Selangor Government hydro-electric plant at Gombak worked satisfactorily. 173,760 units were received from Gombak.

The total mileage of railway telegraph wires is 2,500, increase 409. Sixteen new telegraph offices were opened, the total open being 163. Twenty-five telephones were erected and connected to the railway exchanges at Kuala Lampur and Ipoh. 126 miles of telegraph was constructed for the Post and Telegraph Department and 100 miles dismantled. The total is 2,454 miles. Fifty-five renewals of signals were made and 23 signals were shifted to fresh positions. A large number of wooden poles were supplanted by tubular poles.

FOREIGN NOTES.

German Influence in Spain.—The President of the British Chamber of Commerce for Spain (Mr. R. M. Nosworthy) writes to point out that, in view of the powerful and unscrupulous press campaign which is being carried on in Spain by German and pro-German interests, it is strongly of opinion that a combined effort should be made at once to counteract the effects of this campaign by organising British advertisers to bring pressure to bear on Spanish newspapers.

Such organisation is intended to serve the advancement of British commerce in Spain, and also the well merited support of those newspapers and periodicals which have declined to sacrifice their sense of truth and justice to the pressure of the German Press Bureau. Great Britain has already a large export trade with Spain, but it might be considerably increased by judicious press advertising, a phase of commercial activity which is stated to be still in its infancy in that country. The Chamber is of opinion that a well organised advertising campaign on behalf of British productions would certainly meet with considerable success and a Special Committee of the Chamber has been formed to deal with the subject on the following lines: (1) Advertisements should be inserted only in those newspapers and periodicals free from German influence; (2) a list of the most influential newspapers and periodicals in Madrid, Barcelona, Seville, Bilbao and other centres in Spain with

their advertisement tariffs, will be sent to advertisers on application; (3) the British Chamber of Commerce for Spain, having the placing of a large number of advertisements may be able to obtain specially advantageous rates, the benefit of which will be given to advertisers or their agents; (4) the Chamber will (if desired) undertake the translation of advertisements into Spanish and their publication, free of charge; (5) firms which prefer to leave their advertising to local agents should instruct them to patronise only those newspapers recommended by the British Chamber of Commerce. Applications should be addressed to the Secretary of the Chamber, Plaza Cataluña 9, Barcelona.

Russia.—The British Consul at Petrograd (Mr. A. W. Woodhouse) states that at the time war broke out Russia obtained nearly 53 per cent. of her imports from Germany.

German trade and capital had become paramount in Russia. The Germans had practically monopolised the copper trade and electro-technical enterprise. Copper was in the hands of a syndicate called Med, which also controlled some large metallurgical enterprises, and the trade in zinc and building material was in German and Austro-Hungarian hands. Of electro-technical works with an aggregate share capital of 20,000,000 roubles, 85 per cent. (17,000,000 roubles) belonged in 1914 to German firms. In the Far East the destruction of German mercantile trade cut off supplies of iron and steel goods which came exclusively from Germany. Freights by German vessels were so low that it was impossible for Russian produce to compete at all, and trade in the Amur and maritime districts was almost entirely in the hands of German firms. Russian trade in Mongolia was controlled by Hamburg. Generally speaking, the whole country has been roused to a sense of the abnormal state of bondage it has gradually allowed itself to fall into, and it is determined to foster its own industries wherever economically possible, and to turn to friendly countries for such commodities as it cannot as yet produce at home.

MISCELLANEOUS NOTES.

Fire.—Messrs. Nalder Bros. & Thompson notify that the fire which broke out at their works at Kingsland Green on Sunday morning last was fortunately discovered in time, and the damage done, though somewhat inconvenient, has not shut down the works. They trust their friends will excuse such slight delays as have been caused.

Port of Havre.—The French Government desire it to be known that the Port of Havre is much congested, and it is consequently desirable that British exporters of goods for Switzerland should send, in their own interests, as little as possible by this route for the present; meantime efforts are being made to relieve the congestion.

Telegraphists' Naval Ratings.—The King in Council has approved of the proposal by the Admiralty that they be authorised to promote warrant telegraphists to commissioned warrant rank in such numbers as shall not exceed 8 per cent. of the total number of commissioned telegraphists and warrant telegraphists combined until the normal period of service as warrant telegraphists reaches 15 years when the provisions of the Order in Council of July 19, 1912 (that warrant officers belonging to classes in which commissioned warrant rank is attainable may advance to commissioned warrant rank after 15 years' service as a warrant officer) will become applicable.

TENDERS INVITED.

Electrical and General Stores.

BELFAST Tramways & Electricity Committee invite tenders for the supply of materials, including Mill Furnishings, Packings and Asbestos Goods, &c., Trolley Wire, Overhead Line Material and Galvanised Wires, v.b. Insulated Cables and i.r. Cables and Wires, Electrical Accessories, Lamps, Carbons, Carbon Brushes, Bitumen, Tape, Joint Box Compound, Fuse Wires, Troughing, Meters, m.d. Indicators, &c. Forms of tender and further particulars from the city electrical engineer, Mr. T. W. Bloxam, East Bridge-street, Belfast, and tenders must be lodged with the town clerk, Mr. R. Meyer, City Hall, Belfast, by March 15.

PONTYPRIDD Urban Council require tenders by March 13 for one year's supply of Stores and Sundries, including Joint Boxes, Service Cut-outs, Tramcar and Overhead Equipment, Cables, Wires, Insulating Materials, &c. Forms of tender, from the Engineer, Generating Station, Treforest, Pontypridd.

Tenders are required by first post March 15 for one year's supply of Electrical Goods for the Cheshire County Asylum, MACCLESFIELD. Tender forms from the Clerk.

HEYWOOD Electricity Committee require tenders by noon March 15 for one year's supply of Electricity Meters, Joint Boxes, Cable and Jointing Accessories, Motors and Starting Switches, &c. Particulars from the Borough Electrical Engineer.

KENSINGTON (London) Board of Guardians invite tenders for the supply of Electric Lamps, Electric and Engineers, Fittings, &c., to their Infirmary at Marloes-road, Kensington, for a period of six months from April 1. Forms of tender, &c., may be obtained up to March 8th from the Clerk to the Board, Mr. W. R. Stephens, Marloes-road, Kensington, W.

DUNDEE Corporation require tenders by 9 a.m. March 29 for 12 months' supply of Meters and Electrical and General Stores. Specifications, &c., from the Electricity Department, Dudhope Crescent-road, Dundee.

WARRINGTON Guardians require tenders by 5 p.m. March 21 for 12 months' supply of Electrical Goods. Forms of tender from the Clerk, Bewsey-chambers, Warrington.

MERTHYR TYDFIL Guardians require tenders by March 13 for six months' supply of Electrical Accessories. Forms of tender from the Master of the Workhouse or the Supt. of Cottage Homes, Llwydcoed, Aberdare.

WESTMINSTER Guardians require tenders by noon March 22 for six months' supply of Electric Lamps and Fittings, Engineers' Sundries, &c. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W.

Sub-Station Equipment.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. April 26, for the supply of Electrical Equipment and Accessories for sub-station for the Sandringham–Black Rock tramway (contract No. 29,762). Specifications and forms of tender from the Victorian Railway Commissioners, Melbourne.

Varnish Impregnating Apparatus and Storage Battery.

The Victorian Railway Commissioners, Spencer-street, Melbourne, require tenders by 11 a.m. April 19 for the supply and erection of a Complete Plant for Impregnating Electrical Apparatus with Insulating Varnishes and Solid Compounds (Contract No. 29,678.); also a 1,000 Ampere-hour Storage Battery (Contract No. 29,743). Specifications, forms of tender, &c., from the offices of the Commissioners.

Telegraph and Telephone Material, &c.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (Schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General.

Turbo-Alternator.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

Switchgear.

MANCHESTER Electricity Committee require tenders by 10 a.m. March 22 for 6,600 volts three-phase switchgear for Stuart-street station. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

TENDERS RECEIVED AND ACCEPTED.

CROYDON.—The Corporation tramways have accepted the tender of Siemens Bros. Dynamo Works for Wotan, Tantalum and carbon filament lamps for the ensuing year.

SOUTHAMPTON.—The Tramways Committee has accepted the tender of E. Allen & Co. (at £196) the supply of points and crossings

METROPOLITAN WATER BOARD. The Board has accepted the tender of the St. Helens Cable & Rubber Co (at £40) for a supply of v.i.r. cable and flex.; also the tender of Simplex Conduits (Ltd.), at £28, for electric light fittings.

LEYTON.—The quotation of the British Insulated & Helsby Cables has been accepted for a supply of trolley wire. The approximate value of the contract is put at £743. 2s. 7d.

MARYLEBONE (LONDON). The Electric Supply Committee recommend the acceptance of the tender of British Insulated & Helsby Cables (lowest of seven tenders received) for supply of underground cables for six months ending Sept. 30.

LONDON COUNTY COUNCIL.—The L.C.C. on Tuesday accepted the tender of H. Bessemer & Co., for 500 driving wheel tyres, at £38. 10s. a ton, less 2½ per cent., and 250 pony wheel tyres at £55. 10s. a ton, less 2½ per cent..

BERMONDSEY (LONDON).—The following contracts for annual stores for the electricity department have been renewed:—

Morgan Crucible Co., carbon brushes: Chas. Macintosh & Co., rubber cable (at 2½ per cent. increase on last year's quotation): Dussek Bitumen Co., box compound (at 16s. per cwt., instead of 13s.): Thos. Wragg & Sons, conduits on same terms, except a slight increase for one-way ducts: Sykes & Sugden, joint boxes, &c. (10 per cent. increase). The General Electric Co. were not prepared to renew their contract for cable or for cut-outs, &c., and it is proposed to purchase supplies as required.

HACKNEY (LONDON). The Electricity Committee recommends the Borough Council to accept the following tenders:

Hart Accumulator Co., battery, £250. 17s. Tenders also received from Tudor Accumulator Co. (at £253), Chloride Electrical Storage Co. (£257), and D.P. Battery Co. (£259. 11s.).

Electromotors (Ltd.), charging booster, £53. 17s. Tenders also received from Crypto Electrical Co. (£56), Siemens Bros. Dynamo Works (£58. 10s.) and J. H. Holmes & Co. (£62).

Nalder Bros. & Thompson, switchgear, £98. The committee also recommends the acceptance of the offer of the Hart Accumulator Co. to maintain the battery for 10 years at £17. 16s. per annum.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

The fifty-second ordinary general meeting was held on March 2, Sir JAMES PENDER, Bart., presiding.

The SECRETARY (Mr. C. W. Clarke) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Lord Selborne, who occupied the chair at our last annual meeting, accepted office in July last in the Government, and in consequence he had to resign his directorship in this Company. We were sorry to lose the advantage of his ability and counsel on our Board, and I am sure you will miss the earnest and interesting speech which we have been accustomed to hear from him at these meetings, when he moved the dividend resolution, and reviewed the position of the Company. It has fallen to my lot this year to move the dividend resolution. You have seen that the profit for the year is £108,708, which compares with £109,186 last year, and £114,863 for the year before the war. To that has been added £111,406 brought forward, making a total of £220,114. From this is deducted the interim dividend already paid of £22,410, leaving £197,704 to be dealt with. We propose to distribute the same dividend as last year—namely, 10 per cent., with a bonus of 12s. per share, to increase the reserve fund by £20,000, and to carry forward £110,474. The year under review, owing to the war, has been far from a normal one. Contracts which we had entered into before the war began had to be postponed on account of urgent Government requirements, and it was not until many months had elapsed after the contract dates, that we were able to complete the work which we had undertaken. We have much to thank our clients for in the way of patience and forbearance, in face of the serious inconvenience to which they have been subjected by these delays. We have been working under exceptional difficulties all the year, both on account of scarcity of labour and shortage of supply of materials, and ever increasing price of both. But we have managed, with the loyal assistance of our staff and those hands who have remained with us, to keep our manufactured output quite up to the average of previous years. We have done a good deal of work for the Government, as well as our ordinary business, and we are at present doing munition work at both our factories. Our profits have been comparatively small, rather less than last year, and considerably less than the year before the war, so we shall have no excess war profits to return as payable under the Finance Act; in fact, but for the good rate of interest which we have been getting for money, and the profit realised on the sale of some American Dollar Securities, we should not have been able to show so good a result as we now present to you. Our ships have been actively employed throughout the year, and have often had to carry on their work within the danger zone, but thanks to the foresight of the Admiralty and their provision of the Naval escort which was necessary for protection, the ships have gone through the year without any mishap. I beg to move the adoption of the report and accounts, and the declaration of the dividend and bonus therein set out.

Mr COLIN F CAMPBELL seconded the resolution.

In reply to questions by Mr Croft and Mr Quartermaine, the MANAGING DIRECTOR (Mr Francis R Lucas) said the Company's ships had been doing a good deal of Government work, but had not been commandeered by the Government. They had been working under the Company, and one of them was still so employed. None of their ships were armed, but he thought that that made very little difference. They thought it would be very prejudicial to the interests of the Company to set out the reserves in detail. As regards the other item of the sundry securities, £1,215,000 odd, they were valued at the price on D. c. 31st.

The motion was carried unanimously.

The retiring Director, Sir James Pender, Bart., was then re-elected unanimously, and the auditors, Messrs. Gane, Jackson, Jefferys & Freeman and Messrs. Welton, Jones & Co., were re-appointed, and the proceedings terminated with a vote of thanks to the Directors.

South London Electric Supply Corpn. (Ltd.)

The ordinary general meeting was held on Tuesday, Mr. J. ATHERTON, Chairman of the Company, presiding.

The SECRETARY (Mr. Herbert H. Boyer) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the past year's working has been beset with considerable difficulties, and we, in common with other undertakings consuming large quantities of coal and employing men specially skilled in their work, have had to face the problems of shortage of both coal and labour. In regard to the former, whilst our coal contractors have loyally stood by their contract for the supply of the major portion of our requirements at practically pre-war prices, there has at times been great difficulty in obtaining delivery of the coal through the reduced output at the mines, and the enlistment of miners and the shortage of railway wagons, owing to so many being engaged in military and naval service. We have also been hampered in regard to the maintenance of a proper staff for the satisfactory operation of our generating plant and distribution system, and it was not until the latter half of the year that the Government classed as on war service the specially skilled men requisite in our undertaking. I would here add that the recent Munitions of War Amendment Act includes as munition work the supply of light, heat, or power, thus ensuring in our service for the duration of the war those men who are indispensable. Through continued effort it has been possible to build up a considerable reserve stock of coal, which is essential for the continuity of supply to the many factories taking power and light from our mains and to guard against any temporary stoppage of supply of coal through unforeseen circumstances. We have entered into a contract for our supplies of coal during the present year but at a greatly enhanced price over that paid previously, and although we have not, during the period under review, made a general increase in our charges for supply to consumers, we have now been forced to make an addition of 9 per cent. to such charges as from the reading of the meters last December to partly recoup us for this greatly increased cost. I would mention that it was found necessary by most of the other companies supplying electricity in the metropolis to make an addition of 10 per cent. to their charges early last year for the same reasons. I think you will agree that it is satisfactory to record in these abnormal times a net increase of 2,662 equivalent 35-watt lamps during the year, making the total connections at Dec. 31, 360,518 or 12,820 kw. Included in these additions are 74 motors of 379 h.p., making a total of 988 motors connected to the circuits aggregating 7,000 h.p.; and since the beginning of the present year there has been a considerable accession of power business, applications having been obtained for over 250 h.p., and prospects in this direction continue to be satisfactory, which is largely attributable to the

addition of the two-phase supply three years ago in those parts of our district where factories are likely to displace old residential property.

The total units sold during the year amount to 6,318,140, and comprise 2,040,939 for lighting, and 4,277,201 for power and heating purposes, showing an increase over the previous year of 164,899, and this increase has been achieved notwithstanding the drastic restrictions on lighting which have been in force throughout the year and still continue. Not only have these restrictions considerably reduced our output for lighting purposes, but they have largely caused shopkeepers and others to close their premises earlier than formerly, so that the cumulative effect on our lighting output for the year is represented by a decrease of 433,327 units; but to set against this we have sold 598,226 more units for power purposes, and the revenue derived from the sales of current for all purposes shows a small decrease of £351. 9s., notwithstanding these adverse conditions; and the gross revenue obtained from all sources amounts to £54,782. 3s. 10d. showing a decrease of £248. 1s. 2d., which reduction, however, is more than balanced by the increased amount received by way of interest and dividends on our investments in British Government Securities, which consist of 4½ per cent. War Loan Stock and Government Treasury Bills. On the other side of the revenue account the principal increases in the items of expenditure are for coal, for active service grants to employees with H.M. Forces, and for increased insurance premiums covering damage to your property by hostile aircraft, &c. The whole result may be summed up by stating that the total cost per unit sold amounts to 1·04d. per unit, as compared with 0·99d. in 1914. The gross capital expenditure for the year amounts to £6,763. 11s. 5d.—on machinery and plant £2,009. 19s. 1d., being principally in part payment for an additional cooling tower erected during the year and now about to be put into commission; and on mains, transformers and meters, £4,633. 9s. 10d. —expended in small extensions of mains where such expenditure has been fully justified by the prospective revenue, and also for the cost of connecting up new consumers and the requisite transformers and meters. In regard to the depreciation fund account, the amount expended for renewals of plant is £748. 6s. 8d., principally for the replacement of one of our economisers which had worked out its normal life, and for rebuilding our steel cooling tower. Although the advertising effect of our central showrooms at Brixton has been much curtailed through our inability at night-time to use any attractive lighting, nevertheless they have proved of continued service to our consumers, and have been the means of many inquiries for new business, a large percentage of which produced good results; so that the sales department, of which these showrooms formed a part, had shown for the past year the very satisfactory profit of £1,733. 8s. 7d., against £1,189. 0s. 7d. in the previous year. This department has now settled down in working, and since its inauguration has continued to improve in efficiency. We have released further of our employees for service with the Colours, so that over 40 per cent. of the normal establishment are now serving their country, and their places have been temporarily filled in some instances by the introduction of female labour, which, however, cannot in our undertaking be greatly extended owing to so much of the work being of a skilled and specialised nature, and under these circumstances only a very few of the remaining men can be allowed to leave the Company's service without impairing its working efficiency. You will observe the profit amounts to £27,228. 17s. 7d., out of which we have placed to depreciation fund account £6,248. 6s. 8d., thus bringing this fund up to the satisfactory figure of £55,500, and after providing for debenture interest, amounting to £6,500, and for the dividend on the preference shares, amounting to £1,800, and writing off £713 from suspense account in the general balance-sheet, there remains for further distribution the sum of £16,009. 18s. 8d., which we propose should be distributed by the payment of a dividend of 5 per cent. on the ordinary shares, carrying forward a balance of £3,009. 18s. 8d. I now beg to move that the report and accounts be adopted.

Mr. J. M. HENDERSON, M.P., seconded the motion.

In reply to questions, the CHAIRMAN said that the Company's application with regard to the assessment was very successful, and it meant a reduction of about £2,000 to the Company. The increased expenditure in connection with the office staff, &c., was only a natural increase, which was bound to take place owing to the enormous additional amount of work which had been going on, and which could not be done without extra charge. The Directors' fees always remained the same; they were £1,200 a year whatever the number of the Directors might be. The articles provided that after the Company had earned a certain amount of money or dividend, the Directors took a certain percentage of the profit. That explained the reason why the Directors' remuneration of £1,200 four years ago had increased to £1,400 at the present time. The question of the Directors' remuneration had nothing whatever to do with the amount carried forward.

The motion was then carried, and the dividends on the ordinary and preference shares were declared.

The retiring Directors, Messrs. Algernon Turnor, C.B., and Mr. F. J. Læslie, were re-elected, and the auditors, Messrs. Price, Waterhouse & Co., were re-appointed.

Kensington & Knightsbridge Electric Lighting Co. (Ltd.)

The ordinary general meeting was held on March 2, 1916, under the presidency of Col. R. E. CROMPTON, C.B.

The SECRETARY (Mr. G. S. Britton) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, in my speech at last year's meeting I pointed out that the lighting restrictions and other economies caused by the war had then reduced our output by 7½ per cent. and our revenue by 6½ per cent. This has been repeated during the past year. There have been still more stringent reductions in lighting, and there have been private economies. This has resulted in a further reduction in the output of 9 per cent., representing £5,167 in the money receipts (about 7 per cent.), so that the total reduction for the two years 1914 and 1915—18 months of the war—amounted to nearly 1,000,000 units, representing £10,355 in money receipts. Against this the readjustment of the discounts we determined on last year has so far only increased the average price received per unit by 2 per cent.—that is to say, we got last year for 1 unit 3·35d., as against 3·28d. in 1914. The readjustment determined on by the Board represented a much greater percentage increase than this, but it was largely in high-priced units, and the number of these sold have decreased, whereas that of the low-priced units sold for heating somewhat increased. The Board and management have worked hard at decreasing the cost of generation and distribution. Owing to the rapid rise in the price of Welsh coal used at the company's works here it was found advisable to close these works entirely as a generating centre, and to take the whole of the supply from the Wood-lane works, which, you will remember, is fitted with the most up-to-date machinery, and, therefore, produces the largest amount of electrical energy for a given amount of coal. You will remember that we are practically two-thirds owners and take two-thirds of the total output from the Wood-lane works, and it will be gratifying to you to know that by the development of the most modern form of generating plant and by the extreme care and economy of the management the Wood-lane costs have not shown the increase that would have been expected owing to the large increase in the price of coal. The working, in fact, has been very economical, and you are to be congratulated thereon. The accounts show that a saving of about 15 per cent. has been made on the repairs to our plant, so that our total working expenses, including management, Directors' fees, office, legal and similar expenses, but exclusive of depreciation and renewal fund, have been cut down from £51,623 to £48,852 this year, or 5½ per cent. The Board have very carefully considered the amount that we ought during these times of stress to put to our renewal and maintenance account. We have checked the figures that we have hitherto used, and found them to be somewhat in excess of what is actually necessary to maintain the plant in perfect condition; in other words, we believe that careful valuation will show that the present value of our plant, not taking any credit for the increase in the value of the copper in the mains, which of itself is a very large figure, is in excess of the value at which it stands in our books when depreciated by the figures we have been employing. Under these circumstances we consider ourselves justified as a temporary measure during the period of the war to reduce the balance of the amount placed to the credit of the renewal fund from our last year's figures of £9,745, which was in excess of the figure which we ought to have charged—which we believe to be £8,847—and this year we have put in the accounts £7,261. As it is due to the causes I have just mentioned, the total renewal fund credit stands at £139,021, which is considerably in excess of what the figure should have been in relation to the age of the company, and to our unexpired term up to the year 1931. This, I hope, the shareholders will consider to be a satisfactory figure. During the year we have been actively engaged in contesting the quinquennial assessment of our property by the Borough authorities of Westminster and Kensington, and we have been successful in obtaining a considerable reduction, which, however, does not show itself in this year's accounts, but will make considerable difference during each of the five years over which the new assessment holds. About one-quarter of our staff and workmen have joined H.M. Forces, and several others will have to join later. The two difficulties which have made the work of the staff and of the Board excessively onerous during the past year have been these questions of loss of staff and of rapid increase in the price of coal. The total sum for rates and taxes paid during the past year has been increased by £816. In spite of the above increases the economies effected have been so considerable that I think the shareholders may be congratulated on the results as a whole. Our reduction of dividend has been smaller than that of other companies, although we have only increased our price by 2 per cent. to the public, whereas most of the other companies have increased their prices by a much higher figure. One feature of the year's working which the Board consider satisfactory is that the use of electricity for heating and cooking is steadily increasing, and although at present the profit on the low-priced units is small it will be considerable and well worth having under normal conditions when coal and labour prices are at their normal level.

I think before I propose the adoption of the report that I ought to call the attention of the shareholders to the devoted work of Mr. Miller (hear, hear), who is not only the engineer, but doubles the duties of managing director and of having supreme charge of the Wood-lane works. No man knows better than I do—who live alongside him, and have constant access to him and his office—how heavily he works, and yet in addition he has been able to give part of his time to the munitions department for the manufacture and supply of munitions. I have now only to move that the report and accounts be adopted.

Sir HENRY W. BLISS, K.C.I.E., seconded the motion.

In reply to a question, the CHAIRMAN said the works which adjoined that office—the Cheval-place works—were a generating station and a transforming and battery station, and as a generating station they had closed it, possibly permanently, but a great deal would depend on the attitude of Messrs. Harrods, who, they were informed, were rather sick of supplying themselves, and their large output might come to them. They did not depend on that, but in view of that possibility they could not dismantle the station. In regard to electric cooking there was great progress, but they did not know whether it was in cooking or heating. Personally he had found that it was a great economy—and it did appear to be so—to use electric heaters instead of using fires. He used them, and a great many others did so. That was a matter, however, which had

not helped them much at present, but with the low price at which they were producing the unit now, they believed that a substantial profit would be made in that direction.

The MANAGING DIRECTOR: We have had in the past year the largest increase in heating that we have ever had.

The resolution was carried unanimously. The interim dividend of 3 per cent. paid for the half-year ended June 30 was approved, and a further dividend of 4 per cent. to be paid for the half-year ended Dec. 31 last was declared.

The retiring Director, Sir Henry W. Bliss, was re-elected, and Messrs. Price, Waterhouse & Co. were appointed auditors, a vote of thanks to the Chairman and the Directors terminating the proceedings.

Chelsea Electricity Supply Co. (Ltd.)

The annual ordinary general meeting was held on Wednesday, Mr. W. R. DAVIES presiding.

The SECRETARY (Mr. S. J. Cluer, F.C.I.S.) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, in moving the adoption of the report and accounts I can only voice what must be a regret to us all—namely, that, owing to the class of demand in districts like ours the year's working should necessitate a reduction in the dividend. Some of the companies in the metropolitan area who can command a power load have done better than in 1914, but our business, which is for domestic and shop lighting, has again been adversely affected, not only by the increased lighting restrictions and by the general and proper desire to economise, but also by the fact that there is at present no London season, with the entertainments and festivities which a London season provides. The units sold are 149,000 less, being 3 to 4 per cent. below those of the previous year; but our low-priced power units show an increase of 12 per cent., and the reduction in the sale of the higher-priced units is nearly 10 per cent. We have been exceedingly fortunate in our fuel expenses, which show a reduction of £950. This is partly due to the fact that the Diesel plant has been running for the whole year, and has taken the bulk of our load, and that the cost of oil had not during the period under review increased in anything like the same proportion as the cost of coal. It is also partly due to the fact that we purchased more current from the Central Company, so that the amount we required to generate has been proportionately less, and further, of course, to some slight extent, to our having sold fewer units. Repairs and maintenance and other costs are about the same as last year, but there are two other items on the expenditure side of our revenue account which call for special remark. One is that a special provision for income tax of £1,500 is now necessary on account of the high income tax; and, secondly, that we have paid away £1,200 to our men on military service. These two items alone more than account for the reduced distribution. I am sorry to say that we must not look forward to any improvemennt, and we may even be faced with a further reduction of profit. This is due to two factors: First, the price of oil has risen very considerably; and, secondly, the reduction in the demand for current still goes on. The output for the first two months of this year shows a reduction of 6½ per cent. over the corresponding period. I beg to move that the report of the directors and statement of accounts be adopted, and that the payment of dividends at the rate of 6 per cent. per annum on the preference share capital and 4 per cent. per annum on the ordinary share capital for the year 1915 be approved.

Major W. F. WOODS, J.P., seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. H. R. BEETON, Major W. F. Woods, J.P., was re-elected a director of the Company; and the auditors, Messrs. Cooper Brothers & Co., were re-appointed.

A vote of thanks to the chairman, the directors and the staff for their services in the past year terminated the proceedings.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The capital expended during 1915 on account of the Bournemouth, Poole and Bransgore, Christchurch and District and Pokesdown Orders amounted to £2,674, making the total expenditure on account of these orders £469,623. The balance from last account after payment of the final dividends was £3,829, and the balance of revenue for 1915, after deducting generation and distribution costs, rent, rates, &c., general establishment and other charges and proportion of salaries, was £38,684, making a total amount available for the year of £42,514. Deducting interest on debenture stock, &c. (£29,301), leasehold and special redemption funds and interest (£1,972), and amount carried to reserve (£8,000), the balance available for distribution is £3,140 14s. 9d. Dividends on the 4½ per cent. and on the 6 per cent. second preference shares for the year, and on the ordinary shares at rate of 6 per cent. per annum for the half-year ended June 30 have been paid, and the directors recommend that a final dividend on the ordinary shares at rate of 7 per cent. per annum for the half-year ended Dec. 31, 1915 (less tax) be declared, making 6 per cent. for the year, and that the balance of £3,007 be carried forward. The total applications received at Dec. 31 last were equivalent to 10,549 kw., an increase of 885 kw. for the year. The total number of units sold was 4,061,061. The directors of the Richmond (Surrey) Electric Light & Power Co. have declared a dividend of 6 per cent. on the ordinary shares for 1915.

BRUCE PEEBLES & CO. (LTD.)—The directors' report states that during the year the works have been entirely employed on war work, and having regard to the abnormal times and difficulties the results are satisfactory. The total profit amounts to £14,916. 8s. 1d., and after deducting administration expenses, mortgage debenture interest, &c., the net profit is £7,096. The works are a "controlled" establishment since Sept. 6, 1915. The amount charged to profit and loss in respect of repairs and maintenance of buildings plant, &c., is £4,660. 14s. 10d.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The capital expended during 1915 on account of the company's London districts amounted to £59,105. 13s. 6d., making the net total expenditure in respect of those districts at Dec. 31 last £2,157,654. 15s. 8d. The balance from last account, after payment of final dividends on the preference and ordinary shares, was £12,471 0s 6d., and the balance from revenue account, after deducting generation and distribution costs, rents, rates, taxes, wages, directors' fees, &c., was £159,639. 6s. 5d., making a total amount available for the year of £172,110. 6s. 11d. From which should be deducted interest on first and second debenture stock and interest on temporary loans (£44,377. 17s. 1d.) and amount carried to reserve for depreciation, renewals, &c. (£40,000), leaving £87,732. 9s. 10d. for distribution. Interim dividends have been paid (less tax) as follows: (*a*) On 6 per cent. fully-paid preference shares and on ordinary shares for half-year ended June 30 at rate of 5 per cent. per annum. These interim dividends absorbed £32,026. 0s. 10d., and left £55,706. 9s. The directors now recommend that a further dividend on the 6 per cent, fully-paid preference shares, and a further dividend on the fully-paid ordinary shares at rate of 9 per cent. per annum (less tax) be declared for the half-year ended Dec. 31. These payments will absorb £41,207. 5s. 10d., and leave £14,499. 3s. 2d. to be carried forward.

The applications received during the past year amounted to the equivalent of 5,360 kw., making the total at Dec. 31 last 60,065 kw.; the total units sold were 30,562,045, against 28,012,741 for 1914, an increase of 2,549,304 units, and the number of consumers increased from 24,212 to 25,913. Having due regard to the heavy and continued increases in the cost of coal and other materials, and to the more stringent lighting restrictions imposed during the year, together with other abnormal conditions under which the company is working, the directors consider the above results satisfactory. During the past year supply was commenced in the Urban District of Romford under the Romford and District Electric Lighting Order, 1913. The company is now giving supply in bulk under the Croydon Rural Electric Lighting Order, 1905, to the adjoining districts of Sutton, Carshalton, Wallington and Cheam. The directors of the Bournemouth & Poole Electricity Supply Co. have declared a final dividend on the ordinary shares of that company at the rate of 7 per cent. per annum, making 6 per cent. for the year, and the Coatbridge & Airdrie Electric Supply Co. has made excellent progress during the past year, the units sold having increased from 4,678,350 units in 1914 to 6,134,986 units in 1915.

ELECTRICAL DISTRIBUTION OF YORKSHIRE (LTD.)—Mr. R. W. Wickham presided at the meeting last week, and said that, notwithstanding the increased cost of supply through the high prices of coal, the lighting restrictions and other serious difficulties, the board considered that the results of the year's working were very satisfactory. The capital expended during the year amounted to £6,173, but no fresh capital had been issued during the year. Commencing with a small profit in 1908, the first year of working, each succeeding year had shown a larger profit. There was no doubt that the agreements made with the Yorkshire Electric Power Co. for the supply of energy to and for the management of the company had materially assisted in building up the present satisfactory state of affairs. If separate generating stations had been necessary for each district, such good results would not have been possible, and the large capital expenditure which would then have been required would have made a supply quite impossible in many of the districts in which the residents were now able to obtain electric lighting at prices which compared very favourably with districts having much greater populations. During the year electric lighting orders were obtained for Selby and district and for Stanley (Wakefield), bringing the total of the orders held by the company to 18, but no mains could be laid in these districts until after the war.

LANCASHIRE UNITED TRAMWAYS (LTD.)—At the meeting last week the Chairman (the Hon. Arthur Stanley, M.P.), in moving the adoption of the report and accounts for 1915, referred to the satisfactory result of the year's working, notwithstanding the increase in expenditure caused mainly by the extra cost of materials, war bonuses to employés, &c., and amounts paid to dependents of men who had joined H.M. Forces. 150 men were serving with the Colours, but up to the present the usual service of cars had been maintained through the employment of female labour, which was proving satisfactory. Since the early days of the war the staff and employés of the company have made a regular monthly contribution to the funds of the British Red Cross Society, which amounted to over £900.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The report for 1915 states that the capital expenditure, which at the end of 1914 amounted to £2,228,558 17s., has now reached a total of £2,258,000 16s. 6d., an increase during the year of £30,141 19s. 6d. The gross revenue for the year amounted to £229,200 15s. 6d., compared with £215,544 5s. 9d. in 1914, an increase of £13,659 9s. 9d. The working expenses amounted to £127,149 12s. 8d. an increase of £12,538 8s. 1d. The balance at credit of revenue account, before providing for depreciation, is £102,051 2s. 10d. The directors have set aside £27,000 as an addition to the depreciation and reserve fund, which, after writing off loss on realisation of certain investments, now amounts to £337,348 1s. 3d., carrying to credit of net revenue account

£75,051. 2s. 10d. This sum, with balance brought forward, interest and dividends on investments and other receipts, makes a total of £87,088. 16s. 2d. After deducting interest on debenture stocks and loans, dividend on preference shares and other charges, there remains £34,977. 12s. 2d. An interim dividend of 1s. per share (being at rate of 2 per cent. per annum) on the ordinary share capital, amounting to £10,000, was paid in August, 1915, and the directors recommend that a further dividend of 2s. per share (being at rate of 4 per cent. per annum) on such shares be now paid, making a total distribution for the year of 3s. per share, or 3 per cent. This will leave a balance of £4,977. 12s. 2d. to be carried forward. During the year new connections representing the equivalent of 59,267 25 c.p lamps (equal to 1,778 kw.) were added to the company's system, making a total connection at the end of the year of 1,197,763 lamps. In October last the directors elected Mr. Geoffrey Blackwell. Mr. Gerald Alex. Moncrieff and Mr. Phillip Debell Tuckett to seats on the board. In January last Lord Avebury, Sir James Pender, Bart., and Mr. P. D. Tuckett tendered their resignations as directors, which were accepted with regret. Mr. J. S. Highfield has resigned his position as engineer and manager, and the directors have appointed him to be consulting engineer. They have appointed Capt. W. R. Rendell to be general manager.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—The revenue for 1915 was £513,561. After adding balance brought forward and deducting all expenses (including a provision of £22,715 for reconstruction and renewals) the available balance is £44,275. The directors recommend that £13,000 be placed to reserve, £25,000 be employed in paying the dividend on the preference shares and £4,743 in paying a dividend on the ordinary shares at rate of 1 per cent. for the year, £1,532 being carried forward. The strike of the employés in May last caused an almost entire suspension of the services for 13 days, which included the Whitsuntide holidays, and the loss in traffic receipts amounted to £16,000. The output of the North Metropolitan Electric Power Supply Co., in spite of the decrease in the number of units supplied for traction, has been satisfactorily maintained; the total number of units sold during the year amounted to 39,457,712, compared with 36,869,118. Owing, however, to the abnormal increase in the cost of fuel, the gross profits of the power supply company for the year show a decrease of £6,340. 10s. 9d. compared with 1914.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the recent meeting it was reported that the equivalent of 31,476 32-watt lamps had been connected during 1915, making a total of 223,257 32-watt lamps. The motors connected were equal to 4,668 H.P., an increase of 733 H.P. The output had been 5,055,643 units, compared with 3,958,700 units in 1914. Depreciation account had been increased by £6,750, out of which £500 has been written off mains, £664 off motors, and £1,750 added to reserve. A dividend of 8 per cent. was declared on the ordinary shares for the half-year, making 6½ per cent. for the year, and £3,114 was carried forward.

RUSHDEN & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting it was reported that the company had had a successful year in 1915, during which the number of consumers rose from 79 to 123, and the revenue from sales of current from £463 to £1,699. The extensions of the generating plant would be soon put into commission. For the first proper working year they proposed to pay a dividend of 3 per cent.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO. (LTD.)—Mr. H. St. J. Winkworth, who presided at the meeting last week, said that they had discontinued the column for 35-watt lamps in their table, and substituted connections in horse-power, which was a more appropriate unit at present, having regard to the large demands for power and the continual increase in the domestic demand for heating, cooking and the working of labour-saving apparatus. During the year 313 new consumers were connected, representing 3,860 H.P., equal to 82,281 35-watt lamps, which included 2,313 H.P. for additional bulk supply to the West Kent Electric Co. The new mains were principally for giving bulk supply to the West Kent Co., and for increased demands for power for works and factories. The loss of revenue occasioned by the lighting regulations was estimated at £8,000 to £9,000, but that was made good by new business and extensions, and an additional £9,600 earned, of which about £6,000 was derived from bulk supply to the West Kent Company. The total units sold amounted to 9,185,742, compared with 6,695,481 for 1914, an increase of 37 per cent., but the average price realised was lower by reason of the bulk supply. An agreement having been entered into with Woolwich Borough Council for reciprocal and bulk supply, an extra high-tension main had been laid, at their expense, to connect the company's power-house with their undertaking. A connection with the company's power-house had also been made through the West Kent area with the generating station of Dartford Urban Council. The total sales in the showroom for the year amounted to £9,256, compared with £8,148, and the number of transactions was 4,479 and 3,759 respectively. Coal cost about £5,700 more, due to the increased output, high freight and inferior quality of some of the coal supplied. The increase in wages of workmen (about £800) was due to war bonuses and increased output. The increase in repairs (£790) was mainly on machinery. An increase of 10 per cent. in the charges was made, commencing after the end of the March quarter, which had afforded them some help in meeting the extra expenses due to the war. The total expenditure (£31,385) represented 39 per cent. of the gross receipts, compared with 36 per cent. in 1914. The directors had under consideration the best manner of dealing with the amount due to the company by the West Kent Co. for work done (approximately £30,000). It would be seen, on reference to the table in the report, that the business generally had about doubled since 1909, and the net revenue, which was then £25,382, amounted to £49,190 in 1915. During the same period debenture interest and preference dividends had increased £4,740, thus showing a net increase of £19,068. The West Kent Co. had 3,018 H.P. connected (against 773 H.P.), with 531 consumers, and the gross revenue, £13,320, and net revenue, £3,051. During the year considerable extensions, both of mains and consumers, had been made, securing important power loads of a substantial and durable character. The bulk of the energy had been taken from the supply mains of the South Metropolitan Co. As regards the prospects of the current year, it was very difficult to say what will take place in these days, but their output at present was substantially more than at the corresponding period of last year, due mainly to the increased demand of the West Kent Company. It was difficult to obtain regular deliveries of coal, and owing to the exceptionally high freights it was impossible to say what coal would cost.

TRAMWAYS LIGHT & POWER CO. (LTD.)—At the meeting last week the chairman (Viscount Chilston) said that they owned the whole issued loan and share capital of the Derbyshire & Nottinghamshire Electric Power, the Nottinghamshire & Derbyshire Tramways, the Leamington & Warwick Electrical, the Leicestershire & Warwickshire Electric Power, the Midland Electric Light & Power, and the Cheltenham & District Light Railway Companies, with the exception of a few hundred pounds' value of shares in one of the companies. Notwithstanding the war, the companies had made progress, and, in fact, progress rather greater than indicated by the accounts, because the growth of the business was largely counteracted by progressive increases in cost of production, and in the lighting and power companies particularly owing to the great increase in cost of fuel. The various undertakings had only to continue the present rate of earnings to show a considerable increase during the current year, and the increase should continue for some time unless, after peace is declared, a very substantial change for the worse comes over the trade of the country. The Derbyshire & Nottinghamshire Electric Power Co. developed slowly during the year. The increased receipts were rather more than offset by increased costs, the net receipts being about the same as the previous year. During the current year, however, increased returns would be derived from business connected last year too late to affect the returns. The Leicestershire & Warwickshire Power Co. showed considerable improvement, and during the last few months of the year a substantial increase in net earnings. That property would, judging by present results, contribute a substantial increase during the current year to revenue. Last year he pointed out that a large additional revenue could be earned from the money expended on the power properties, and that statement had been amply justified during the year, additional consumers having been connected to the power companies' supply mains, equal to about £10,000 receipts per annum. The current year would show, unless something very unforeseen occurred, a satisfactory increase over last year. Their receipts (in interest, dividends, fees, &c.) amounted to £30,501, which, together with the carry forward of £1,712, made £32,214, from which they had to deduct £1,874 general expenses and £11,016 debenture and loan interest, leaving £19,324 available, compared with £18,329. The directors propose to pay the dividend on the 6 per cent. preference shares for the year 1915, and to carry forward £3,348.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—The profits earned during the year ended Jan. 31, 1916 (after deducting administration expenses) were £39,819, against £39,001 9s. 10d. in previous year. After transferring £11,000 to reserve and adding £14,212 brought forward, the balance available was £43,030. 10s. 1d., against £40,611. 12s. 3d. The directors propose to declare a dividend at rate of 8 per cent. for year (of which an interim dividend of 2½ per cent. was paid in August last), leaving to be carried forward £17,430. 10s. 1d., against £15,011. 12s. 3d. The additional plant which is to be installed at Weardale power station is making satisfactory progress at the manufacturers' works, and the extensions to Grangetown station, which are in course of erection, will (it is hoped) be completed during the next three or four months. The supply of waste heat and gas and the output of electrical energy has been less but the costs are less by the smaller amount which has been paid to the owners of the collieries and ironworks.

CITY NOTES.

MEMORANDA (March 8).—**Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57⅜. Consols Pay Day, April 5. Stocks and Shares Ticket Days, March 28 and April 12. Pay Days, March 29 and April 13. Price of silver, 27d.**

BRITISH INSULATED & HELSBY CABLES (LTD.)—The directors recommend a final dividend of 10 per cent., making 15 per cent. for the year, together with a bonus of 2½ per cent.; £98,500 is placed to reserves and depreciation, and £160,000 carried forward, the latter to meet duties for excess profits.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of members will be closed from the 8th to the 23rd inst. inclusive.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—The gross receipts for 1915 were £7,511. After providing for debenture interest the balance is £528, which is to be carried forward.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—Subject to audit, the directors have decided to recommend a final dividend on the ordinary shares of 10 per cent. (less tax), making 15 per cent. for the year, and also a bonus of 10s. per share, less tax.

INDIA RUBBER, GUTTA PERCHA & TELEGRAPH WORKS CO. (LTD.)—The holders of the 4 per cent. first mortgage debentures, which fall due for payment at par, together with the current half-year's interest, on 25th inst. have been notified that the directors intend to issue in place thereof first mortgage debentures to bearer for £400,000 in debentures of £100 each, bearing interest at £5 per cent. per annum (payable on March 25 and Sept. 25) at the price of £93 for each debenture. The debentures will be repayable on March 25, 1926.

JARROW & DISTRICT ELECTRIC TRACTION CO. (LTD.)—Including £1,026 brought forward the profit for 1915 was £3,937. A dividend of 4 per cent. is proposed, adding £900 to reserve, and carrying forward £1,040.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN. (LTD.)—A dividend of 1½ per cent. has been declared for the quarter ending March 31.

MIDLAND ELECTRIC CORPN. FOR POWER DISTRIBUTION (LTD.)—dividend of 3 per cent. (3s. per share) has been declared on the ordinary shares for the past year, £7,919 has been appropriated for depreciation and £4,275 written off issue expenses, the carry forward being £8,932.

MIRRLEES-WTSON CO. (LTD.)—A dividend of 5 per cent., less tax, has been declared.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO. (LTD. —A dividend of 6 per cent., together with a bonus of 4 per cent., making 10 per cent. for the past year, is recommended.

UNITED ALKALI CO. (LTD.)—A dividend of 1s. per share (5 per cent.) has been declared on the ordinary shares and of 7s. per share on the preference shares, or 7 per cent. for year.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date, March 7, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	17d.
Solid Drawn Copper Tubes	18½d.
Brazed Copper Tubes	18½d.
Brazed Brass Tubes	19d.
Brass Wire	16½d.
Copper Wire	18d.
Rolled Brass	16½d.
Brass Sheets	16½d.

	per ton.
Copper Sheets	£148 0 0
Spelter	£110 0 0

	per ton.
English Lead	£33 0 0
Antimony	Nominal.

Old Metals.	per ton.
Braziery Copper Scrap	£87 0 0
Hollow Pewter	£120 0 0
Black Pewter	£75 0 0
Gun Metal	£82 0 0

Clean scrap brass and copper, old lead and old zinc are not quoted in view of Government restrictions.

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date March 7, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£140 0 0
Clean Mixed Brass	£66 0 0
Clean Copper	£90 0 0
Braziery Copper	£84 0 0
Gun Metal	£80 0 0

	per ton.
Old Lead	£27 0 0
Tea Lead	£25 0 0
Old Zinc	£70 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£80 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £115; Blowpipe Solder, £120.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, March 7. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues., March 7.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 5 5	Mar, Sept
10	4½%	†Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	†Do. 6% Cum 2nd Pref.	10⅛	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar. Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar. Aug
St.	4%	Central Elec. Supp. G. Deb. St	80	5 0 0	..
St	4%	Charing Cross West End & City Debs.	82	4 17 7	Jan, July
5	2/3	Do. 4½% Pref.	3⅛	6 18 6	..
5	5%	Do. Ord.	3⅛	7 2 10	Aug, Feb
5	4½%	Do. City Pref.	2⅛	8 9 5	Jun, Dec
5	5%	Chelsea Elec. Supp. Co. Ord.	4⅛	5 8 1	Mar, Sept
St.	4½%	Do. do. Deb.	90	5 0 0	Jan, July
10	9%	City of London Elec. Lt. Ord.	11⅛	7 10 9	Feb, Aug
10	6/0	Do 6% Pref.	10⅛	5 10 4	Mar, July
St	5%	Do. 5% Deb St.	97½	5 2 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	85½	5 12 11	Jun, Dec
10	7%	County of London Ord.	13⅛	6 14 11	Mar, Sept
10	6%	Do. 6% Pref.	11⅛	5 18 6	Feb, Aug
St	4½%	Do. 1st Deb.	89½	5 4 0	Jan, July
St.	4½%	Do. 2nd Deb.	87	4 13 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	9%	Kensington and Knightsbridge Ord.	⅛	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79½	5 9 11	Jan, July
5	3/0	London Elec. Supp. 6% Pref.	4½	7 1 2	..
St.	4%	Do. 4% Mort. Debs.	79½	5 0 4	Jan, July
St.	4½%	Metropolitan E. Supp. Ord.	2½	7 17 9	Mar, Aug
St.	5%	Do. 1st Mort. Deb.	80	5 11 6	Jan, July
..	6%	Midland Elec. Corpn. 1st Mort. Deb. St.	99	5 1 0	Jan, July
St	5%	Newcastle & Dist. E.L. 6% 2nd Deb.	99½	6 0 6	Mar, Sept
..	6%	Newcastle-on-Tyne E.S.S. 6% 2nd Mt. Db. St.	99½†	5 8 5	Mar, Sept
..	6%	North Metropolitan E. P. Supp. 6% Pref.	⅛	7 8 0	Apl, Oct
4	5%	South London E.S. Ord.	3⅛†	6 13 1	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., March 7.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	5⅞†	6 16 2	Feb, Aug
5	7%	Do. do. Pref.	5 11/16†	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅜	7 6 3	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5⅛†	6 10 3	Mar, Sept
5	4½%	Do 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	81½	6 1 6	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	73½	8 3 3	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	67⅞†	5 10 10	..
St.	4%	Do. do. Assented Def. Ord.	67⅞†	5 18 0	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½	8 0 0	Feb, Aug
10	⅛%	London Electric Ry. Ord.	1⅛	3 5 8	Jan, July
St.	4%	Do. 4% Pref.	65⅜	6 2 10	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23	4 6 11	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 14 3	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	15⅝	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan, July
St.	4%	Do. 4% Guar. Stock	68	5 18 6	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅝	5 5 8	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅛	5 11 1	Mar
100	5%	Do. Prior Lien Debs.	87½	5 12 0	Jan, July
1	6%	Do. 6% Pref.	⅞	6 15 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	10⅛	6 19 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅛	5 15 6	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm. 6% Pref.	⅝	6 15 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91†	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅛	6 13 4	April
100	6%	Do. 6% Prior Lien Debs.	102	5 17 11	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	63½	6 5 8	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11⅛	6 9 0	Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅞	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅝	5 6 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs	71	5 12 8	Jan, July
..	10%	General Electric Ord.	103	9 10 6	July
10	6%	Do. 6% Pref.	9⅛	6 5 6	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13	7 5 1	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½†	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9½	10 16 3	Feb, Aug
10	5%	Do. Pref.	7⅛	6 11 2	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	36⅛	6 10 7	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅞	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	79½	5 0 8	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	99½	6 0 9	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 19 2	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	76	5 14 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 11 2	May, Nov
10	10%	Do. 10% Pref.	13	8 6 8	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	7⅝	6 18 5	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	126½	5 10 8	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64½	5 12 10	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	75⅛	5 1 1	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78½	5 2 3	Feb, Aug
10	7%	Do. Ord.	12⅝	5 10 11	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	31	6 9 5	Ja, My, Jly
25	13%	Indo-European	5⅜	6 8 5	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅜	5 3 3	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅛	8 18 10	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12⅞	5 5 11	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	76⅛	5 4 1	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	94⅛	4 10 3	May, Nov.
		Telephones.			
1	7½d.	• Monte Video Telephn. Ord	⅜	6 12 5	Nov.
1	10%	Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅜	6 15 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅞	5 10 4	Jan, July
St.	4½%	Do. Deb Stk.	94½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10⅜	5 15 0	Sp,De,Mr,Jn
10	6%	Do. 6% Pf.	9⅝	6 1 6	Sp,De,Mr,Jn
100	5%	Mackay Companies' Common	83½†	6 4 7	Ja, Ap, Jly, O
..	4%	Do. £100 Pref	67⅞	5 18 5	Ja Ap Jly O
100	6%	Submarine Cable Trust Certs.	124	4 16 0	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs.	95½	5 4 9	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10	6 0 0	..
St	4½%	Do. 4½% Debs.	87½	5 2 10	Jun, July
5	9%	Calcutta E. S. Corp. Ord.	6	7 10 0	May, Nov
5	5%	Do. 5% Pref.	4⅝	5 11 11	May, Sept

* And 13⅓% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 827
Arrangements for the Week .. 830
Continuous-Current Railway Motors. By Ernest V. Pannell. Illustrated 831
The Electrical Industry Before and After the War 834
Notes on the Measurement of High Voltage. By William R. Work. Illustrated 835
Apparatus for Starting and Controlling Electrical Running Machinery. By C. C. Garrard. Illustrated.—*Continued* 837
London County Council Tramway Accounts 839
A Direct-Current Generator for 10,000 Volts. By W. Linke. Illustrated 842
Efficiency of Projectors and Reflectors. By Haydn T. Harrison 842
THE PROBLEMS AFTER THE WAR 844
REVIEWS 845
Electric Arc Phenomena [Tornberg].
Questions and Solutions in Telegraphy and Telephony (Final Examinations) [Few].
The Use of Continuous Current for Terminal and Trunk-Line Electrification. By Norman Wilson Storer. Illustrated 846
CORRESPONDENCE 848
"The Stranger that is Within Thy Gates" (A. A. Campbell Swinton and M. J. E. Tilney).
Uniformity in Drawing Electrical Diagrams (C. C. Garrard).
Eddy Current Loss in Dynamo Teeth (A. Press).
Principles and Systems of Electric Motor Control (W. Perren Maycock).
The "Electrician" Commercial and Industrial Section .. 851-860

NOTES.

Stars and Lesser Fry.

WE have no intention of entering into a discussion as to why the State should redeem the pledge given to married men by Lord DERBY when voluntary recruiting was at a low ebb last November. Such discussion can well be left to the non-technical press, but we must state that in our opinion little good will come to an army composed of men who for the most part feel, and rightly feel, that they have been deceived. This is, obviously, a matter for the State to settle. In reading the accounts of indignation meetings held in various towns during the week, the view we have long held concerning the scandal of the starred trades has been emphasised. It is estimated that there are 700,000 young men in starred occupations, and perhaps a total of over half a million single men who ought to be available. Of the 700,000 young men in starred occupations in all likelihood at least 90 per cent. are engaged on work which could be done equally well by others. To regard as engineers many of the young men engaged in the manufacture of munitions is to degrade engineering. To look upon meter-readers and testers as indispensable men is nonsensical. This class of work is, essentially, work for women. During the past year it has been made evident that women can quickly be trained in the unskilled mechanical work which represents a large part of the labour in the making of munitions. Having no family ties it has been easy for the single men to enter munition works, whereas the married man has of necessity had to remain at home. We hope that the endeavour will be made to dislodge those who deprive our women of work it is their privilege to perform, and who under existing conditions make it virtually impossible for the Tribunals to give proper consideration to the claims of the married men. In Parliament, on public platforms and at every recruiting centre, it has been stated that full consideration would be given to these claims, and in view of this we ask, Whither are we drifting? If we be at war because it suited our neighbour to disregard his pledge, is it not our duty to insist that our own people keep to their pledges? Or are we also going to earn, and richly to deserve, the title of hypocrite? Had it been the intention of our Ministers lightly to treat pledges when it appeared expedient for them so to do, surely it would have been better for them not to have talked nonsense 20 months ago about treaties being binding. As we go to press there are signs of weakening on the part of the authorities. We hope that those affected will strengthen their positions and will not "wait and see" before deciding to act. The situation is ludicrous in the extreme, and is one which ought never to have arisen.

Mobilise the Engineers.

AT a recent meeting of one of the engineering institutions, after listening to many speakers, it occurred to us that at some time or another an opportunity must have pr sented itself to most of these men, as well as to most of the members present, of proving their engineering worth. To our knowledge many of them had seized the opportunity and had "made good." One of these days it will be said of the engineers that during the years 1914 to — they forged the chains which bind our Empire together. Without doubt many of the men to whom we had been listening were actually engaged in making the links of the chains. Nevertheless, we cannot help feeling that the desire for the interchange of ideas which first brought these men together applies to-day with far greater weight, seeing that we are faced with engineering work not only of unparalleled magnitude, but of unparalleled urgency. Work which requires for its execution the combined talent of all our engineers, and which, to be worth while, must withstand the test conditions. It need not be argued that the cash value of such talent is higher than that we can afford to pay the clod-hopper for his services, but were the two of equal value we ought still to avail ourselves of the skilled services of those engineers who join the Forces by putting them on engineering work. Waste in time of war is inevitable; but it is as important to endeavour to minimise such waste as it is for our people to economise. In engineering work none but engineers can minimise waste or can economise. For this reason we again urge the State to mobilise the engineers, or, alternatively, to call upon all engineers to engage in war work.

The London Electricity Supply Companies.

IT is gratifying to see that the position of the London Electricity Supply Companies, as shown by the annual general meetings which are held at this time of year, is financially satisfactory, considering the difficult conditions under which

the work has been carried on. There has been an extreme reduction of street lighting and a minimum of society functions, which in normal times bring considerable revenue. Apart from this reduction in receipts, the cost of production has been seriously greater owing to the high price of coal; thus in the case of the London Electric Supply Corporation, the cost of coal has increased from about ½d. up to ⅔d. per unit, which is a very serious matter for an undertaking, more particularly when a large part of the output is used for power purposes and is, therefore, supplied at a low figure. In the case of the County of London Electric Supply Co., the cost of freightage alone is now more than the cost in pre-war times of the coal itself delivered into the bunkers. Under these conditions it is only natural that supply engineers should feel strongly that more serious Government action should be taken. Nevertheless, this Company has made very good headway and is supplying in various directions in outlying districts, such as Romford, Sutton, Carshalton, Wallington, and Cheam. This is to the advantage of London electricity supply, as it is in the direction of unification. In the case of the Kensington & Knightsbridge Electric Lighting Co., we see that the past year has given the largest increase in heating that the Company has so far experienced. We notice that the South Metropolitan Co. has done well in regard to power contracts, and has thus made up for the loss in revenue from the smaller amount of lighting. Altogether we feel that the Companies are to be congratulated upon maintaining their positions during a very difficult time, when it has been necessary to obtain larger outputs with the disadvantage of depleted staffs.

L.C.C. Tramways.

From the detailed accounts of the London County Council tramways, of which an abstract is given in another column, we are glad to see that the results, considering the abnormal conditions, may be described as being reasonably satisfactory. There is still a heavy loss, but we must be glad that it is not heavier. The number of passengers has considerably increased, and the revenue, although not correspondingly higher, is at least higher than it has been for some years; and it is satisfactory to note that the receipts per car-mile are higher than for the year 1913-14, being the same as 1912-13. The sum expended on war service allowances amounts to £12,209, which is a large amount for an undertaking which has never been in a very flourishing condition; but for this the financial position would have been considerably more satisfactory. As it is there is a net deficiency after meeting all capital charges of £78,023. Under the circumstances it is not surprising that the renewals fund has fared very badly. At March 31, 1914, the sum of £531,341 had been invested for this fund. During the year, however, it was necessary to realise portions of the investments, so that the total invested has now been reduced to £395,727. This fact probably shows the greatest weakness of the position, which we hope will be improved during the present year, as the curve of passengers carried shows a distinct upward tendency.

"Train Lighting and Uncorroborated Evidence."

Under the above heading the "Journal of Gas Lighting" deals editorially in its current issue with the report of Lieut.-Col. P. G. Von Donop upon his inquiry into the circumstances attending the disastrous railway accident on the North-Eastern Railway last December. According to our esteemed contemporary, "Following precedent, gas lighting on trains is again condemned, and electric lighting is recommended. This sort of thing . . . is becoming quite a fetish with the Railway Inspectors of the Board of Trade, while the Inspectors engaged in the work of other Government departments do not appear to trouble themselves, though faced by a long roll of fatalities, regarding the expulsion from mines of electricity used for power purposes, with a recommendation that its place be taken by compressed air, or from factories and workshops, with a proposal that other forms of power with fewer mantraps associated with them should be adopted." Till we read our contemporary we had always imagined that, in comparison with the fatalities from gas explosions in mines, the electrical fatalities were negligibly small. In comparison with the output, the electrical fatalities in our works and factories are also negligibly small. As to what our contemporary calls a "fetish," we hope Inspectors will continue to condemn gas lighting on trains as long as minor accidents become holocausts due to its use.

Education and Labour.—A manifesto has been issued by the British Workers' National League calling, among other things, for educational reform, so as to give greater technical efficiency combined with a more popular access to knowledge. The manifesto is signed by a number of Labour members of Parliament.

Kyoto Imperial University.—We have received several memoirs of this college of science. These deal with "Stereochemistry" and the "Systems: Sodium Sulphate–Sodium Chromate–Water." "On the Geometry of Somas in Elliptic Space" and other Papers deal with metallographical research. All are beautifully printed in English or German, and are of a very high standard.

On the Electrical Capacity of Approximate Spheres and Cylinders.—In the current issue of the "Philosophical Magazine," Lord Rayleigh discusses this question. It is pointed out that there is an important difference between the two cases. The capacity of a sphere in the open is finite and equal to its radius, whereas when we come to the cylinder, supposed to be entirely isolated, we have to recognise that the capacity per unit length is infinitely small. The author deduces formulæ to meet the two cases.

Flow of Air Through Nozzles.—Capt. Thos. B. Morley, B.Sc., deals with this question in a Paper read recently before the Institution of Mechanical Engineers. In the first portion of the Paper various forms of nozzles are compared as regards their effectiveness for producing jets of air having as high a mean velocity as possible. It was found that nozzles having a rapid taper were much less effective than those in which the taper was gradual, and the best results were obtained with nozzles shorter than the length calculated from theory. The reaction of jets on a flat plate were compared, the stream lines of air flowing into the jet being observed by means of fine threads, or smoke. The results obtained showed that the expansion was complete at, or extremely near, the nozzle.

Electromotive Forces.—In a Paper read before the American Electrochemical Society Mr. W. D. Bancroft discusses the theory of the voltaic cell. He points out that the proper starting point is van't Hoff's formula for the reaction isotherm. He uses the formula,

$$E \frac{RT}{nF} \log K \Sigma p_1 . \Sigma p_2 .$$

where Σp_1 refers to the substances which are consumed during the reaction and Σp_2 to the substances which are formed. It is suggested that Nernst's work should be used as an introduction, after which the van't Hoff equation should be deduced and applied to all cases. In the discussion which followed the Paper there seemed to be general agreement that hypothetical solution pressures, osmotic pressure and other "aids" were more confusing than helpful.

New Electric-Resistor Material. According to "Metallurgical and Chemical Engineering," an alloy of nickel, copper and chromium to be used for electrical resistors has recently

been patented. The alloy is said to combine high resistivity with low temperature-coefficient of resistance. The proportion of nickel used is large, compared to the copper and chromium, and an alloy which has been found to give good results consists of the following : 85 parts nickel to 15 parts copper, with 20 parts chromium to 100 parts of nickel and copper. This alloy has a resistivity of 113 microhms per centimetre cube at 20°C., and at this temperature has a temperature coefficient of 0·000078 ohm per degree Centigrade per ohm. The copper increases the resistivity up to a certain point and the chromium is said to effect a reduction in the temperature-coefficient.

Upkeep of Miners' Cap Lamps.—The " Coal Age " recently referred to the cost of upkeep of miners' electric cap lamps. The principal items of repair in the installation at Crows Nest mine, near Greensburg, Pennsylvania, where 250 of these are in use, are bulbs and cables. In six months the lamps were burned for 34,419 lamp shifts. The cost of spare parts and acid consumed was £83. 10s., of which £17. 4s. was for breakages. The United States Bureau of Mines requires that the average life of lamp bulbs be not less than 300 hours for primary and acid storage batteries, and not less than 200 hours for storage batteries using an alkaline solution. At Crows Nest the results gave 627 burning hours per bulb. The weak point in electric cap lamp installations is the cable. This cable is bent on the miner's back about 7,000 times during the shift. Regarding tending charges one man can handle 150 electric safety cap lamps and give satisfaction, or 300 lamps can be tended by one lamp master and his assistant.

Wave-length for Thin Straight Conductor.—In the " Philosophical Magazine " Prof. J. A. Pollock, D.Sc., in a Paper on " The Wave-length of the Electrical Vibration Associated with a Thin Straight Terminated Conductor," discusses this question. Abrahams and other writers have concluded that the wave-length of the disturbance in free ether due to the gravest electrical vibration in such conductors is to a first approximation twice the length of the rod. Taking Abrahams' second approximation, viz., $\lambda=2l(1+5{\cdot}6\varepsilon^2)$, where $\frac{1}{\varepsilon}=4\ \log_\epsilon(l/b)$, and b is half the minor axis of the ellipsoid of revolution, he calculates the value of λ for different lengths of oscillators used by different experimenters. The results of the calculation are compared with the observed values, and show a close agreement. This supports Lord Rayleigh's contention, viz., " That the difference between the half wave length of the gravest vibration and the length l of the rod (of uniform section) tends to vanish relatively when the section is reduced without limit."

Wiring Rules of the I.E.E.—The seventh edition of "The Wiring Rules of the Institution of Electrical Engineers" has just been issued. The alterations that have been made are largely matters of detail, but the following points may be noted : The clause relating to gas pipes is strengthened, and combined gas and electric fittings are not to be used. If gas fittings are adapted they must be entirely disconnected from the gas piping. The test for cables has been somewhat modified. A pressure of 1,000 volts for half an hour is stipulated for 250-volt cables, but this is increased to 2,500 volts for 650-volt cables. These grades of cable are defined by the radial thickness of dielectric and the insulation resistance. The testing current is to be alternating at a frequency of 50–100, and the alternator must have an output of not less than 5 kw. Some modification has been made in the specification of flexibles, and bunching in wood casing is allowed to a larger extent. In regard to lead-covered conductors, these must be exposed to view ; but it is not clear whether this clause covers Henley's special system. Switches having handles projecting from an open slot in the cover are now barred. Definite distinguishing colours are recommended for positive, negative and neutral conductors, and for three-phase conductors. A clause has been introduced admitting the use of uncased conductors protected by tough rubber compound ; this doubtless has reference to the well-known C.T.S. cables.

Hele-Shaw Transmission Gear.—A fully illustrated description was given in a recent issue of " Engineering " of a 30-ton traverser by Stothert and Pitt, fitted with the Hele-Shaw transmission gear. This gear consists of an oil-pump driven by a 50 B.H.P., three-phase, 25-cycle induction motor, and three oil-motors driven by the oil-pump. Two of these oil-motors are required for the traverser and one for operating the capstan-head by means of which wagons are hauled on or off the traversing carriages. The oil-motors are governed by regulating the pump capacity ; change-over valves, non-return valves and safety valves being also provided. An electrically-operated emergency brake is fitted to each axle-shaft and is operated by means of a switch interlocked with the controller, so that the brakes cannot be applied unless the controller-handle is in the " off " position. Current is applied to the motor from overhead wires, through trolley collectors mounted on a tower at one end of the locomotive. The traverser was specified to be capable of an average speed in either direction of 300 ft. per minute measured over a length of track of 220 ft. when propelling or hauling one of the traversing carriages carrying a loaded wagon weighing 30 tons. The acceleration when starting under such conditions is 0·5 ft. per second per second, so that a maximum speed of 440 ft. per minute is reached in 15 seconds. Under normal conditions the capstan head is capable of exerting a rope-pull of 750 lb. at a speed of 300 ft. per minute, and this figure can be increased to 2,000 lb. The traverser has to serve any one of eight sidings, and fearing that with any form of three-phase motor drive much time would be lost, Mr. R. T. Smith, the electrical engineer of the Great Western Railway Co., decided to adopt the Hele-Shaw hydraulic transmission gear for communicating the drive from the motor to the wheels. This arrangement has proved most successful and the ease with which the traverser can be accelerated or retarded, speeded up or reversed is said to be very remarkable. Working drawings of the Hele-Shaw gear are given, and the article also includes the record of a series of tests.

A Commonwealth Institute of Science and Industry.—The report of a Committee appointed in consequence of a motion passed at a Conference convened by the Prime Minister of the Commonwealth of Australia, has been issued. An advisory committee was appointed to formulate proposals to the Government regarding the establishment of a Commonwealth Bureau of Science and Industry.

This Committee includes representatives of commerce and manufacture as well as of science, and State departments. The report of the Committee, of which we give an abstract below, has, we understand, the approval of the Federal Government, and on the Prime Minister's return to Australia from this country, a bill will probably be laid before the Federal Parliament to give effect to their recommendations.

The recommendations suggest the establishment of a Commonwealth Institute of Science and Industry. This Institute is for the purpose of industrial research, establishment of a bureau for the purpose of distributing scientific information amongst the industries, the establishment of national laboratories, and their control and administration: to utilise immediately the present Institutions. To make recommendations from time to time regarding the establishment or development of special departments, and to award studentships and fellowships ; to direct attention to new industries and to keep in touch with Government departments, and scientific and learned Societies.

The prevention of overlapping is referred to, and steps to be taken to increase the numbers of those capable of research. The Committee do not wish to interfere with the present Government laboratory, but new laboratories specially created for research purposes should be controlled by the Institute. Recommendations regarding the constitution of the Institute were made, viz. : An Advisory Council of nine members representing science and the principal primary industries is suggested ; that these be appointed by the Governor-General in Council. That three directors be appointed, these directors being *ex officio* members of the Council, one of these directors to be a business man, the other two scientific. Regarding any discoveries made by any of the workers employed by the Institute, these to be used to the public advantage. Bonuses to be paid to successful discoverers, or inventors. That the Institute charge fees. Further the work of technical colleges and trade schools throughout Australia be co-ordinated, and attention given to the study of modern and Oriental languages. Pending the establishment of the Institute, an Advisory Council be appointed to initiate researches in connection with industry, and collection of scientific information; also that bodies representative of trade, and others, make recommendations regarding industrial research. A series of problems requiring solution are suggested by the Committee, and a recommendation that funds be placed at the disposal of the Committee for these purposes.

OBITUARY.

Louis Duncan.—We regret to note the death at the early age of 53 years of Prof. L. Duncan, formerly associate professor of Applied Electricity at Johns Hopkins University, and Head of the Department of Electrical Engineering at the Massachusetts Institute of Technology. Prof. Duncan was twice President of the American Institute of Electrical Engineers. He obtained his technical training at Johns Hopkins University under the late Prof. Rowland, and worked with him on the determination of the ohm, which still remains a fine piece of research work having important practical results. He possessed in a very high degree originality in attacking engineering problems, and routine was distasteful to him. He early specialised in electric railway work, collaborating with F. J. Sprague, and carrying out experiments at Richmond, Va. His work has left a strong impression on electric railway development, particularly in the middle west of the United States, where his activity was conspicuously shown. Later he was often engaged as a patent expert, and his work in this direction was characterised by the same directness as his engineering. He wrote on Electrical Traction for the "Encyclopædia Britannica," and was also employed as consulting engineer during the electrification of New York's transit system. Amongst his students his inspiration will be affectionately remembered, and his professional career was a fine example at a time when there were suspicions of it yielding here, and there, under commercial importunity.

C. W. Fairweather.—The death of Mr. C. W. Fairweather, consulting engineer, took place at his residence at Haydon Bridge, near Newcastle, on Tuesday. Mr. Fairweather was for some years associated with Messrs. Ernest Scott & Mountain, and, subsequently, became a consulting electrical engineer. He acted for various large enterprises in Newcastle and the district, including several collieries. He was one of the joint founders of the Northern Counties Electricity Supply Co.

PERSONAL.

Sir George Greenhill, F.R.S., and Mr. Charles Bright, F.R.S.E., M.Inst.C.E., desire it to be known that they have requested their names to be withdrawn from the Executive Committee of the Aeronautical Institute.

The President of the Board of Trade has appointed Mr. E. G. Moggridge, Assistant Secretary, Marine Department, to be Assistant Secretary, Railway Department, in place of Mr. W. F. Marwood, who has been appointed Second Secretary to the Board; Mr. C. Hipwood becomes Assistant Secretary in the Marine Department, in place of Mr. Moggridge.

Mr. W. A. Scott, A.M.I.E.E., works manager of Bruce Peebles & Co. (Ltd.), Edinburgh, was married on the 9th inst. to Alexandrina, second daughter of Mr. Alex. Mann, Edinburgh. A few days prior to the wedding Mr. Scott was presented with a handsome canteen of cutlery and a silver cigarette case by his many friends amongst the workmen and staff.

Mr. J. W. Dugdale, tramways manager to Oldham Corporation, has resigned his position.

Honour for Bravery.—It is now officially announced that Temp. Lieut. Algernon C. Sparks, R.E. (son of the President of the Institution of Electrical Engineers) has been awarded the Military Cross for conspicuous bravery and initiative when taking part in a raid on the enemy's trenches.

INSTITUTIONS AND SOCIETIES.

Dublin Section of the Institution of Electrical Engineers.—At a largely attended general meeting of this Section held at the Royal College of Science, Dublin, on Friday, 10th instant, the following resolutions were passed:—

1. That the meeting is of opinion that the membership of this Institution of any citizen, born of alien enemy parentage naturalised or not naturalised, shall forthwith cease, and that after the termination of the war no such citizen shall be eligible for membership; and, further, that any citizen of the Empire or allied or neutral nations, being a member of any grade of this Institution, who becomes an agent for a firm owned or controlled by citizens of those enemy nations shall automatically cease to be a member.

2. That the chairman, hon. secretary and another attend the general meeting to be held in London to support the terms of the foregoing resolution.

Croydon Wireless Society.—At the meeting of the above society held on the 10th inst., Mr. E. H. Pollett, B.Sc., gave a lecture and demonstration on electric welding. The methods of welding electrically may be divided into two classes—resistance welding and arc welding. Of "resistance" methods in commercial use the "Thomson" process, in which the heavy current necessary is obtained by means of a specially-designed alternating-current transformer, having a secondary frequently of one "turn" only, the circuit of which is completed through the weld, was described. In the "electro-percussive" system one member to be welded is fixed, and the other is held in a jaw which may be allowed to drop so that the members come together with considerable impact. They are connected to the poles of a large charged condenser, the explosive discharge of which produces a current of sufficient intensity to perform the weld. In "arc" welding the arc may be struck between the work to be welded and a separate carbon electrode, or between two carbon electrodes, in either case filling metal being fed in externally. In an alternative method the filling itself forms an electrode, the work constituting the opposite pole.

Institute of Industry.—As mentioned in our issue of the 25th ult., a Committee was recently appointed to meet trade representatives with a view to forming a strong central organisation. The names of the Committee were given in our issue referred to above. The Committee have convened a meeting to be held at the Savoy Hotel on Thursday, the 30th inst., at 2:30 p.m., with a view to furthering these objects.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 17th (to-day).

Institution of Mechanical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, S.W. Paper by Sec. Lieut. R. W. Fenning, R.E., B.Sc., on "The Composition of the Exhaust from Liquid Fuel Engines."

Electro-Harmonic Society.

8 p.m. At the Holborn Restaurant. Smoking Concert.

SATURDAY, March 18th.

Royal Institution.

3 p.m. Lecture by Prof. Sir J. J. Thomson, F.R.S., on "Radiations from Atoms and Electrons." (Lecture II.)

TUESDAY, March 21st.

Manchester Section, Institution of Electrical Engineers.

7:30 p.m. At the Engineers' Club, Albert Square. Paper by Mr. N. W. Storer, on "The Possibilities in the Design of Continuous Current Traction Motors."

THURSDAY, March 23rd

Royal Institution.

3 p.m. At Albemarle-street, W. Lecture by Prof. H. E. Armstrong on "Organic Chemistry in War." (Lecture II.)

FRIDAY, March 24th.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington. Papers on "A New Method of Determining Ionic Velocities," by Mrs. Griffiths; "An Explanation of the Migration of Ions," by S. W. J. Smith, M.A., D.Sc., F.R.S.; and "A Method of Exhibiting the Velocities of Iodine Ions in Solution," by S. W. J. Smith, M.A., D.Sc., F.R.S.

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding, Lt.-Col. C. B. Clay, V.D.

Orders for week commencing March 20th, 1916:—

Drills: 6:25 to 7:25, 7:25 to 8:25.

Monday, March 20th. Sections 1 and 2 Technical; Sections 3 and 4, Lashing and Trestle Bridging. Signalling Class and Recruits.

Tuesday, March 21st. School of Arms, 6:0 to 7.0 p.m.

Thursday, March 23rd. Shooting for Sections 1 and 2 and Signalling Class.

Friday, March 24th. Sections 3 and 4, Technical; Sections 1 and 2 Lashings and Trestle Bridging. Signalling Class and Recruits.

Saturday, March 25th.—Uniform Parade at 2:45 p.m.

Attendance is specially desired for all members on Saturday, March 25th, as it is proposed to hold Battalion Drill.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 46, Regent street, S.W.

Sections for Shooting Parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate hill, E.C., as soon as possible.

CONTINUOUS-CURRENT RAILWAY MOTORS.*

BY ERNEST V. PANNELL.

Summary.—The Paper is intended to cover some interesting features in the design of continuous-current motors for traction purposes. Weights and dimensions, speed and tractive effort are discussed, as well as commutating poles and field-control motors. The question of rating and ventilation, and the effect of the latter on outputs, is considered. The effect of commutating poles on the voltage rating is dealt with, and the limitations of the design in various directions are clearly indicated. The ultimate conclusion is reached that the higher voltage motor needs to be designed for a stronger field and weaker armature. The main features of present-day design are set forth.

Introductory.

In an introductory note reference is made to recent progress, and throughout the Paper the following assumptions apply: (*a*) The rated output is the power delivered through the gears according to the standard one-hour basis of rating. (*b*) Power throughout the Paper is defined in kilowatts, the horse-power unit for motor rating being considered obsolete. (*c*) Voltage, except where otherwise specified, is assumed to be 600. (*d*) Rated speed or rated current is the speed or current corresponding to the rated output. (*e*) The object of the Paper being to consider general tendencies in design, the curves and tables should be regarded as representative of such tendencies rather than of precise quantities.

Weights and Dimensions.—In the last few years, owing partly to the competition of the alternating-current motor, but more to the widespread demand for increased economy in all branches of engineering work, considerable improvements have been effected in the design of the traction motor. Curves showing the weights of motor and gearing and rated output then follow in the Paper.

The figures below are of interest as showing the weights of two motors of identically the same rated output at 500 volts. The GE 74 machine was, however, introduced in 1904 and the GE 201 in 1910.

Type of motor	GE 74	.....	GE 201
Rated kilowatts	48	.....	48
Weight—motor without gears	3,119 lb.	.....	2,385 lb.
,, armature and pinion	845 lb.	.....	639 lb.
,, gears	240 lb.	.....	220 lb.
,, gear case	175 lb.	.....	130 lb.
,, motor and gears complete.	3,534 lb.	.....	2,735 lb.
,, per kw. rated output	74	.....	57

This reduction of nearly 800 lb. in weight has been secured partly by the increase of rated speed made possible by the adoption of commutating poles, but to a greater extent by the use of more carefully chosen material of higher weight efficiency and a ventilated structure.

A comparison is then given of prices and weights of motors as alternative arrangements for a train. The question of linear dimensions is next discussed, and it is found that the limitations are of even more strict a nature than those governing the weight. Output and dimensions of armature are dealt with.

Speed and Tractive Effort.—Railway motors, being invariably series wound, attain high rotational speeds at light loads. The free-running speed in service usually coincides with about one-third the rated load, and is nearly double the rated speed. In other words, a motor having an armature diameter of 20 in. and a rated load speed of 600 revs. per min. would attain a rotational speed of about 1,000 revs. per min. and a peripheral speed of 5,250 ft. per minute when free running. With higher degrees of saturation the increase at light load will not be as great; but in any event it will be very near the maximum judicious peripheral velocity. This, together with the fact that the gear and friction losses are greatly increased at high rotational speeds, provides an argument against the use of higher rated speeds than 600 revs. per min. Indeed, this figure may be said to cover practically all types of motor for car operation other than those designed for control by sectional fields. The main disadvantages of extreme speeds may be indicated as follows:—

High speed.	Low speed.
High core and friction losses.	High copper losses.
Excessive forces on armature.	Excessive pinion stresses.
Faulty commutation.	Poor ventilation.
	Heavy machine.

In general the efficiency of the high-speed motor is better at rated load and inferior at light loads, as compared with the lower-speed design. In the former motor the core and friction losses are higher and the copper losses, owing to the fewer armature turns, are less; this in a measure discounts the high-speed motor for service involving much high-speed running. On the other hand, the lower-speed motor having a higher armature resistance will be less desirable for work involving frequent accelerating periods at the full rated current; it will operate with higher efficiency on long straightaway runs with few stops.

The influence of the form of saturation curve upon the motor characteristics has been well illustrated by comparison with curves showing the hypothetical maximum and minimum degrees of saturation. Figs. 1 and 2 indicate the typical speed and torque curves for a large railway motor compared with similar characteristics of a theoretical machine with maximum saturation in which the field flux is constant, and also of a motor in which the saturation is nil, the flux increasing as the square of the current. It will be seen that the actual practical design tends towards one or other of these extremes, according to the service for which the motor is designed. For long runs without stops, where time has to be maintained in spite of adverse conditions, the motor showing the least variation in speed for a given difference in torque—in other words, the highly saturated motor—is desirable. On the other hand, for services with frequent stops, involving rapid acceleration, a fair proportion of the running will be upon the motor speed curve, which needs, therefore, to be of the flexible type, characteristic of a machine with a less highly saturated magnetic circuit.

It should be noted that the motor losses will influence the characteristics, copper losses tending to reduce the speed and core losses to diminish the torque.

Commutating Poles.—From the nature of its design the continuous-current traction motor must be expected to commutate poorly compared with stationary machines of similar output and voltage. In generator design it is usual with increasing output to increase the number of poles and of parallel paths through the

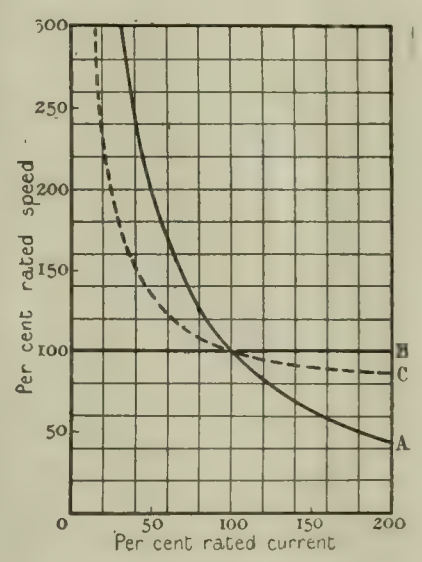


Fig. 1.—Speed Curves.

(A) Limiting minimum saturation; (B) limiting maximum saturation; (C) typical 170 kw. railway motor.

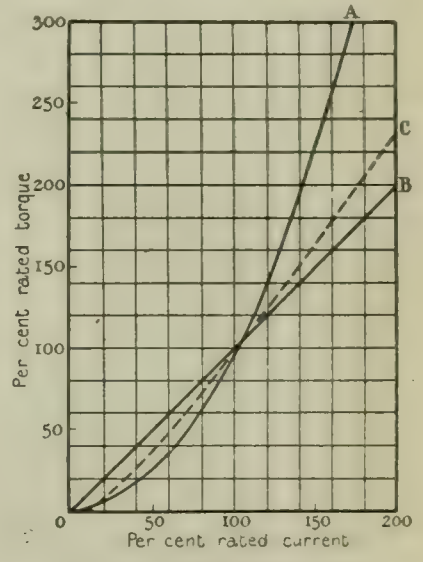


Fig. 2.—Torque Curves.

(A) Limiting minimum saturation; (B) limiting maximum saturation; (C) typical 170 kw. railway motor.

armature in order to improve the collection of current. These devices are, of course, inapplicable in the case of traction motors on account of the confined space; the armature size is limited and the number of poles is restricted to four. Moreover, in order to balance out inequalities in the air-gap and to permit of operation with only two brush sets, the two-circuit winding is universal. Practically all motors of 100 kw. and over are designed for one armature-turn per segment in order to reduce the reactance per coil; but until the general introduction of commutating poles no other device could be adopted excepting the maintenance of a well-saturated magnetic circuit, a wide neutral zone and the lowest practicable commutator speed. Even with motors of the most careful design and construction the reactance voltage at rated load is of the order of 9 or 10, or four times that of a reasonably good generator. Certain motors have been designed with four brush sets, mainly with the idea of shortening the commutator and providing more space for the armature core. It has been found difficult, however, to secure adequate space for the four brush studs and still to maintain sufficient spacing to guard against flash-overs; moreover, the increased friction and heating offset the improvement (if any) in the commutation.

A device which has found universal adoption is the grooving out of the commutator mica to a depth of about $\frac{1}{16}$ in. below the surface of the copper. This avoids any trouble due to high mica, and has a remarkable effect in keeping the commutator surface clean and cool. Soft brushes are, of course, never employed with this type of machine, and with the hard carbons in common use centrifugal force is found quite sufficient to keep the slots free from particles.

* Abstract of Paper read before the Institution of Electrical Engineers on the 9th inst.

The use of compensating windings, leading eventually to commutating pole design, is then sketched.

An important influence of the commutating pole upon the design of the motor is the increase of the armature and decrease of the field component in the same proportion. To accommodate the interpole, the neutral zone has to be slightly widened and the polar arc shortened; consequently the total flux entering the armature from the main pole is reduced to a corresponding degree. On the other hand, the reduced armature reaction permits of an increased loading in ampere-turns on the armature. Moreover, although it has been urged by some designers that the commutating pole could never be introduced into railway motors on account of the confined space, it is found that the traction motor is no larger, and, as already seen, is lighter than the pre-interpole machine. A notable instance of the use of the commutating pole in a motor of extremely limited size is found in the machines on the Moselhütte mineral line in Lorraine, where the locomotives are operated at 2,000 volts, the pressure on each motor being 1,000 volts. The gauge of the line is only 39½ in., notwithstanding which it has been found possible to equip the locomotives with motors rated at 120 kw., the armatures being of 26 in. diameter with a core length of only 6¼ in.

Field-control Motors.—As already seen, although 600 revs. per min. represents the average speed at rated load of by far the majority of satisfactory designs, there are occasions where some variation of this quantity is desirable. It is frequently the case that a certain type of motor being standardised by a railway company will be called upon to perform widely different classes of service, possibly interchanging local service with as many as two stops per mile with express schedules running 5 miles or more without a stop. For the local service, high-speed low-copper-loss motors are required having a low-speed gear, whilst the most suitable machines for the fast service are those rated at a lower speed and having a low core-loss and high-speed gearing. The use of sectional or tapped field control affords one method of effecting the compromise and operating a system of diverse characteristics with one type of motor. More valuable still is the use of field-control for notching up on the controller during acceleration. A motor designed for this principle will probably have at its full field a speed 10 per cent. lower than the average machine, whilst with the short field this speed is increased by some 25 per cent. The motor is thus able to run upon either of two speed curves at the will of the motorman.

Sectional field-control was used on some of the very early motors, but the method later fell into disuse, and it was not until the general adoption of the commutating pole that field-control was definitely established. Without interpoles, as may be imagined, field weakening leads to excessive rushes of armature current, sparking and flashing over. To a small extent these troubles in earlier motors of the type were due to the shunting of a portion of the field winding rather than to its being open circuited. Such a procedure naturally increased the lag of the field current, opposing the growth of the flux, and serious sparking was the result. The commutating characteristics are so improved in the interpole machine, however, that reduction of the main field by 50 per cent. does not appear to affect the collection of current. Typical speed and torque curves for a field-control motor are shown in the Paper.

The "full field" characteristic of a motor of this type should be a good flat curve, denoting extremely high saturation, otherwise the "short field" curve will show dangerously high speeds at light load; 450 revs. per min. for the rated load speed at full field, and 550 or 600 at short field, are typical of what has been found most satisfactory practice for a 200 kw. motor. Too great a disparity in the speeds at any given armature current leads to a pronounced current "kick" when changing, and would probably tend to induce flashing over.

To those accustomed to laying out performance curves for electric railway equipment it is sufficient to say that the field control motor provides a shorter rheostatic period and a much longer period of motor speed curve running. The lower the full field speed of the motor the quicker will the rheostats be cut out and the less the rheostatic losses for a given acceleration rate. On one of the suburban railways in Christiana, Norway, the field windings of the 1,200 volt motors are not only divided for short and full fields, but are grouped for series and parallel connections. This gives four different running speeds all with the motors directly on the line.

Rating.—Under this heading are discussed the associated subjects of efficiency, losses and heating. The output of a railway motor is based upon a certain definite temperature rise under certain definite conditions, which is closely related to the watts lost in the motor and to the effective dispersal of these losses. At the present day there are three general types of motor in use—namely, (*a*) enclosed, (*b*) ventilated and (*c*) forced draught; but on the usual one-hour rating there are all brought into line, as by common consent no kind of induced ventilation is permitted for the 60-minute heat run.

The overall efficiency of a motor allows for losses in the copper, core and commutator, together with gear and bearing friction and windage. As factors in the temperature rise, however, all but the gear losses are effective. In the short, one-hour, heat run these are absorbed in the mass of the machine, there being little radiation with heavy motors; it is therefore justifiable, as proposed by Mr. H. M. Hobart, to assign a certain definite value of kilowatts per ton weight of motor for the 75°C. temperature rise. This "kilowatt per ton" expression is, however, one of a very approximate nature, and useful only when comparing motors of similar type, size and ventilation characteristics.

The curves in Fig. 3 throw some light on this point, and referring to these it will be seen that, although two different machines may have exactly the same rated one-hour output efficiency, and possibly weight, their performance on runs of longer period is radically different. Motor A, it will be seen, will take much heavier loads to reach its 75°C. rise than motor B for two, three or four hours' running. The former is representative of the recent ventilated design, and the latter of the totally enclosed carcase motors which are only just being superseded by type A.

Actual service, however, does not demand a steady current input, but a very fluctuating one, the values of which can only be predicted by graphical construction of the speed and current time diagrams. The voltage, too, is a variable quantity, taking into account the number and duration of the stops, coasting periods, &c. It is obvious that the heating, so far as it is influenced by the copper losses, depends upon the square root of the mean of the squares of the varying current input. A curve is given below of the losses in a 180 kw. motor, and the relation between magnetic flux and copper losses are referred to.

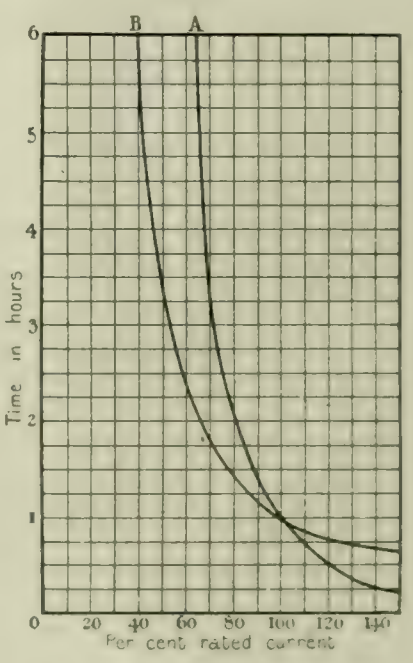


Fig. 3.—Time taken to attain 75°C. Temperature Rise in hottest accessible parts.

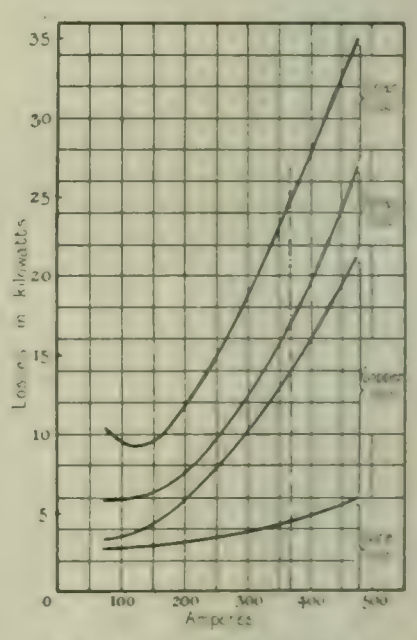


Fig. 4.—Losses in 180 kw. Motor.

Reference to Fig. 3 will demonstrate that copper and core losses are far from being the only losses of significance. The stray losses due to journal and commutator friction and windage are all factors in the temperature rise, whilst the gear friction detracts a further 3 per cent. to 7 per cent. from the efficiency, according to the speed.

The basis of both the American and European methods of rating railway motors is the 75°C. temperature rise in a one-hour run on the test bed with covers removed and no artificial ventilation. It is usually recognised that the one-hour rating represents the maximum desirable current input for acceleration, and that the average load for a complete day's running should not exceed 30 per cent. rated load for unventilated, or 50 per cent. rated load for ventilated, machines.

Ventilation.—Reverting to the curves in Fig. 3, and bearing in mind the fact that the average load on a railway motor is from 25 per cent. to 45 per cent. of its one-hour rating, the value of the present ventilated designs is fully evident. In more than one instance on electric railway systems in America ventilated motors rated at 50 kw. are doing the same work as the 80 kw. non-ventilated machines which they have superseded, with a net saving of 50 per cent. on the equipment weight and of 30 per cent. on its cost. Contrary to general opinion, ventilated motors have been found to operate satisfactorily even under the most adverse circumstances of dusty and gritty ballast. Some of the earlier ventilated motors on the Central London Railway are next referred to, and in the Paper there

is a table of data of 600-volt continuous-current railway motors. Several diagrams are given in the Paper showing old system of ventilation, series-fan and multiple-fan system. In all ventilated motors properly so called the air circulation is effected by an exhaust fan of very compact type, usually of aluminium or pressed steel, which is bolted to the armature core and actually forms the end core plate. The velocity imparted to the air is sufficient to retain in suspension any dust which might enter the casing and to carry it out again. The drawback to the earlier semi-ventilated motor was that no positive velocity was given to the air, and also that the structure of the machines provided dead-ends and pockets into which the dust, grit, iron oxide and other particles were driven and permitted to accumulate. The present type of motor, with its strong induced draught and clean-cut and direct air passages overcomes these drawbacks entirely.

High-voltage Motors.—The increase in rated voltage to values higher than 600 followed immediately upon the introduction of commutating poles into railway motor design; commutation was thereby so much improved that an increase of 100 per cent. in the average volts per commutator segment was found permissible. Previous to this, however, it was a common commercial test to run non-commutating pole motors on the test bed at 50 per cent., and in some cases at 100 per cent., over voltage; with the later designs this was accomplished with a marked absence from flash-over tendencies.

The practicability of increased pressures of 1,200 or 2,400 volts has greatly broadened the limits of continuous-current working. Where these high pressures are employed it is generally for fairly heavy service of the interurban or extra-suburban order, demanding powerful motors; this is a favourable feature, as in common with other classes of electrical machine the high-voltage traction motor becomes a more economical proposition with increasing outputs. As will be surmised, there is a perfectly definite limit to the pressure which can be applied to the motor terminals, and this would appear to be about 2,000 volts for car motors of the type under review.

In any four-pole series motor with a two-circuit armature the internal voltage at rated load is given by $V=0{\cdot}02N\Phi f$, where N =total number of turns on armature, Φ=polar flux in megalines, f=frequency=revs. per min. 30.

Evidently in a motor of given dimensions Φ is limited, and therefore an increased voltage can only be secured by a higher speed or a higher value of the armature loading. Higher rated speeds are being put out of court by the general adoption of field control, apart from the desirability of keeping the commutating constants as good as possible; hence to increase the number of turns in proportion to the higher pressure is the only alternative. The diminishing space-factor of the armature slots, however, prevents this being effected in an armature of given diameter.

In another direction some latitude is permissible; with increased voltage of course the current to be commutated is reduced, consequently the commutator can be shortened in almost the same proportion. This applies to the working length, and assumes a fixed brush width, though there may be cases where with a very high voltage the circulating currents between the toe and heel of the brush would necessitate a narrower brush. It is, however, generally found that the working length of commutator for 1,200 volts need be only half that required for 600 volts. Every inch by which the commutator is reduced may be added to the core length, thus immediately securing an increase in the effective flux passing through the armature. This very nearly compensates for the reduced armature loading consequent upon the low space factor in the slots, and leads to the interesting conclusion that with given dimensions the higher-voltage motor needs to be designed for a stronger field and weaker armature. This is just the tendency required for a satisfactory design.

The question of limits governing commutator design is next described, and a table giving design data for three types of 200 kw. ventilated railway motors follows. In an appendix there is an extract from the American Standardisation Rules regarding railway motor rating.

This Paper is not intended to be a treatise on railway motors, but merely to summarise a few of the improvements which have been effected in this class of machine during the last few years and the main features of its present design.

DISCUSSION.

Mr. F. W. Carter said he thought Mr. Pannell attached too much importance to the hourly rating. The hour rating was perhaps the only convenient way of comparing railway motors, but it was not a criterion of the service capacity of the motor. The meaning of the hourly rating was given in the appendix and was taken from the American Institute Rules, which were framed by the committee of which he (Mr. Carter) was a member. He did not think it was now true that the one-hour rating represented the maximum desirable current input for acceleration. In the old tramway type of motor that was probably correct, but he would say the thermal rating increased faster than the commutating capacity at first, and the result was that the proper commercial rating of a motor like the G.E. 69 (Table III.) would be 200 H.P. Although the 240 H.P. was strictly the one-hour rating it was too much to signify the accelerating current in ordinary service, and the result was that this was classed as a 200 H.P. motor. The other tendency had now taken place, and the latest motors often accelerated at higher than their rated capacity. G.E. 248 (Table III.) was called 160 H.P., and would accelerate as high as G.E. 69, which was called 240 H.P. He compared these to show that the one-hour rating was not a suitable criterion of the service capacity. The latter was an old type, as railway motors went. The two had about equal bodies, the same wheel diameter (18½ in.) and the same armature diameter. The smallest wheel diameter that would be tolerated in America was 33 in. The G.E. 69 was designed for the Rapid Transit Co., which operated the subways in New York, and the G.E. 248 for the New York Municipal Railway. The service was practically the same as our Underground. The clearance on the 33 in. wheels of those motors was about 3½ in. He believed the smallest wheels on which we would put those motors was 36 in. (as on the District Railway). That gave a clearance of 5 in. beneath the motor. In the Paper, Mr. Pannell seemed to assume that a 20 in. armature diameter could be got on a 33 in. wheel, but a 42 in. wheel would be wanted to get that. As to the differences of the G.E. 69 and G.E. 248, the former had a core length of 14½ in. and the latter of 11¾ in.; the former was an old type of motor without commutating poles and had radial ventilating points, while the latter had commutating poles and multiple ventilation similar to the figure in the Paper, except that the circulation was in the opposite direction, going in at the commutator end and out at the open end. G.E. 248 was a field-control motor. He did not know where Mr. Pannell got his figure of 25 per cent. in excess of normal for the shunting. He thought it was more like 70 per cent. The rating given to the motors mentioned in Table III. seemed to indicate that the design of railway motors had taken a retrograde step. Whereas in G.E. 69 (designed about 1902) the weight per kilowatt was 33 lb., and in the G.E. 248 it was 50 lb. That was on the one-hour rating, and it did not give any idea of the capacity for service. The capacity for service of G.E. 248 was greater than that of G.E. 69, and the accelerating current of the former might be much higher than the rated current, and equal to G.E. 69. The ventilating types when introduced by the G. E. Co. about 1911 were looked at askance, dust trouble being feared, but they were now used throughout the States. The G.E. Co. had sold from 15,000 to 20,000 motors of that type. G.E. 66 was mentioned as a semi-ventilated motor, and a diagram was given of the form of ventilation. That was designed by the Manhattan Railway about 1901. It was only applied to one or two motors as it was found to have little effect on the ventilation, while it deposited dust in the motor. It was superseded, and G.E. 66 had a solid shaft like other motors. The mistake came about through the drawing showing the hollow shaft having got out by mistake first, he thought, in Parshall and Hobart's book, and having been repeated. In the 200 kw. motor the bearings seemed very small. He thought it had 8 in. by 4½ in. bearings at the opening end, and 5 in. by 4½ in. at the commutator end. The G.E. 49 and 212 motors of less than 200 kw. had 10 in. by 4¼ in. at the opening end and 7¼ in. by 3¾ in. at the commutator end. The L. & Y. Railway and L. & S.W. Railway motors described in the Paper also had larger bearings. That could not be got without reducing the length of the core. With regard to the use of the lip of the commutator of a 12,000-volt motor as an oil thrower, he thought those with experience of tramway motors knew that getting oil on the commutator shell was one of the things to be avoided. The oil would creep round the lip and get between the mica, and in a few months the commutator would be going to ground from the end of the commutator between the mica layer and the rim. A proper oil thrower would be required to make the motor satisfactory. If there were a main oil thrower practically inside the commutator shell of the L. & Y. Railway motor depicted nothing like 18 in. of core could be got. We had not yet experience enough to recommend roller bearings. They would possibly be smaller than the plain bearings shown. A 200 kw. motor would require probably a 6 in. gear plate, which would cut into the length of the core. He doubted whether a 200 kw. motor of the ventilated type could be got into the standard gauge. There was no way out of the difficulties unless the designer were granted a larger diameter of wheel or unless he could put in roller bearings or something of that sort. On the L. & S.W. Railway they used a totally-enclosed motor of 200 kw. It was not desirable to have any sort of artificial limitations, such as a certain hourly rating which might compel the designer to design an old type of motor. If an engineer called for a motor totally enclosed he could at any time put gridded covers on, and thereby increase the capacity, but he would probably be cutting into the bearings, reducing the size of them. To get a totally-enclosed rating he would not be getting as good a motor as if it was designed for a properly ventilated type.

Prof. S. P. Smith said field control seemed to be on the increase. The field control was in vogue before the series-parallel control came along. While that was being developed field control had to take a second place, but now we combined both. The following formula showed the advantage of this practice: $E=n\Phi/k$. This was the E.M.F. in a continuous-current machine. For the product of the speed n and the flux Φ divided by a constant you could write $n=RE\ \Phi$, or $n=k(v-RI)\ \Phi$. E would be the terminal voltage. We could say v was the pressure of the third-rail, and we got this equation. You would get 600 volts

for parallel working or 300 for series working. This gave uneconomical speed control, because pressure was being consumed in resistance. In starting, that was the only means we had, because it was not possible to limit the current in any other way. Several curves were then drawn on the blackboard. If you got that series of curves for parallel connections you got a much wider system of control and increased the economy enormously in starting, because, instead of relying on resistance alone for keeping the current down, you could effect a good deal of it by field control, and the loss was very small. No extra loss was caused by connecting the field coils in series or parallel. A figure was then drawn on the blackboard that showed the advantage of field control, and it was good to see that present-day practice was moving in that direction. The difficulty would be with regard to big systems such as the District or Metropolitan railways already working. They had an enormous number of motors which were standard, and a great number of parts in stock for renewals. The number of types on such railways must be kept to a minimum, so that the capital cost of the introduction of field control would be enormous. Then an ordinary motor designed for series or parallel control would not be suitable for field control. He might mention, however, that he worked out one of the latest G.E. motors for field control, and found it gave very good results. He did not agree with Mr. Pannell as to what might be done. On high-voltage motors Mr. Pannell gave comparative designs for 200 kw. motors for three different rated voltages. In regard to the 1,800-volt motor, he said in order to get this in he used a long core and added various other things, but the volts per segment for the 600-volt motor were given as 13·3, which agreed with what was done in rotary converters, and which would mean a maximum of about 20 volts, about as high as a designer cared to go. For the 1,800-volt motor 20 volts per segment was given, but on the preceding page Mr. Pannell said "the limiting desirable average voltage per segment is believed to be 20 for a reasonably good field distribution." That mean of 20 could scarcely have a maximum of less than 30, and when a spark started at 30 volts it would be maintained. In a motor on the road, carbon dust got between the segments, and it was not difficult for sparking to be started, even with interpoles, and with 30-volt maximum it was risky. He questioned whether it was not forcing the motor too much to do that in order to get the segments into the space. As it was the segment pitch was only about 3½ mm. These conditions might be safe if the working were steady, but in traction work the current varied rapidly, and there was intense vibration. He would like to hear whether such voltages had been used, and if so what precautions were taken to prevent flashing over. He would not care to put 10 segments per slot in a generator or a rotary converter.

Mr. C. H. Lydall said Dr. Smith had shown how to obtain some considerable degree of field weakening by paralleling the two N-poles with the two S-poles. Perhaps that was the most expensive way of doing it, because of the number of connections inside the motor. There was little room for field connections inside a traction motor. The first and, perhaps, the most convenient way of carrying out the field shunting was by diverting current from the field coils by means of a diverting resistance, because this did not add to the number of leads coming out of the motor or the internal connections between the field coils, but, as mentioned in the Paper, this led to trouble, because if there were a momentary interruption of the voltage the current had two paths to go to the armature, through the field windings or the resistance. It had been suggested that a relay of some kind should be used to get over that, so that if there were an interrruption of the voltage at a time when the field was weakened the field weakening could be cut off the moment the current was interrupted. But it required a sensitive relay, which was better avoided in traction work. An alternative way was to cut out part of the field winding. The two bottom poles could be cut out, but it was not advisable to short-circuit them, because that might cause an upward pull, and interfere with the steady running of the bearings. If the two N-poles were cut out it might interfere with the proper distribution of the commutator flux in the commutation poles and cause sparking. The only satisfactory way was to divide each of the main coils into two parts, and connect them all up into series, and cut out half of each series by tapping off from the middle winding. If one could keep to the standard arrangement of coils and avoid the troubles introduced by simply diverting current through a non-inductive resistance it would be better. It was undesirable when considering the properties of a motor to say anything about the average voltage. It was purely a numerical quantity. What had to be considered was the maximum voltage. Although 18 was a respectable figure for average voltage, one must go rather beyond that when the worst conditions prevailed, and one must be much more careful if field control was adopted. One must consider how far it is possible to go in shunting the field without coming to the conditions that lead to trouble. In the standard motors in Table II, the number of slots seemed to be very small leading to a very wide slot. That was not good practice for interpole motors.

Mr. E. G. Barton said there was much trouble caused by the use of a diverter which would be devoid of self-induction. Had a diverter in the contact circuit been used?

Mr. J. S. Highfield said he was glad Mr. Barton asked about the use of an inductive shunt. One common method was to shunt the main field with a diverter. He had several machines controlled in that way. Originally the shunts were non-inductive, and, of course, they had trouble from the causes explained by Mr. Lydall. Variations in current took place through the diverter instead of through the field. Then they made the shunts more inductive than the field, so that the degree of regulation was rather increased than decreased, as had been the case before. The change was entirely successful with these series wound generators and motors.

Mr. Roger T. Smith said he would make one or two remarks on the discussion, although he would leave the author to reply to it. Mr. Carter had said too much importance had been attributed to the hourly rating of the motors, with which he agreed, and he thought the Paper showed that the author agreed. In the Paper it was stated that the buying and selling of motors should be on the continuous as well as the hourly rating. The hourly rating was used simply to have some basis on which motors could be compared, but if pushed too far that comparison nearly always broke down. The Engineering Standards Committee had not yet legislated for traction motors, although the American Standards Committee had done so, and for the time being the American Standards were practically used here. He agreed that in the figure for the 1,200-volt motor in the Paper there were several defects from the operator's point of view. Besides the small bearings round the oil-thrower on the end of the commutator there was no doubt that for a 1,200-volt motor there was too little clearance between the end of the commutator and the bearings. In the most successful design of 1,200-volt motor in use on the Manchester and Bury section of the L. & Y. Railway the clearances were much increased. The criticism with regard to the length of the core he would leave to Mr. Pannell, but he endorsed what Mr. Carter had said about the impropriety of railway men buying motors imposing other limitations on the designs than those imposed by the actual physical dimensions within which they had to be made. The railway motor did not use the active material to the best advantage, otherwise its speed would be much higher. The less difficulties put in the way of the designer limiting him in any direction the better was the result, as a rule. Dr. S. P. Smith spoke on field-control and Mr. Lydall gave some illustrations of its difficulties. Field-control of a railway motor was one of the two things that appeared to be making the direct-current series motor really useful for railway purposes. The other feature the author had not mentioned was regenerative control. Those two features appeared to him (Mr. Smith) of singular importance in making the direct-current series-motor more fit than it had been before for the work railway men demanded of it. He was glad Mr. Barton raised the point about the inductive shunt, giving Mr. Highfield the opportunity to tell them his experience with the Thury type of direct-current motor. Mr. Lydall pointed out that field-control was simplified by the use of inductive shunts, and it might well be that this would largely solve the difficulty.

A vote of thanks to the author and to Mr. Roger T. Smith closed the proceedings.

THE ELECTRICAL INDUSTRY BEFORE AND AFTER THE WAR.

In a Paper read by Mr. G. H. Nelson before the British Westinghouse Club attention is first called to the extent to which American companies are taking up research work. For example, the General Electric Co. of America have a building which cost upwards of £400,000 to build and equip, and which costs about £150,000 a year to maintain. In addition, a scientific committee is considering the best way of tackling the technical education question in order to give scientific knowledge of various trades to the workers. It becomes necessary, therefore, not only to consider Germany but America after the war. The Board of Trade returns show that of the total export trade of Germany 28 per cent. went to our Allies before the war. At that time Germany had established herself in markets abroad that were open to us, but which we, owing to lack of proper consideration, had let slip through our fingers. The advancement of German electrical industry between 1907 and 1911 is remarkable, the number of firms having increased 41 per cent., and the hands employed by 80 per cent. The total earnings of the hands employed increased 5 per cent., and the earnings per person employed by 3½ per cent. There is no doubt that German electrical goods are sound and efficient, and we have lost trade to Germany even in our own colonies, such as India and Africa; yet, owing to the very large population of the British Empire, it should be possible to establish our trade on a very firm basis. In the opinion of the author the reasons that Germany has been able to make advances in commerce are (1) careful attention to manufacturing organisation and the application of research; (2) technical education; (3) careful attention to the selling organisation in considering the requirements of the countries in which they want to trade; (4) the German banking system, embodying long credits for small security; and (5) the import duties, which assure manufacturers of their home markets.

Manufacturing organisation may be divided into two headings dealing (*a*) with factory expenses and (*b*) with design of product. Factory expenses are largely influenced by the fixed charges; consequently the cost of the product depends very greatly upon the extent of the output, and for this reason the working of night shifts is profitable, even though certain charges incurred may be higher for night work than for day work.

The design has a most important bearing on the production of large output. This is a point which has been appreciated by the Germans very forcibly, as also the desirability of considering the customer

With regard to the latter point it would be an advantage to provide the selling man and erecting man with cards suitable for indexing and recording every motor sold, with the particulars of the load, type of plant it is driving and the conditions under which the motor works. Such data would be valuable when designing new motors as giving a record of the various conditions which the motors are required to meet. When a German sets out to develop new plant reliance is not placed on the ideas of one man; all the departments are brought together, so that the most suitable design is produced from all points of view. In this country designs are generally not tackled on a thorough basis, and consequently many designs are developed that the salesman cannot sell or the shopman cannot build. The author compares a German motor of 2 H.P., weighing 130 lb., and running at 1,200 revs. per min., with an old type of British machine having an output of 1¼ H.P., weighing 185 lb., and running at 1,200 revs. per min. The British machine was not designed for a fan or commutating poles, whereas the German machine was designed for both, and the armature had bigger slots and more copper in the armature. By altering the end brackets so that they were alike at each end, and providing sufficient space, a fan was introduced and other alterations were made, so that a 2 H.P. motor was produced; and by a new design a 3½ H.P. motor was made weighing 160lb. running at 1,200 revs. per min. Such a detail as making both brackets the same at each end of the motor is important from the point of view of cheapening the cost of production.

In experimental work there is much loss of knowledge owing to the fact that one firm does not know what another firm has done. The author considers that there should be in London or some other big centre an experimental and research bureau to which the results of experiments would be sent to be recorded, so that any firm could refer to this bureau for information before beginning to carry out tests, such information being sent free of charge. Such a bureau should be maintained by the State, as the trade of the country would benefit by the results. Similarly, manufacturers should be educated to look at the matter from the patriotic point of view, and should publish the results of their researches.

The great progress of Germany has been due to the following causes: (1) Careful attention to organisation; (2) careful attention to factory expense and hours of working; (3) working night shifts under proper conditions; (4) the continual endeavour to get maximum outputs; (5) careful attention to design; (6) co-operation between all sections of industry; (7) careful study of customers' requirements; (8) careful study of competitors' machines; and (9) systematic recording of results of research work.

In regard to education, there should be a greater study of the application of science to manufacturing and commerce. The German engineer is trained to a larger extent in applied science than in this country. It is to his advantage to hold an engineering degree or diploma when applying for an appointment in Germany, whereas in this country it is usual for applicants to keep silent in regard to such matters. Many employers require educating to the value of scientific training.

In regard to foreign trade, it is necessary to study the requirements and finance of each country concerned, and to deal through men who are familiar with the people, their language and their ways. Also to adopt the units of weight and other measures of the country.

German bankers give long credit to manufacturers on small security; that is, they allow manufacturers to have money on the security of an order, which places the German manufacturer at a great advantage. The British Government, assisted by expert advisers, should act as guarantors to banks for loans to manufacturers requiring financial assistance. The German manufacturer has also the advantage that German people support German enterprise; thus their home market is secured in a better way. In this country British manufacturers are not supported in the same way, nor do our big industrial firms consider one another. In conclusion, the author gives a German code of business by which Germans are pledged to support German industries.

BOOKS RECEIVED.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free (unless otherwise stated), on receipt of published price, adding 3d. for books published under 2s. and 5 per cent. for books published net. Add 10 per cent. for abroad or for reign books.]

"Electrical Apparatus Making for Beginners." By A. V. Ballhatchet. (London: Percival Marshall & Co.) Pp. 164. 2s. net.

"Text Book of Practical Physics." By H. S. Allen, M.A., and H. Moore, B.Sc. (London: Macmillan & Co.) Pp. xv.+622. 8s. 6d. net.

"Structure and Properties of the More Common Materials of Construction." By G. B. Upton. (London: Chapman & Hall.) Pp. v.+327. 10s. 6d. net.

"Telegraph Engineering," by Erich Hausmann, E.E., Sc.D. (London: Constable & Co.) Pp. xii+406. 12s. 6d. net.

NOTES ON THE MEASUREMENT OF HIGH VOLTAGE.*

BY WILLIAM E. WORK.

Summary.—A brief account is given of some experiments made to determine the relative accuracy of certain methods used in measuring high voltages. The methods comprise the use of a tertiary or voltmeter) coil in the high-tension transformer, the direct measurement of voltage by a crest voltage meter and the derivation of the high-tension pressure from the primary voltage.

This Paper is an account of some tests which were made with the view of comparing the several methods for the measurement of high voltages which are free from the objections peculiar to the spark gap.

Experimental Apparatus. The generator used is a 60 k.v.a. 250-volt eight-pole 60-cycle three-phase alternator with both ends of each phase winding brought out to the terminal board. In these tests the excitation was kept substantially constant at normal value and three schemes of connection, designated A, B and C respectively,

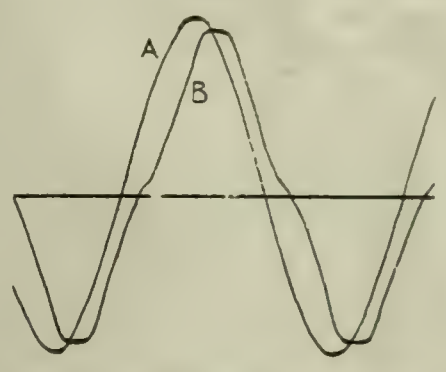


FIG. 1.—NO-LOAD WAVE FORMS OF A AND B.

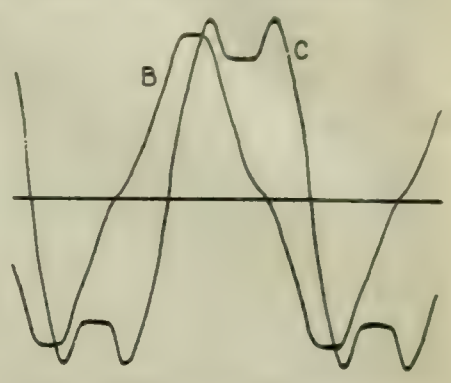


FIG. 2.—NO-LOAD WAVE FORMS OF B AND C.

were used. (A) Windings connected in *Y*. Wave shape approximating a sine form (Fig. 1). (B) One phase winding alone. Prominent third harmonic with other harmonics giving a flat-topped wave (Fig. 1). (C) Two windings connected in *V*. Same fundamental as B, but the third and ninth harmonics are doubled in value, and the wave has a prominent hollow at the quarter-cycle point (Fig. 2).

The transformer, Fig. 3, has a capacity of 100 k.v.a. at 200,000 volts 60 cycles. One end of the high-tension winding was grounded. The primary winding consists of four separate 480-volt coils arranged to be connected in parallel, in series-parallel, or in series. The reactance drop is about 4·5 per cent., the resistance drop about 0·6 per cent. The transformer had been equipped with a tertiary, or voltmeter coil intended to serve as a means of determining the secondary voltage. The accuracy with which the secondary voltage could be determined by the use of this coil was one of the things investigated. Control of the voltage was obtained by means of an induction regulator.

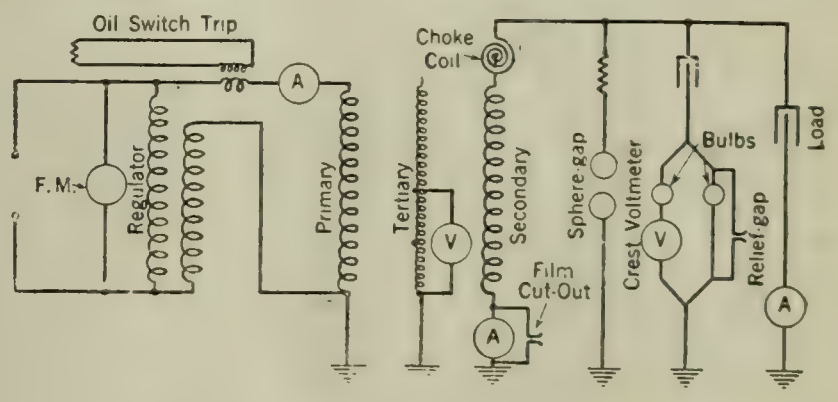


FIG. 3.

The actual secondary voltage was determined by a standard 250 mm. sphere gap used in accordance with the Standardisation Rules of the Institute. In most of the tests the gap was set at a certain length and the voltage slowly raised until spark-over occurred; in some cases, however, the gap was shortened slowly with the voltage constant. There was little difference in the results obtained by the two methods of manipulation although the first method gave slightly more consistent results, and was, therefore, preferred. Each point is the mean of five to seven trials.

Determination of Crest Factors.—Polar oscillograms of the voltages and currents were taken and the first six odd harmonic components of the waves were determined. The crest values were then obtained by calculating the ordinates of the waves at a few degrees on either side of the angle at which an inspection of the oscillogram indicated the peak. The crest values thus determined from the harmonic

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Table I.—*Secondary Voltage Derived from Tertiary Voltage.*

(Secondary pressure derived from the observed tertiary voltage and expressed as the R.M.S. value of the sine wave of equal peak.)

Ratio of secondary turns to tertiary turns = 1,000 : 1.

Test	1	2	3	4	5	6	7	8
Supply	A.	A.	A.	A.	B.	B.	C.	C.
Sec. current (amp.)	0·024	0·035	0·114	0·342	0·031	0·110	0·0306	0·323
Tertiary R.M.S. volts $\div 1{,}000 = E_3$	99.300	95.400	68.900	59.000	86.000	63.300	56,100	48.600
Crest factor of tertiary voltage $\div \sqrt{2} = F_3$	1·026	1·024	1·011	0·968	1·127	1·067	1·017	1·212
R.M.S. value of sine of equal peak of ter. volts $\div 1{,}000 = E_3 F_3$	101.900	97.700	69.700	57.100	96.900	67.500	57.100	58.900
Secondary volts by gap R.M.S. value of sine of equal peak E_2	103,700	96.900	69.300	57,600	96,600	67,400	57,900	57,600
Per cent. error by (*a*) R.M.S.ter.volts alone	1·2	1·5	- 0·6	- 2·4	11·0	6·1	3·1	15·6
(*b*) tert. volts corrected for crest factor	1·7	- 0·8	- 0·6	- 0·9	- 0·3	- 0·2	1·4	+2·3

components were checked by direct measurement of the amplitudes on the oscillograms.

An inspection of the above data shows that the tertiary voltage *corrected for crest factor* is a satisfactory measure of the actual secondary voltage as determined by a sphere gap.

Obviously the R.M.S. value of the tertiary voltage should not be used alone as a measure of the secondary voltage, when the latter is defined in terms of the crest value, unless something is known about the crest factor. The wave shape of the secondary voltage depends upon so many factors of complex relationship, some of which are mentioned by the author, that it is practically impossible to predict how the crest factor will be changed by a given change in the conditions of load or supply.

As an illustration of this the author gives a number of oscillograms. In tests 1 to 4 the generator was connected to give a "good" E.M.F. wave. As the load was increased the tertiary voltage wave-shape changed from a peaked form to a flat-topped form, the crest factor varying apparently as a linear function of the secondary current. In tests 5 and 6 B was used, and the third harmonic was 19·2 per cent. of the fundamental with the lighter load, but only 6·5 per cent. with the heavier load, the resulting change in the crest factor being from 1·593 to 1·509. Tests 7 and 8 are especially interesting, in that they show great changes in wave shape and crest factor produced by simply changing the load. The chief impurity in the tertiary wave shape is again the third harmonic. Here an increase in the load lowered this component in value from 36 to 24 per cent., and what is of more importance, practically reversed its phase, resulting in a change in the crest factor from 1·438 to 1·714. The addition of load in this case therefore increased the crest factor.

There is some evidence that the tertiary voltage wave form is more likely to resemble the secondary voltage wave form than the wave form of the primary voltage. Figs. 4, 5 and 6 compare the several voltage waves as mechanically synthesised from their respective harmonic series. The scale of these figures is so chosen that all the waves have the same R.M.S. value. The secondary wave shape determined in this manner is not strictly correct, on account of some corona current which was present. By integrating the whole load current and thus ignoring the in phase component due to corona the resulting wave is made to appear to the right of the true curve; and, further, since the shift of the fundamental is proportionately greater than for the higher harmonics, the shape of the wave is affected. This error is especially noticed in Fig. 5, where the capacitance of the load was the smallest and the corona current, therefore, largest as compared to the condenser current. Fig. 6 shows a marked difference between the primary voltage wave and the secondary voltage wave obtained by integration, but the latter wave is in fair agreement with the wave of tertiary voltage.

These tests, few as they are, show the necessity for a knowledge of the crest factor *under the particular conditions of the test* in order to use the voltage of a tertiary coil as an accurate measure of the secondary voltage.

Secondary Voltage Measured by Crest Voltmeter.—Crest voltmeters having indications dependent upon the average value of the charging current taken by a condenser and thereby measuring the peak value of the voltage across the condenser have been used in experimental testing.* In order to learn something of the usefulness of these meters under conditions prevailing in ordinary high-tension testing a meter of this type was also used to measure the high-tension pressure in all but test 1.

For clearness the observations are here exhibited in a separate table.

The measurement of high voltages by this method has substantially the simplicity of the ordinary methods for low voltage, with a precision apparently limited only by the difficulties of original calibration, save in one respect. Meters of this type employing rectifying bulbs, are inherently incapable of giving indications proportional to the highest peak of a voltage wave which has several peaks in a half-cycle. With waves of this kind the current through the condenser will have both positive and negative lobes in a half-cycle. Now the crest value of the voltage is proportional to the maximum quantity of electricity in the condenser, and this quantity is proportional to the net area of the current-time curve for one half-cycle, negative lobes counting as negative areas. The permanent magnet type instrument in series with a rectifying bulb indicates the average positive current throughout a whole cycle and thus measures the sum of the areas of all the positive lobes of the current-time curve in a whole cycle, failing to subtract the areas of the negative lobes when these are present in the first half-cycle and adding the areas of the same lobes when they appear on the positive side in the second half-cycle. The error is therefore a double one, both elements causing the meter to measure a current greater than the true average current, and, therefore, to indicate a voltage greater than the true high-tension voltage.

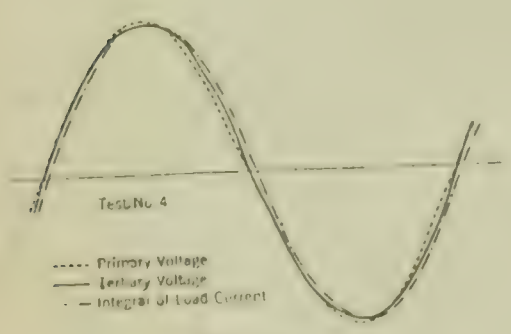


Fig. 4

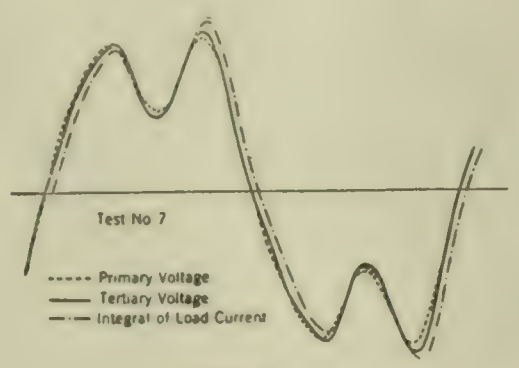


Fig. 5

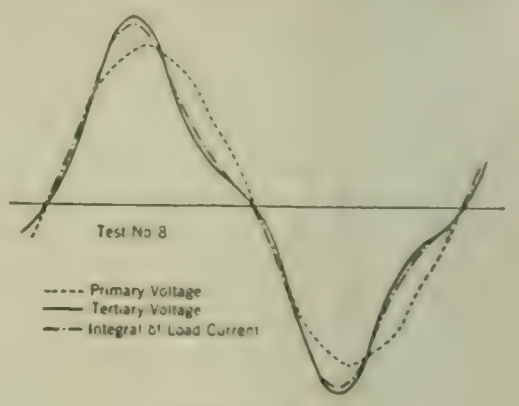


Fig. 6.

An error of another kind will be introduced in the measurement unless the frequency of the E.M.F. being measured is the same as the frequency employed in the original calibration of the meter. Since with a constant E.M.F. the meter reading will vary directly as the frequency, the proper correction can be easily applied.

As would be expected, the primary voltage, even when corrected for crest factor, is not, in general, a satisfactory measure of the secondary voltage, largely because the wave form of the primary voltage may or may not resemble the wave form of the secondary

Table II.—*Secondary Pressure Measured by Crest Voltmeter and Expressed as the R.M.S. Value of the Sine Wave of Equal Peak.*

Test.	Supply.	Crest voltmeter reading.	Sec. volts by gap R.M.S.	Sec. volts by integ. load cur.	Error of crest voltmeter per cent.
2	A	96,600	96,900	...	- 0·3
3	A	69,600	69,300	...	+0·4
4	A	57,500	57,600	57,400	- 0·2
5	B	96,400	96,600	...	- 0·2
6	B	68,300	67,400	...	+ 1·3
7	C	82,700	57,900	...	+ 42·8
8	C	56,900	57,600	57,100	- 1·2

* "Calibration of the Sphere Gap Voltmeter," Chubb and Fortescue. "Trans." A.I.E.E., 1915, Vol. XXXII., p. 739. "The Electric Strength of Air," Whitehead and Gorton. "Proc." A.I.E.E., June, 1914, p. 929.

voltage under given circuit conditions, the difference being especially noticeable in Fig. 6. Of course, the use of the simple ratio of turns is responsible for part of the error, because the internal resistance and and reactance drops in the transformer are thereby neglected.

Conclusions.—For the conditions of test and with the apparatus used, the following conclusions may be drawn :—

(*a*) It is possible to wind in a high-tension transformer a tertiary (or voltmeter) coil in such a manner that the voltage induced in this tertiary coil, when corrected for crest factor, is a satisfactory measure of the secondary terminal pressure.

(*b*) A crest voltmeter provides a convenient and, in general, an accurate means for measuring high voltages, though errors can be introduced by the use of extremely distorted voltage waves.

(*c*) The primary voltage, even when corrected for crest factor, is an uncertain measure of the secondary voltage because the respective wave forms may differ.

APPARATUS FOR STARTING AND CONTROLLING ELECTRICAL RUNNING MACHINERY.*

BY C. C. GARRARD.

(*Continued from p.* 774.)

Summary.—The apparatus dealt with consists of variable resistances to enable electric motors to be started up without taking an excessive current from the mains and without mechanical shock, and also to enable the running speed of the motors to be varied at will.

Comparison of Star-Delta Switches with Auto-transformers for Starting Squirrel-cage Induction Motors.—The star-delta switch is the cheapest form of starter for small squirrel-cage motors, and is always to be preferred when the conditions allow of its use. The question that follows therefore is : Under what circumstances must the more expensive auto-transformer starter be used ?

The star-delta starter is, of course, simply an appliance for switching the motor direct on to the mains with its stator windings connected in star, the normal running conditions being with the stator delta connected. When a squirrel-cage motor is switched directly on to the line it will take, before it starts, a definite amount of current equal to the voltage applied per phase divided by the impedance of the whole motor per phase. This latter remains constant whether the machine be connected star or delta, so that if E is the voltage between the line wires then the starting current, the stator being connected in star, is equal to $I=k_1\frac{E}{1\cdot73}$, where k_1 is a constant, since $\frac{E}{1\cdot73}$ is the voltage applied per phase. This is also the value of the current drawn from the mains. The starting torque experienced by the rotor before it begins to rotate is, for a given motor, proportional to the square of the voltage applied per phase winding—*i.e.*, again with the stator connected star, we have starting torque$=k_2\left(\frac{E}{1\cdot73}\right)^2$, where k_2 is a constant ; that is to say, if the opposing mechanical torque is greater than this amount, the motor cannot be started by a star-delta switch.

We thus have two limiting conditions ; in the first place the supply authority may object to suddenly switching on a current equal to $k_1\frac{E}{1\cdot73}$, or the opposing mechanical torque may be greater than $k_2\left(\frac{E}{1\cdot73}\right)^2$. In both these cases the auto-transformer starter offers a solution. We will consider the two cases as follows :—

(*a*) *To Draw a Small Starting Current from the Mains.*—The star-delta arrangement imposes a voltage per phase at starting on the motor of $\frac{E}{1\cdot73}$ volts. If a smaller starting current is required it is obvious a transformer having a larger ratio than 1·73 must be used. Suppose we use an auto-transformer with a 40 per cent. tapping—*i.e.*, a ratio of 1/2·5. The connections are shown in Fig. 3. The current taken per phase of the motor is $k_1 0{\cdot}4E$. The currents flowing in the connections A, B and C are $k_1 0{\cdot}4E\sqrt{3}$. The current taken from the mains (neglecting magnetising current of the auto-transformer) is

$$\frac{k_1 0{\cdot}4E\sqrt{3}}{2{\cdot}5}=\frac{k_1 E}{3{\cdot}61},$$

that is to say, the current drawn from the main is 48 per cent. of the current which was drawn by the star-delta starter. On the other hand, the starting torque is reduced from $k_2\left(\frac{E}{1\cdot73}\right)^2$ with the star-delta starter to $k_2(0{\cdot}4E)^2$ with the auto-transformer, which is also only equal to 48 per cent. of what it was when the star-delta starter was used.

(*b*) *To Secure a Large Starting Torque.*—Let us assume that we use an 80 per cent. tapping on the auto-transformer. Then using the same diagram as before, the current in each phase of the stator will be $k_1 0{\cdot}8E$, and the current in each connection A, B and C will be $k_1 0{\cdot}8E\sqrt{3}$.

The current taken from the mains will be

$$\frac{k_1 0{\cdot}8E\sqrt{3}}{1{\cdot}25}=\frac{k_1 E}{0{\cdot}9},$$

which equals 192 per cent. of the current taken by the star-delta arrangement. On the other hand, the torque has increased to 192 per cent. of the star-delta torque.

Applying these figures to a specific case of a 7 H.P. three-phase motor 1,500 revs. per min. 50 periods, having, with star-delta starting, a starting torque of 35 per cent. of full load torque and a starting current from the mains of 175 per cent. of full-load current, we have :—

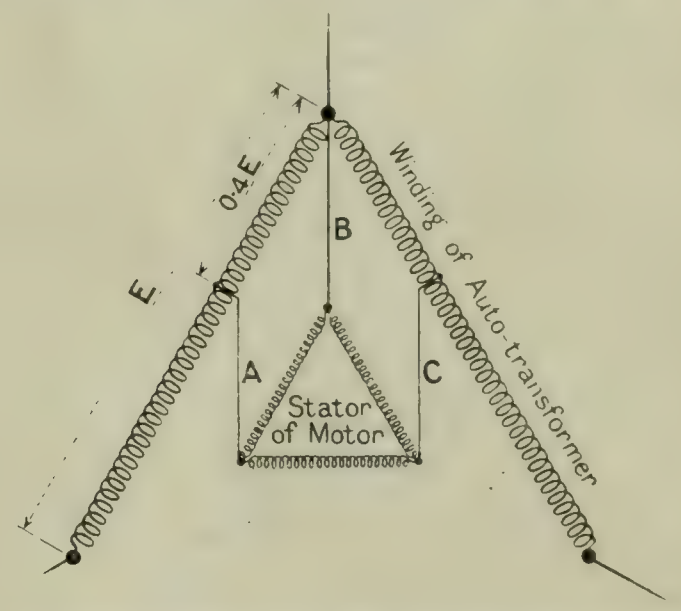


FIG. 3.—DIAGRAM ILLUSTRATING AUTO-TRANSFORMER STARTING OF SQUIRREL-CAGE MOTOR.

Table I.—*Comparison of Star-Delta Starter with Auto-transformer Starter.*

Method of starting.	Per cent. of full-load starting current drawn from the mains	Per cent. of full-load torque.
40 per cent. tapping on auto-transformer	% 84	% 16·8
Star-delta or auto-transformer, having ratio of 1/1·73	175	35
80 per cent. tapping on auto-transformer	336	67

It follows from this that no matter whether an auto-transformer or a star-delta switch be used, the starting torque is proportional to the current drawn from the mains.

Comparison of Resistance-type Starters for Squirrel-cage Motors with Auto-transformer Starters.—Starters consisting of resistances connected in series with the stator winding are sometimes used for starting up squirrel-cage motors. The connections are as per Fig. 4.

Let us suppose that sufficient resistance is used so that at the moment of starting up a voltage of 0·4E is applied across the stator terminals. Then, current taken per phase of motor

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$=k_1 0{\cdot}4E$, current taken from mains$=\sqrt{3}k_1 0{\cdot}4E$, and starting torque$=k_2(0{\cdot}4E)^2$.

Similarly, if the resistance be reduced so that a voltage of 0·8E is applied across the stator terminals at the moment of starting, then current taken per phase of motor$=k_1 0{\cdot}8E$, current taken from mains$=\sqrt{3}k_1 0{\cdot}8E$. and starting torque $=k_2(0{\cdot}8E)^2$.

Applying these figures we get :—

Table II.—*Comparison of Auto-transformer Starter and Resistance Starter.*

Method of starting.	Starting current drawn from the mains as a percentage of full-load current.	Starting torque as a percentage of full-load torque.
40 per cent. tapping on auto-transformer	84	16·8
Series resistance to give applied voltage of 40 per cent.	210	16·8
Star-delta or auto-transformer, having ratio of 1/1·73	175	35
Series resistance to give applied voltage of E/1·73	303	35
80 per cent. tapping on auto-transformer	336	67
Series resistance to give applied voltage of 80 per cent.	420	67
Switching motor direct on in delta	525	105

It will be seen from the figures in Table II. that the resistance type of starter for squirrel-cage motors is a very inefficient piece of apparatus. Its use is not to be recommended except

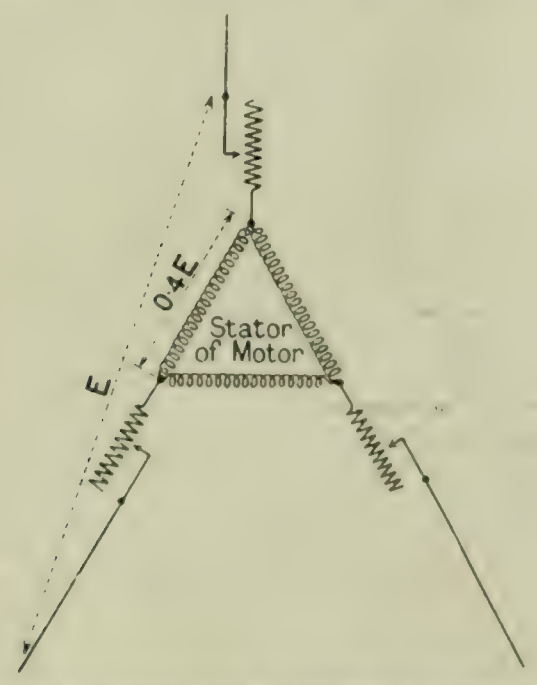


Fig. 4.—Diagram Illustrating Resistance-method of Starting Squirrel-cage Induction Motors.

perhaps sometimes for small sizes of motors. With it, it is not possible to obtain anything like a reasonable torque with a small current from the mains. Even when very little series resistance be used, the starting current taken from the mains is considerably larger than that taken by the auto-transformer for the same starting torque.

General Conclusion as to Choice of Type of Starter for Squirrel-cage Motors. The general conclusions to be drawn from the foregoing are as follows: The resistance type of starter for squirrel-cage motors should very rarely be used. Its only advantage is that it can easily be made with no-volt and overload releases, and thus for small sizes may find application sometimes. For motors up to 25 h.p., and occasionally for larger sizes, where the motor is started up light—*e.g.*, when it is connected by a clutch or loose pulley to its load, or where it only has to start up short lengths of shafting—the star-delta switch is best. When the starting conditions are severe, or unknown, or when the local or supply authority places restrictions on the value of the sudden starting current, then auto-transformers afford the best solution.

THE STARTING AND SPEED CONTROL OF THREE-PHASE SLIP-RING INDUCTION MOTORS.

Three-phase slip-ring induction motors are started and have their speed regulated by inserting non-inductive resistance in the rotor circuit. It has been suggested to use variable reactance coils instead of resistances. These, however, do not yield such good results owing to the starting torque being adversely affected by the increase of reactance of the motor.

Current Drawn from Mains when Switching on an Induction Motor.—If the motor be switched on with the slip-rings short circuited the momentary current drawn from the mains before the rotor starts will be simply limited by the impedance of the motor and may reach, say, six times the full-load current. This is like switching on a short-circuited transformer. The current induced in the rotor will be nearly equal (divided, of course, by the transformation ratio of the windings) to the primary current. The first object of the starter is to diminish this momentary rush of current. It is obvious that if resistance be inserted in the rotor circuit the rush of current in the rotor will be lessened; as, moreover, the primary (stator) ampere-turns are equal, approximately, to the secondary (rotor) ampere-turns, the stator current is likewise limited.

Let E_r be the voltage induced in each phase of the rotor with full stator voltage E_s applied and the rotor standing. Then, with the rotor resistance R we have rotor current

$$=I_r=\frac{E_r}{R}$$

(neglecting the internal resistance of the rotor and its reactance, which are small as compared with R).

The corresponding stator current with the rotor standing will be

$$=I_s=\frac{E_r}{R}\times\frac{E_r}{E_s}.$$

Now, E_s and E_r are constants, therefore, it will be seen that the momentary current taken from the mains is inversely proportional to the resistance of the rotor. The above figures are, of course, only approximate, as they do not take the mag-

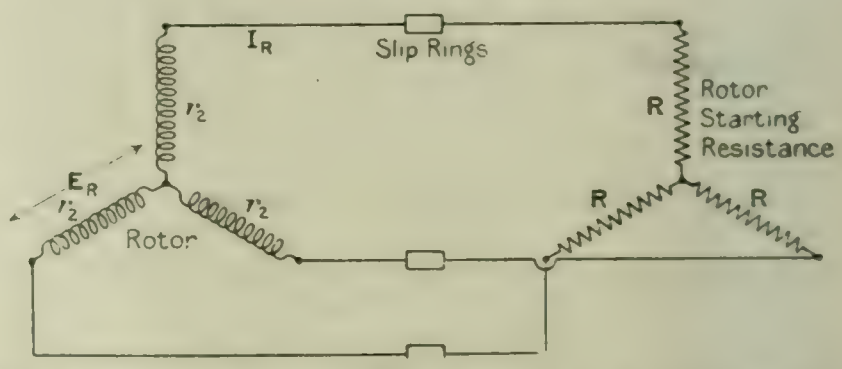


Fig. 5.—Diagram of Connections of Rotor of Induction Motor with Resistance connected to Slip-rings.

netising current and the reactance of the motor into account. Nevertheless the calculation, when dealing with ordinary starting gear, is quite accurate enough to illustrate the point discussed.

Starting Torque of an Induction Motor.—In the previous paragraph it was mentioned that the first object of inserting resistance in the rotor circuit was to reduce the current drawn from the mains when the motor is switched on. The second and more important object to be served is to increase the starting torque. This follows from the well-known fact that the starting torque of an induction motor is increased by adding, up to a certain limit, to the resistance of the rotor winding.

The physical reason of this is that if the motor is switched on with short-circuited secondary, owing to the large magnetic leakage the rotor current is displaced in phase relative to the magnetic field, which is effective in imparting the torque to the rotor, to such an extent that in spite of the large rotor current the starting torque is diminished.

In Fig. 6 are given representative speed-torque curves of an induction motor. The continuous line curve represents the

conditions when the motor is switched on with the rotor slip-rings short-circuited. The distance A represents the torque developed at starting, and the values of the vertical ordinate represent the torque which could be developed by the motor at any particular speed. It will be seen that the torque rises to a maximum and then falls again ; at synchronous speed the torque is zero. The normal full-load torque and speed is represented at D, the distance BC being the normal slip. If now a certain amount of resistance be inserted in the rotor winding, the curve changes to the dotted line shape, and further, as more resistance is added, goes to the chain-dot line curve. With this latter the starting torque has reached its maximum possible value ; further increase of rotor resistance will then have the effect of decreasing the starting torque below the maximum value. It will be seen that the maximum value of torque of each curve is the same, as this maximum possible value is independent of the resistance of the rotor.

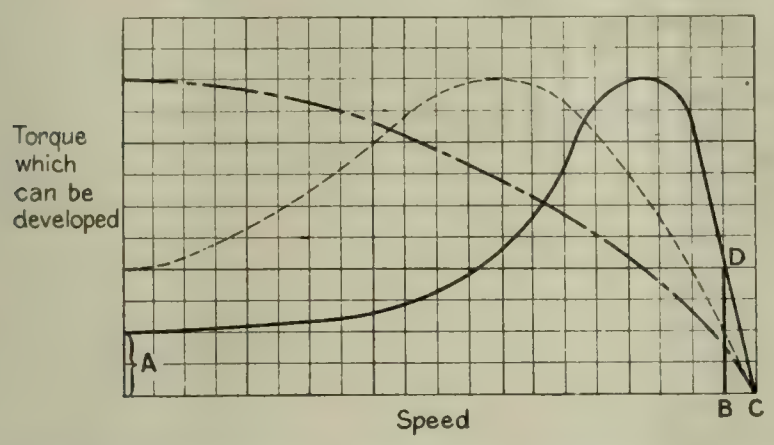


Fig. 6.—Torque-speed Curves of Three-phase Induction Motor with Various Resistances in the Rotor Circuit.

If a horizontal line be drawn through D this will cut the various curves at points which will give the speeds the motor will run at with the various resistances in the rotor circuit, presuming, of course, that the opposing mechanical torque remains constant and equal to the full-load value. There remains now to determine the speed at which the motor will run with the different values of resistance inserted in the rotor circuit.

(*To be concluded.*)

LONDON COUNTY COUNCIL TRAMWAY ACCOUNTS.

These accounts, together with the report on the traffic service, appear in Volume I. of the Annual Report of the London County Council, which has now been published. We give below an analysis of those parts of the accounts, together with extracts from the reports which accompany them in so far as they are of interest to electrical engineers.

The total length of the Council's tramways (excluding approach lines to car-sheds) on January 1, 1914, was 147 route-miles, and on December 31, 1914, 149½ route-miles, of which about 143½ miles were electric tramways. During the year 1914 nearly 60,000,000 miles were run by the Council's tramcars, while nearly 535,000,000 passengers were carried.

Extensions.—Reference was made in the report for 1913 to the fact that the Council's officers had been directed to prepare a scheme for linking up the existing dead-end termini, and otherwise consolidating the system. The Highways Committee subsequently submitted recommendations to the Council with a view to applications being made in Parliament in the session of 1915 for authority to construct tramways with the object of abolishing 11 of the dead-end termini. The total expenditure involved would have amounted to £787,035 in respect of tramway works. The Council, however, on November 10, 1914, having regard to the desirability of conserving public funds, instead of expending them on contentious Parliamentary proposals, declined to proceed during 1915 with any schemes to which consent could not be obtained. Subject to this decision it was decided to make application to Parliament to construct five tramways, viz., Seven Sisters-road to near Crouch Hill station, Charles-street to Charterhouse-street, Mare-street to Terrace-road, High-street, Shoreditch, to Cambridge-road, and Aldgate to near Mark-lane. Other new tramways authorised, but not begun, were Hammersmith Broadway to the northern end of Hammersmith Bridge, and the junction between Tooting High-street and Mitcham-road. With regard to the former, the powers obtained lapsed in 1910 and again in 1913, the authority being renewed by the L.C.C. Tramways and Improvements Act of that year. In the second case, steps were being taken to renew the authority which lapsed in 1915.

Supply.—The Greenwich electricity generating station was opened in two sections in 1906 and 1910 respectively. The cost of power supplied from the station during the financial year ended March 30, 1915, including interest and sinking fund charges but exclusive of sub-station expenses, was 0·396d. per unit. The amount of coal required for the working of the station during the year ended March 31, 1915, was 157,691 tons. The average price paid therefor was 16s. 8d. per ton. Reference was made in the reports for 1912 and 1913 to the question of enlarging the capacity of the plant at the station, to cope with the rapidly increasing load, consequent upon the extension of the tramways system in recent years, and to the decision to substitute a steam turbine of 8,000 kw. normal capacity for each of the four reciprocating engines. The new normal capacity of the station when worked entirely by turbines will then be 52,000 kw., as compared with a previous capacity of 34,000 kw. The work is being carried out in two stages, the first of which was commenced in 1913. One of the turbo-generators was installed on May 27, 1914. Messrs. Kennedy & Donkin have been engaged to advise on the work in the second stage of the extension. At the end of 1914 tenders were being invited for the second two turbo-generators required. It was considered desirable that steps should be taken to increase the existing car services, but before this could be done it was necessary to obtain a temporary supply of power from an outside source. Arrangements were accordingly made on November 17, 1914, with the London Electric Supply Corporation, who agreed to supply the additional quantity of power required up to 1,500 kw. at a price of £3 per kilowatt per annum, and 0·4d. per unit. This power was provided at the Lewisham sub-station, and was sufficient to enable between 50 and 60 additional cars to be run. In consequence of the constantly increasing number of car services some of the tramways sub-stations are being called upon at certain times to supply the maximum amount of energy which can be transformed thereat. Steps were therefore taken to provide not only for any increase in the car services which might have to be made from time to time, but also a greater margin of plant in time of emergency, and a comprehensive scheme was, on July 28-29, 1914, approved whereby the existing plant is to be re-arranged, and additional machinery installed. The total expenditure involved by this scheme is estimated at £48,270. Arrangements have been made to secure that the works shall, if possible, be completed by June, 1915.

Renewals.—The Council on June 23, 1908, agreed that, subject to the approval of His Majesty's Treasury being obtained in due course, provision should be made for the repayment within a period of 15 years from March 31, 1914, of the debt outstanding on that date (estimated at £961,954) in respect of obsolete expenditure on horse tramways. At the same time it was considered that the further charge due to the acceleration of the repayment of such expenditure should not be made obligatory upon the undertaking, until the Council was satisfied from experience that this could be done without prejudice to the establishment and maintenance of an adequate renewals fund. The accounts for the year 1912-13 showed a balance of only £497 available for the renewals fund, while the accounts for 1913-14 showed a deficiency to be met out of the general reserve fund of £88,525. The Council accordingly, on January 27, 1914, decided that the question of expediting the repayment of the debt should be considered in the year ending March 31, 1917, or earlier if and when there should be any surplus available for the purpose after the renewals fund had been made up to the full amount necessary on the basis agreed upon, which is at present at the rate of ⅔d. per car-mile

Petrol-electric Cars —In the report for 1913 reference was made to the equipment of three horse tramcars for use as petrol-electric cars. These cars were run experimentally on the Tooley-street to Greenwich Church route, but as the experiment did not prove satisfactory they were withdrawn from service. It has now been decided to use them as tractors of trailer cars between the main tramway routes and the depots in which the trailer cars will be housed. The first depot to be adapted for this purpose is that at Balham, which was originally utilised for the purpose of accommodating horse cars and horses. The Council, on July 14, 1914, decided to obtain 150 new trailer cars for running on the southern tramways.

Fares.—It was decided to issue on the tramways a 6d. ticket available on the day of issue only for any four journeys. The following additional arrangements regarding the conveyance of children on the tramways were approved during the year: (1) School children visiting medical-treatment centres to be charged ½d. fare for a single journey on each car between 9:30 a.m. and 4 p.m., except on Saturdays, Sundays and public holidays. (2) Children under 14 years of age to be charged on Saturdays, Sundays and Bank Holidays ½d. for 1d. single-journey stages, 1d. for 1½d. and 2d. single-journey stages, and 1½d. for 2½d. and 3d. single-journey stages. Consideration was given during the year to the question of the desirability of issuing season tickets on the tramways, but it was decided that no action should be taken in this direction.

The total capital expenditure upon the undertaking to March 31, 1915, amounts to £13,315,723. 4s. 5d., of which £287,603. 13s. 6d. represents expenditure during the year 1914-15. The result of the year's working is as follows:—

	Electric. £ s. d.	Horse. £ s. d.	Total. £ s. d.
Income	2,389,046 4 7	10,800 11 9	2,399,846 16 4
Working expenses (including war service allowances)	1,684,243 10 10	16,327 11 4	1,700,571 2 2
Surplus on working	704,802 13 9	5,526 19 7 (*deficiency*)	699,275 14 2

We give below details of the capital expenditure for the year ending March 31, 1915:—

Greenwich Station.		
Land	£58,693	
Buildings	314,555	
Pier, river wall and condenser water pipes	79,486	
Machinery and plant	473,771	
		£926,505
Distribution, Sub-stations, &c.		
Land	£102,630	
Buildings	158,781	
Machinery and plant	277,088	
Cables	540,568	
Ducts	351,838	
		1,430,905
Plant in temporary generating stations		42,083
		£2,399,493
Construction, &c.		
Permanent way	£4,815,662	
Overhead equipment	42,179	
Alterations to bridges	135,949	
Depots and offices	1,258,814	
Machinery and plant	104,981	
Cars	1,499,962	
Temporary subway	205,193	
		8,062,740
Street improvements		714,352
Pimlico site		66,343
Total electric traction		£11,242,928
Horse and cable traction		142,398
Obsolete capital (horse traction)		1,930,397
Total outlay		£13,315,723

At March 31, 1914, £534,341 had been invested for the Renewals Fund. During the year it was found necessary to realise a portion of the investments costing £138,614. 18s. in order to meet current and contemplated expenditure on renewals, reducing the total invested at March 31, 1915, to £395,726. 12s. 2d. The market value of the investments at that date was £348,155. The Council on June 23, 1908, resolved that during a period of five years any balance remaining after providing fully for renewals should be carried to the General Reserve Fund. The last amount so credited to the fund was in respect of the year 1911-12. At March 31, 1915, £173,129. 18s. 3d. was invested, the cash balance of the fund being overdrawn, owing to the transfer to Net Revenue Account to meet the deficiency for the year being larger than anticipated. The market value of the investments was £146,280.

The total income on Revenue Account amounted to £2,399,847, of which £2,333,391 was derived from passenger traffic.

	Car miles.	Passengers.	Traffic receipts.
Electric traction	58,706,161	547,283,332	£2,323,130
Horse traction	272,631	3,244,661	10,261
	58,978,792	550,497,993	£2,333,391

Table I. gives particulars of revenue during the last four years.

Table I.—*Tramways Revenue, &c., of Year 1914-15, Compared with Previous Years.*

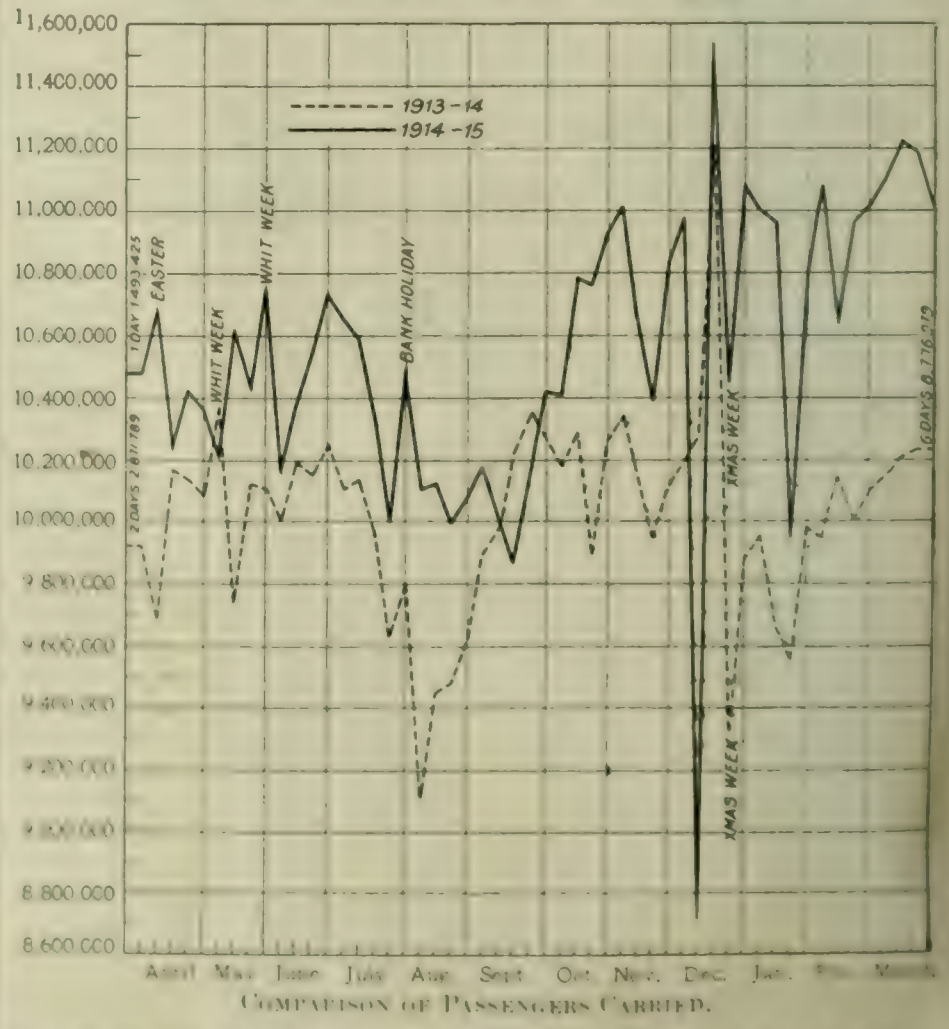
	1911-12.*	1912-13.	1913-14.	1914-15.
Total revenue	£2,356,180	£2,251,729	£2,268,668	£2,399,847
Passenger traffic rev.	£2,292,259	£2,181,103	£2,202,489	£2,333,391
Passengers carried	533,440,235	512,652,653	522,952,640	550,497,993
Car-miles	50,457,812	53,943,104	59,209,289	58,978,792
Avg. fare pd. per pass.	1·03d.	1·02d.	1·01d.	1·02d.
Total avg. receipts per car-mile (electric)	11·29d.	10·04d.	9·21d.	9·77d.
Do. (horse)	8·81d.	8·73d.	8·15d.	9·51d.

Table II.—*Number of Passengers Carried.*

Fare, d.	*†1911-12. Passengers. (approx.)	Per cent.	†1912-13. Passengers (approx.)	Per cent.	1913-14. Passengers (approx.)	Per cent.	1914-15. Passengers (approx.)	Per cent.
½	144,662,000	27·12	143,719,400	28·03	150,246,800	28·73	158,557,000	28·80
1	239,139,200	44·83	224,328,400	43·76	218,467,200	41·78	225,081,900	40·89
1½	47,467,150	8·90	41,909,400	8·18	35,660,800	6·82	35,643,400	6·47
2	53,020,700	9·94	48,492,000	9·46	15,568,200	2·98	15,129,100	2·75
2½	7,437,100	1·39	6,486,600	1·26	3,507,000	0·67	3,718,500	0·68
3	11,723,400	2·20	13,284,400	2·59	3,210,500	0·61	3,464,900	0·63
3½	1,555,150	0·29	1,214,000	0·24	186,600	0·04	132,300	0·02
4	507,100	0·10	1,057,900	0·21	201,000	0·04	165,500	0·03
4½	22,650	0·00	18,600	0·00	16,900	0·00	30,900	0·01
5	400	0·00	355,800	0·07	41,500	0·01	54,500	0·01
5½	...	...	...	...	...	...	1,200	0·00
6	50	0·00	28,700	0·01	6,400	0·00	9,600	0·00
Rtrn.								
1	...	...	...	...	112,000	0·02	123,700	0·02
1½	...	...	...	...	93,400	0·02	115,800	0·02
2	...	...	...	...	24,497,600	4·68	25,270,900	4·59
3	...	...	...	...	17,293,600	3·31	20,184,600	3·67
4	...	...	...	...	3,774,000	0·72	5,001,700	0·91
5	...	...	...	...	2,390,200	0·46	3,606,400	0·65
6	...	...	...	...	113,200	0·02	65,200	0·01
8	...	...	...	...	...	...	30,000	0·01
9	...	...	...	...	...	...	200	0·00
Exch.	27,905,300	5·23	31,757,500	6·19	47,565,700	9·09	54,110,200	9·83
Total	533,440,200	100·00	512,652,700	100·00	522,952,600	100·00	550,498,000	100·0

and Table II. an analysis of passengers. The diagram gives a comparison between the last two years.

It is satisfactory to note that the increases in the receipts from the passenger traffic became apparent some time before war broke out,



COMPARISON OF PASSENGERS CARRIED.

and before any of the competing omnibuses were acquired by the Government. Owing to the continued extension of transfer tickets

* Coronation year. † No separate record kept of return tickets.

the increase in the passengers carried is greater than is apparent from the returns. Previous to transfer tickets being issued a passenger changing from one car to another was counted as two passengers, whereas a passenger holding a transfer ticket, although travelling on two or more cars, is counted as a single passenger.

The operating costs for electric traction amounted to £1,636,358.18s., or 6·69d. per car-mile, as against 6·47d. in the previous year. A sum of £47,884. 12s. 10d. was expended on special charges, including £42,209. 2s. 1d. for war service allowances. The total working expenses (exclusive of war allowances £42,209) for 1914-15 was £1,642,034, or 6·71d. per car-mile, as compared with £1,585,251. 5s. 5d., or 6·50d. per car-mile for 1913-14. The war service allowance caused a deficiency of £33,172. 12s. 1d., which was met out of the General Reserve Fund. But for the allowances mentioned there would have been a surplus of £9,036. 10s. The deficiency for 1913-14 was £88,525. 15s. 11d. The increase in the receipts would have been greater but for the facilities given for free travelling to special constables and men serving in the forces of the Crown and the reduced travelling by the public during the first months of the war owing to disorganisation of business and the darkening of the streets.

We give below a detailed statement of the expenditure and revenue on the electrically operated lines and the capital charges thereon for the year 1914-15, including the costs of each item per car-mile for the years 1913-14 and 1914-15.

ELECTRIC TRACTION.

		Per car-mile. 1914-15.	1913-14.
Traffic Expenses.			
Traffic superintendence	£6,528	0·02d.	0·02d.
Wages of motormen and conductors	544,223	2·21d.	2·14d.
Wages of other traffic employees	76,645	0·31d.	0·28d.
Cleaning and oiling cars	78,257	0·31d.	0·31d.
Conduit cleaning	16,331	0·06d.	0·07d.
Cleaning and sanding track	7,015	0·03d.	0·03d.
Printing and stationery	29,81	0·01d.	0·02d.
Fuel, light and water for depots	8,117	0·03d.	0·03d.
Ticket checks	26,867	0·10d.	0·10d.
Uniform and badges	15,169	0·06d.	0·06d.
Compensation	37,294	0·15d.	0·19d.
Licences	4,641	0·02d.	0·02d.
Miscellaneous	6,707	0·02d.	0·03d.
Total Traffic Expenses	£830,775	3·35d.	3·30d.
Advertisement Expenses	£6,478	0·02d.	0·02d.
Repairs and Maintenance.			
Permanent way	£100,523	0·41d.	0·42d.
Electrical equipment of line	14,174	0·05d.	0·05d.
Building and fixtures	9,287	0·03d.	0·04d.
Track in depots	2,595	0·01d.	0·01d.
Workshop tools	...	...	0·01d.
Cars	231,381	0·92d.	0·86d.
Other rolling stock	...	...	0·01d.
Miscellaneous	6,104	0·02d.	0·01d.
Total Repairs and Maintenance	£464,064	1·44d.	1·41d.
General Expenses.			
Salaries	£25,347	0·10d.	0·10d.
Stores expenses	17,293	0·07d.	0·07d.
Rents	3,725	0·01d.	0·01d.
Rates and taxes	23,556	0·09d.	0·08d.
Rates on permanent way	87,843	0·35d.	0·36d.
Printing and stationery	2,518	0·01d.	0·01d.
Fuel, light, water	1,013	0·00d.	0·01d.
Law charges	...	0·00d.	0·00d.
Insurances, &c.	2,215	0·01d.	0·05d.
Central offices	1,701	0·00d.	0·01d.
Workmen's compensation	3,189	0·01d.	0·01d.
Miscellaneous	2,696	0·01d.	0·02d.
Total General Expenses	£171,096	0·66d.	0·73d.
Power Expenses (*see* below)	£250,124	1·02	1·01d.
Special charges	5,002	—	0·03d.
TOTAL WORKING EXPENSES (*ex* capital charges)	**£1,642,034**	**6·71d.**	**6·50d.**
Revenue.			
Passenger traffic	£2,323,129	9·43d.	8·94d.
Advertisements	24,369	0·10d.	0·10d.
Leased lines and through running arrangements	26,498	0·10d.	0·12d.
Sale of old materials	14,140	0·05d.	0·04d.
Miscellaneous	910	0·00d.	0·01d.
TOTAL REVENUE	**£2,389,046**	**9.68d.**	**9·21d.**
Balance carried to Net Revenue Account	£704,803	2·81d.	2·71d.
Capital Charges.			
Greenwich Station (interest)	£24,602	0·10d.	0·10d.
,, ,, (sinking fund)	26,547	0 10d.	0·11d.
Distribution (interest)	38,660	0·15d.	0·16d.
,, (sinking fund)	51,440	0·20d.	0·21d.
Construction (interest)	217,008	0·88d.	0·88d.
,, (sinking fund)	284,966	1·15d.	1·13d.
Street Improvements (interest)	23,999	0·09d.	0·08d.
,, ,, (sinking fund)	11,942	0·04d.	0·04d.
Pimlico site (interest)	1,612	0·00d.	0·01d.
,, ,, (sinking fund)	376	0·00d.	0·00d.
Total Capital Charges	£681,152	2·71d.	2·72d.
Deficit (electric traction)	£33,173		

The figures for horse traction are as follows :—

HORSE TRACTION.		Per car-mile. 1914-15.	1913-14.
Horsing expenses	£5,854	5·15d.	4·40d.
Traffic expenses	4,737	4·17d.	4·06d.
Advertisement expenses	8	0·01d.	0·01d.
Repairs	3,877	3·41d.	1·53d.
General expenses	904	0·80d.	0·59d.
Special charges	947	0·83d.	0·80d.
Total Capital Charges	£16,327	14·37d.	11·39d.
Deficit (horse traction) (*incl.* capital charges)	£5,527		£8,590

There are also the following capital charges on obsolete capital to be met :—

Interest	£19,728
Sinking fund	26,919
Total	£46,647

Adding this total to the deficit on electric traction, and the deficit on horse traction, the total deficit together with Parliamentary and other expenses comes to £78,023. As mentioned above the power expenses for electric traction amounted to £250,124, and the various items making up this total are as follows :—

POWER EXPENSES.

Greenwich Generating Station.		Cost per unit.
Salaries and wages	£17,099	—
Fuel	134,393	—
Water	732	—
Oil and waste	954	—
Repairs	12,268	—
Rates, taxes and insurance	18,266	—
Miscellaneous	1,753	—
Total Generating Expenses	£185,465	0·396d.
Temporary Power Supplies	£34,745	—
Distribution (sub-stations, &c.)	37,476	—
Total Power Expenses (*ex* capital charges)	£257,686	—
Less power used for other purposes	7,562	—
Power Expenses	£250,124	—

The total number of units used during the year was 156,701,313. This includes sub-station lighting and units used in car-sheds and depots. The total units purchased from outside was 13,961,903. The number of units used per car-mile was 2·6, as compared with 2·63 during the previous year. Each electric car on the average travelled 117·07 miles per day, at an average speed of 8·95 miles per hour. The average number of cars in use was 1,374, together with 10 horse cars. The average number of passengers per car-mile amounted to 9·32 for electric traction, and 11·90 for horse traction.

Cooling of Cylinders.—Private J. Alfred Hughes, B.Sc., E. Company R.A.M.C., has a Paper in the "Philosophical Magazine" entitled "On the Cooling of Cylinders in a Stream of Air." The cylinders were arranged with the axis perpendicular to the stream, and the results obtained were of the form $H = kv^n$, where H is the rate of heat loss, k is the constant, and v is the velocity of the stream. For diameters between 0·43 cm. and 1·93 cm., the index was 0·55 to 0·65. For the large cylinder of diameter 15·5 cm. the index was 0·98, but at low velocities it was 0·6. These results are in agreement with those of previous experimenters. Some experiments were also made regarding the loss of heat from bodies having stream line sections. The experiments showed that regarded as a cooling apparatus a stream line section was much more efficient than a circular one.

A DIRECT-CURRENT GENERATOR FOR 10,000 VOLTS.*

BY W. LINKE.

The highest direct-current voltage yet obtained for industrial purposes was probably that obtained on the Thury system, for the power transmission scheme from St. Maurice to Lausanne. Several motors and dynamos were coupled in series; the dynamos gave a maximum pressure of 2,200 volts. Altogether there were 10 such machines, and this gave a maximum pressure of 22,000 volts. The bedplates of the different dynamos were completely insulated; therefore, with each machine, only a pressure of 2,200 volts had to be considered. Besides this installation, the maximum industrial pressures may be said to range between 2,000 and 3,000 volts, as in the cases of Maizière Saint Marie, Hull, &c. Lately several railways have been constructed with pressures between 2,000 and 3,000 volts. The usual plan in such cases has been to put two machines in series. There have also been experimental attempts to construct small machines for pressures up to 5,000 volts; and for testing the insulation of the Thury installation, a very small machine giving 1 ampere at 22,000 volts was made, and designed on very unusual lines. The induction winding, in the form of a ring, and the commutator were both fixed; the field and the brushes rotated. The voltage between segments of the commutator was fairly high, and amounted to about 50 volts. There was the question of getting sparkless commutation, and this was done by inserting condensers between the different segments of the commutator. A stream of compressed air was also directed on the commutator in order to extinguish the sparks at the tips of the brushes.

The Allgemeine Elektricitäts Gesellschaft has recently supplied a machine to the Reichsanstalt giving a pressure of 10,000 volts, and an output of 10 kw. The machine is intended for scientific purposes,

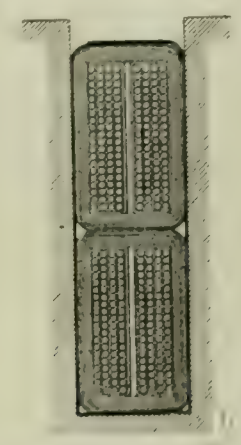


Diagram showing the Insulation of the Windings in the Slots of the Drum Armature.

(Five-fourths of the full size.)

such as the examination of the phenomena attending discharges in gases, and the properties of insulating materials under high direct-current stresses. There was a clause in the specification which rather troubled the designers. This provided that the construction should be such that any pole could be earthed or connected to the bedplate; therefore the other pole had to withstand the entire pressure of 10,000 volts between its windings and the iron core; further, the voltage of 10,000 was to be so arranged that at lower voltages a correspondingly larger current could be obtained. It was thought better to design the machine on usual lines; a good deal of experience has been accumulated in the process of years, and it was thought better to utilise this. The voltage was divided between two machines, each of which had two commutators. There were thus four commutators in all, over each of which there was a pressure of 2,500 volts. The armatures are wound on the normal drum system. The pressure between the segments on the commutator was not above the usual figure; there were 212 segments on the commutator, between each of which there was a pressure of about 24 volts. The main difficulty lay in the insulation of the winding, and particularly in protecting the windings imbedded in the slots in the armature from the full working pressure of 10,000 volts. The best insulating materials were chosen, and the windings, which were embedded in the slots, were very carefully wrapped on the Hafely system with micarta foil, the wrapping being pressed on without a join. The accompanying diagram is a section through the winding in the slot to a scale of about five fourths of the actual size. In this way a thoroughly satisfactory insulation was obtained. The separate coils were tested with a pressure of 22,000 volts, and the complete armature was tested with an alternating pressure of 20,000 volts. The machine naturally had commutating poles; the commutation was almost completely sparkless up to overloads of 150 per cent. of the normal output. The pressure being very high, the insulation might be exposed to serious risk on closing the switch, and it has therefore been necessary to take suitable precautions by providing it with suitable devices to protect it against surges.

* Translated from the "Elektrotechnische Zeitschrift," Heft 12, 1915.

EFFICIENCY OF PROJECTORS AND REFLECTORS.*

BY HAYDN T. HARRISON.

The author refers to recent researches that have resulted in improvements in the design of searchlights which make the useful illuminating power nearly eight times that of the searchlight used hitherto. He has also been experimenting with gas-filled incandescent lamps, with the object of concentrating their light for certain other purposes, and it is these experiments which have led him to the conclusion that the efficiency of reflectors will play a very important part in the future of electric lighting. To ensure that the gain in lamp efficiency is not lost by shading or diffusing, it is essential that these should be carried out in a scientific manner.

Fortunately the cause of the increased intrinsic brilliancy—viz., the reduced area of the light source—is an aid to efficient reflection; and it is to be hoped that makers of gas-filled lamps will place the coiled filaments close together so as to concentrate the light source.

The importance of a concentrated light source for efficient reflection is clearly brought forth by the fact that with a 6-volt 108-watt lamp it is possible to produce a reflector giving seven times the multiplying power obtainable when using a 100-volt lamp under the same conditions, the spread in the latter case being more than double. The author will, therefore, submit reasons why he considers this is likely to become an important factor in future private and public lighting.

There is little doubt that many of the attempts to produce efficient lighting by means of reflectors have failed, due to psychological reasons. In workshops and places where the æsthetic side does not receive much consideration there is little objection to leaving the shop in what, compared with daylight, is darkness, and only supplying local lighting for the work in hand. Personally, whilst thoroughly approving of the strong local lighting, in the author's opinion, a good general light tends to improve the temper and discipline of the workers.

In other places than workshops and factories local lighting rarely meets with approval. It will be remembered that the introduction of indirect and semi-indirect lighting was largely due to the desire to hide the brilliance of the light source brought about by the increased efficiency of the lamps, and that in one of the best known of these indirect systems reflectors are used to concentrate the light on the ceiling, from whence it is diffused into the room.

Assuming that the efficiency of these reflectors was good, and that 70 per cent. of the luminous flux was concentrated on the ceiling, and that the reflecting value of the ceiling was 70 per cent., thus allowing about 50 per cent. of the original light for illuminating the objects in the room; this 50 per cent. was being diffused from a reflector which distributed it in all directions in the lower hemisphere, therefore the luminous flux was divided over an angle of 180 deg. In most rooms the bulk of the light is required over an angle of 90 deg. when the light source is high up, therefore, of the original light produced the luminous flux used $0{\cdot}5(1 - \cos 45)(1 - \cos 90) = 0{\cdot}146$. A semi-indirect fitting would have been more efficient, as some of the light would have been allowed to pass into the required direction through a diffuser, but the efficiency would still be very low.

Both the indirect and semi-indirect systems were primarily designed to avoid glare, but it is also contended that they have advantages owing to the light being very widely diffused. In the case of the indirect system this diffusion is often carried to an unnatural degree. The desire to avoid glare is very natural, but before means can be devised for avoiding this effect it is necessary to investigate the cause.

It appears to be the general impression that the sole cause of glare is the high intrinsic brilliancy of a light source. In the author's opinion this is not so, for the following reason: If a 10-in. diameter motor-car headlight, producing, say, a maximum of 5,000 c.p., is compared with an arc lamp which, when enclosed in a 10-in. opalescent globe also gives 5,000 c.p., the headlight will appear to be much more glaring than the arc lamp, although the intrinsic brilliancy of the source is the same. The difference lies in the fact that the apparent intrinsic brilliancy of the source tapers off in one case to nothing, whereas in the case of the headlight it ceases nearly abruptly. Thus there is a means of reducing the unpleasant effect of glare

* Abstract of a Paper read before the Liverpool Engineering Society.

without necessarily reducing the high intrinsic brilliancy of the source, namely, by gradually accustoming the eye to the brilliancy.

In considering a lighting problem the first point to settle is the degree of intrinsic brilliancy of light source which is harmless and pleasant to the eye. It may be assumed that a shallow glass bowl, equally illuminated all over, would be suitable for an average room. For example, a room 15 ft. square by 12 ft. high would require $15\times15\times2=450$ lumens to produce an average of 2 ft.-candles. If this average were taken at 2 ft. 6 in. above the floor and the light source were 2 ft. 6 in. below the ceiling, these lumens would be directed over a solid angle of about 90 deg. Now, a modern gas-filled electric lamp distributes light equally in nearly all directions. Therefor it will produce C.P. $\times 4\pi$ lumens, and the candle-power required will be $450/4\pi=36$, to which must be added certain losses to be considered later, when it has been decided how best to direct the luminous flux over the desired angle.

The method that naturally suggests itself is the use of a reflector that will collect the rays over an angle of 270 deg. and direct them over an angle of 90 deg. But this would mean that, within the angle of 90 deg. the lamp would be visible, and that the only light ou side the 90 deg. would be that reflected from the surroundings.

Both of these conditions are unpleasant, therefore a diffusing bowl is necessary, and the author would suggest one 9 in. in diameter. Having designed the reflector for a spread of 90 deg., if below it were placed a diffusing glass three things result : (1) The visible area of the light source is increased ; (2) a loss due to absorption occurs ; (3) further diffusion of light occurs.

The visible area of the light source is increased to something over 63 sq. in., depending on the depth of the bowl. Therefore the intrinsic brilliancy of the light source is reduced to less than 4 c.p. per square inch, which is about the same as a flat-wick petroleum lamp flame, generally admitted to be a pleasant light. Thus, one of our objects has been attained.

The degree of diffusion or dispersion will depend largely on the type of glass used. The depth of the bowl can be regulated to obtain a pleasant but small illumination on the walls up to the height of the light source, which will again be reflected from the walls to illuminate the ceiling sufficiently to cause a good effect. Moreover, the amount of side diffusion can be largely regulated by designing the reflector to concentrate the light in a downward direction ; in other words, to produce a nearly parallel beam.

This brings one back to the scientific use of reflectors. If it were not for the fact that the modern lamps lend themselves to efficient handling by means of reflectors, their future for domestic purposes would be very limited. Therefore, it is most important that their capabilities in this respect be carefully investigated, and that the makers use every effort to concentrate the filaments in order that the work of the reflector designers be made as easy as possible. Good reflectors exist at the present time for use with ordinary tungsten lamps, but the actual efficiency of such reflectors is comparatively low.

In order to compare the possible efficiency of a reflector with the actual result obtained, it is only necessary to take the total lumens produced by a light source and compare it with the lumens received by a reflector : the mean spherical candle-power $\times 4\pi$ gives the total lumens. The solid hemispherical angle over which the reflector distributes the light can be found by the $2\pi(1-\cos\theta)$ formula, where θ represents half the angle in question. By taking the maker's curve of a reflector the author shows that there is still a long way to go before commercial reflectors can be considered efficient.

In his work in the Navy the author has been able to produce reflectors which, with a dispersion of 6 deg. produce a mean candle-power about 1,000 times that of the original lamp. Let us suppose that such a reflector had been used in the case of the 9-in. fitting, previously referred to. Little of the total light flux would then have been lost in the reflector ; therefore, the only losses would have been the glass absorption. The position of the light source being suitable for distribution in the room, an efficient and pleasing illumination would result even when using a lamp of a high intrinsic brilliancy.

With reference to public lighting, this branch is one where the use of reflectors properly designed should save much public money, but unfortunately, there appears to be considerable difference of opinion as to what is actually required.

The Street Lighting Specification Committee proposed a certain basis of minimum horizontal illumination dependent on the class of street to be illuminated. This basis was criticised both here and abroad, the feeling being that such minimum illumination did not ensure suitably lighted streets, and it was moreover suggested that the illumination requirements of the specification could be obtained at the expenditure of less power by utilising reflectors of a suitable type. Ten or 15 years ago the author was able to prove that low efficiency electric lamps could compete with upright incandescent gas mantles, provided that suitable reflectors were used. Since that time, the increased efficiency of electric lamps has made it unnecessary to use such projector type reflectors in order to compete with gas. Nevertheless, the fact remains that by far the greater part of the light produced is not utilised in lighting the street.

Since the days referred to, every writer on the subject of street lighting has pointed out the correct distribution of light for the purpose ; yet an unaccountable prejudice appears to exist against the use of reflectors which produce this particular characteristic.

He is inclined to think that prejudice on this subject will shortly disappear for the following reasons :—

(*a*) Fast driving vehicles are allowed to use headlights which produce the correct distribution of light for road illumination, thus accustoming the public to that form of lighting, and these headlights are directly in the line of vision.

(*b*) It is becoming more generally admitted that the safest method of street lighting is that which produces considerable contrast and definition of objects by producing shadows.

The distance at which an object is visible from a motor car using a headlight of moderate power, is in itself proof that the lighting of roads could be more efficiently carried out without increasing the cost. A 32 c.p. lamp provided with a suitable reflector will produce a beam by which a dark coloured object can be seen at a distance of 750 ft. That is to say, with lamps 250 yds. apart, illuminating conditions could be produced which would ensure public safety. Whereas the conditions now are such that with lamps of similar power placed 70 yds. apart, the illumination is so bad that traffic is often dangerous.

To suggest that two 32 c.p. lamps erected on lamp posts at a distance of 750 ft. would be an improvement on the present method of putting a 60 c.p. lamp at distances of 50 ft. to 70 ft., will strike those who have not considered the matter as ridiculous. Nevertheless drivers of fast vehicular traffic rely entirely on the light produced by their own headlights.

It is, however, common knowledge that the headlights of vehicles produce glare which might prove a serious drawback to the adoption of concentrated light for street or road lighting purposes. The author has already mentioned his opinion of one cause of this glare, but in the case of public lighting there is another means of reducing it, namely, by placing the light sources at such a height that the most powerful rays are only within the line of vision when the lamps are viewed from a distance, and as the observer nears the light source the candle-power of the beam reaching his eyes is reduced. This method also has the advantage of following the correct curve necessary for even illumination.

There is no insuperable difficulty in raising the height of lamps for street lighting, especially if they are not heavy or bulky. It has been the practice for some time to erect lamps of 1,000 c.p. or over, at a height exceeding 16 ft. from the ground, with the object of obtaining better distribution. The light sources which have been described are of comparatively small weight and bulk and, though of low spherical candle-power, are producing as far as their particular purpose is concerned, a candle-power far in excess of 1,000, and, therefore, should be placed at a higher level.

Such a scheme in practice would work out somewhat as follows : Take, for example, a road 50 ft. wide which it is desired to illuminate up to the standard of 0·1 ft. candles minimum horizontal illumination. If two lamps be used at each lighting source fitted with reflectors of the projector pattern, it will be found that, with a spacing equal to 100 yds. between each post and the lamps placed at 20 ft. above the ground, the following candle-power of the beam is required (approximate) :—

Over an angle of 20 deg.		(1,750 lumens)	17,500 c.p.
,, ,,	20 to 27 deg.	(350 ,,)	5,500 c.p.
,, ,,	27 to 45 deg.	(125 ,,)	800 c.p.

NOTE.—These figures must be halved, as two lamps are covering the same ground from opposite directions.

With a reflector correctly designed this result could be produced with a lamp giving 93 mean spherical candle-power, or, allowing for losses in reflectors, say, a 125 c.p. lamp. There being two such lamps on each post the electrical energy required at 0·7 watts per mean spherical candle-power would amount to 175 watts per post. And as there would be only 17 posts to the mile, the total energy required per mile of lighting would be under 3 kw.

To compare this with the most efficient of the present systems, one might take the case of a 500-watt flame arc lamp using a dioptric globe and giving 2,500 c.p. in the required direction. In order to obtain the same minimum illumination these would have to be placed about 60 yds. apart. This would represent 30 to the mile, or 15 kw. per mile of lighting. Moreover, these being arc lamps, they would cost considerably more to install and maintain.

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THE PROBLEMS AFTER THE WAR.

Of the many problems that will follow the present war public attention has so far been directed to only one to any serious extent: namely, to the capture of German trade. But there are others equally important, and if these are not carefully considered all preparations for the expansion of our foreign trade will be of small avail. This aspect has so far impressed the Council of the Institution of Civil Engineers that they asked Mr. HAROLD COX to address the members of the Institution upon Industrial Development, and a short account of this lecture was given in our last issue. Mr. Cox has been concerned with public affairs for many years and has given much thought to matters of this kind, so that his views are worthy of careful consideration, and we think the Council did well to arrange for such a lecture.

Undoubtedly the most immediate problem to be considered is the effect that will be produced by the disbanding of a large army, now amounting to some millions of men, by the discharge of large numbers of men and women now engaged in munition work, and by the expiration of separation allowances. It has taken a long time to bring about the change from normal times to the state of affairs which now exists, but the converse change from the present position required by the military situation to those of peace time will take place very much more rapidly. The possibility of men returning and finding no work for them to do has been looked upon by some people as so serious that they consider a state of revolution not impossible. Undoubtedly if the situation is not dealt with by the Government with proper foresight (and, unfortunately, this is a quality which we often lack) the state of affairs will be very serious. Mr. Cox put forward the suggestion that our men might be employed in the task of putting down and rebuilding portions of London so that these would be worthy of the

great metropolis of which they form part. Although we agree with him that London leaves very much to be desired from the point of view of both art and comfort, we feel that there will be far more useful work to be done at the end of the war than the rebuilding of the city. There will surely be the rebuilding of the greater part of Belgium, a task which is essential for that unfortunate country and which will certainly not be accomplished in a day. Apart from the reconstruction of roads and similar public works, which can be carried out easily by unskilled labour, there will be the rebuilding of factories and dwellings and other work which might be undertaken by the skilled workers in the ranks of our army. In this way all would be given employment until the time arrives when they can be discharged to take up civilian work once more. The married men should obviously be given the first option to return, and men, whether married or single, would only be released as it was definitely found that they were required or had means of support. This course might entail a somewhat heavy burden upon the country for a time, but it would be far better to have this financial burden than the possibility of want and lack of work for those who have been defending the Empire.

Apart, however, from the question of the return of our men, which presents a problem that will in any case exist for only a comparatively short time, there is the greater problem of maintaining our industries on a proper basis. Mr. Cox rightly points out that after the war men will wish to continue the higher wages which they have recently enjoyed. Such wages, however, cannot be given unless the output per man is higher than it has been in times of peace. Moreover, if there is a greater output it is essential that there should be a larger market; and the point particularly emphasised by Mr. Cox is that if the workman has a higher wage he can produce a larger market at home by his increased spending power, thereby enabling his employer in turn to give the higher wage. To a large extent this is true, though it will operate more in some trades than in others. For example, the expenditure on the part of the workman will not go in the direction of engineering appliances, and, therefore, the manufacturers of engineering appliances must find their market elsewhere. The great difficulty, of course, is restriction of output and it may be doubted whether this will be relaxed in any sense after the war. Politicians have promised to return to the old state of things, and it will remain for employers to demonstrate that it is to the disadvantage of the men to return to those pre-war conditions. We fear it will be a difficult matter. There will still be the old fallacy that there is only a certain amount of work to be done, and that as this cannot be increased a restriction of output is the best thing for labour. The replacement of such an idea by the fact that the lowering of costs brings a larger market, and, therefore, more work, will take a long time for it to be effective. But apart from this, there is the important fact that the rate of pay in this country must bear some relation to the rate paid in other countries with which we are in competition, and must not be in excess to a prohibitive degree.

Apart from the question of restriction of output there is also the weight of establishment charges which has to be borne. If these can be diminished in any way it is all to the good of an undertaking. The simplest means of so doing, where there is considerable capital involved, is, no doubt, to run night shifts; preferably to run three shifts as suggested by Mr. Cox. But whether three shifts are the best from the point of view of the health of the community may perhaps be doubted, and on this account it might be better to run merely two shifts. Even so, the establishment charges would be much reduced, but if such a course were adopted it would be necessary to arrange for the proper management of both shifts and this would entail a certain amount of expense. It is useless to expect good work from a night shift without suitable supervision and facilities. The matter is much more simple in the case of piece-work than where large jobs are concerned and where such work has to change hands from shift to shift. Also, if higher wages become general and two or three shifts are required, it becomes much less easy for small firms and for any firm starting business with a comparatively small staff.

Mr. Cox emphasised the desirability of employers considering the well-being of their employees as one of their primary objects. This sentiment we would fully endorse. Much of the trouble in the past would have been avoided if employers had taken a true interest in their employees. Now that there has been so much friction between capital and labour it is all the more difficult to bring about a proper feeling between the two. There is no doubt, however, that the employer—who has a much better general knowledge of the whole situation than the employee—should make the first advance and attempt to break down those suspicions which do so much to prevent harmonious working. Unfortunately, there is a great deal in the problem of production which the workman does not appreciate. The employee takes no risk; the employer, on the other hand, may fail to see dividends for years, and it is only due to his foresight and proper conduct of affairs that a successful undertaking is at length produced. He is, therefore, entitled to a very substantial reward. On the other hand, if the workman puts forth his best efforts in order to produce success, there is no doubt, in our opinion, that he also should share in the success when it comes. The only question which is difficult of solution is to what extent he should benefit. We confess that the problem is by no means one that is easy of solution, but we hope that this will not deter employers from taking the initiative in introducing terms which are equitable in taking a true interest in the welfare of their employees to a much larger extent than hitherto. Men of all classes have fought shoulder to shoulder in the present war; let them continue to fight shoulder to shoulder in the industrial fight which must come in times of peace.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Electric Arc Phenomena. By E. RASCH. Translated by K. TORNBERG. (London: Constable & Co.) Pp. xvi.+194. 8s. 6d. net.

This book is an addition to the literature of a subject about which little is known. It will appeal to the physicist rather than to the engineer, though the latter, if conversant with recent physical research, will find a good deal of matter in each chapter to interest him.

In an introductory note the author makes a few general remarks on the fundamental cause of light. A satisfactory solution of the problem of economical light production by electrical discharges through gases presupposes a thorough understanding of numerous phenomena derived from widely different fields of knowledge. For instance, besides purely electrical relations, there are to be considered important practical questions pertaining to arc stream conditions, the characteristics of different forms of discharge and the requirements for equilibrium. The nature of electric conduction through incandescent gases, and the relation of conductivity and light

intensity to temperature, point to facts and theories which are part of physical chemistry, while the selective radiation of incandescent gases is a branch of spectrum analysis. The electrode phenomena depend on properties of materials, on high-temperature chemistry and on the laws of black-body radiation.

The book contains eight chapters, and the following will serve to give the reader some idea of the author's breadth of treatment. Chapters I. and II. give a general outline of electric-arc phenomena and an account of the typical carbon arc. Typical electrode materials and their physical properties are discussed in the next chapter, and a great deal of useful matter has been compressed into a small space. Chapter IV. on the theory of electrical discharges through gases deals with the ionisation of gases and with the dynamics of disruptive discharges through gases. We are inclined to think that the importance of the subject warrants somewhat fuller treatment than the 10 pages given to it by the author. A chapter on spark discharges follows, and Chapter VI. is devoted to a consideration of the voltage and current conditions in the arc. The distribution of the energy in the arc is dealt with in the seventh chapter, and a discussion on the efficiency of commercial types of arc brings the volume to a close.

As far as we are aware, this is the first book in which modern physical theory has been applied to the arc and to the consideration of arc phenomena. The author presents his facts in such a way as to make them interesting, and the student of the arc will read the book with pleasure and profit. Many engineers are of the opinion that the arc is rapidly becoming obsolete, and that the metal filament lamp will take its place. It would be idle to deny that the development of the latter has been rapid, but the performance of metal lamps is determined by factors which are of small account in the arc. For this reason we are glad to note that the properties of the arc are still being closely investigated.

Questions and Solutions in Telegraphy and Telephony (Final Examinations). Compiled by H. P. Few. (London: S. Rentell & Co.) Pp. 74. 1s. 6d. net.

This little book is a companion volume to "Questions and Solutions in Telegraphy and Telephony, Grade I." by the same author. In addition to the examination papers in both subjects from 1906 to 1914 and answers to all the numerical questions; the author gives the complete solutions to the questions in telegraphy and telephony at the last examination. These should be useful to students. Teachers and students will welcome a collection of questions covering all the City and Guilds Final Examinations that have been held in the two subjects during the last 10 years. Those desirous of sitting or their Final this year will do well to buy the book.

THE USE OF CONTINUOUS CURRENT FOR TERMINAL AND TRUNK-LINE ELECTRIFICATION.*

BY NORMAN WILSON STORER.

Summary. The Paper discusses the series motor acceleration, and questions of control. Regenerative systems are considered, as well as the question of voltage and interchangeability.

It would be presumption on the part of the present author to discuss what is purely a transportation matter, the question of handling trains in Great Britain where the conditions are so different from those in America, so that this Paper will deal chiefly with the characteristics and possibilities of the continuous-current motor for handling trains in the most economical and satisfactory manner, not only on one line, but for interchanging equipments on lines where different conditions prevail.

The Series Motor.

It is only about 30 years since the electric motor was first used in real commercial railway service. Many experiments were made prior to that time, but it is a noteworthy fact that the electric railway motor did not become commercial until the first continuous-current series-wound motor was built and geared directly to the car axle. After that event the progress of electric railways was by leaps and bounds. The invention of the multiple-unit control system gave a great impetus to its growth, especially in heavy city and suburban train service, and now electric motors have been applied to a greater or less extent to practically all classes of railway service.

The changes which have taken place are referred to, and the defects in design. Of course, such a condition did not long obtain, and the improvement has been both rapid and continuous from that day to this when the up-to-date continuous-current commutating-pole self-ventilated and oil-lubricated railway motor leaves little to be desired, either electrically or mechanically.

The advantages of the steep speed and torque curves are mentioned. These characteristocs have proved to be admirably adapted not only to tramways and heavy multiple-unit trains in frequent stopping service, but to the requirements of locomotives for long-haul-passenger and freight service.

The series motor has proved itself more successful than any other type of motor, being nearly "foolproof," more reliable and cheaper to maintain. It also gives the best commutation and is least subject to injury resulting from the fluctuating line voltages that are common to all electric railways. It is well known that a shunt or compound motor is very sensitive in commutation to sudden changes in voltage, and that practically every attempt to use such motors in railway service has come to grief. The field of such a motor is so much more sluggish than that of the series motor that

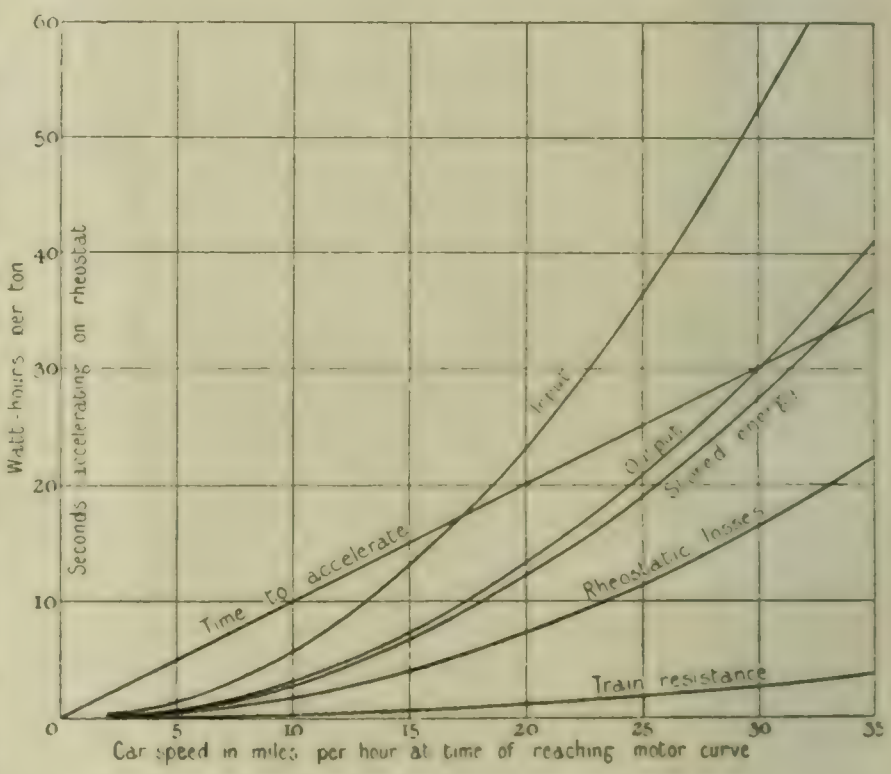


FIG. 1.—ANALYSIS OF POWER CONSUMPTION IN STRAIGHT-LINE ACCELERATION.

Data: Weight ..... 1 ton (2,240 lb.)
Acceleration ..... 1 mile per hour per second
Total tractive effort ..... 121 lb.
Train resistance ..... 11 lb.
Allowance for rotative inertia ..... 7.5 per cent.
Control ..... Series-parallel
Motor efficiency at normal voltage ..... 85 per cent.
Voltage drop in motor ..... 3 per cent.

flashing is almost inevitable where sudden changes of voltage take place on lines of heavy capacity. It is a matter of record that voltages of more than three times the normal have been reached on heavy-capacity third-rail lines due to surges following the opening of heavy loads or short-circuits, and that even series motors must be well designed to escape flashing in such cases.

While a variable-speed shunt motor possesses certain theoretical advantages in improving the efficiency of operation if it could be made as reliable, practically the motor is heavier and more expensive, due to the heavy fine-wire shunt coils which would also be liable to be a continual source of trouble.

Series-Motor Characteristics.—Most of the early designers of railway motors secured a certain amount of speed control by varying the effective turns on the field. This was the only way they had to obtain a variation in speed, as the series-parallel control did not appear until the early nineties; but after that was introduced, the control of the field was abandoned, partly to simplify the equipment and partly because of the grave troubles from commutation and overload which were introduced by running on the weak field. Thanks to the great progress that has been made in motor design,

* Abstract of Paper read at the Institution of Electrical Engineers on the 16th inst. A Paper entitled "Economics in Power Consumption of Electric Railways," by the same author, was published in Vol. LXXV., 709.

notably in the development of the commutating pole and in the ability to predetermine the work demanded of the motor for any class of service, these objections no longer obtain and field control is once more being employed where the service conditions justify its use. While field control will give the greatest economy in accelerating, its introduction has again called attention to the advantages of the motor with the steep speed curve and the unsaturated field.

The figure in the Paper shows corresponding speed and torque curves for two motors—one with saturated and the other with unsaturated magnetic cirduits. It will be seen that the speed curves cross at approximately 42 miles per hour, but at the one-hour rating of the motor, which is practically 350 amperes, the speed of the saturated motor is 37 miles per hour, while the other runs at 35 miles per hour. Stating it in another way, the tractive effort of 2,500 lb. which is developed by the saturated motor at its full-load of 350 amperes, would be developed by the unsaturated motor with a current of about 320 amperes. It is stated that the unsaturated motor will accelerate much more quickly, an advantage for frequent stopping.

Fig. 1 brings this out very clearly in terms which cannot be misunderstood. It shows in one curve the rheostatic losses in accelerating 1 ton at a specified rate by means of series-parallel control, and certain motor efficiencies. This curve shows that the rheostatic losses vary directly as the square of the speed at which the last

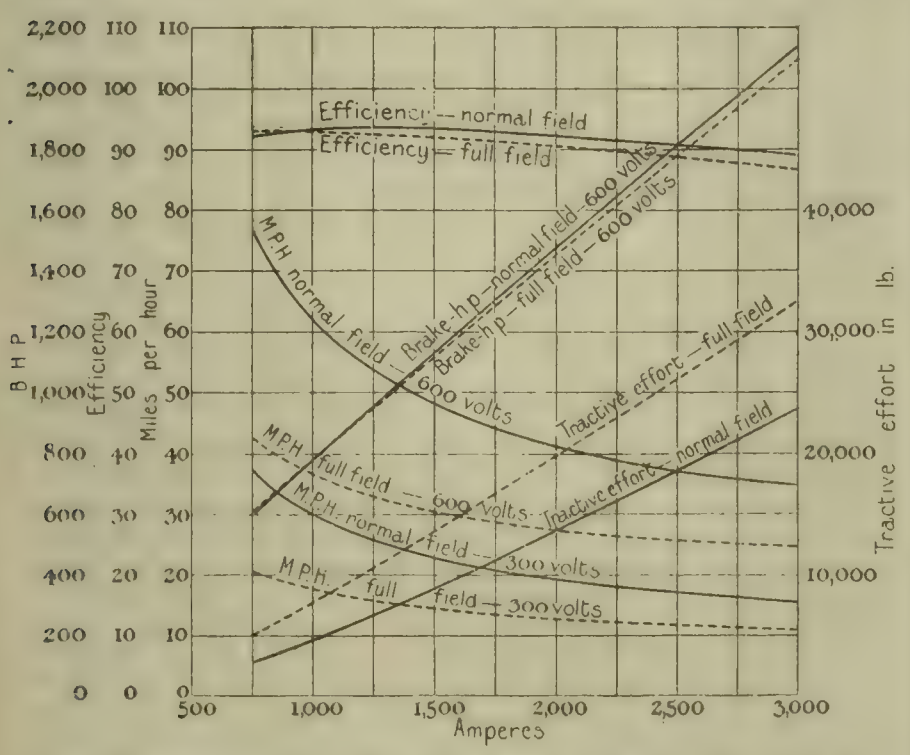


FIG. 2.—WESTINGHOUSE NO. 315A RAILWAY MOTOR, 600 V., 72 IN. WHEELS $\frac{9}{16}$ IN. AIR-GAP.

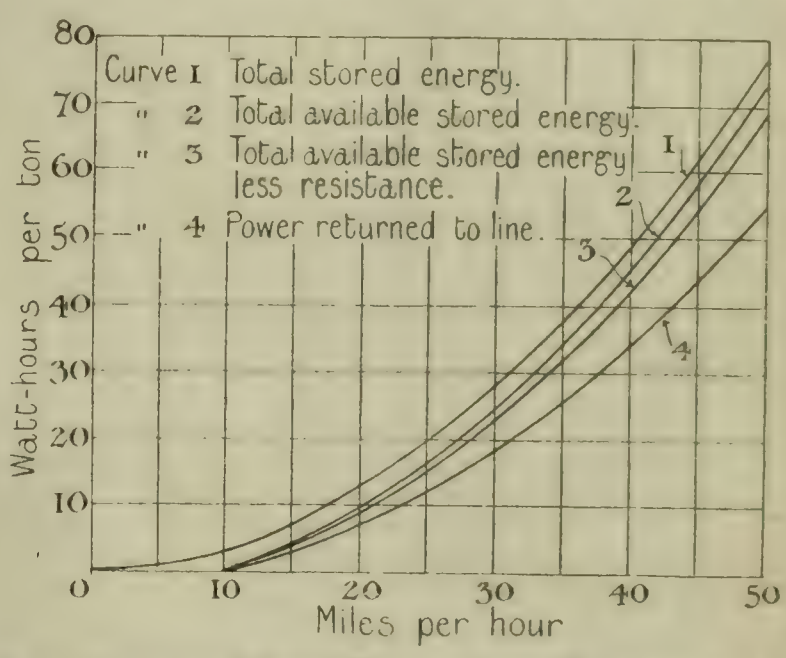


FIG. 3.—ANALYSIS OF POWER REGENERATION, REGENERATING TO 10 MILES PER HOUR.

resistance is cut out of the motor circuit, or at which the motor curve at full voltage is reached. Referring to Fig. 1, if the load were accelerated at a tractive effort of 3,300 lb., the motor curve on the saturated motor would be reached at a speed of 35 miles per hour, while the unsaturated motor would reach the motor curve with the same tractive effort with about 10 per cent. less current and at a speed of 31·5 miles per hour. Referring to Fig. 1, it will be seen that the rheostatic losses in the one case would be 22·2 watt-hours per ton, and in the other 18 watt-hours per ton—*i.e.*, a saving of 4·2 watt-hours per ton for each acceleration.

Field Control.—The use of field control still futher improves the efficiency of acceleration, and offers, where desirable, additional operating speeds. This was first applied in recent years to the alternating-current continuous-current locomotives installed on the New York, New Haven & Hartford Railroad to provide some speed control on the continuous-current zone of operation. The motors were operated on the single-phase lines with two halves of the field in parallel; on the continuous-current lines the coils were all in series and the field was shunted, in order to obtain higher speeds. The first large installation with purely continuous-current locomotives was on the Pennsylvania, New York & Long Island Railroad, for the New York terminal of the Pennsylvania Railroad.

Fig. 2 shows the curve of the motor for this locomotive, which it will be remembered has only two motors. The usual series-parallel connections combined with field control give four speed curves. These curves simply show the maximum range of speed at which the motor is designed to operate at normal and half voltages, but there are two intermediate speed curves on each voltage which may be used if desired between the full field and the normal field position.

Criticism of electric locomotives compared with steam is then referred to, and the author considers the Pennsylvania locomotives better adapted to conditions than any steam locomotive.

If locomotives are to be compared simply on the basis of the continuous or the one-hour rating, comparisons are likely to be misleading. The speed control shown on the curves for the Pennsylvania locomotives is quite within the range of possibility for well-designed continuous-current locomotoves, and while it is admitted that the electric locomotive does not entirely meet the speed-torque characteristic of the steam locomotive which seems to be so desirable for express service, the author believes there are few cases where this is necessary over the wide range of speed for any considerable length of time. In cases where a heavy tractive effort is required for short periods of time, the electric locomotive has the enormous superiority of being able to handle the load at a higher speed.

Rheostatic losses are next dealt with, and it may be assumed as certain that when maximum use is made of a field-control equipment it will reduce the rheostatic losses to not more than one-half of what they would be with the usual series-parallel arrangement. The total saving per ton-mile will, of course, depend on the number of accelerations made.

In general, if it is desired to reduce the power consumption to a minimum, the unsaturated motor having a steep speed curve is to be recommended either with or without field control wherever the service requires frequent acceleration or very heavy grades are encountered. The saturated-field motor or the one having the flat speed curve is to be recommended for use only where it is desirable to obtain a more nearly constant speed over long runs, regardless of variations in grades and trailing loads, and reduces the chances of mechanical damage by limiting the speed.

Regenerative Control.—Many attempts to regenerate have been made by utilising shunt motors, but as a matter of fact such systems have thus far, for one reason or another, proved to be unsatisfactory. The problem will never be given up as long as there is a possibility of saving any considerable portion of the power, which is now expended in wearing out brake-shoes and wheel types. It is well known that 50 per cent. of the total power taken from the line is expended in this way on a great many lines, so that it is a matter if great importance.

The scheme adopted long ago on the Central London Railway, of saving this energy by elevating the station tracks, is one that can be tried in special cases with excellent results. It has one great advantage over any scheme of electrical regeneration in that it adds nothing to the equipment and makes the work easier, so that smaller motors may be used. However, it has its limitations as shown on the curve in the Paper, which gives the height to which a train must be raised in order to save all of the stored energy. It will be seen that a train operating at 30 miles per hour would stop without brakes if allowed to climb to a height of 30 ft. A 14 ft. elevation would be required to absorb all of the energy in a train moving at 20 miles per hour. Of course, it would not be feasible to save all of the stored energy, nor, in fact, would it be feasible to save any large part of it on a line having long trains and a high schedule speed. That it is possible to make very considerable sav-

ings, however, is shown not only on the Central London Railway, but on the South Side Line of the Chicago Elevated Railway. Such a plan for saving power as this is not practical for the large majority of railways, so that some other scheme must be adopted, but it may be noted that any scheme of electrical regeneration may be supplemented by the elevated station tracks.

As a matter of fact, such a scheme is already pretty well developed, and it is hoped that it will soon be in commercial operation. It involves the use of the standard series motor, with separate excitation during regenerative periods. The control may be entirely automatic from the time it is applied until the lowest speed is reached at which the motors when connected in series can develop the line voltage. At the same time it can be stopped at any desired speed. The regeneration at high speed is with the motors connected in parallel, and the change from parallel to series is effected by a bridging method especially adapted to this purpose. There is no break in the retardation of the train from the maximum speed until it comes to a standstill; for the control is so arranged that the air brakes may be applied as soon as the minimum regenerating speed is reached. The use of the standard series-motor in this connection is of the greatest importance, and it is also noteworthy that the motor is so designed for field control also assists in securing the maximum saving of energy owing to the fact that the regeneration can be carried to a lower speed.

It is usual practice in equipments for heavy multiple-unit service for city and suburban traffic to have the motors geared for a speed of about 15 to 18 miles per hour at the one-hour rating of the motors. Such an equipment will retard the train by regeneration down to a speed of 8 to 10 miles per hour. Fig. 3 is plotted so as to show the possible saving that can be effected by regenerating down to a speed of 10 miles per hour. The top curve shows the amount of energy that is stored in the car. From that is deducted the amount left in the car at a speed of 10 miles per hour. The next curve deducts the amount that is required to overcome train resistance at a specified rate of braking down to 10 miles per hour. From this curve is deducted the amount of power that is lost in the equipment during regeneration. In this case the efficiency of regeneration is assumed to be 80 per cent., which allows for a considerable loss in the auxiliaries. The lowest curve shows the energy in watt-hours per ton that should be restored to the line under the specified conditions from any speed under 50 miles per hour down to 10. Owing to the fact that the equipment required to permit regeneration adds somewhat to the weight of the car, the net saving in power will be somewhat less than that shown. A single example will suffice to show what may be expected from this system. At a speed of 25 miles per hour the amount of stored energy is 19 watt-hours per ton. The curve indicates that not less than 12 watt hours per ton will be restored to the line. It is pointed out that a probable saving of 45 per cent. of stored energy is returned to the line.

Line Voltage.—By successive steps the line voltage has been raised until the standard for most tramways and suburban lines is now 600 volts. This seems to be the economical limit for small equipments such as tramway motors, and to have many advantages for heavy suburban work. If only the motor and control equipments were to be considered, 600 volts would probably continue to be the standard, not only for suburban and terminal electrifications, but for all classes of service. It is well known, however, that the tendency to adopt higher voltages on account of the economy of transmission and the necessity in some cases for using the overhead contact wire for heavy service has been increasing at a very rapid rate, and in the United States a voltage of 1,200 to 1,500 has become the standard for interurban railways, whilst pressures of 2,400 and 3,000 volts are also being used in one or two instances. A continuous-current voltage of 5,000 has also been in use on an experimental equipment of the Michigan United Traction Co. for the past seven or eight months. In England 1,200 and 1,500-volt lines are now in operation, and a 3,500 volt experimental equipment has been in use for several years on the Lancashire & Yorkshire Railway. In other parts of the world, voltages of 750, 800 and 1,000 are also in use. The tendency among the railways centring in London seems to be to adopt the 600 volt third-rail system.

In view of the possibility of still higher voltages and other contact systems being introduced in Great Britain, the question of interchangeability of equipments has become very prominent.

Two conditions of prime importance are necessary to enable equipments to operate interchangeably over different lines, namely: (*a*) The contact conductors must be so arranged that any equipment can take power from any line without change. (*b*) Every equipment must be so designed as to operate at required speeds over the various voltages of the different lines.

It seems especially pertinent to the occasion that everyone should have a full knowledge of the possibilities and the difficulties of interchanging continuous-current equipments over lines having several different voltages. It is the purpose of the author to discuss briefly the possibilities and to show the complications that are introduced. The subject may be divided into four topics:—

(1) The contact and collector system. (2) The motor. (3) The control. (4) The auxiliary power equipment.

(*To be concluded.*)

CORRESPONDENCE.

"THE STRANGER THAT IS WITHIN THY GATES."

TO THE EDITORS OF THE ELECTRICIAN.

Referring to your notes on this subject in your issue of the 10th inst., may I point out that it is precisely because they must have infringed an important rule of conduct that I think that naturalised Germans, who have arranged not to be denaturalised in their own country, should be expelled from the Institution. According to the German Nationality Law of 1913, a German who becomes a British subject can only retain his German nationality under German law by applying and receiving the written permission of the competent authorities of his Home State before he acquires British nationality; consequently when he obtains naturalisation here he obviously does so by a species of false pretence, which is quite a sufficient reason in my opinion for his expulsion.

London, March 13. A. A. CAMPBELL SWINTON.

TO THE EDITORS OF THE ELECTRICIAN.

May I suggest that in your list of things to be remembered, in connection with the proposed action by the Institution, there is one important point you have entirely overlooked.

We have many members who are serving at the front who have seen and heard at first hand things that utterly pass the understanding of those of us who are safely at home as to the devilish behaviour of the Huns.

There are, moreover, many of us who have friends and relations, prisoners in Germany, who have some knowledge of the tortures and bad treatment that have been meted out, and I fear will be meted out still more, if America breaks off negotiations, to our prisoners in Germany when the inevitable time of defeat arrives for that country.

Do you imagine that those men are going to be willing to associate again with members of a nation that has by its *kultur* put itself outside the pale of civilisation? And are not we who remain at home under some obligation to see to it that all for which they have shed their blood and suffered is not again given away by "sloppy sentimentality"?

It is just that sort of thing that we must guard against at the end of the war, or this country will again become the happy hunting ground for Germans, who will undersell our labour and our goods merely to get a footing, if they can once more, in our labour and commercial markets.

In regard to Mr. Wigham's outburst, I cannot but think that my former chief has shut his eyes and ears to obvious facts, or he would not stigmatise as "piffling" a desire to purge our Institution once for all of those on its list of members who are also members of a nation that has presumed to set up as its God the devilish doctrine that "might is right."

Watford, March 14. M. J. E. TILNEY.

[Few of our readers will accuse us of sentimentality of the kind referred to by Mr. Tilney as "sloppy." It must surely have occurred to our correspondent that in all likelihood we also have suffered personal losses. Nevertheless, we earnestly hope that the day may be far distant that will see us endeavouring to shirk the responsibilities and obligations the nation owes to those whose interests we have pledged ourselves to safeguard, or to adopt a "scrap of paper" policy.—EDS. *E.*]

UNIFORMITY IN DRAWING ELECTRICAL DIAGRAMS.

TO THE EDITORS OF THE ELECTRICIAN.

I have read Dr. Kapp's article on uniformity in drawing electrical diagrams with great interest, and in this connection would draw attention to the list of standard symbols issued by the British Electrical & Allied Manufacturers' Association, which was recently described in your pages. This list is fairly complete, but the suggestion by Dr. Kapp whereby it is possible to obtain from the diagram many of the electrical properties of the machines illustrated is extremely ingenious, and if it could be adopted universally would be extremely useful. Doubtless the matter is one which in time would be considered by the International Electrotechnical Commission.

In the meantime the matter should be settled as far as we ourselves are concerned. This at once brings up the disadvantages which we suffer under in this country due to the inactivity of the Institution of Electrical Engineers in such matters. As far as I am aware the Institution does not possess a Standardisation Committee of any kind. It is true the Institution supports and has representatives upon the Engineering Standards Committee. But this is not enough, as surely there are many special problems, such as the one raised now by Dr. Kapp, which the Institution should specially attend to and arrive at a solution thereof. The Institution does not seem to be able to make up its mind whether it is an engineering and scientific society or a trade association; between the two stools it seems likely to fall to the ground.

Sutton Coldfield, March 14. C. C. GARRARD.

EDDY CURRENT LOSS IN DYNAMO TEETH.

TO THE EDITORS OF THE ELECTRICIAN.

My attention has been called to an interesting formula for calculating teeth eddy current losses published in your journal under date January 21st last.

Although a method of calculating these losses by means of the slope formula $\int_r \left(\frac{dB}{dt}\right)^2 dt$ had already been given by me some 13 years ago (*vide* THE ELECTRICIAN, October 16, 1903, p. 1049), I did not express it in the very convenient way that Mr. F. W. Carter has done. However, in the article on iron losses above referred to, mention was made of the fact, which apparently was new at the time, that one could account for and calculate the incremental loss for full-load as an iron loss. In a book published on "Dynamo Design" in 1905, p. 32 (McGraw-Hill Book Co., New York, N.Y.) I gave a working formula for calculating this skew-flux incremental-loss based on the above method.

Yet this is not the entire story. For, as Mr. G. F. C. Searle pointed out to me in 1904, there is a tacit assumption made that a straight line relationship subsists between B and H. Besides there is also the fact that the above integral only represents an approximation to the "skin effect," which was allowed for in a manner in the Paper to which Mr. Carter refers. There is also what might be called the Mordey-Hansard effect, which I attempted to explain in 1904 (*see* Mr. Searle's acknowledgments in "Journal" of I.E.E., December, 1904). A considerable amount of deviation from the generally assumed simple theory can be accounted for by the double bend in the B-H curve from 0-10,000 gausses by its effecting the distribution of eddy currents as B itself may go through a cyclic sinusoidal variation. There is finally, moreover, the hysteresis effect which makes the H of an eddy current filament, so to say, go through a complicated cyclic function when the integrated B or F goes through a simple cyclic variation. A good deal of this latter is, of course, bound up with the Mordey-Hansard effect.

Yet apart from the teeth iron losses there is the core itself to consider. In a letter to THE ELECTRICIAN by Prof. E. Wilson commenting on the slope method (*see* issue of January 29, 1904, p. 577) it was pointed out that it was not safe to draw conclusions as to the iron losses of the core of a dynamo by judging the aggregate iron loss as one must do to-day because of the lack of a suitable separation method. In a Paper submitted to the Physical Society of London about four months ago I gave a mathematical solution of Prof. Ernest Wilson's dynamo-core problem, taking into account the simultaneous effect the hysteresis loop must have upon the *total iron loss*, with the single assumption of a straight line locus for the B-H loop critical points. The solution was based upon the use of the mathematical operator Q_m, which I have already outlined in your pages.

Although it was pronounced by them as being of considerable value, I was astonished to learn that the Society was not publishing this type of Paper. Perhaps when they do I can only hope not to be in the unfortunate position of being too late. The "Electrical World," of New York, has very kindly accepted the Paper in question for publication, in spite of its mathematical and physical interest, though a curve was attached showing the relationship of core-depth to pole-span for given iron losses, which latter should prove of considerable interest to engineers.

New York, Feb. 23. A. PRESS.

PRINCIPLES AND SYSTEMS OF ELECTRIC MOTOR CONTROL.

TO THE EDITORS OF THE ELECTRICIAN.

May I be permitted to say that the article entitled "Principles and Systems of Electric Motor Control" in your issue of January 21st just fails to be very complete and interesting because the numerous important connection diagrams are not fully explained.

The diagrams are so good, and the subject is of such wide interest, that the scant description seems incomprehensible. I notice the article was slightly abbreviated by you, but I assume that the fault I have indicated is the author's.

However that may be, on behalf of those of your readers (including myself) who are not experts in "contactor controls," but want to know something about them, I beg to say that it is maddening to see the diagrams and not be able to enjoy them.

West Norwood, March 14. W. PERREN MAYCOCK.

[The section of Mr. Knight's Paper dealing with industrial contactors was given practically in full. Notwithstanding the brevity referred to by our correspondent, we are of the opinion that most of the diagrams are self-explanatory.—EDS. *E.*]

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

1,405 FRIED. KRUPP AKT. GES. Continuous-current generators. (31/1/13. Addition to 1,407/13.)

12,282 HEYLAND. Polyphase commutator dynamos and motors. (14/6/13.)
A polyphase commutator dynamo or motor, having a chord winding on the rotor with brushes on the commutator short-circuited in pairs in different axes according to the number of phases, or connected by circuits of low tension, said brushes bearing on parts of the commutator, whose angular distance apart measured around the commutator periphery is greater or less than the angle between the axes of the several phases of the stator winding.

17,851 SUCHOSTAWER. Electric transformer motors. (13/2/15.)

23,107 COX & SMITH. Electrical switches. (Addition to 23,162/12.)

1915 SPECIFICATIONS.

596 JAMES. Automatic electro-dynamic brake system for feed reels and the like.

1,076 SLATTER & WILDE. Heating unit or resistance element for electric heating apparatus.

1,774 LANCASHIRE DYNAMO & MOTOR CO. & HARGREAVES. Apparatus for electrically operating planing machines and the like reciprocating tools.

2,045 HAWORTH. Electric accumulators.

2,180 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Electric switch panels.

2,250 WELCH. Convertible electric fire.

2,312 BERRY. Electrical heating apparatus.

2,328 HUMPHREYS, QUINT & FELT. Electric switches or devices for making or breaking electric contacts.

2,356 BROWN. Means for intermittently starting and stopping as desired electrical machines.

2,390 NIELD. Electricity meters for multi-wire circuits.

2,489 FORRESTER. (Dunham.) Portable electric lamps.

2,532 MAJOR & SMITH, MAJOR & STEVENS (LTD.) Controllers for electric lifts.

2,618 CROMPTON & CO. & PENSABENE. Dynamo-electric machines.
The object is to provide a machine which when running as a dynamo driven by the engine will give an almost constant voltage over a very wide range of speed, or when running as a motor from power supplied by the accumulators, will be capable of giving a powerful torque in the most efficient manner for the purpose of starting the engine.

2,696 MARKS. (Interstate Electric Novelty Co.) Tubular electric pocket lamps.
2,786 TORNER. Electric transformers. (21/2/14.)
An electric transformer having a closed core for the primary and secondary winding and a bridge permeable to magnetism arranged so that it can be introduced into withdrawn from the magnetic field, the bridge being influenced by a spring or by gravity so that it is normally held outside the core but is drawn into the space within the core when the magnetic force attains a certain value.
3,366 INTERNATIONAL ELECTRIC CO., LE NOIR & FUNCCIUS. Telephone exchanges.
3,987 WESTERN ELECTRIC CO. Printing telegraph receivers. (19/3/14.)
4,110 BROUGHTON. Means for connecting electrical conduits to their fittings. (Cognate application, 4,885/15.)
4,681 PERREUR-LLOYD. Apparatus for the electrolytic production of zinc. (28/5/14.)
5,351 VAUGHAN. Electrically heated hot-air syringe for dental or surgical use.
6,642 MOORE. Combined electric switches and connecting plugs. (Cognate application 8,736/15.)
7,003 QUARZLAMPEN-GES. Method of and device for kindling mercury vapour electric apparatus. (15/6/14.)
A device for kindling mercury vapour electric apparatus using a kindling body operated magnetically and acting after the manner of a spraying nozzle, having two systems of magnets, one of which causes the kindling body to enter the mercury whilst the other is switched in on kindling and serves to maintain the kindling body immersed in mercury.
7,622 JEANS & JEANS (LTD.) Electric lamps as applied for advertising purposes.
7,868 BURDON. (Siemens & Halske Akt. Ges.) Röntgen or X-ray apparatus.
The source of heating current is arranged in direct proximity to the Röntgen instrument, preferably in the receptacle containing the instrument, and one of the heating conductors is united with the tube current conductor or high potential conductor which runs to that particular electrode, whilst the other (insulated therefrom) is stranded up therewith so that the two form a single cable.
8,272 ALLGEMEINE ELEKTRICITATS-GES. Arc lamp with electrodes of highly refractory metals, tungsten in particular. (3/6/14.)
8,412 BURDON. (Siemens Schuckertwerke Ges.) Electrical safety fuse devices.
9,246 W. R. SYKES INTERLOCKING SIGNAL CO. & SYKES. Electric relay.
9,279 B.T.-H. CO. (G.E. Co.) Targets for X-ray tubes and the like.
A target for an X-ray tube or the like comprising a body of molybdenum of considerable thermal capacity having inset or otherwise secured in good heat conducting contact therewith a target proper of tungsten.
11,819 MELLERSH-JACKSON. (American Smelting & Refining Co.) Electrolytic refining of tin.
12,886 DODGE. Marking devices for ropes or cords.
12,892 BOWEN. Electric lock switches.
12,951 WILLIS. Electromagnetically controlled valves for building constructions and building construction elements.
13,985 BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. Dynamo-electric machines for [illegible]. (3/10/14.)
14,548 REIK & OESTERREICHISCHE DAIMLER MOTOREN AKT. GES. Electromechanical driving arrangements for vehicles and other purposes. (2/9/13.)
15,750 IMRAY. (Society of Chemical Industry in Basle.) Process for electrolytically reducing or oxidising organic substances.

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked * are open to inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When complete Specification accompanies application an asterisk is affixed.*

January 17, 1916.
695 CAMERON. Trolley-system electric tramways.
722 DORWAN. Telepathy.
732 ENTWISTLE & MARCONI. Wireless telegraph transmitters.
731 FRANKLIN. Wireless telegraph transmitters.
710 KNIGHT. Air-inlet attachment for sparking-plugs of internal-combustion engines.
723 SCHOLEY. Electrically-operated portable vacuum cleaners.

January 18, 1916.
820 BAKER & HEYL. Telegraphic transmission of pictures.
802 B.T.-H. CO. (G.E. Co.) Electric switches.
77 JONES Electric resistances.
801 MCLACHLAN. Shade-holders for gas or electric light fittings.
821 WOODS. Dynamo-electric machines.

January 19, 1916.
876 BYGRAVE & RELAY AUTOMATIC TELEPHONE CO. Telephone systems.
894 PETTERSON. Current limiters or mercury meters.
869 SIEMENS & HALSKE AKT.-GES. Electrical relay systems.

January 20, 1916.
972 BALDING & SCANTLEBURY. Coin-freed telephonic apparatus.
904 BERRY. Mica-cutting machines in connection with direct-current generators.
955 DEVENTER. Electrical condensers.
936 [illegible]
951 [illegible]
946 [illegible]
967 [illegible]
930 WESTON. Electric lamps.

January 21, 1916.
999 [illegible]

January 22, 1916.
1,057 [illegible]
1,053 [illegible]
1,037 [illegible]
1,063 [illegible]
1,038 WHITE. Electric lamphloders, adaptors, &c.

January 24, 1916.
1,123 [illegible]
1,116 [illegible]
1,098 [illegible]
1,097 [illegible]
1,103 [illegible]

January 25, 1916.
1,183 [illegible]
1,187 [illegible]
1,143 [illegible]
1,189 [illegible]

January 26, 1916.
1,271 [illegible]
1,[illegible] B.T.-H. Co. & [illegible]
1,246 [illegible]
1,247 [illegible]
1,248 [illegible]
1,278 [illegible]

1,266 QUINTAL, ROBERT & TANQUAY. Switch-operating mechanism.
1,282 RELAY AUTOMATIC TELEPHONE CO. Transmitting impulses.
1,229 THOMAS & THOMAS TRANSMISSION (LTD.) Power transmission.

January 27, 1916.
1,309 BULLERS (LTD.) & TWISS. Supporting and insulating electric lines
1,299 CRACKNELL. Gas and electric globe gallery screw.
1,287 HAIR. Joint box for armoured electric cables.

January 28, 1916.
1,374 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Controlling and regulating electric motors.
1,381 LEITNER. Electric accumulators.
1,368 SHORT. Electric lampholder.
1,384 WEST. Electric lamps.

January 29, 1916.
1,434 B.T.-H. CO. (G.E. Co.) Multi-speed alternating-current motors.
1,418 GIMINGHAM. Arc incandescent lamp.
1,396 ORANGE & SIBLEY. Motor cable and air-line lorry.
1,436 PENSUTI. Controlling electric ignition in internal-combustion engines. (3/2/15 Italy.)
1,417 WESTERN ELECTRIC CO. (Western Electric Co.) Cores for Pupin loading coils, magnets, &c.

January 31, 1916.
1,469 BYGRAVE. Electrical selectors or impulse responders.
1,472 CLARK & HART ACCUMULATOR CO. Cells or boxes for secondary batteries.
1,452 ELLEFSEN. Motor controllers.
1,483 FANTINI. Electromagnetic release or cutout.
1,481 GIRARDEAU. Make-and-break switches. (29/1/15, France.)
1,475 OLDHAM. Miners' electric safety lamps.

February 1, 1916.
1,469 BYGRAVE & RELAY AUTOMATIC TELEPHONE CO. Electrical selector or impulse-responders.
1,526 KAWAKAMI. Electric motor pump. (5/2/15, Japan.)
1,502 WESTERN ELECTRIC CO. (Western Electric Co.) Testing arrangements for machine telephone switching systems.

February 2, 1916.
1,596 BERRY. Electric heat radiators.
1,597 BETHENOD & GIRARDEAU. Radiotelegraphy. (2/2/15, France.)
1,609 ECHAVARRIA & GRATTAN. Electrically-operated ordnance machine guns, &c.
1,595 GALLETTI & GALLETTI'S WIRELESS TELEGRAPH & TELEPHONE CO. Transmission of wireless signals.
1,584 HUGHES & HUGHES & SON & STARLING. Magnetic compasses.
1,550 MCCOLL. Protective gear for alternating-current feeders and circuits.
1,580 SEABURY. Power transmission and reversing gear.
1,561 SHOULS. Converting reciprocating into rotary motion.
1,546 TOMPKINS. Turbines.

February 3, 1916.
1,617 DAVIS. Mercury contact and short-circuiting devices for electrical measuring instruments, &c.
1,620 GARRARD & RAILING. Equalising or balancing electric currents, applicable to rotary converters.
1,643 IGRANIC ELECTRIC CO. (Cutler-Hammer Mfg. Co.) Motor controllers.
1,618 LANCHESTER. Searchlights and apparatus for detection of aircraft.
1,520 MASCHINENFABRIK OERLIKON. Constructing turbine stators. (3/2/15, Switzerland.)
1,628 REUSS & ROBERTS. Electrolytic apparatus for laundry, &c., purposes.
1,652 SCHNEIDER. Apparatus for regulating delivery pumps feeding an accumulator.
1,635 SCHOLES. Electric joint.

February 4, 1916.
1,705 B.T.-H. CO. (G.E. Co.) Controlling alternating currents.
1,724 CLARKE, CHAPMAN & CO. & HARRIS. Electrical resistances.
1,698 JOEL. Electric batteries.
1,707 KIELL & STOW. Electric heat-regulating switch.
1,719 SMITH. Production of motive power.
1,714 SCOTT-SNELL. Lighting road vehicles.

February 5, 1916.
1,748 CARLMARK. Electroplating tubes.
1,747 HOLLANDS. Railway point and signal apparatus, &c.

February 7, 1916.
1,794 ADAMS. Portable electric-lighting devices.
1,811 ANDERSON & ELLISON. Electro-magnets for brakes, &c.
1,778 BARR. Electrical apparatus for heating liquids.
1,779 BARR. Electrical apparatus for heating and/or sterilising liquids.
1,827 BINYON & LEE. Apparatus for wireless telegraphy, &c.
1,821 BRYANT, INMAN, WARD & RELAY AUTOMATIC TELEPHONE CO. Automatic telephone systems.
1,787 DAVIES. Junction-box or sleeve for wire-armoured electric cables.
1,825 GELL. Electric arc generators for high-frequency oscillations.

February 8, 1916.
1,868 BRYANT, INAM, WARD & RELAY AUTOMATIC TELEPHONE CO. Automatic telephone systems.
1,869 BRYANT, INMAN, WARD & RELAY AUTOMATIC TELEPHONE CO. Telephone systems.
1,842 COUSE & ROSENBAUM. Trolley wheels.
1,862 NAAMLOOZE VENNOOTSCHAP DE NEDERLANDSCHE THERMO-TELEPHOON MAATSCHAPPIJ. Thermic telephones. (3/2/15, Germany.)
1,854 [illegible]
1,875 PORRILL. Dry batteries.
1,861 RODRIGUEZ. Syntonisation by frequency of groups of electromagnetic waves.
1,876 WESTERN ELECTRIC CO. (Western Electric Co.) Machine switching telephone systems.

February 9, 1916.
1,902 GARNER. Electrically-operated alarm signalling device.
1,915 HAMLYN. Electric radiator or heat projector.
1,921 SHARMAN. Electrical signalling systems.

February 10, 1916.
1,978 [illegible]
1,943 [illegible]
1,970 [illegible]
2,003 [illegible]

February 11, 1916.
2,076 BARKER & S[illegible] & BARKER [illegible]
[illegible]
[illegible]
[

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	851	Catalogues, Novelties, &c.	161
Imports and Exports of Electrical Manufactures	852	The Lighting of a Large Co-operative Stores. Illustrated	162
Legal Intelligence	852	"Lektrik" Switches. Illustrated	164
Business Notices	853	Attention-Attracting Novelties in Window Display. Illustrated	166
Bankruptcies, Liquidations, &c.	853		
Electricity Supply	853	Tenders Invited	856
Traction Notes	854	Tenders Received & Accepted	857
Empire Notes	854	Companies' Meetings and Reports	857
Foreign Notes	854	City Notes	859
Miscellaneous Notes	855	Electrical Companies' Share List	860
The Round Table	159		
The Electro-Harmonic Society	159		
Control Equipment for Winders and Hoists. Illustrated	160		

COMMERCIAL TOPICS.

Trade After the War. Last week an influential deputation, representing the Chambers of Commerce of the United Kingdom, waited upon the Prime Minister in order to urge upon him the necessity of immediate steps being taken by H.M. Government, Chambers of Commerce and other kindred associations throughout the country to formulate adequate action for the defence and improvement of trade and employment after the war.

It also recommended the establishment of a Ministry of Commerce to carry out a constructive commercial policy for the country, and that steps be taken, by means of close co-operation, to improve the commercial relations between the United Kingdom, H.M. dominions beyond the seas and our Allies.

In the course of his reply, Mr. Asquith said that there was no department of State more ably administered than the Board of Trade, whose functions were very multifarious. The haphazard agglomeration of those had been brought about from time to time, and the logical and scientific system of administrative distribution and allocation of them might possibly be separated and otherwise divided. But he thought that the Board of Trade, particularly the permanent officials of the Board, for a generation past had been most vigilant and painstaking. There had been an enormous improvement in the collection of statistics, in the intelligible presentation of all the various facts which it was important for men of business to know and consider in the last 30 years, and that was a remarkable illustration how, although the machinery had remained formally and substantially the same, a great Government department might improve its results to the community and the State. He was not one of the people who were in favour, as so many people were nowadays, of the creation of new Ministeries. He was not certain that in the dual capacity of President of the Board and of Minister of Labour he did not derive a certain amount of advantage in width of outlook and elasticity. It was a matter worthy of careful and deliberate attention that the growth and the complexity of our commercial relations, especially in view of the entirely altered economic conditions, were of such a kind as to suggest the necessity, or at least the desirability, of their being entrusted alone and singly to such a department. He was not at all disposed to limit the holding of office to any particular class of people. Although there was a good deal to be said in favour of an Advisory Council, that was another matter. He would, even if a new Ministry were to be created, deprecate any artificial limitation of choice as to the sort of person to preside over it. He was not going to make any declaration of policy, because they had arranged, in concert with our Allies, to hold a conference in Paris, which he hoped would take place in the course of the next fortnight or so, at which all the Allied States would be represented, and at which the whole question of the economic and commercial relations, inter se, and as between them jointly and individually on the one side and our present enemies on the other, would form a subject of deliberation.

We agree that the creation of a Ministry of Commerce, with a staff of Civil servants of the usual type, would not be of much use in the campaign to capture German trade, and we are also in agreement with the Premier when he says that the Board of Trade has done useful work. It is quite fashionable just now to bait Government departments and officials, but much useful work has been and is being done by the various branches of the Board of Trade. Our principal objections to the work of the Board are the formalism of some of its officials, the rigid adherence to obsolete forms and ideas, and the great anxiety to placate municipal opinion. The duties of the Board are also so multifarious that it is impossible for the President to keep in touch with all that is being done, and we think it would be well if these duties were subdivided. Those branches which relate, directly or indirectly, to foreign trade and commerce, exports and imports, and possibly means of transport also, should be placed in charge of a new Minister, who might be termed Minister for Commerce. It is not, however, the title, but the work of the Ministry that matters. One of the first things which a Minister of Commerce should do should be to reorganise the consular service thoroughly. Consuls and consular officials should be trained, fully qualified men, whose sole duty it should be to advance the interests of British trade and commerce. At present many of our consular officials are aliens; they are engaged in trade on their own account; this trade is often carried on in competition with ourselves; their annual reports are, in many cases, merely long meaningless columns of statistics which are quite out of date when they are published here. The Minister should also supervise the work at present done by our commercial attachés and should, if possible, keep in touch with what is being done by the consular officials of other countries.

* * * *

Italian Industry and Germany. It is reported that the Italian Cabinet recently considered a scheme for emancipating Italian industry from its dependence upon Germany for raw materials, plant, &c.

It is proposed (1) to exempt from import duty and octroi for five years all machinery and materials for the construction of machinery destined to increase the production of existing industries or to create new industries with the object of producing articles not at present manufactured in Italy, or to start new methods of manufacture; (2) to exempt from taxes for five years land and buildings forming an essential part of factories which come under the categories above mentioned; and (3) to exempt from income tax, also for five years, all revenues arising from these new industrial enterprises.

British manufacturers and exporters would do well to take note of the movement to get rid of German influence on trade and industry in Italy, as it should mean a greatly increased demand for British goods.

In connection with this movement it is interesting to note that an agreement has been made between a British financial group (represented by the London County & Westminster and Lloyds Banks) and an Italian financial group (represented by the Credito Italiano, of Milan) for the promotion of commercial and industrial undertakings in Italy. It is proposed to form two new companies in England and in Italy respectively, entitled the British Italian Corporation and the Compagnia Italo Britannica, which are to work in close association. The British company will have a capital of £1,000,000, and the Italian company a capital of 10,000,000 lire (£400,000).

* * * *

Electric Supply Companies in 1915. All the London and many of the provincial electric supply companies have now issued their annual reports, and though they have all been affected by the lighting restrictions, the greatly increased cost of coal, materials, &c., the results may be considered quite satisfactory under the circumstances. The gross revenue of three of the London companies (the London Electric Supply Corpn., the County of London Electric Supply and the S. Metropolitan Electric Light & Power Companies) was higher than in 1914, but owing to the enhanced price of coal, higher wages, &c., the net revenue of the two first-named companies was less than in the previous year. The County of London, Charing Cross, Notting Hill, S. London and Smithfield Markets Companies maintain their dividends, and the S. Metropolitan Company, the only company whose net revenue showed an increase in 1915, is paying 4 per cent. on the ordinary shares, against nil in 1914. The City of London, Metropolitan, St. James' & Pall Mall, Chelsea and Kensington and Knightsbridge Companies, and the Westminster and London Electric Supply Corporations are making somewhat reduced distributions, but these companies have been badly affected by the lighting restrictions, the economies effected by their consumers, &c. On the whole, we think the results of the year's working are very satisfactory considering the difficult and exceptional conditions under which the companies worked.

Indeed, a much more serious set-back might have been expected, and it only needs peace conditions to prevail once more to see a rapid return to the old position. Many of the companies have a heavy and rapidly increasing power load; others, like the Brompton and Kensington, the St. James' & Pall Mall, the Kensington & Knightsbridge Companies, are cultivating the heating and cooking business with great success, and, provided the coal difficulty can be successfully overcome, we see no reason to view the situation with alarm.

Of the provincial companies, those operating in the industrial areas, owing to the heavy power load, did well, while those in seaside towns, &c., were greatly affected by the lighting restrictions and other difficulties. For instance, the profit of the Newcastle-on-Tyne Electric Supply Co. was £204,418, compared with £178,380 in 1914, and the available balance is £151,668, against £132,405, the dividend being raised from 5½ to 6 per cent., with larger appropriations for depreciation and general reserve. We are also pleased to see that that pioneer power company, the Midland Electric Corpn. for Power Distribution, had an exceptionally good year. Its gross receipts increased by £17,000 and the trading profit by £11,300. For 1914 the preference dividend was paid for the first time, and now the ordinary capital comes in for an initial distribution, 3 per cent. being declared. The forward balance is augmented from £3,650 to £8,932, subject to the assessment for excess profits tax. On the other hand, the distribution of the Bournemouth & Poole Co. has dropped from 7 to 6 per cent., that of the Oxford Electric from 6½ to 6 per cent., and the Scarborough Company pays no dividend for 1915.

* * * *

Electric Lighting in Hospitals and Nursing Homes.

In our issue of March 3, we reproduced extracts from a letter written by Mr. S. O. Stephenson, manager of the Worthing Gas Co., to the "Worthing Gazette," in which he characterised as unpatriotic and positively dangerous to the national community that electric lighting should be used in place of gas at the present time. His remarks were chiefly directed at The Grange Convalescent Home, Worthing, where electric light is being installed for the benefit of sick and wounded soldiers. Mr. Stephenson even went as far as suggesting that a large proportion of the cost will go out of the country. In a letter to the "Worthing Observer" Mr. A. C. Evans, the secretary of the Grange, deals promptly with Mr. Stephenson's innuendoes.

"A letter appeared in the 'Worthing Gazette' by Sidney O. Stephenson, which I have read with much interest, in which he practically accuses the Committee of the Grange Convalescent Home of lack of patriotism. I think it necessary to show that we are patriotic, when we are looking after our wounded boys. The correspondent's initials are rather appropriate, viz., 'S.O.S.', but I can assure him no signal of distress will be hoisted at the Grange. We are urged by the Government to economise, and by having the electric light installed we shall certainly economise; further, instead of being a luxury, it is for health and safety's sake that the electric light is being installed. Regarding the assertion that a large proportion of the money will go abroad, this I challenge, and I think it would have been advisable if the facts had been ascertained before such rash statements were published. I have a letter from Messrs. Page & Miles (the contractors) in which they state that all the material is of British manufacture, and, further, the manufacturers' certificate to that effect can be produced. Just recently the military authorities have installed electric light at Shoreham Camp, so if 'S.O.S.' is complaining merely from a patriotic point of view, why has he not criticised their action, or has trade jealousy anything to do with the question?"

The sting is in the tale of Mr. Evans's letter. Are we to take it as the reasoned opinion of gas managers that they regard the use of electric lighting, in place of gas, as an unpatriotic proceeding?

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 6, 1916, *to* March 11, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

[illegible]

EXPORTS

To Australasia.—*Auckland:* Wire and cable, £1,308; unenumerated, £172. *Melbourne:* Wire and cable, £13,639; elec. machinery, £880; unenumerated, £655. *Sydney:* Elec. machinery, £437; wire and cable, £5,451; unenumerated, £876. *Wellington:* Wire and cable, £319; elec. machinery, £130; unenumerated, £1,081. *Adelaide:* Unenumerated, £30. *Perth:* Unenumerated, £74. *Christchurch:* Unenumerated, £26. *Dunedin* Elec. machinery, £47; unenumerated, £24. *Lyttelton:* Elec. machinery, £197; wire and cable, £805; unenumerated, £62. *Townsville:* Elec. machinery, £950. *Hobart:* Unenumerated, £65. *Fremantle:* Wire and cable, £2,500; unenumerated, £87. *Newcastle:* Wire and cable, £122. *Invercargill:* Unenumerated, £52. *Nelson:* Unenumerated, £190.

Africa.—*Durban:* Elec. machinery, £60; wire and cable, £1,146; unenumerated, £714. *Cape Town:* Elec. machinery, £22; telegraph material, £31; unenumerated, £1,399. *Port Elizabeth:* Elec. machinery, £61; wire and cable, £3,178; unenumerated, £83. *East London:* Elec. machinery, £204; wire and cable, £136 unenumerated, £431 *Zanzibar:* Unenumerated, £46. *Napier:* Elec. machinery, £27. *Beira:* Telegraph material, £24; unenumerated, £299.

South and Central America.—*Buenos Ayres:* Unenumerated, £419. *Rosario:* Unenumerated, £137.

Gibraltar.—Elec. wire and cable, £162; telegraph material, £276.

Holland.—*Amsterdam:* Wire and cable, £95; unenumerated, £248. *Rotterdam:* Wire and cable, £306; unenumerated, £607.

Canada.—*Montreal:* Elec. machinery, £310; unenumerated, £129. *St. John's:* Unenumerated, £576. *Vancouver:* Unenumerated, £61.

Java.—*Batavia:* Wire and cable, £384; unenumerated, £65. *Sourabaya:* Wire and cable, £1,152; elec. machinery, £167.

U.S.A.—*New York:* Wire and cable, £40; unenumerated, £38.

Egypt.—*Alexandria:* Unenumerated, £94. *Port Sudan:* Wire and cable, £252 unenumerated, £619.

British Guiana.—*Demerara:* Unenumerated, £11.

Burma.—*Rangoon:* Wire and cable, £49; unenumerated, £105.

India, Ceylon, Indo-China and Straits Settlements.—*Bombay:* Wire and cable, £383; elec. machinery, £110; unenumerated, £378. *Calcutta:* Elec. machinery, £25; wire and cable, £5,523; unenumerated, £887. *Ceylon:* Unenumerated, £58. *Madras:* Elec. wire and cable, £443; unenumerated, £101. *Karachi:* Elec. machinery, £62; unenumerated, £154. *Penang:* Wire and cable, £496. *Singapore:* Wire and cable, £210; elec. machinery, £98; unenumerated, £217.

China.—*Shanghai:* Elec. machinery, £32; wire and cable, £56. *Tientsin:* Unenumerated, £84; unenumerated, £1,717. *Hong Kong:* Unenumerated, £261. *Hankow:* Wire and cable, £95.

Japan.—*Nagasaki:* Wire and cable, £4,325.

France.—*Paris:* Unenumerated, £566. *Boulogne:* Unenumerated, £194. *Havre:* Unenumerated, £61. *Dunkirk:* Unenumerated, £147. *Dieppe:* Wire and cable, £516; unenumerated, £116.

Minitilan.—Elec. wire and cable, £24.

Italy.—*Genoa:* Telegraph material, £117; unenumerated, £107.

Russia.—*Petrograd:* Wire and cable, £844; unenumerated, £56.

Portugal.—*Lisbon:* Wire and cable, £45; unenumerated, £71.

Sweden.—*Gothenburg:* Unenumerated, £709.

Denmark.—*Copenhagen:* Unenumerated, £84.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £985. *Perth:* Unenumerated, £24. *Bombay:* Unenumerated, £135. *Durban:* Unenumerated, £345. *Amsterdam:* Unenumerated, £39 *Barcelona:* Unenumerated, £20. *Lisbon:* Unenumerated, £98. *Adelaide:* Unenumerated, £38. *New York:* Unenumerated, £84. *Paris:* Unenumerated £114. *Penang:* Unenumerated, £50.

Note.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

LEGAL INTELLIGENCE.

Re British Electric Traction Co. (Ltd.)

In the Court of Appeal (the Master of the Rolls and Lords Justices Phillimore and Warrington) on Friday the hearing was resumed of the appeal of the Public Trustee, as the executor of the late Mr. Leopold Salamon, holder of £12,960 non-interest bearing income certificates of the British Electric Traction Co. from an order of Mr. Justice Astbury, sanctioning upon the petition of the company a reduction of its capital from £4,000,000 to £2,998,397. 15s., and also sanctioning the scheme of arrangement under sec. 120 of the Companies (Consolidation) Act, 1908, so as to bind the various clauses of shareholders and also the holders of income certificates issued by the company. By the scheme of arrangement as sanctioned by the Judge the non-interest bearing income certificate holders were given in full satisfaction of the certificates 10 per cent. of their face value in new cumulative fully-paid preference shares and 25 per cent. of their face value in fully-paid ordinary stock. The case for appellant was that he was not bound by the scheme as it might be that the acceptance by him of the shares as fully paid would involve him in some future liability.

At the conclusion of the arguments their Lordships dismissed the appeal with costs.

Effect of War on Commercial Contracts.

On Monday Mr. Justice Bray heard an action brought by the Birmingham Private Telephone (New System) Co. (Ltd.) against the Deutsch Privat Telephon Gesellschaft, H. Fould & Co., and Mr. Alfred Gunz (formerly chairman and managing director of plaintiff company, but now interned as an alien enemy), for a declaration that three contracts, dated Jan. 4, 1911, were determined by the outbreak of the war and ceased to be binding.

Mr. Disturnal, K.C., and Mr. Giveen appeared for plaintiffs and Mr. Douglas Hogg for Mr. Gunz.

Mr. Disturnal said plaintiff company was an English company, registered on Aug. 29, 1911, and carried on business as dealers in private telephone installations. The company was promoted by Mr. Gunz to take over and work in the Midland counties three contracts between himself and the German company, by which he acquired the exclusive right to dispose of the German company's goods in the counties o Stafford, Worcester, Warwick and Salop, and agreed not to buy or deal

in any other apparatus than that sold by the German company. Though plaintiff company was formed in 1911, Mr. Gunz did not make a formal assignment of the benefits and obligations of the contracts before the outbreak of the war. In November, 1914, however, he purported to execute an assignment of the contracts to plaintiff company. Mr. Gunz had since got rid of his shares in and ceased to be a member of the company, which was now being worked with English capital and by English directors. But it was impossible for the company to carry on business unless it could enter into contracts for the purchase of goods from English manufacturers. Therefore the company asked for a declaration that the contracts between Mr. Gunz and the German company were determined by the outbreak of the war.

Mr. FREDERICK T. JACKSON, managing director of plaintiff company, said that since the war Mr. Gunz had ceased to be a director and shareholder of the company. The present directors and shareholders were all British subjects. There were about seven similar companies in this country.

Mr. HOGG (for Mr. Gunz) said his client had no interest in the contracts and did not want to do anything to interfere with any right plaintiff company might have to any declaration his Lordship thought fit to grant, but as he had been made a defendant he desired to take the point that German contracts should be construed according to German law. Counsel also submitted that the royalty on the use of mark 60 was not extinguished by the war.

His LORDSHIP granted a declaration that the contracts were determined at the outbreak of the war. As the contracts had been determined, the right to the mark 60 ceased.

Judgment was entered for plaintiff company, without costs.

BUSINESS NOTICES.

The headquarters of the Ministry of Munitions is now at the Hotel Metropole, Northumberland Avenue, London, S.W.

Plant for Sale.—An advertiser has two Lahmeyer motor generators and a Langdon-Davies dynamo for sale.

BANKRUPTCIES, LIQUIDATIONS, &c.

Jas. R. Whitehouse, managing director of an electrical company, 43, St. Andrew's-road, Golder's Green, Middlesex, has been adjudicated bankrupt.

A meeting to receive an account of the winding up of the Eureka Clock Co. (Ltd.) will be held on April 12 at 8, Staple Inn, London, W.C.

Deed of Assignment.—Claims are to be sent by March 27 to Mr. G. E. Corfield, Balfour House, Finsbury-pavement, London, E.C., preparatory to the payment of a first and final dividend under a deed of assignment executed Nov. 19, 1915, by Wm. G. R. Cook, electrician, Clarendon-road, Red Hill.

ELECTRICITY SUPPLY.

EXTENSIONS.

Bath.—The L.G. Board have authorised a loan of £1,400 for laying an electric supply main to Messrs. Stothert & Pitt's premises.

Bradford.—The Finance Committee of the Guardians recommends that the new buildings at Bowling Park Colony be lighted electrically and that a guarantee be given to the Corporation ensuring a minimum revenue of £150 per annum for seven years.

At Tuesday's Council meeting Ald. G. H. Robinson, chairman of the Electricity Committee, said they had accepted offers for additional plant consisting of boilers and economisers at the electricity works at a cost of £23,500. The committee recognised it was a very heavy expenditure, but they had to face the fact that the load on the station had greatly increased. Last year there was a demand for 15,000 kw. per hour, and next winter it was expected to be 20,000 kw. to 24,000 kw. per hour. At the Valley-road works there were three turbo-generators of 3,000 kw. each, and one recently installed of 5,000 kw., making a total of 14,000 kw. There were also four low-speed reciprocal engine sets, bringing the total to 18,000 kw. In No. 2 works there was an old plant which could turn out something like 3,000 kw. That plant, however, was only used on special occasions, because the coal consumption was double that of the later turbos. Altogether they were thus able to produce 21,000 kw., and in the coming winter they expected between 20,000 kw. and 24,000 kw. As to boilers, however, they were not in the same position, and they wanted additional boilers. The committee expected that the Treasury would grant them borrowing powers for the new plant, seeing that a great deal of the increased load was due to the extra demand from factories and works of various kinds.

Burnley.—The new electric generating plant at the electricity works and the Holmby-street sub-station were formally inaugurated on the 4th inst.

At the generating station a 2,000 kw. Westinghouse turbo-generator was started. Electrical energy is supplied at 6,600 volts to the sub-station, whose equipment includes two 600 kw. rotary converters and transformers for supplying energy for traction and for power in the district. The cost of the extensions has been over £26,000. The generating plant and switchgear has been supplied by the British Westinghouse Co. The new turbo-alternator runs at a speed of 3,000 revs. per min. with steam of 160 lb. pressure, and is capable of developing 25 per cent. continuous overload for two hours, or the equivalent for 3,000 H.P.

Fulham (London).—The Borough Council are recommended to authorise an expenditure of £950 for the extension of the cable and the erection of a sub-station in order to give a supply of electrical energy to the Townmead Engineering Works. The firm have guaranteed a revenue of not less than £1,000 for three years.

The Electricity Committee proposes to extend the mains to give an additional supply of energy to the Pedrail Transport (Ltd.), and it has reported that Battersea Borough Council has applied for the supply of at least 700 kw. for the ensuing year under the linking-up scheme. The Committee understands that it is probable that the Battersea demands may amount to some two or three million units per annum, and under the agreement the cost per unit payable to Fulham will be materially affected by the price of coal. The Committee is informed that Battersea has made arrangements for their coal supply during the next 12 months, including a contract with E. Foster & Co. for Pooley Hall small nuts at 20s. 7d. per ton. In view of the supply to be taken from Fulham, however, Battersea anticipates that their contracts may exceed requirements, and suggest, with a view to keeping down the coal cost, that Fulham should agree to take a transfer of 4,000 tons of the coal specified at the price quoted, plus cost of delivery. The Committee recommends acceptance of the Battersea Council's offer. It is also recommended that a contract be entered into with Cory Bros. to deliver 100 tons per week for the next six months of small Welsh coal at 23s. 6d. per ton.

Rotherham.—The cost of extending the boiler house at the power station (£1,854) is to be defrayed out of the renewals fund.

Sheffield.—The L.G. Board recently sanctioned the borrowing of various sums, amounting to £111,642, for providing additional plant at Neepsend power station.

The revenue of the electric supply department for the current year is estimated at £277,000, or £150,000 more than in 1914. This great increase is due to the very heavy demand for electrical energy for power. Seven years ago receipts were only £77,700.

Wolverhampton.—The L.G. Board has sanctioned the borrowing by the Council of £1,085 for laying mains to supply local works.

GENERAL.

Accrington.—At the recent meeting of the Council complaint was made by Councillor Ashworth as to the failure of the supply of electric power to mills and works in the town, causing stoppages and great inconvenience.

The chairman of the Electric Supply Committee (Ald. Higham) said the electricity undertaking, which was a great success, was the victim of circumstances brought about by the war and things over which they had no control. The stoppages referred to were known by the firms, and they were not finding such fault as the members of the Council.

Bredbury and Romiley.—The Urban Council will consent to Stockport Corporation getting a provisional order to supply electrical energy in this district.

Dartford.—At the meeting of the Urban Council last week the Electricity Committee reported a deficit of £3,300, and it was recommended that the charge for current be increased 20 per cent.

It was stated also that the amount sanctioned by the L.G. Board for extensions of the electric supply station had been exceeded by £1,076, and it was proposed to ask the Board to approve the raising of a loan of this amount.

A special meeting is to be called to discuss the matter.

Dover.—It was reported to the Council last week that the Admiralty were willing to renew the loan of £157,000 for the electric supply department for seven years from May 6, with power for both to pay off at six months' notice after five years.

The rate of interest to be ½ per cent. above the rate payable by the Government on the last war loan, with a minimum of 5 per cent.

Ald. LEWIS said that that meant they would pay 5½ per cent.

The TOWN CLERK said that the last war loan was at 4½ per cent., so that the rate would be 5 per cent.

The L.G. Board have sanctioned a loan for £3,814 for a new main to East Cliff, the amount to be repayable in 25 years.

Lowestoft.—The Council have decided to increase the charges for electric current by 10 per cent.

Shaldon (Devon).—At a recent meeting of the Council Dr. Purves attended and outlined a scheme of electricity supply for the district. A resolution in favour of adopting electric lighting was carried.

Swansea.—Subject to the approval of the Board of Education, the Education Committee proposes to instal electric irons and a cookery stove at the domestic subjects centre.

Walsall.—The Electricity Committee has made arrangements with the British Thomson-Houston Co. to supply motors on the deferred payment system.

The department will execute the necessary wiring where such motors are supplied to consumers.

Finding it difficult to obtain suitable men to fill the vacancies, the Electrical Engineer is applyong to the War Office for the return of a shift engineer and sub-station attendant, who have enlisted.

TRACTION NOTES.

Bristol.—At the last meeting of the City Council the Tramways Option Committee reported the result of their negotiations with the local tramways company as to what rent or other sum the company would be willing to pay, and what concessions they would be willing to make to that Coporation if the latter agreed to refrain from exercising their option of purchasing the undertaking for 7, 14 or 21 years.

The committee stated that the company are unwilling to make any payment in the nature of a wayleave or to make such adequate concessions in the way of revision of fares or otherwise as in the Committee's opinion they would be justified in recommending the Council to accept in consideration of the Corporation refraining to exercise their option. Having regard to existing circumstances the Committee is not prepared to make any recommendation at present on the advisability of the purchase of the tramways. They, therefore, had come to the conclusion that until the time for advising the Council arrives they should be authorised from time to time as and when necessary to apply to the Board of Trade for any further order extending the purchase period.

The Council have decided to adopt this suggestion.

L. & S.W. Railway.—The electric train service from Waterloo, through the new stations at Barnes Bridge, Chiswick, Kew Bridge, Brentford, Isleworth, Hounslow and thence to Twickenham Junction was inaugurated on Sunday.

The service, which is an hourly one on Sundays and half-hourly on week days, has already become quite popular.

Manchester Traffic Problems.—At the recent meeting of the Manchester, Liverpool and Counties Commercial Motor Users' Association, notice of a recommendation of the General Manager of the Manchester Corporation Tramways to prohibit motor-wagons using the centre of the road on tram-lines was reported.

It was resolved to write to Manchester Corporation Tramways Committee asking for their views on the question, and it was further resolved that the Association's Parliamentary agents should make strict inquiries of the possibility of any Bill being put forward on this question.

Newcastle-on-Tyne.—On the advice of the Improvement and Streets Committee, it has been decided to purchase an electrically-driven van for the collection of domestic refuse.

EMPIRE NOTES.

Australasia.—The establishment of a Commonwealth Bureau of Science and Industry to consider and initiate scientific researches for the promotion of primary or secondary industries in the Commonwealth of Australia is the principal recommendation in the report presented to the Prime Minister by the sub-committee of the conference in Melbourne on the question of the application of scientific research to the problem of industry. Mr. Hughes announced that he was prepared to spend up to £500,000 on a national laboratory, and that he proposed to take practical steps towards starting the laboratory before he left for England.

The erection of a technical college at Ipswich, at a cost, with equipment, of £6,000, has been recommended to the Government as an urgent matter. A sum of £1,000 has been raised locally towards the object.

"Tenders" (Melbourne and Sydney) says a scheme for supplying Kingaroy (Queensland) with electricity is being prepared by Mr. Jacob Bonding, who has secured an Order in Council.

Australian Electric Steel (Ltd.) has been registered in New South Wales to carry on business as steel founders, and an electric furnace has been ordered from Great Britain. Mr. J. M. Deschamps is managing director.

Canada. The Government of Ontario has completed negotiations for the purchase, at a cost of $8,340,000, of the whole of the undertaking of the Consolidated Electric Power Co. and its 22 subsidiary companies which are operating in Central and Eastern Ontario. The object of the Provincial Government is to supply electric energy at cost price, and to duplicate in the eastern part of the province the extensive network of the hydro-electric system of Western Ontario.

Manufacturing industries in Winnipeg and other parts of Western Canada are, it is reported, steadily increasing their production owing to the general revival of trade. Plants with facilities for making war supplies have been receiving a share of the huge orders placed in Canada, and this has helped to keep town staffs busy in the dull season. At present there is practically no unemployment in Canada; there appears to be ample labour available to meet present manufacturing demands, and work on the land has not yet opened for the season.

FOREIGN NOTES.

Aluminium Smelting in Norway.—Aluminium smelting works are being erected at Höyanfjord, Norway, where there is a waterfall which may furnish 60,000 H.P.

It is proposed to develop 20,000 H.P. at once, to provide for the production of 4,000 tons of aluminium per year. The subscribed capital is about £550,000. Bauxite beds have been secured in southern France, where the ore will be worked into oxides and shipped to Norway for conversion into metal by electrical furnaces.

Exports to China.—The Amoy Electric Light & Power Co., Amoy, has been added to the list of firms in China to whom goods may be consigned.

Mozambique.—A consular report from Mozambique says a contract has been signed by the Camara Municipal for the public and private lighting of the island.

It is proposed to employ steam-driven plant. The streets are to be lit by 16 c.p. metal filament lamps with 12 arcs for the public squares. Insulated lead-covered overhead mains will be used, supported in most cases on 2-metre iron roof poles. The promoters propose to charge a fixed price per month per lamp to avoid the expense of meters.

Russia.—A consular report on the trade of Finland for 1914 contains the following information:—

With regard to Helsingfors it is stated that towards the end of May, 1914, experts were directed by the local Senate to formulate a project for the regulation of the course of the Wuoksen River and of the water level of the Saima Lake, and to consider the desirability of erecting hydro-electric stations along the Wuoksen River for the utilisation of from 100,000 H.P. to 600,000 H.P. The experts have expressed the opinion that a petition by a Petrograd company, for a concession to erect a power station at Kurmanpohja for the utilisation of the water-power of the upper portion of the Wuoksen River, should be declined. At Petrograd the authorities are making inquiries as to the amount of electric power required there. The Petrograd company in question have offered a portion of the water-power to the Finnish State railways, for the electrification of those railways. It appears probable that the project of harnessing the falls proceeding from the Saima Lake will come up again for consideration in the near future.

British Trade.—It has been said that British trade suffers through not giving long credit. To some extent this is true, but the principle under which German firms allow lengthy credit appears in the nature of a gamble. Tramway cars now in Helsingfors were purchased from Germany, a Dresden firm agreeing to take debentures, redeemable at 20 years. The firm was unable to dispose of the debenture bonds and bankruptcy ensued. Adaptability ought, however, to be shown by British firms, and has been shown by many. German goods have much improved in quality during the last few years, and in many branches are beginning to compare favourably with British goods, especially as regards machinery. British machinery seems to be almost too strongly made and is practically never worn out. Germans appear to aim at making machines which will last a certain number of years and work out the exact structural strength required, and their machinery can be sold at a good profit and at a cheaper price than the British article. A local firm recently bought two steam engines, one of British, the other of German make. Both work very well. The German engine is, however, much more economical, of a better and more modern design, excellent workmanship and a lower price. The British machine will probably last longer, but will get more and more out of date and less economical compared with fresh designs every year. When the German machine is ready to be scrapped, it is reckoned to be about the right time to buy a new machine of modern design. The German manufacturers can sell at a lower price an article that is 20 per cent. inferior, though offered as of equal value to the British one.

Germany has sent a great number of commercial travellers to Finland, who know the language and the customs. This has not been practised to the same extent by British firms, but in cases where the latter have done so, good results have followed. In electrical machinery Germany, Sweden and Switzerland have held the market, and there should be an opening for British enterprise. German manufacturers allow drafts at three and six months' acceptance as payment, and, although they have their standard types of machine, will always turn out fresh types when required for the Finnish market. British manufacturers will not, generally speaking, thus adapt themselves to the requirements. The machines imported include electrical machines, steam engines and turbines, boilers, lathes, planing, shaping and all kinds of machinery for workshops. Turbines came from Germany and Switzerland, principally the former; steam engines from the United Kingdom, Germany, Sweden and Denmark; boilers, except where locally manufactured, from Germany; lathes, planing, &c., machinery equally from the United Kingdom, the United States, Germany and Sweden.

The Vice-Consul at Ekaterinburg (Urals) says amongst the list of goods formerly imported into the Ural districts from Germany and Austria-Hungary (chiefly Germany) and for which there is an opening for similar

goods from the United Kingdom, are machinery of many descriptions, including turbo-generators, steam engines and locomobiles, mining and wood-cutting machinery; hardware and tools; electric lamps, fittings, &c.; glassware; leather goods; &c. It is essential for British firms to send out their own travellers (British, if possible, with a knowledge of Russian) and acquaint themselves with the local demand as well as the local conditions of credit, at the same time finding out the prices formerly paid to the Germans for similar goods. They could open agencies in conjunction with other British firms intending to deal in other classes of goods. Even recently attempts made by British firms to do business in the Ural districts have been feeble in most cases. Catalogues and correspondence in English continue to arrive, and samples received are frequently of inferior quality, and Russian firms will have nothing to do with them. German care and attention in considering the likes and dislikes of Russian customers have made them fastidious. In machinery American firms are well represented. Owing to the restrictions to be imposed on Germans in future, *e.g.*, prohibiting them from occupying positions of authority, there should be a lack of educated technical labour, as, for instance, mechanical engineers, mining engineers, electrical engineers and commercial men, &c. Some slight knowledge of Russian would be essential.

Spain.—For the construction and working of an electric tramway in Madrid (Monte del Pardo district) the Ministerio de Fomento has granted a concession to the Sociedad Tranvia del Este de Madrid

The Ministerio de Fomento has granted permisssion to Don Justo Calcedo to utilise, at the rate of 2,200 gallons per second, the waters of the river Ebro in the district of Miranda for industrial purposes and has allocated land as a site for a power station.

Statistics published by the Union Eléctrica Española show that there are 50 hydro-electric works in Spain of over 800 H.P. The ultimate aggregate capacity of these works is intended to be 1,008,876 H.P., of which 266,576 H.P. is now in use. There are 21 similar works of from 300 H.P. to 700 H.P., the total power of which is 10,243 H.P. all in use. The number of enterprises representing less than 300 H.P. is 39.

MISCELLANEOUS NOTES.

Customs Duties.—The following are import duties payable under the Brazilian Budget Law for 1916:—

Carbon or metal filament electric lamps, 2 milreis per kilog. gross (about £6. 17s. 10d. per cent.); material for first public installation of light and power (exclusive of material for private installations), articles for improvement of harbours, railways and electric tramways, analytical laboratories and refuse destructors, when imported on the requisition of state authorities or municipalities, 8 per cent. ad val.

A decree was issued recently which exempts from harbour, communal, municipal or other tax various articles upon importation into Greece, including motors (including steam, electric, petroleum and petrol) for driving, reaping or threshing machines, and means for conveying motive power (including wire for electric transmission). The exemption is to hold good for four years from Jan. 1/14, 1916.

Electric Light Switching Competition.—We are informed by Messrs. A. P. Lundberg & Sons that all past records have been well beaten in regard to the number of answer-papers received in respect of the examination questions sent out by them lost month.

We also understand that the quality of the papers is exceptionally high in all three grades. For the first time the ladies have entered the field. There are still the papers to come in from overseas competitors, who are naturally given a longer time to compete.

Enemy Firms to be Wound up.—Orders have been made by the Board of Trade under the Trading with the Enemy (Amendment) Act, 1916, requiring the following businesses to be wound up:—

Balashol Belting Co. (Ltd.), Berndorf Metal Works, Bradshaw Asphalte Co. (Ltd.), British Graetzin Light (Ltd.), Calmon Asbestos & Rubber Works (Ltd.), Electrical Co. (Ltd.), Hanover Rubber Co., Harburg & Vienna India Rubber Co. (Ltd.), Jaeger Bros., New York Hamburg India-rubber Co. (Ltd.), Rhenish Rubber & Celluloid Co. (1908) (Ltd.). and Wurttembergische Metallwarenfabrik (Ltd.),

Enfield Military Hospital.—Collections among the staff and employés of the Edison & Swan United Electric Light Co., which were made by Miss F. Wootton, realised sufficient to purchase a piano, stool and invalid chair for this hospital.

On the occasion of the presentation, which took place on the 8th inst., a concert was organised by Mr. Lishmann (a member of the company's staff), who acted as treasurer of the fund. Several items in an excellent programme were contributed by employés of the Edison & Swan Co. It is suggested that this practical demonstration of sympathy for our wounded soldiers is one worthy of emulation.

Inquest.—Last week an adjourned inquest was held on Ivor Edwards, colliery labourer, who died on Feb. 14.

A collier who was working near deceased at Oakwood Colliery said deceased went towards the wires to "knock up," and a second later he noticed deceased holding on to the wires. As witness approached him Edwards fell to the ground and witness picked him up and called for help. Artificial respiration was tried without success. It was part of deceased's duty to "knock" for the winding of trams. They pulled the wires by one hand and knocked with a knife. The ground on which deceased stood was damp, but not wet.

Arthur Jones, electrician at the colliery, explained that the system for knocking was to bring the two wires together and tap them with the blade of a knife. This completed the circuit and caused the bell to ring. The electric current was about 3 volts. The signalling wires were close to a power cable which supplied the fan, and on the day of the accident witness found one bare place in the cable. At one part that cable was only 12 in. from the signalling wires. The cable was carrying electrical energy at 500 volts. There was a high wind, and if the signalling wires got into contact with the cable it would electrify the wires. He last examined the cable about four weeks ago, but he had examined parts of it periodically since then.

Medical evidence showed that the valves of the heart of deceased indicated previous heart disease, but the man died from syncope from electric shock, and the jury returned a verdict that deceased was accidentally killed by an electric shock.

Military Tribunal Cases.—On the 9th inst. Mr. C. Furness, borough electrical engineer, of Blackpool, appealed for four single men employed in his department.

It was said the men were indispensable. There were 107 men at the beginning of the war and 43 had enlisted. The four were technical men whom it would be impossible to replace; they were sub-heads of departments. He was not there on personal grounds, but as representing the Corporation. If he could replace them with married men or men unfit for service he would do so. It was beyond human endurance to expect men to go on week after week doing two men's work. He would not keep any man out of military service if his place could be filled.

Conditional exemption was granted.

At Nelson on March 9 the Tramways Committee appealed in respect of the traffic clerk.

The Tramways Manager said the trams would have to stop if the man went; it was absolutely impossible to go on working. Only 13 were employed by the department on similar work to that they did before the war.

A month's exemption was granted.

Miners' Electric Safety Lamps.—In a recent memorandum the Home Secretary calls the attention of makers of miners' electric safety lamps to two accidents with electric lamps of an approved type which occurred in December last.

The accidents were due to the ignition of celluloid. While the lamps were in use underground, a quantity of dense smoke was evolved inside the lamp, and in one case such pressure was developed as to bu st the lamp open. In the other case the lamp did not burst, as it was not tightly screwed up, and the pressure was relieved by the gas escaping. On subsequent examination and experiment it appeared that the accidents were due to the loose spring terminals with which the lamps were fitted. These had been accidentally bent over, and had come into contact, with the result that the accumulator was short-circuited, and the heat generated was sufficient to decompose the celluloid of the accumulator case.

In order to prevent the occurrence of accidents of this kind in future, the Home Secretary has decided to prohibit the use in approved miners' electric safety lamps of spring terminals liable to be bent over, and a general provision to this effect will be included in the new Safety Lamp Order which will be made shortly. Any electric lamps at present in use which are fitted with such terminals should accordingly be refitted at once with rigid terminals.

Presentation.—An interesting event took place on the 6th inst. at the Woolwich works of Messrs. Siemens Bros. & Co. (Ltd.), the occasion being the completion of 50 years' service in the employment of the company by Mr. Robert Bertram, of the despatching and receiving department.

Mr. Alexander Siemens, in well-expressed terms, congratulated Mr. Bertram on having attained his jubilee of service, during which time he had seen the business grow from a very small beginning, when about 50 persons comprised the whole staff, to the present time, when the number of the employés is about 4,000. He had pleasure in presenting him with an illuminated address and a cheque from his colleagues at the works as a token of their esteem and regard, and also a cheque on behalf of the company as a recognition of his faithful service and the manner in which his duties had always been performed.

Mr. Bertram, in a neat little reply, thanked the company through Mr. Siemens and also his colleagues, most of whom had assembled to witness the presentation, for their gifts and the expression of their goodwill, and referred to some of his very early experiences when this neighbourhood was still rural.

Technical Education Grants.—In the House of Commons on Thursday last, Sir P. Magnus stated that apprehension was entertained by educational authorities that the grants for technical schools were to be reduced, and asked for a reassuring statement on the subject.

In reply, Mr. J. H. Lewis (Parliamentary Secretary, Board of Education) said the Board of Education were strongly convinced of the importance of maintaining the standard of technical instruction, even under war conditions, and of developing that instruction to the highest possible point as soon as the pressure of external circumstances was removed. The total amount taken by the Board in the estimates for 1916-17 out of which to pay grants to the large technical schools showed no reduction upon the amount which was being expended in the current financial year, and those interested in technical schools might be able to infer from that fact that they were not faced with any prospect of sweeping reductions.

Trading With the Enemy After the War.—At the last meeting of Birmingham Corporation attention was called to the resolution recently passed by Manchester City Council declaring that in future no trading relations should exist between that civic body and Germany and Austria.

Manchester Council decided to send a copy of the resolution to every municipality in the kingdom, and certain local authorities have passed similar resolutions.

Ald. Sir W. BOWATER said that the Manchester resolution had reached the Town Clerk, and was brought before the General Purposes Committee. The Committee did not consider they need be troubled at present with a question as to whom they were to deal with after the war. Some Councils in the country seemed to have plenty of time to deal with abstract resolutions; in Birmingham they had not. The General Purposes Committee thought the position would be best dealt with by ordering the communication to lie on the table.

On the other hand, Swansea and Nottingham Corporations have adopted the resolution.

War Relief Funds.—The employees of the India Rubber, Gutta Percha & Telegraph Works Co. have, since Sept., 1914, been contributing to various funds and the total collected is now £1,300.

Nearly £700 has been sent to the Prince of Wales' Fund, nearly £350 to the British Red Cross Society, £260 to the Belgian Relief Fund, and lately they have started to contribute to the Serbian Relief Fund and the Anglo-Russian Hospital at Petrograd.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during February, 1916, and (*b*) the aggregate figures from Jan. 1 to Feb. 29, with the increases or decreases compared with the corresponding periods of 1915:—

Electrical machinery, (*a*) £85,728 (decrease £45,119), (*b*) £183,233 (decrease £122,688), including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £14,315 (increase £1,298), (*b*) £30,668 (increase £1,803), and electrical machinery unenumerated, (*a*) £71,413 (decrease £46,417), (*b*) £152,565 (decrease £130,491); telegraph and telephone cables, other than submarine, (*a*) £8,065 (increase £7,675), (*b*) £21,473 (increase £17,944); telegraph and telephone apparatus, (*a*) £8,103 (increase £5,041), (*b*) £22,852 (increase £14,906); other electrical wires and cables, rubber insulated, (*a*) £15,172 (increase £13,101), (*b*) £17,896 (increase £11,547); with other insulations, (*a*) £528 (decrease £2,115), (*b*) £1,155 (decrease £2,631); carbons, (*a*) £7,950 (decrease £97), (*b*) £19,314 (increase £4,312); glow lamps, (*a*) £13,123 (decrease £4,413), (*b*) £26,638 (increase £5,060); arc lamps and electric searchlights, (*a*) nil (decrease £293), (*b*) nil (decrease £499); parts of arc lamps and searchlights (other than carbons), (*a*) £4,601 (decrease £2,447), (*b*) £11,025 (decrease £3,683); primary and secondary batteries, (*a*) £18,058 (increase £5,520), (*b*) £42,703 (increase £20,828); meters and measuring instruments, (*a*) £1,420 (decrease £355), (*b*) £6,447 (increase £2,381); switchboards, (*a*) £25 (decrease £939), (*b*) £248 (decrease £2,161); electrical goods and apparatus unenumerated, (*a*) £19,449 (increase £9,738), (*b*) £45,645 (increase £21,349). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £96,494 (increase £27,316), (*b*) £215,396 (decrease £89,453).

Exports.—The exports of electrical machinery, material, &c., (*a*) during February, 1916, and (*b*) from Jan. 1 to Feb. 29, with the increases or decreases compared with the corresponding periods of 1915, were as follows:—

Electrical machinery, (*a*) £101,367 (increase £15,441), (*b*) £203,980 (increase £21,024), including railway and tramway motors, (*a*) £5,298 (decrease £2,587), (*b*) £8,442 (decrease £2,032), other generators and motors other than aeroplanes, motor cars and cycles, (*a*) £53,598 (increase £10,509), (*b*) £108,236 (increase £37,845); and electrical machinery unenumerated, (*a*) £42,471 (increase £7,519), (*b*) £87,302 (decrease £14,786); telegraph and telephone cables, submarine (*a*) £6,568 (decrease £18,360), (*b*) £25,794 (decrease £49,070); other than submarine, (*a*) £46,308 (increase £24,029), (*b*) £100,513 (increase £52,648); telegraph and telephone apparatus, (*a*) £23,450 (increase £11,673), (*b*) £47,413 (increase £18,694); other electrical wires and cables, rubber insulated, (*a*) £31,834 (increase £17,734), (*b*) £70,547 (increase £27,113); with other insulation, (*a*) £68,071 (increase £41,632), (*b*) £113,283 (increase £49,226); carbons, (*a*) £537 (decrease £176), (*b*) £1,064 (increase £69); glow lamps, (*a*) £11,967 (increase £1,151), (*b*) £23,985 (increase £4,681); arc lamps and searchlights, (*a*) £351 (increase £204), (*b*) £2,309 (increase £1,895); parts of arc lamps and searchlights (other than carbons), (*a*) £1,644 (increase £1,180), (*b*) £2,410 (increase £702); primary and secondary batteries, (*a*) £15,674 (increase £4,470), (*b*) £38,373 (increase £4,836); meters and measuring implements, (*a*) £15,511 (increase £6,607), (*b*) £30,052 (increase £4,467); transformers, (*a*) £9,533 (increase £7,604), (*b*) £12,620 (increase £7,769); switchboards, (*a*) £7,564 (increase £5,284), (*b*) £15,111 (increase £5,676); electrical goods and apparatus unenumerated, (*a*) £59,626 (increase £21,736), (*b*) £97,097 (increase £6,102). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £298,638 (increase £124,768), (*b*) £578,571 (increase £134,808).

TENDERS INVITED.

Main Switches, Fuses, &c.

The COMMISSIONERS OF H.M. WORKS, &c., are prepared to receive tenders for the supply of Main Switches, Main Fuses, Switch Fuses and Fuse Boards during one year from April 1, 1916. Forms of tender, conditions of contract, &c., from the Controller of Supplies, 18, Queen Anne's Gate, S.W., and tenders (by 11 a.m. March 24) to the Secretary, H.M. Office of Works, Storey's Gate, London, S.W. *See an advertisement.*

Electrical and General Stores

KENSINGTON (London) Board of Guardians invite tenders for the supply of Electric Lamps, Electric and Engineers, Fittings, &c., to their Infirmary at Marloes-road, Kensington, for a period of six months from April 1. Forms of tender, &c., may be obtained up to March 8th from the Clerk to the Board, Mr. W. R. Stephens, Marloes-road, Kensington, W.

DUNDEE Corporation require tenders by 9 a.m. March 29 for 12 months' supply of Meters and Electrical and General Stores. Specifications, &c., from the Electricity Department, Dudhope Crescent-road, Dundee.

WARRINGTON Guardians require tenders by 5 p.m. March 21 for 12 months' supply of Electrical Goods. Forms of tender from the Clerk, Bewsey-chambers, Warrington.

WESTMINSTER Guardians require tenders by noon March 22 for six months' supply of Electric Lamps and Fittings, Engineers' Sundries, &c. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W.

Tenders are required by March 23 for six months' supply of Electrical Sundries to the Welsh Metropolitan War Hospital, WHITCHURCH, Cardiff. Forms of tender from the Clerk.

Tenders are required by March 25 for 12 months' supply of Electric Fittings and Materials to the Graylingwell War Hospital, CHICHESTER. Forms of tender, &c., from the Clerk.

DUNDALK Urban Council require tenders by 4 p.m. March 21 for 12 months' supply of Cables and Wires, Incandescent Lamps, Meters, &c. Forms of tender from Engineer and Manager.

Turbo-Alternator.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

Switchgear.

MANCHESTER Electricity Committee require tenders by 10 a.m. March 22 for 6,600 volts three-phase switchgear for Stuart-street station. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Varnish Impregnating Apparatus and Storage Battery.

The Victorian Railway Commissioners, Spencer-street, Melbourne, require tenders by 11 a.m. April 19 for the supply and erection of a Complete Plant for Impregnating Electrical Apparatus with Insulating Varnishes and Solid Compounds (Contract No. 29,678.); also a 1,000 Ampere-hour Storage Battery (Contract No. 29,743). Specifications, forms of tender, &c., from the offices of the Commissioners.

Electric Generators, Gas Producer Plant, &c.

WANGANUI (N.Z.) Borough Council require tenders by noon May 9 for the supply and erection of Additional Plant at their tramway power house, including Pressure-type Gas Producer Plant, Gas Engine, Electric Generator and Switchgear. Specification, &c., from the Town Clerk.

Train Lighting Cells.

The SOUTH AFRICAN RAILWAYS AND HARBOURS Administration require tenders by noon March 20 for the supply of 5,106 Train Lighting Cells, in accordance with a drawing, copies of which may be obtained from the Railway Stores, Cape Town, Port Elizabeth, East London, Durban and Germiston. Specification may be obtained from the Secretary to the Tender Board, South African Railways Headquarters Office, Johannesburg.

TENDERS RECEIVED AND ACCEPTED.

SHEFFIELD.—The following tenders have been accepted by the Electric Supply Committee :—

C. A. Parsons & Co., turbo-alternator, £37,625 ; Stirling Boiler Co., three boilers and accessories, £34,400 ; E. Taylor (Ltd.), extending condensing water service, &c., at Neepsend, £3,560 ; A. Reyrolle & Co., six-panel ironclad h.t. two-phase switchboard, £646.

BEXHILL.—The following tenders have been accepted by the Council :—

Sturtevant Engineering Co., fan housing, £155 ; Messrs. G. & J. Weir (Ltd.), pump, £82.

WOLVERHAMPTON.—The Electricity Committee recommends the acceptance of the tender of Bruce Peebles & Co. for the supply of a 750 kw. rotary converter.

SHEFFIELD.—The following tenders have been accepted :—

A. Reyrolle & Co., 20 panels of three-phase e.h.t. sub-station switchgear, £4,426 ; Thos. A. Ashton, David Ashton & Co., J. Chapman and Morgan Crucible Co., electrical fittings.

GLASGOW.—The Corporation have accepted the following tenders for the tramways department :—

J. Stewart & Co., galvanised steel wire ; St. Helens Cable & Rubber Co., 91/18 cab-tyre cable ; British Insulated & Helsby Cables, three-core cables, ozone-proof cable and asbestos-covered wire.

DERBY.—The Corporation have accepted the tender of Edison Accumulators, Ltd., for supply of two electric omnibuses at £2,266.

SWANSEA.—The Corporation is recommended to accept the tenders of J.W. Law (at £560) for wiring the Brynmill and Cwmbwrla Schools. Three tenders were received.

BATTERSEA (LONDON).—The Electricity Committee recommends acceptance of the following tenders for annual supplies :—

British Insulated & Helsby Cables, consumers' fuse boxes ; Reason Mfg. Co. and Bastian Meter Co., electrolytic meters ; Chamberlain & Hookham and Ferranti (Ltd.), mercury meters ; Callender's Cable Co., troughing, conduits, &c. ; Dussek & Co., box compound ; Pryke & Palmer, engine room stores, ironmongery, &c. ; Price's Co., oils (excepting turbine oils).

The committee does not propose to enter into contracts at present for house service boxes, &c., and watt-hour meters.

HAMMERSMITH (LONDON).—The Electricity Committee recommends the acceptance of the following tenders for annual supplies :—

W. Lucy & Co., box frames, covers, &c., approximate amount based on annual quantities, £445. 13s. 3d. (four tenders received) ; Baxter & Caunter, electrical accessories, £28. 11s. 5d. (three tenders) ; General Electric Co., insulated wires, £174. 17s. (11 tenders) ; Dussek Bitumen Co., insulating box filling compound, 17s. per cwt. (eight tenders) ; J. E. & S. Spencer, tubes and fittings, 47½ per cent. discount for steam tubes, 52½ per cent. for fittings and 47½ per cent. for flanges (two tenders) ; Middleton Bros., steam packing and jointing materials, £15. 15s. 9d. (three tenders) ; Jas. Gibb & Co., stores, tools and implements, £18. 0s. 2d., and ironmongery, £28. 3s. (two tenders) ; Albion Clay Co., fire bricks, &c., £57. 1s. 6d. (part of items only) (two tenders).

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Charing Cross, West End & City Electricity Supply Co. (Ltd.)

The annual ordinary general meeting was held on March 9, Mr. WILLIAM FRANCIS FLADGATE, M.V.O., presiding.

The SECRETARY (Mr. Cecil G. Stanesby, F.C.I.S.) read the notice convening the meeting and the auditors' reports.

The CHAIRMAN : Gentlemen, I think that the result of the accounts, both in the West End and in the City, may be said to be a very favourable one in a difficult year. The accounts submitted for 1914 dealt with only five months of this terrible war, which has now for nearly 18 months been devastating Europe, and although the period for which the war lasted in 1914 was only five months the result upon our West End business was a reduction in net profit of nearly £12,000. The result last year, when the war proceeded throughout the 12 months, we did not expect to be better—in fact, we feared it might be much worse—but I am glad to say that the total result for last year as against the preceding year of 1914, is a further drop in the net profit of only £3,000, making a total reduction, as against the pre-war year of 1913 of some £15,000. Fortunately the reserves which we had thought it prudent to set up in earlier years enabled us last year and this year to meet this decreased revenue. When I addressed you a year ago I pointed out that we carried forward on revenue account £18,000, and we brought forward into the last current year the same amount, and that on general reserve account we had £7,000, which we proposed, if necessary, to fall back upon in aid of our profits for 1915. Well, gentlemen, we have decided to recommend the payment of a dividend of 5 per cent., and to enable us to do this we had to have recourse to that dividend reserve account, which was set up for the express purpose of meeting such a contingency, to the extent of some £6,000. The account is an income account, and it was set up for the express purpose of meeting any deficiency on one year's income out of what was put by from a preceding series of years, and I think we are the more justified in dealing with that sum in that way when we look to the very small amount of change of ownership that there has been in our securities. The transfer fees and sundry receipts for 1915 amount to only £193, against £506 for 1914, showing what a very small amount of business has been done in dealing with your securities. Taking very briefly the results in the West End, the net earnings for the year amounted to £68,895, and interest amounts to £2,977, which makes a total of £71,912 without reference to the carry forward of £18,000 from last year. This sum of £71,912 enables us to pay our debenture stock interest of £17,829, our preference share dividend of £18,000, to set apart for depreciation fund £22,000, being the amount which some few years ago we decided was a sufficient amount to make for depreciation in the West End, and having made these payments and set aside that depreciation it leaves us £14,083 on account of our dividend. Now, our dividend at the rate of 5 per cent. requires £20,000, and, therefore, we have, as I have already mentioned, recommended to you to transfer from general reserve income account the sum of £6,000 to enable us to pay a dividend at the rate of 5 per cent. We are then able to carry forward to the current year the £18,000 untouched, leaving us with a sum of £1,140 still at reserve income account for next year. The result of putting £22,000 to depreciation is that in the West End we have now some £171,000 standing to the credit of that account. I do not propose to trouble you with any comment on the figures, but we have considered it our duty to our employés to give £1,233 for war allowances for the benefit of the dependents of those of our employés who are serving in His Majesty's Forces. There is also a sum of £770 for professional charges which you may think somewhat large, but it is, in effect, the costs of the attempted amalgamation of the companies which was being carefully considered by your Board, in connection with the Boards of the other companies, prior to the outbreak of the war. I now pass to the City undertaking, and here, again, the result may, I think, be considered satisfactory. The war has affected the net receipts of 1914 by about £2,500, and that has been increased during the last year by some £3,000, but the amount which we have taken from the City undertaking enables us to pay, as has been our custom, the interest on the debenture stock, the dividend on our preference shares, and to carry forward £15,300 to the general reserve in respect of the City undertaking, which now amounts to over £86,000. At the same time, we carry forward the £18,000 which we brought in from last year. In the accounts for the City undertaking there is also a considerable amount in respect of allowances for the dependents of our employés, viz., £1,400, which, of course, is a very considerable sum out of our income. That is briefly the result of our working for the year, and I think it is a good one. In saying so I should like to express the appreciation which this Board feels for the work that has been done by our chief engineer, Mr. Kingston.

When I tell you that the average price of coal increased between the preceding year and last year by no less than 50 per cent. you will at once realise that it has required management and care to enable us to arrive at the result put before you to-day. I should not like to forget to mention that, of our employés, 88 are serving with the Colours. I have to tell you with regret that three of them have been killed, one has been missing for many months and we fear he has met a similar fate, and another has died of wounds since his return to this country. As to what the future is to be, none of us can for one moment foretell. Personally, I hope that the war may not last for any great period longer, but I hope even more strongly that it will not be concluded without our arriving at a lasting and definite peace. With regard to the position of your Company, we look upon it with the greatest confidence. It has, of course, been impossible during this trying time to attempt in any way the amalgamation of this Company and the other companies, or to carry on further negotiations with the L.C.C., but that is a matter which your Directors will again consider when the period of war is over. I should like also to refer to the fact that during this year we have lost the services of our late secretary, Mr. Seale. He had been with us for very many years—I think, with the exception of myself, he is the oldest person attached to this Company—but for some time his health has not been very satisfactory, and it was, therefore, arranged between him and the Board that, having regard to that fact, it would be better for him to retire from active work which he had done, and we have given him a

pension, which we think he deserves and has fully earned. We have filled his place out of our own staff by appointing Mr. Stanesby as secretary, and I should like to express the very satisfactory feeling which we have of the way in which he has hitherto performed the duties which he has been called upon to carry out. I should also like to refer in terms of gratification and approval to the general work of the staff, which has been exceedingly heavy and difficult, consequent upon the number of our men who have been taken away from us for the sake of the country. I beg to move that the report and accounts for the year 1915 be adopted.

Mr. JOHN M. GATTI (Managing Director) seconded the resolution, which was carried unanimously, and the dividends recommended in the report were then agreed to.

Mr. W. F. Fladgate and Mr. R. Chadwick, the retiring directors were unanimously re-elected, and Messrs. C. R. Johnson & Sons, the retiring auditors, were also re-appointed, a vote of thanks to the Chairman and Directors terminating the proceedings.

ABERDEEN SUBURBAN TRAMWAYS (LTD.)—At the recent meeting Mr. Jas. Sellar (who presided) stated that the profit earned for the half-year amounted to £1,438, and he thought that the result was very satisfactory. Referring to the negotiations between the directors and the Corporation with reference to the purchase of the company's undertaking, he said that the Corporation then took the advice of Mr. Dalrymple, of Glasgow, and he understood that Mr. Dalrymple had advised that the value was not far short of the price asked by the directors. The Corporation had decided to take no further action in the matter during the war.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—The accounts for 1915 show, after paying all manufacturing costs and expenses of administration, a net profit of £21,094. 15s. 8d., and, with amount brought forward (£3,477. 11s. 2d.), the total available is £24,572. 6s. 10d. The Board recommend that £7,500 be placed to reserve and £1,500 to depreciation reserve, that a dividend of 6 per cent. for the year 1915 be paid on the preference shares, and a dividend of 7½ per cent. on the ordinary shares (3 per cent. of which was paid as an interim dividend in September last), that extra remuneration of £837 be paid to the directors, and that £4,604. 4s. 4d. be carried forward.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—At the recent meeting the chairman (Mr. W. M. Crowe) said that they had entered on the manufacture of magnetos and other motor accessories. The company was fortunate in being able to serve the country by taking up this line of manufacture, for which its factory was well suited. The past year was one of steadily increasing difficulties for most classes of manufacturers, because of the growing scarcity of labour and of the general increase in cost in all directions. It was extremely gratifying, therefore, that the new fields of business that the directors had cultivated had yielded very satisfactory results, and that the profits of 1915 were an advance on the year before. The outbreak of war put a stop to telephone development, on which the business of the company mainly depended, and shareholders would recognise that it was to the energy and enterprise of the management that the favourable result of the past 12 months' working was due. The trading profit of £42,268 was nearly £7,000 more than in 1914, but the income from interest was much lower. Net profit, after paying debenture interest and providing £11,882 for depreciation, was £22,593. Dividend on the ordinary shares at rate of 8 per cent. per annum was again recommended, and £9,000 was added to the reserve. Considerable expenditure has been incurred on the premises and plant at Beeston, and the book-value of those assets, after deducting sums provided for depreciation, was £7,600 greater.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The total capital expenditure up to Dec. 31, 1914, was £2,622,812. 10s. 5d., and the expenditure during 1915 on additions, extensions and replacements was £25,951. 12s. 11d. The amount written off prior to Dec. 31, 1914, was £588,193. 19s. 4d. (from reserve formed from revenue, &c., £579,793.19s.4d. and from revenue direct £8,400), and the further amount written off in respect of buildings, plant and other works dismantled during 1915 was £30,738.4s.5d., making net expenditure at Dec.31,1915, £2,029,831.19s.7d., or a net deduction during the year of £4,786. 11s. 6d. With the amount proposed to be carried forward to 1916 (£18,023. 14s. 6d.) the total of the reserve funds is £287,853. 7s. 5d. The annual profit has naturally been prejudiced by the enforced reduction of lighting and by the increased cost of coal and of all other items of production. The revenue for the year was £309,050 4s. 2d., and with interest on investments and discount, &c. (£2,769. 7s. 6d.), the total receipts were £311,819. 11s. 8d. Deducting expenses of generation and distribution (£82,504. 19s. 10d.), repairs and maintenance of buildings, machinery, &c. (£9,237. 11s. 10d.), street lighting expenses other than supply of electricity £3,481. 1s. 1d., and rent, rates, taxes, management expenses and special charges (£96,850 0s. 3d.), the balance is £1,50 759 18s. 8d., and with balance brought forward (£3,372 4s. 2d.) the total available revenue is £174,132 3s. 5d. Out of this sum the following amounts have been distributed or provided for: Interest on loan from bankers, consumers' deposits, &c. (£1,697 8s. 11d.), interest on first and second debenture stock for year (£29,033 6s. 8d.), interest transferred to debenture stock premium redemption account (£1,884 9s. 3d.), leasehold redemption account, interest and appropriation (£298. 1s. 11d.), contributions to employees' provident funds and under National Insurance Act (£1,749 4s. 10d.), and amount transferred to reserve account (£30 000), leaving available £87,769 11s. 10d. The directors now recommend that the following dividends for the year 1915 be declared, less tax: 4% on the preference shares 12s. per share, being at full rate of 6 per cent. per annum, and on the ordinary shares 16s. per share, being at rate of 8 per cent. per annum (against a distribution of 9 per cent. for 1914). On account of these dividends 6s. per share on the preference and ordinary shares (less tax) was distributed in September last, and there remain to be distributed 6s. per share on the preference and 10s. per share on the ordinary shares, leaving a balance to be carried forward of £18,023.

The gross revenue from all sources showed a decrease of £5,735 and the net revenue a decrease of £13,705, compared with 1914. The average price per unit obtained for private supply was 2·27d. per unit (against 2·26d. in 1914 and 2·33d. in 1913). There were 14,720 private consumers (against 15,090 in 1914), a decrease of 370, and the number of kilowatts connected (including power and heating) was 46,161 (compared with 45,522), an increase of 629. The reduction in the number of customers is attributed to the war, and was caused by the suspension of many businesses, notably stockbrokers and foreign importing agents. 34,643,297 units were generated (against 33,906,963) and units sold were 29,479,079 (against 29,182,165). The maximum supply demanded was 17,424 kw. (against 19,739 kw.). Total units sold showed an increase of 296,914 over 1914, notwithstanding that the consumption for lighting purposes was more than a million units less. Units sold for power and heating continued to show a steady increase, the total units sold for these purposes being 15,220,213 (power 12,375,577 and heating 2,844,636) = 53 per cent. of the total units sold for private supply. A considerable quantity of power is now being supplied to munition factories. The engineer to the Corporation of London has certified the completion of the new system of street lighting as at Oct. 1, 1915. 164 members of the company's staff have joined H.M. Forces; four of these have been killed and nine wounded. Liberal allowances have been made to all who have joined.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Monday Mr. H. B. Renwick (managing director) presided, and in moving the adoption of the report said the gross receipts had grown from £274,080 to £298,269, an increase of £24,189, but the costs and expenses had increased by £28,592, with the result that the sum carried to net revenue account was £159,639, against £164,043 for 1914. The increased costs would be found in the items for coal and other fuel, salaries and wages, and rates and taxes and insurance. A dividend was recommended on the ordinary shares of 7 per cent. for the year, being the same as in 1914, and £14,499 would be carried forward, against £12,471. Had it not been for war burdens the company would have had a record year in all respects. The great increase in working expenses had been in respect of coal, the average price of which was about 50 per cent. above 1914 prices. Their normal supplies of coal were seaborne, and the cost of freightage alone was now more than the cost in pre-war times of the coal itself delivered into the bunkers. The coal question was still a matter for serious concern, not only from the point of view of price, but also in regard to the difficulty in maintaining proper stocks of coal. It was time some public action was taken to deal with the matter on lines similar to the recent Act determining the maximum price of coal at the pit's mouth or by constituting a Board of Control similar in duties to the Railway Executive Committee now doing such good work in regulating the traffic of the British railways. In order partially to recoup the company for those additional expenses, the charges for supply to the company's consumers had been increased by 10 per cent. during the year. Of the capital expenditure during the year of £59,105, a sum of £31,745 had been expended on mains, which included the expenditure necessary to give supply in bulk to the districts of Sutton, Carshalton, Wallington and Cheam, and also in the district under the Romford order. During the year applications had been received for 5,360 kw., against 5,206 kw. in 1914 and 4,137 kw. in 1913. The units sold were 30,562,045, an increase of 2,549,309, and the number of consumers had increased from 24,212 to 25,913. They had also secured during the year two long-term contracts for supply in bulk, one with the South Metropolitan Electric Tramways & Lighting Co., in respect of their Sutton districts, and the other with a company in respect of the districts of Banstead, Chipstead and Walton-on-the-Hill. Supply had already been commenced in the Sutton districts, but in the other districts operations would probably be deferred until after the war. Those contracts had a significance and importance far beyond their revenue-producing value, seeing that they carried matters a step further in the direction of unification of supply and were in keeping with the company's policy of "linking-up" and centralisation. The generating station at Sutton was being scrapped, and the necessity was avoided of erecting a station for the Banstead district. They had commenced supply in Romford under their Romford and District Electric Lighting Order (1913), a step which again advanced the company's policy in the direction of concentrating supplies. The company and its associated companies had 303 men on active service, of which number the County of London Co. had contributed 201.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The revenue for 1915, consisting almost entirely of dividends and interest receivable from the subsidiary companies, amounted to £122,429 12s. 5d., compared with £118,579 11s. 2d. for 1914. After deducting all expenses, including debenture and loan interest, and providing for sinking fund charges upon the 5 per cent. debenture stock, there remains £80,754. 1s., making, with £2 886 6s. 3d. brought forward, a total of £83,641 1s. 3d. Out of this balance there has already been paid the full dividend upon the 5 per cent. cumulative preference shares, leaving £3,483 to carry forward.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The following circular dated March 7) has been issued to the shareholders of this company:—

For some considerable time we, in common with many other shareholders of the above company, have been far from satisfied with the way

in which its affairs have been administered. The dividend on the ordinary shares, which in 1905 was 10 per cent., has now fallen to 3 per cent., and we learn that three of the directors (Lord Avebury, Sir James Pender and Mr. P. D. Tuckett, the latter having recently joined the board) are all so dissatisfied with the position that they have resigned their seats on the board. We feel the time has come for the shareholders to take some action to protect their interests, and we accordingly invite you to give us your support at the forthcoming general meeting of the company, with a view to securing the appointment of a committee of shareholders to examine into and report upon the position. If your are in favour of this action, which in the interests of the shareholders we strongly recommend, we request you to sign and forward the enclosed form of proxy in the enclosed envelope not later than Friday, March 17.

GERALD BUXTON. (Sd.) JOHN DENISON-PENDER.
ROGER GREGORY. W. S. POOLE.
J. T. MILLS.

In reply, the company has issued the following circular, signed by the secretary (Mr. E. Cunliffe Owen, C.M.G.), and dated March 10 :

You have probably received a circular signed by five shareholders asking for support to a proposal for a committee of investigation. Without explanation the circular is entirely misleading. The board has not been satisfied recently with the conduct of affairs, and in June last decided upon a complete change of management. This has been effected, and it is on this change of management that the present opposition is presumed to have arisen. The board, in asking for your support, and the return of the proxy which accompanied the report and accounts, if you have not already done so, directs me to state that the chairman will give the fullest explanation of the position at the general meeting on the 22nd inst., at which it is hoped that you will be present.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—Mr. E. Garcke, who presided at the meeting on Monday, said that during the past year they had been obliged to reduce their services of cars. But for the strike and the lack of conductors the company would have shown a large increase in traffic receipts. The traffic receipts of 1915, especially in the latter part of the year, had undoubtedly been very good, in spite of the reduction of over 15 per cent. in the car mileage. The total expenses, including payments to local authorities, repairs and maintenance charges, and interest on loan capital were £470,400, or about £14,500 less than in 1914. A dividend at rate of 1 per cent. on the ordinary shares was declared.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The connections to the company's system at the end of 1915 amounted to 258,390 H.P., an increase of 26,965 H.P. over 1914. The profit for the year is £204,418, and adding balance from 1914 (£5,946) the total is £210,365, against which has been charged interest on debenture stocks, loans, &c. £58,696), leaving £151,669. The directors recommend payment of a dividend of 2½ per cent. on the preference shares (making with the interim dividend of 2½ per cent. paid in July last, 5 per cent. for the year) and a dividend of 3½ per cent. on the ordinary shares (making with the interim dividend of 2½ per cent. paid on Jan. 1 last, 6 per cent. for the year), the transfer to reserve for depreciation of £25,000 and to general reserve of £28,000, carrying forward £5,191. 5s. 2d. The plant and system generally have been maintained in an efficient state out of revenue, the sum of £93,965 having been spent thereon. The additions to capital expenditure for the year amount to £110,078. 15s. 3d. and represent further cost of extensions in progress at the Carville and Dunston power stations, and also to the general distribution system. The nominal value of the shares held in the County of Durham Electrical Power Distribution Co. has been adjusted to correspond with the reduced share capital of that company.

OXFORD ELECTRIC CO. (LTD.)—At the recent meeting Sir Hy. Mance stated that the profit (including £1,054 brought forward) was £13,340, and they proposed to pay a dividend at rate of 6 per cent. per annum on the ordinary share capital, and to place £1,000 to reserve and renewal of plant account, leaving £968 to be carried forward. The revenue from sales of current by meter showed a reduction of £1,184, and the revenue from street lighting was also less. Considering the exceptional times, he thought they might congratulate themselves on the result of the year's working. The colleges, which were the company's largest consumers, were practically deserted. The lodging houses also contributed a good deal to their revenue, and those were adversely affected by the absence of students. A considerable reduction in the demand for current by shops and other places of business had also to be reckoned with. On the other hand, the many hospitals now established in Oxford required a considerable amount of current, and there was a satisfactory growth in the demand for cooking, heating and power.

PARA ELECTRIC RAILWAYS & LIGHTING CO. (LTD.)—At the recent meeting the chairman (Mr. F. Holt) said there had been again a reduction in gross receipts owing to the continuance of the financial crisis in Brazil. The loss in receipts amounted to £6,408, or 2½ per cent. on the previous year's figures, the principal cause being a decrease of 957,000 in the number of tramway passengers carried. That reduction had been met by a reduction of 13 per cent., or over £17,000, in working expenses. That result had not been obtained by the management by skimping the upkeep of the plant and equipment, but by employing wood fuel, now obtainable locally at a reasonable price, in place of imported coal for power production, and by a very strict supervision and revision of all items of expenditure. After placing £15,000 to depreciation they were able to pay a dividend of 5 per cent. on the ordinary shares.

SOUTH METROPOLITAN ELECTIC TRAMWAYS & LIGHTNG CO.(LTD.)—The revenue for 1915 was £69,281, compared with £65,323 in 1914. After adding balance brought forward and deducting expenses, and after setting aside £4,500 to renewals fund, the surplus is £15,486. The directors recommend that £4,500 be placed to reserve, payment of dividend at rate of 5 per cent. per annum on the preference shares for the year 1914, and payment on account of preference dividend for 1915 at rate of 1 per cent., and that £812 be carried forward. The gross receipts from the tramways and light railways were £48,409, an increase of £3,144, compared with 1914. The net receipts from the motor omnibuses were £2,876. The gross receipts from the electricity supply section of the undertaking (including amount represented by the sale of energy to the tramways) amounted to £17,242, compared with £16,441. The total number of units sold during the year (including 200,315 supplied to the tramways) was 1,185,371, compared with 1,090,633 in 1914. The number of units sold for lighting and power was 985,056, an increase of 95,174 units, or over 10 per cent. The number of consumers at Dec. 31 was 2,229, against 2,030 at the end of 1914, an increase of 10 per cent. An agreement has been entered into with the County of London Electric Supply Co. for the supply of current in bulk to the company's station at Sutton, which is accordingly being converted from a generating station to a sub-station. Supply from the County Company was first taken on Dec. 12, and the directors look with confidence to considerable advantage accruing to the company as a result of the arrangement.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—At the meeting last week Lord Geo. Hamilton, in moving the adoption of the report, said in virtue of the London Electric Railways Companies Facilities Act (1915), the City & South London, the Central London, the London Electric and the Metropolitan District Railway Companies, and the London General Omnibus Co. had entered into an agreement providing that the five companies were to afford each other all reasonable facilities for through passenger traffic, and were to afford through fares and through bookings and convenience for the exchange and interchange of passengers without apportioning the through fares among the five companies. The total income of the Underground Company during the past year was £680,741, or a decrease of £3,884, compared with 1914. The balance from the last account amounted to £38,441, making a total of £719,182. On the debit side the service on the 4½ per cent. bonds required £95,291, and the service on the three-year notes £31,500. The amount paid under the guarantee on the Central London Railway assented stock amounted to £26,931, while the service on the 6 per cent. first cumulative income debenture stock required £76,380 and the interest on the 6 per cent. income bonds £438,731. Those sums, plus the amount paid for general charges, left £38,575 to be carried forward. He thought the results would be considered satisfactory.

The Chairman, in reply to a suggestion of Sir Robert Perks that fares should be raised on their railway, stated that the adoption of such a policy would encourage competition. They were constantly attacked on the ground that they were a monopoly, but although they had a predominating control in the railway traffic of the metropolis, he did not think they had got a monopoly. In view of their position, however, he thought that if they put up fares without very good reason there would be a great outcry throughout London. It was very easy to lose traffic, but traffic once lost was very difficult to recover.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—At the meeting last week Mr. F. S. Newall, who presided, said that the total capital expenditure at Jan. 31 was £277,649, an increase of £3,654 over that of 1915. The expenditure was almost entirely in connection with the extensions at Weardale and Grangetown stations. The total capital expenditure involved in the extensions would be about £45,000. The profit earned during the year was £39,819, an increase of about £817. The directors suggested that a dividend of 8 per cent. be paid, which would absorb £25,600 and leave £17,430 to be carried forward. The supplies they had been able to give to the power companies had been of even greater advantage to them than in normal times, as without the supplies of electrical energy derived from waste heat they would have been subject to large increased costs owing to the higher price of coal.

CITY NOTES.

MEMORANDA (March 15).—**Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57 3/16 Consols Pay Day, April 5. Stocks and Shares Ticket Days, March 28 and April 12. Pay Days, March 29 and April 13. Price of silver, 27 1/16 d.**

COMPANIA DE ELECTRICIDAD DE LA PROVINCIA DE BUENOS AIRES (LIMITED AND REDUCED).—A petition for confirming a reduction of the capital of this company from £1,350,000 to £825,000 will be heard by Mr. Justice Neville on March 21.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—The directors have declared a dividend of 3 per cent. (less tax) on the ordinary shares for the past year: £6,000 has been placed to depreciation account and £2,688 carried forward.

DICK, KERR & CO. (LTD.)—An interim dividend at rate of 6 per cent. per annum has been declared on the preference shares.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The Board have decided to recommend payment of the dividend at rate of 10 per cent. per annum on the preference shares (less tax), and a dividend (tax free) at rate of 6 per cent. per annum on the ordinary shares (making 5 per cent. for the year 1915), both for the half-year ended Dec. 31 last, and payable on 1st prox. In addition to the above the directors will recommend payment of a bonus on the ordinary shares of 2 per cent. for the year 1915, tax free.

DOULTON & CO. (LTD.)—The directors have declared a dividend of 5 per cent. (less tax) on the preference shares for 1913, payable on April 1.

W. T. GLOVER & CO. (LTD.)—Dividends of 5 per cent., less tax, on the preference and ordinary shares have been declared; £6,500 has been placed to debenture redemption fund, £20,000 to reserve and £11,700 carried forward (compared with £7,950 in 1914).

HADFIELDS LIMITED.—The directors recommend, in addition to the interim payment of 1s. per share on the ordinary shares, a further dividend of 2s. per share, together with a bonus of 2s. per share, both tax free.

LAUNCESTON & DISTRICT ELECTRIC SUPPLY CO. (LTD.) A dividend of 3 per cent. per annum has been declared.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—An interim dividend has been declared at rate of 6 per cent. per annum on the preference and ordinary shares for the half-year ended Dec. 31 last.

RANSOMES, SIMS & JEFFERIES (LTD.)—The net profit for 1915 was £34,074, and £23,525 was brought forward. A dividend on the ordinary shares of 5 per cent. (tax free) is recommended, adding £10,000 to reserve and leaving £20,134 to be carried forward.

SCARBOROUGH ELECTRICITY SUPPLY CO. (LTD.)—The profit for 1915 was £1,078, and £2,002 was brought forward. After providing for interest charges and placing £1,000 to depreciation fund, £1,716 remains, which it is proposed to carry forward.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the second quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, 1916, being at the rate of 6 per cent. per annum. The transfer books will be closed from the 17th to the 24th March inclusive, and the dividend will be payable on the 25th inst.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date, March 14, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	17d.
Solid Drawn Copper Tubes	18½d.
Brazed Copper Tubes	18½d.
Brazed Brass Tubes	19d.
Brass Wire	16½d.
Copper Wire	18d.
Rolled Brass	16½d.
Brass Sheets	16½d.

	per ton.
Copper Sheets	£148 0 0
Spelter	£85 0 0

	per ton.
English Lead	£36 0 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Copper Scrap	£101 0 0
Clean Brass Scrap	£63 0 0
Braziery Copper Scrap	£86 0 0
Old Lead	£27 10 0
Old Zinc	£52 0 0
Hollow Pewter	£120 0 0
Black Pewter	£75 0 0
Gun Metal	£87 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date March 14, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£140 0 0
Clean Mixed Brass	£66 0 0
Clean Copper	£92 0 0
Braziery Copper	£86 0 0
Gun Metal	£80 0 0

	per ton.
Old Lead	£28 10 0
Tea Lead	£26 10 0
Old Zinc	£56 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £115; Blowpipe Solder, £120.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, March 14. The greatest care is taken in compiling the figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues., March 14.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9½	7 5 5	Mar, Sept
10	4½%	†Do. 4½% Cum. Pref.	9⅛	4 15 8	Feb, Aug
10	6%	†Do. 6% Cum. 2nd Pref.	10⅜	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord	7⅜	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. G. Deb. St	80	5 0 0	..
St.	4%	Charing Cross West End & City Debs.	80	5 0 0	Jan, July
5	2/3	Do. 4½% Pref.	3⅜	7 1 2	..
5	5%	Do. Ord.	3⅛†	7 2 10	Aug, Feb
5	4½%	Do. City Pref.	2⅛	8 7 5	Jun, Dec
5	4%	Chelsea Elec. Supp. Co. Ord.	4⅛†	4 6 6	Mar, Sept
St.	4½%	Do. do. Deb.	87	5 3 5	Jan, July
10	9%	City of London Elec. Lt. Ord.	12	7 10 0	Feb, Aug
10	6/0	Do. 6% Pref.	10⅜	5 15 0	Mar, July
St.	5%	Do. 5% Deb. St.	97½	5 2 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	80	5 12 6	Jun, Dec
10	7%	County of London Ord.	10⅜	6 15 9	Mar, Sept
10	6%	Do. 6% Pref.	10½	5 18 6	Feb, Aug
St.	4½%	Do. 1st Deb.	86½	5 7 6	Jan, July
St.	4½%	Do. 2nd Deb.	97	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	9%	Kensington and Knightsbridge Ord.	6⅜	7 5 5	Feb, Aug
St.	4%	Do. Deb. St.	79	5 1 3	Jan, July
5	6/-	London Elec. Supp. 6% Pref.	4⅛	7 10 0	..
St.	4%	Do. 4% Mort. Debs.	80	5 0 0	Jan, July
5	3⅛%	Metropolitan E. Supp. Ord.	2⅛	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	88	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn., 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Dbs	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2d Mt. Db. St.	92½	5 8 5	Mar, Sept
1	6%	North Metropolitan E. P. Supp. 6% Pref.	⅜	6 8 0	Apl, Oct
4	5%	South London E.S. Ord.	3⅛†	6 10 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Last Dividend	Name.	Price, Tues., March 14.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	5⅛	6 17 8	Feb, Aug
5	7%	Do. do. Pref.	5⅛	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1½†	7 2 3	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5½	6 7 3	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80½	6 4 0	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	71½†	8 7 10	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	67½	5 10 10	..
St.	4%	Do. do. Assented Def. Ord.	67½	5 18 0	..
St.	4½%	Do. 4½% Pref.	99½	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½†	8 0 0	Feb, Aug
10	1%	London Electric Ry. Ord.	1⅜	3 5 8	Jan, July
St.	4%	Do. 4% Pref.	64†	6 5 0	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	22½	4 7 7	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74½	4 13 9	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82½	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16½	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72†	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	109	5 10 1	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71	5 12 8	Jan, July
St.	4%	Do. 4% Guar. Stock	68†	5 18 6	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅛	5 1 10	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅞	4 4 3	Mar
100	5%	Do. Prior Lien Debs.	83½	5 13 0	Jan, July
1	6%	Do. 6% Pref.	⅞	6 15 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11	6 16 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅞	5 15 8	Jan, July
1	6%	British L.M. Ericssion Mfg. Cm. 6% Pref.	⅛†	6 15 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2⅛	6 13 4	April
100	6%	Do. 6% Prior Lien Debs.	101½	5 17 11	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	63	6 7 0	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11½	6 14 9	Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	3⅜	1 17 2	Sept
5	..	Edison & Swan U. Elec. Lt. A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	59½	5 4 0	Jun, Dec
1	6%	Elec. Construction Ord.	⅜	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	71	5 12 8	Jan, July
..	10%	General Electric Ord.	10½	9 10 6	July
10	6%	Do. 6% Pref.	9⅛	6 3 10	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	13⅜	7 5 1	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4½	4 14 9	..
St.	4½%	Do. 4½% Db.	88	5 2 3	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅜	10 18 5	Feb, Aug
10	5%	Do. Pref.	7	7 2 10	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	33½†	7 3 3	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅛	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	79½	5 0 8	Jun, Dec
St.	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	53	7 10 11	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	99½	6 0 11	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 19 7	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	69⅛	5 15 4	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7⅛	6 11 2	May, Nov
10	10%	Do. 10% Pref.	12	8 6 8	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	5⅛	7 0 8	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	127	5 10 3	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	64	5 9 4	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77⅛	5 2 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	78⅛	5 2 3	Feb, Aug
10	7%	Do. Ord.	12⅛	5 10 11	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	33⅛	6 11 10	Ja, My, Jly
25	13%	Indo-European	47½	6 10 9	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1⅛	4 3 0	July
10	1%	West India & Panama Ord.	1⅜	8 18 10	May, Nov
10	6%	Do. 1st Pref.	7⅛	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12⅛	5 10 11	Mr, Jly, O, Dec
St.	4%	Do. 4% Deb. St.	79⅛	5 4 1	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99⅛	4 10 3	May, Nov.
		Telephones.			
1	7½d.	Monte Video Telephn. Ord	⅜	6 12 5	Nov.
1	10%	Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St	89	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅛	6 16 2	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4½	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	84⅛	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10½	5 17 1	Sp,Dc,Mr,Jn
10	6%	Do. 6% Pf.	9⅞	6 1 6	Sp,Dc,Mr,Jn
100	5%	Mackay Companies' Common	80⅛	6 4 7	Ja, Apl, Jly,O
..	4%	Do. $100 Pref	67	5 19 5	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 16 9	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	5	6 0 0	Mar, Sept
St.	5%	Do. 5% Debs.	95⅛	5 4 9	Jun, Dec
10	6/-	Bombay E. S. & T 6% Pref.	10	6 0 0	..
St.	4½%	Do. 4½% Debs.	87⅛	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord	6⅜	7 7 8	May, Nov
5	5%	Do. 5% Pref.	4⅛	5 11 11	Mar, Sept

* And 13⅓% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 861
Arrangements for the Week .. 864
Magnetos for Electric Ignition. By H. Armagnat. Illus. .. 865
Continuous-Current Railway Motors.—*Discussion* 869
Hoisting Controllers for Large Electric Revolving Cantilever Cranes. Illustrated .. 870
Apparatus for Starting and Controlling Electrical Running Machinery. By C. C. Garrard. Illustrated.—*Concluded* 873
The Sphere of the Scientific and Technical Press in Relation to Technical Education and Research.—*Discussion* 875
The Resistance of Moist Sandstone to High and Low Frequency Alternating Currents. By N. W. McLachlan, B.Sc. (Eng.) Illustrated .. 875
The Problems of Coal. By Prof. H. E. Armstrong, F.R.S. 876
The Hirsch Portable Electric Lamp. By Hiram H. Hirsch 877
STANDARDISATION RULES FOR ELECTRICAL MACHINERY .. 878
REVIEWS 879
Diesel Engines for Land and Marine Work [Chalkley].
Graphics and Structural Design [Hess].
Life Jottings of an Old Edinburgh Citizen [Macdonald].
Proctor's Useful Tables.
The Use of Continuous Current for Terminal and Trunk-Line Electrification. By Norman Wilson Storer. Illustrated.—*Concluded* 880
CORRESPONDENCE 882
Uniformity in Drawing Electrical Diagrams (Philip R. Coursey).
"The Stranger that is Within Thy Gates" (M. J. E. Tilney).
Edge Effect of Plate Condensers (C. J. Watson).
Physical Society 883
Trade After the War 884
Education Estimates 884
The "Electrician" Commercial and Industrial Section .. 885-894

NOTES.

Magnetos.

THE elimination of Continental sources of supply of many small manufactures and of raw materials has brought home to us in a striking and somewhat unpleasant manner the state of dependence into which we have allowed ourselves to be brought for the supply of these essential commodities. An outstanding case in this connection of considerable importance occurs in the case of the high-tension magneto, which, starting some years ago with equal chances of success in this country and Germany, had, until the outbreak of war, become almost a complete monopoly of the enemy. The name of Bosch in connection with magnetos stands out as a synonym of reliability and practical perfection of design; it is no exaggeration to state that fully 60 per cent. of the automobiles and motor cycles of other than American origin were, before the war, fitted with this make of magneto. It is, however, gratifying to be able to state that, since the outbreak of war, our failing in this respect has been tackled with a realisation of the importance of developing in this country magnetos equal in every respect to those of German origin. There are at the present time several firms manufacturing magnetos to suit the various requirements from materials of entirely British origin, and it would seem that such materials to meet the very exacting requirements can be obtained in this country.

ON another page we give a translation of an article which constitutes a complete mathematical theory of the magneto, and is by one who is an authority on the subject, and who has had great experience of these machines. The agreement of the calculated performance with experiments carried out on actual machines is satisfactory, showing that the theory rests on a sound basis. The Paper should, therefore, prove of value to those engaged in magneto design and manufacture as indicating the details to which particular attention should be given. One important point which the author does not seem to have insisted on is the necessity of using permanent magnets of high coercive force if the satisfactory operation of the machine under working conditions is to be guaranteed over long periods. The mechanical details (on which the Paper purposely does not touch) must also be attended to with particular care, as it is in the perfection of these that the German magneto has to a large extent demonstrated its superiority. Whether British manufacturers can in time establish their productions on a basis guaranteeing uniformity and perfection of design equal to those of the German article, and produced on a scale such as to make us independent of it after the war, remains to be seen; but, in any case, it will only be achieved by scientific attention at every point, based on knowledge of the underlying principles and of the conditions which the magneto has to fulfil in practice.

The Scandal of the Starred Trades.

IT is now apparent that the attempt is about to be made to force the attested married men into the army irrespective of the pledge given to them last November. In virtue of this pledge the majority of the married men attested. Furthermore, we are strongly of the opinion that it was not so much ability to join the army as to acquire the right to appeal that made many of our married men offer their services. The indignation meetings held daily throughout the country serve to strengthen these opinions. A sufficiency of such meetings will convince Ministers and others that the attested married men do not mean to be trifled with, and we welcome the outspokenness of certain of the daily newspapers. We question whether those in office realise what it means for a married man, of some social standing, to sell up his home and to leave his wife and children to fare as best they can on the broken meat and slum apartments which can with difficulty be obtained on the allowance made by the State to the dependents of our heroes. Although heckling of the Government at such a time is to be deplored, we must face the facts. During the week two cases of what we have called the scandal of the starred trades have come before our notice. The first is that of a young unmarried man, 21 years of age, with neither works nor drawing-office experience, and no engineering knowledge to speak of, obtaining a good post on the engineering side in one of the national steel factories. The second case, identical with the first as regards experience, is that of a youth of military age who has just been engaged for the tool-room by one of the largest armament firms in the country. If this be allowed to

continue unchecked in Government workshops, and unexposed by those who chance to come across these *pseudo* war workers, it is not unlikely that married men of 50 years of age will be called up.

Crane Controllers.

PROBABLY in no branch of industry has the development of the electric drive been more rapid or more successful than in the handling of materials. Much of the success is due to the controller, and the experience gained in tramway-type controllers has been invaluable in the development of the crane controller. For a long time the controller was looked upon more as a necessary evil than as an apparatus which made or marred the entire equipment. Even at the present time many crane makers and more users are slow to take full advantage of the possibilities of the controller. For instance, drum-type controllers are still provided, and are still called for, on heavy and busy cranes, when all experience goes to show that this type is less suited to the service, and in the long run is more expensive than is the controller of the magnet-switch type. Elsewhere in this issue will be found descriptions of two controllers, one of the drum type and the other of the magnet-switch type, which have been developed by the Westinghouse Company for the large twin-hoist electric revolving cantilever cranes used at dockyards and shipyards for the fitting-out of vessels. For this service it is customary to use two independent motors and sets of lifting mechanism, one to work in conjunction with each of the two slings, which are not necessarily equally loaded. Although initially the more expensive, the magnet-switch controller with 21 notches on each side is undoubtedly much superior to the drum-type. Since the cost of the controller is small in comparison with the cost of the crane, the higher cost of the magnet-switch system of control does not necessarily mean any serious increase in the cost of the crane.

London-Birmingham-Liverpool Telephone Cable.—We understand that through telephonic communication has now been established between Liverpool and London, with very satisfactory results. This Liverpool to London cable takes the place of 20 overhead wires, and since the cable is loaded speech is very distinct. A description of this telephone cable was given in our issue of September 10, 1915, Vol. LXXV., p. 857.

Diagrams, Rules and Symbols.—A fortnight ago, in dealing with the above, we said that to popularise the standard symbols of the International Electrotechnical Commission we should like to hear of permission being granted to our colleges and schools to have them printed for free distribution to their students. We understand that there is no objection to this being done, provided that proper acknowledgment be given to the International Electrotechnical Commission. We are informed that the question of standard diagrams is being considered by the Commission.

Electrification of Fibres.—According to the "Yorkshire Post" a research is being made at Leeds University on this question. In drawing and spinning processes the electrification of fibres sometimes causes great trouble. Wool, for instance, subject to electrification almost as readily as silk, and owing to its short fibres, it is more difficult to control. The Textile Institute, which is instigating the research, is receiving the assistance of the Silk Association, and Silk Weavers' Guild of London, and so deep is the interest in the matter that several Yorkshire manufacturers have already offered to carry out large scale experiments.

Light by Recombination of Ions.—Mr. C. D. Child, writing in the "Philosophical Magazine" on "The Production of Light by the Recombination of Ions," refers to a recent article by Strutt, in which the conclusion is reached that the light given off by the vapour comes from the positive ions, whereas in a previous Paper the author had concluded that the light was due to recombination between positive and negative ions. Certain experiments are discussed, and the conclusion is reached that the recombination theory is more reasonable at present than any other. Consequently, in the case of mercury vapour the assumption that light is due to recombination is to be preferred.

"X"-Rays and Atomic Structure.—A Paper on this subject by Prof. C. G. Barkla, F.R.S., and Janette G. Dunlop, M.A., B.Sc., appears in the current "Philosophical Magazine." The conclusions to be drawn from some of the experimental results are as follows: That the scattering of "X" rays of very short wave-length by equal masses of various substances varies but little with the atomic weight of the scattering element. With "X"-rays of greater wave-length the scattering is more marked. So that, mass for mass, the heavier elements scatter more than light elements for long wave-lengths, *i.e.*, "soft" rays. It is pointed out that these variations are inappreciable among elements of low atomic weight.

Work Done by Escaping Electrons.—Mr. H. H. Lester, in a Paper entitled "The Determination of the Work Function when an Electron Escapes from the Surface of a Hot Body," in the current "Philosophical Magazine," discusses Richardson's equation. The work done is represented in this equation by a constant, b, which should equal the E.M.F. φ required. Accordingly Richardson and Cook's work is reviewed, and certain details of secondary importance are considered inaccurate. Values of φ for three new materials are given and new values for tungsten are found. Also the complete identification of b with φ is established, and it is shown that traces of active gases influence the value of φ, but inert gases have no effect. A new method of determining filament temperatures is described, in which the Richardson equation is used, and b is determined from measurements of φ.

Quantitative Experiments with the Audion.—Mr. L. W. Austin deals with this question in a Paper in the "Journal" of the Washington Academy of Sciences. The first experiment was to determine the law of response of the circuit in the old audion connection, the sending wave being excited by a buzzer. The results obtained showed that the response is proportional to the square of the high frequency received currents. The same law held for the ultraudion, when no local oscillations were produced. With the audion in ultra-audion connection and oscillating, and with damped and undamped waves, in this case the response in the case of local oscillations was greater for undamped oscillations than for damped oscillations, and was proportional to the received high-frequency current, and not to its square, as in the case of the non-oscillating audion. It was also found that the oscillating ultraudion gave from 300 to 1,000 times the audibility, the old audion being regarded as unit, and with the non-oscillating audion the signals are from 20 to 40 times as strong as with the old audion. As the law of response is different in the two cases the ratio decreases as the signals grow stronger.

Iron Losses in Direct-Current Machines.—An informative Paper on this subject was read on March 7th by Mr. B. G. Lamme before the American Institute of Electrical Engineers. The author shows that no great accuracy is possible in the calculation of the actual iron losses, except in special cases, due to the fact that the ordinary treatment of materials during manufacture is such that large discrepancies are almost sure to occur in certain types of apparatus. A brief explanation of several causes of variation in losses is given. In the treatment of core losses in direct-current machines the four principal sources of losses are considered, namely, armature ring loss, tooth loss, eddy-currents in buried conductors and pole-face losses. Under eddy-current loss is given an explanation of certain losses not usually taken into account, and a method of calculation is given along with tabulated results. Under pole-face loss a formula is given, also with tabulated results. The effect of load on losses is discussed, and some of the effects of flux

distortion on the losses are shown. One of the principal objects of the Paper is to show the impracticability of calculating all the core losses with any great accuracy at no-load, and the still greater difficulty in predetermining them with load.

The Ignition of Gases by Impulse Electrical Discharge.—A Paper on this subject was read recently by Dr. W. M. Thornton before the Royal Society. The ignition of gases by impulsive discharge is considered first as a function of sparking distance. It is shown that the shorter the distance the greater the spark, so that the volumes of the least igniting sparks are, in a typical case, the same for all spark lengths. Ignition may occur with intense momentary brush discharge, generally with the true disruptive spark. The products of combustion are found to be ionised and to carry a positive charge. The gases examined were mixtures in air of hydrogen, methane, propane and pentane ; of thylene and acetylene ; carbon monoxide and cyanogen ; coal gas and a mixture of equal volumes of hydrogen and methane. Hydrogen, propane, pentane and carbon monoxide rise gradually in difficulty as the percentage of oxygen is reduced ; methane is ignited by the same spark whatever the percentage of gas may be ; acetylene and cyanogen have the stepped atomic type of ignition ; ethylene is more inflammable in rich mixture. Hydrogen and methane in equal volumes are ignited as methane in type, hydrogen in magnitude. The limits of inflammability of the paraffins are shown to be reached the upper limit when there is twice the volume of combustible gas to that in the mixture for perfect combustion, the lower limit when the volume of oxygen is twice that for perfect combustion less one atom to the molecule. The ignition of coal gas is through methane. Four types of electrical ignition are given, covering all from the most rapid to the slowest rate of discharge from the poles.

Screw Gauges.—We have received from the National Physical Laboratory a pamphlet entitled " Notes on Screw Gauges." This contains some 12 sections dealing with accuracy and verification of screw gauges, notes on tools, periodic pitch errors and the use of reference grooves and cylinder. Referring to the section on screws, it is shown that of the seven elements in a Whitworth screw the most difficult to control are the pitch and effective or pitch diameter. The pitch error may be present in two forms—progressive and periodic. Screw gauges which are consistently long or short by a constant amount on each pitch require to be compensated by a suitable reduction in effective diameter. Periodic error, a lengthening or shortening alternately, of the pitch, is less serious, and such a gauge must have a reduction in effective diameter, otherwise it will not go right up in a check ring of correct size. Curves are given illustrating the periodic and other errors. Regarding measurements, effective diameter may be determined by placing specially selected sewing needles, or small cylinders of silver steel, in the grooves (two on one side and one on the other) and measuring the shortest distance between the small cylinders on opposite sides of the axis. To this distance a constant is added. These cylinders are supplied by the N.P.L. Core diameter is measured in exactly the same way, only prisms of hardened steel are used, instead of needles. To measure the angle of plug screws, a microscope is used fitted with a fine cross wire. A simple apparatus is illustrated for this purpose. Another useful check is a standard reference bar for the measurement of core, and effective diameters. One end of the bar is a plain hardened cylinder for calibrating the micrometer used to measure core diameters, and the other end consists of a cylinder with a circular V-groove, having an angle of 55 deg. cut to a suitable depth. This groove is tested just as if it were a screw thread, and its effective diameter determined once for all. Altogether the publication contains a good deal of information of use to manufacturers. The price is 1s. 6d. (W. F. Parrott, Teddington.)

Modernising of an Electric Supply Undertaking.—A Paper by Mr. E. M. Hollingsworth, read recently before the Liverpool Engineering Society, deals with the alterations and extensions to the plant at St. Helens.

It appears that seven years ago it became necessary to carry out considerable extensions to the plant and feeders. At that time 2,750,000 units were sold and the load factor was 26·5 per cent. ; now the units sold are 6,250,000 per annum and the load factor is 28 per cent. The capacity of the plant is now 7,200 kw., of which 6,000 kw. (0·8 power factor) is modern plant. The cost per kilowatt of the new plant, including buildings, boiler plant, generators, cooling towers and switchgear was £7. 17s. 6d., and converting plant with switchgear cost £3 per kilowatt, the total cost being £10. 17s. 6d. The present boiler plant consists of four Lancashire boilers and economisers and four water-tube boilers, all working at 170 lb. per square inch and superheated to 535°F. At the normal rating of the boilers 30 lb. of fuel (Lancashire slack, calorific value 11,000 B.Th.U.s per lb.) can be burnt per square foot of grate area, and this can be increased for short periods to 40 lb. Forced draught with 2½ in. pressure of water is used. The intake of the fans is connected to the engine room, so that warm air is supplied to the boilers. Tests show a combined efficiency of boiler and superheater of 76 per cent. With the 1,250 and 2,500 k.v.a. turbo-alternators the lowest monthly average is 2·56 lb. of fuel per kilowatt-hour. With the 3,750 k.v.a. generator it is anticipated that the average figure for 12 months will be 2·5 lb. The water supply is taken from two distinct mains on town's supply, and the water has a hardness of 14 deg. The boiler feed water is reduced to 5 deg. hardness by a lime-soda softening plant, and is taken from the cooling towers. A " Permutit " filter is also used. The modern generators comprise three high-pressure turbines of 1,250, 2,500 and 3,750 k.v.a. respectively, the latter having a steam consumption at its most economical load (75 per cent. of the maximum) of 13·9 lb. per kilowatt-hour. All these generators are excited from an exciter mounted on the shaft, and are self-ventilated. At present the air is drawn through cloth filters, with the intake outside the station, but a wet rotary filter is being installed. The condensers used with the turbines are of the low-level jet type, operated with natural draught chimney cooling, and the discharged water is delivered over the towers by motor-driven centrifugal pumps. Jet plant was adopted on account of the trouble experienced by corrosion of the tubes in surface condensers, all the means tried to counteract this trouble having failed. Three-phase current at 6,000 volts 50 periods is transmitted to static sub-stations, where it is transformed to 400 volts for power and 230 volts for lighting purposes. All the transformers are wound " delta " on the primary side and " star " on the secondary, the neutral point of the " star " being earthed. Two feeders are laid to the most distant sub-stations, each in turn being " looped " into alternate sub-stations, and two other feeders are connected to the half-way sub-station. There are 10 sub-stations, having outputs from 125 k.v.a. to 1,000 k.v.a. Curves and diagrams are given in the Paper. The saving effected by the change is less than was anticipated, chiefly owing to the rising price of fuel ; but it is more than sufficient to meet the annual capital charges on both the original and modern plant, and the latter is sufficient to cope with a considerable increase in the demand.

Scientific and Industrial Research.—In exercising the functions assigned to it in the Government scheme for the organisation and development of scientific and industrial research, the Advisory Council has taken initial action on the lines indicated below.

In order to secure that researches already in progress should so far as possible be carried on in spite of the war, scientific and professional societies were invited to submit applications for aid to continue researches for which the necessary staff and equipment were obtainable. Grants have already been made, or will shortly be made, to the Institution of Mechanical Engineers (hardness tests and the properties and composition of alloys), to the Institution of Electrical Engineers (heating of buried cables and the properties of insulating oils), to the Institute of Chemistry (laboratory glass and optical glass), to the Institution of Mining and Metallurgy (methods of extracting tin and tungsten), to the Institute of Metals (corrosion of non-ferrous metals), to the Institution of Gas Engineers (refractory materials), to the Manchester Association of Engineers (tool-steel experiments), and to the National Physical Laboratory (optical glass). Other proposals of the same type are still under consideration. The Advisory Council has also recommended a grant in aid of an important new research into the manufacture of hard porcelain, which has been undertaken by the governing body of the Stoke-on-Trent Central School of Science and Technology, in conjunction with the Staffordshire Potteries Manufacturers' Association, with a view to the establishment of the manufacture of hard porcelain in this country.

The Council is now approaching other proposals of great importance which have come from institutions or individuals, and in order that they may be in a position to do justice to the branches of industry concerned have decided to appoint Standing Committees of Experts. Strong committees in mining and metallurgy have already been constituted. The Mining Committee will have two sections, dealing respectively with the mining of non-metals and the mining of metals. Sir William Garforth has accepted the chairmanship of the Committee and of the non-metals section, and Mr. Edgar Taylor has accepted the chairmanship of the metals section. The Metallurgy Committee will also have two sections, dealing in this case with ferrous and non-ferrous metals respectively. Sir Gerard Muntz, Bart., has accepted the chairmanship of the Committee and of the non-ferrous section, and Sir Robert Hadfield, F.R.S., has accepted the chairmanship of the ferrous section. The Advisory Council hopes at an early date to constitute a similar committee for engineering.

Particulars have been obtained of the research work, not only of the scientific and professional societies, but also of the Universities and higher technical schools, with a view to the establishment of a register of

research. The possibility of proceeding to collect in the near future information as to the research work of particular firms is also under consideration.

The training of an adequate supply of research workers will be an important branch of the Advisory Council's work, and the steps to be taken for that purpose will require much careful thought. It is plainly impossible to make any definitive plans during the war, but the Advisory Council is so much alive to the urgency of the matter that it has thought it necessary to take immediate interim action, and has, therefore, made recommendations which, if adopted, will, it is believed, secure that all that is practicable in existing circumstances shall be done.

OBITUARY.

IVAN LEVINSTEIN.—The death is announced of Mr. Ivan Levinstein, head of Levinstein & Sons, chemical manufacturers, of Manchester.

Mr. Levinstein, who was well known as an advocate of patent law reform, was born in Charlottenburg, Berlin, and was educated at the Technical High School, Berlin. He established dye works in Manchester in 1864, since when he has been prominently connected with the commercial and civic life of that city.

JOHN CLAY.—The death of Mr. John Clay, of the Cambridge University Press, occurred on Monday. Mr. Clay joined the University Press before taking his degree, and became a partner with his father (Mr. C. J. Clay) in 1882.

LADY KELVIN.—We regret to record the death of Lady Kelvin, which took place at Netherhall, Largs, on the 16th inst., after an illness of five weeks. Lady Kelvin was the daughter of Mr. Charles R. Blandy, of Madeira, and she became the second wife of Lord Kelvin (then Sir William Thomson) in 1874, the wedding taking place at Funchal, Madeira. She met Lord Kelvin at Madeira when he went there on one occasion to repair a cable. Lady Kelvin took little part in public life, but was the President of the West of Scotland Women's Unionist Association.

KILLED IN ACTION.—Lieut. John M. Thornton, R.E., who was killed in France on Jan. 19th last, was an electrical engineer. He graduated B.Sc. (in Engineering) at the London University. At the outbreak of war he was a private in the London Scottish, and was dangerously wounded at Messines in October, 1914. When he recovered he received a commission in the Royal Engineers.

PERSONAL.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

London Electrical Engineers: Chief Petty Officer H. J. Waller (from R.N.A.S.), Corp. A. J. Anido and Spr. F. G. Hart to be Second Lieutenants (on probation).

Tyne Electrical Engineers: Second-Lieut. Thos. T. Tucker to be temp. Lieutenant.

APPOINTMENT VACANT.

A trustworthy meter reader is required by an advertiser; permanent situation. Commencing salary 30s. per week.

INSTITUTIONS AND SOCIETIES.

Scottish Local Section of I.E.E.—At the monthly meeting of this Section, held on March 14, at Glasgow, the following office-bearers were nominated for 1916-17: *Past Chairmen*: Messrs. D. A. Starr, Sam Mavor and James Lowson; *Chairman*: Mr. J. K. Stothert; *Vice-chairmen*: Messrs. J. E. Sayers and E. T. Goslin; *Hon. Secretary*: Mr. Joseph Taylor; *Assistant Hon. Sec.*: Mr. Wm. F. Mitchell; *Committee*: Messrs. F. H. Whysall, W. W. Lackie, A. Page, W. B. Hird, Prof. Magnus Maclean, Alex. Lindsay, A. S. McWhirter, D. M. McLeod, Archd. Wilson, A. S. Hampton and Prof. Cormack.

Institute of Radio Engineers.—A meeting of the Institute of Radio Engineers of New York was held on March 1, when a Paper on "Recent Standard Radio Sets" was read by Mr. Harry Shoemaker.

Mining Institute of Scotland.—Under the joint auspices of the Mining Institute of Scotland and the Scottish branches of the National Association of Colliery Managers and the Association of Mining Electrical Engineers, a largely attended meeting was held at the Royal Technical College, Glasgow, last Saturday afternoon. Mr. A. B. Murhead occupied the chair. Mr. Frank Onslow (Glasgow) read a Paper of much practical interest on "Types of Modern Electric Winding." He explained at the outset that he did not propose to discuss the relative merits of steam and electric winding. Those who had considered the question during the past decade knew that there was a useful field for each, and that the final selection must depend upon the particular requirements of each case. No complete statistics were available, but from data published from time to time, it was safe to say that the aggregate of electric winding plant in this country and on the Continent could not be less than 1,000,000 H.P. An interesting point arose in connection with electric winding, especially where the supply of power was taken from an outside source or from a colliery company's own generating station situated at another colliery. Electric winders themselves were quite reliable and not liable to breakdowns, but if the source of supply failed they were helpless. This had to be seriously considered in many cases, and it would be of interest to hear the views of mining engineers on the point. Having described at length the features of interest peculiar to the Ward-Leonard, Thury and Ilgner systems of electric winding, Mr. Onslow passed on to say that while the winder was only one of many factors which went towards the full equipment of a colliery, it was the factor without which the others availed nothing. The first consideration in a winder was reliability, and this, through extended and wide experience, had been attained in the steam winder. The very nature, however, of the load was such that on the score of economy and other considerations there was a field for improvement, and into this field electricity stepped, and had already secured for itself a holding which was bound to extend. Modern electric developments and the introduction of turbines of the high-pressure, mixed-pressure and low-pressure types, together with the fact that public supplies were largely available, had rendered the possibilities of economy a matter for wide consideration. Mainly the alternatives were : (1) Shall the colliery be entirely electrically equipped and supplied with power from an outside source of supply or from electricity generated at the collieries? (2) Shall the colliery depend upon its own steam plant for its winding, with the possibility of utilising in a mixed-pressure turbine the available exhaust steam augmented with live steam for the generation and supply of electricity for the auxiliary plant? Since it had become an established fact that electric winding was reliable and economical, the two alternative questions referred to assumed an importance and claimed a consideration which was not the case before electric winding had passed through its period of probation, and had established itself as having "come to stay."

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 24th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S.W. Papers on "A New Method of Determining Ionic Velocities," by Mrs. Griffiths; "An Explanation of the Migration of Ions" and "A Method of Exhibiting the Velocities of Iodine Ions in Solution," by S. W. J. Smith, M.A. D.Sc., F.R.S.

SATURDAY, March 25th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, W. Lecture by Sir J. J. Thomson, D.Sc., P.R.S., on "Radiations from Atoms and Electrons" (Lecture III.).

WEDNESDAY, March 29th.

STUDENTS' SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7:45 p.m. At Victoria Embankment, W.C. Annual General Meeting.

FRIDAY, March 31st.

ROYAL INSTITUTION.

5:30 p.m. At Albemarle street, W. Discourse by Prof. A. Fowler, F.R.S., on "The Spectra of Hydrogen and Helium."

ENGINEERING INSTITUTIONS VOLUNTEER TRAINING CORPS.

Commanding Officer: Lieut.-Col. CLAY, V.D.

Orders for week commencing March 27, 1916 :—

Drills: 6:25 to 7:25; 7:25 to 8:25 p.m.

Monday, March 27.—Sections 1 and 2, technical; Sections 3 and 4, squad and platoon. Signalling class and recruits.

Tuesday, March 28.—School of arms, 6 to 7 p.m.

Thursday, March 30.—Shooting for Sections 3 and 4.

Friday, March 31.—Sections 3 and 4, technical; Sections 1 and 2, squad and platoon. Signalling class and recruits.

Saturday, April 1.—Adjutant's instruction class at 2:30 p.m.

Sections for technical parade at headquarters, London Electrical Engineers, 46, Regency-street, S.W.

Sections for shooting, parade at miniature ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate-hill, as soon as possible.

MAGNETOS FOR ELECTRIC IGNITION.*

BY H. ARMAGNAT.

The article is divided into three sections :—

1. Commercial and industrial conditions in France.
2. History of the magneto.
3. General theory of the magneto.

The first section deals entirely with conditions in France, and is abstracted shortly as follows :—

The author first points out that France was tributary to the German market in the supply of magnetos, and he states that this is not due to a lack of technical ability or want of inventiveness. He goes on to point out that the discouragement of French manufacturers of automobiles is partly due to the absorption of a large part of the profits by the intermediaries, and also to the lack of organisation necessary to turn out models in very large quantities of varying patterns. A third reason is given, as the lack of foresight on the part of the capitalists in not allowing enough of the profits to be appropriated by the manufacturers to research in order to perfect their productions.

He also suggests that part of the blame rests on the clients who, on account of ignorance, are a prey to unscrupulous dealers.

He considers that French manufacturers should be capable of regaining their position in the production of magnetos by attending to these points.

He then proceeds to sketch rapidly the historical development of the magneto and finally develops a general theory of its action which is confirmed by experiments.

Development of Electric Ignition.

The first gas engine operating by the help of electric ignition was that of Lenoir (patent Jan., 1860, with additions in April of the same year).

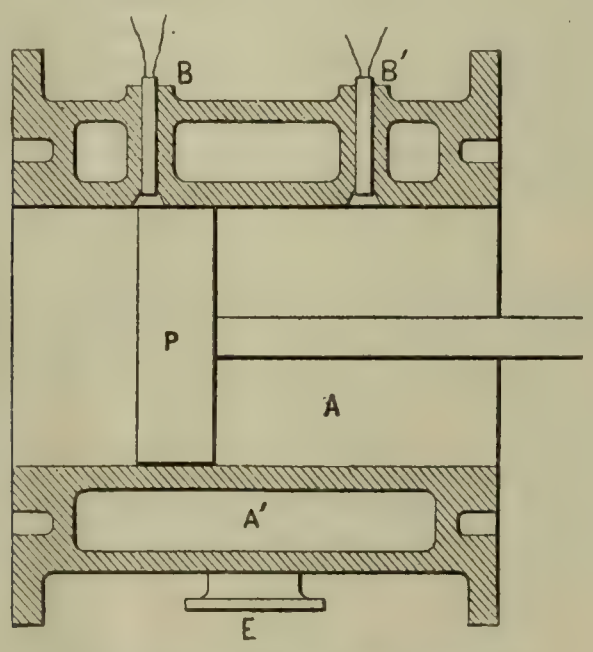


Fig. 1.—Lenoir Ignition Scheme.

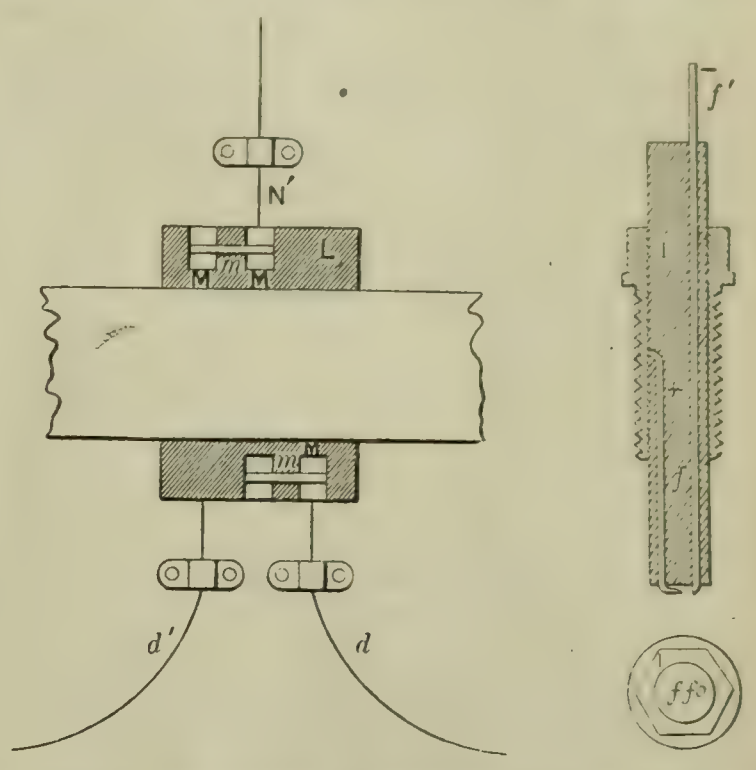
Since that time electric ignition has passed through many stages of development, and its success has been assured by the development of the engines used in automobiles and for aviation. At the present time the trend of design in stationary engines is to approach more and more the principle of the Diesel engine, in which ignition is effected entirely by the compression of the explosive mixture, in distinction to aircraft and automobile engines, which operate entirely by electric ignition.

The Lenoir engine embodies all the essentials found in present day engines (Fig. 1). The Lenoir system of ignition was based on the use of a high-tension spark, furnished by an induction coil, and caused to take place at the right moment between an insulated electrode and the cylinder. The coil, operated by two or three Bunsen cells, had a hammer break of slow period which periodically interrupted the primary current, giving rise to the secondary spark. A high-tension distributor (Fig. 2) mounted on the main shaft of the engine connected the secondary, successively, to the plugs, one at each end of the cylinder. This arrangement necessitated the continuous operation of the coil, and is not used at the present day.

The plug (Fig. 3) consisted of an outer bronze casing holding a porcelain insulator through which passed the central insulated electrode, thus comprising the elements of the present day high-tension plug.

The next stage was in 1883, when Marcus, of Vienna, already known by his electromagnetic mine exploder, patented the first magneto especially applied to the ignition of explosion engines.*

Marcus' arrangement (Fig. 4) consisted of a low-tension generator and a system of cams and levers operating to break the circuit in the interior of the cylinder, in the explosion chamber. This is the first application of the "extra current" due to self-induction. This system by Marcus embodies the essential features of the low-tension system of ignition ; the armature of the magneto is similar to Siemens H-type ; the cam determining the break of the circuit is shaped so



Figs. 2 and 3.—High-tension Distributor and Plug of Lenoir Engine.

as to effect as rapid a separation of the contacts in the cylinder, as possible.

About 1885 Forest applied a similar system to some of his engines, and the Otto engines of 1888 made use of the Deliège system of ignition based on exactly the same principle.

The development of the automobile dates from 1893, when the ignition of the small engines used on tricycles was greatly improved by De Dion in conjunction with Bassée and Michel. These small engines worked at a high speed, and the tremblers of the coils were not sufficiently regular or rapid to give ignition at the right moment ; this difficulty was overcome by these inventors, who disposed the contact spring in such a manner as to be operated by a cam driven directly from the engine. They further designed this cam so as to permit of an angular displacement relative to the crankshaft ; they thus realised advancing and retarding of the ignition (Fig. 5).

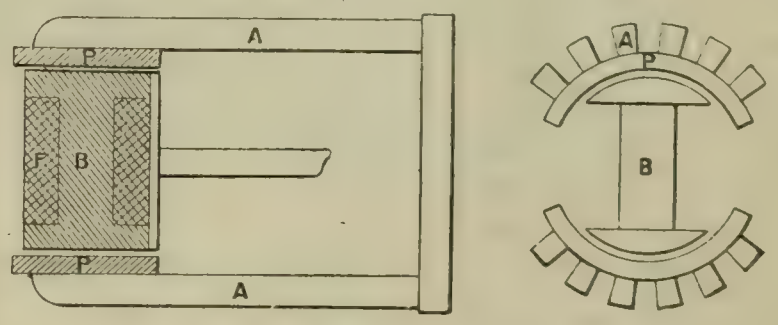


Fig. 4.—Marcus' Low-tension Generator.

In 1898 † Simms and Bosch brought out their rotating sector magneto, consisting of a fixed H-armature between the pole-pieces of a permanent magnet ; in the intervening large air-gap (Fig. 6) are disposed two rotatable sectors mounted on a shaft and geared to the engine. These sectors form each a quarter of a cylindrical tube, and by their rotation reverse the flux in the armature four times each revolution, thus inducing currents in the winding on the iron core.

In 1900 a Frenchman, M. Boudeville, having already patented a

* Translated and reproduced with slight abbreviations, by kind permission of the editor of "La Revue Electrique."

* D.R.P. 25,947, May, 1883 ; Dingler's "Polytechnic Journal," Vol. CCLVI., May 6, 1885, p. 198.

† "Industries and Iron," 1898.

magneto * with break, conceived the idea of putting two windings on the armature, one of thick wire short-circuited on itself through an interrupter, and the other of fine wire connected directly to a high-tension plug (Fig. 7). Such an arrangement behaves as an induction coil in which the primary current is induced by the rotation of the whole in a magnetic field; on breaking this primary current a high E.M.F. will be induced in the secondary winding. Unfortunately, the patent says nothing about the use of a condenser. It had to wait until 1902 when the Vesta magneto appeared, and also the Simms-Bosch magneto giving direct sparks. These high-tension magnetos have to-day quite superseded the older low-tension machines.

The low-tension magneto has the advantage of simplicity, its current being easily led to the cylinder, but it suffers from the serious drawback of requiring a system of cams and levers on the engine for breaking the circuit in the interior of the cylinder.

Many inventors sought to overcome these defects, and two other forms of ignition were devised. One of these sought to combine the

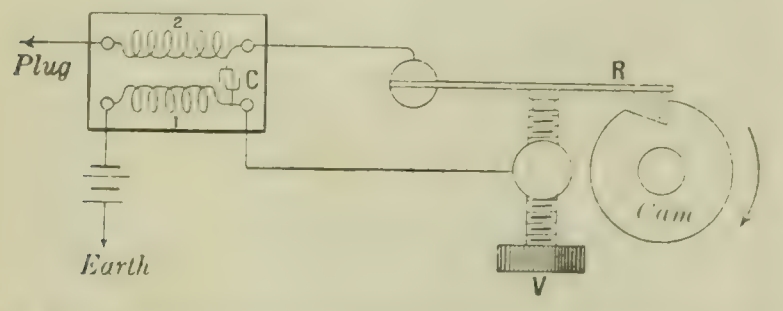


Fig. 5.—Bassé, Michel and De Dion Arrangement. Contact-breaker Operated by Cam.

advantages of the magneto with those of the induction coil; by using them in combination the battery is done away with. The first to suggest this arrangement seems to have been Eisemann,† followed some time after by the Nilmelior Company.

Eisemann utilised the extra current at break by causing it to circulate in the primary of a transformer the secondary of which was connected to the plug (Fig. 8).

A contact spring, *b*, pressing against a toothed disc, *a*, alternately short-circuited and connected to each other the generator winding *m* and the primary *c* of the transformer; at each break of contact the self-induced current generated a high E.M.F. in the secondary of the transformer.

Zubaloff,‡ experimenting in quite a different direction, entirely suppressed the mechanical equipment necessary to break the circuit in the interior of the motor by replacing the high-tension plug with

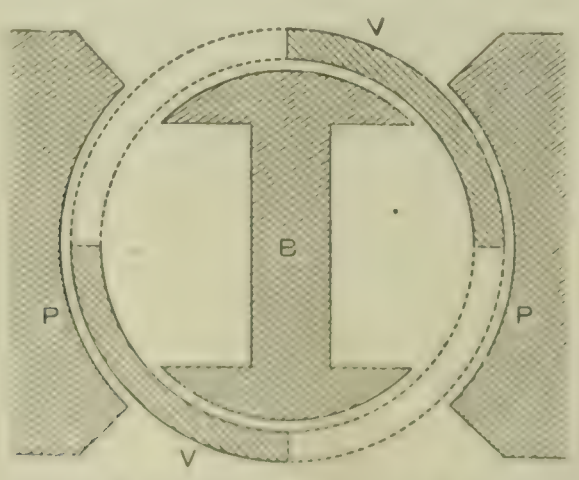


Fig. 6.—Simms and Bosch Rotating Sector Magneto.
P, P1, pole pieces. B, winding. V, V1, sectors.

an electromagnetic device into which the current was sent from a low tension magneto or battery at the correct moment by a cam or any other suitable contacting device. The electromagnetic apparatus energises a movable piece of iron which is rapidly attracted and suddenly breaks the circuit in the interior of the cylinder; when the contact at the cam is broken the piece of iron falls back again and closes the circuit in the cylinder. Other arrangements on similar lines to this have been proposed by Caron, Simms Bosch, &c.; they all embody the principle of replacing the high-tension plug by a self-operating internal interrupter; they have not been found successful on high speed motors, but are found in various forms on stationary engines.

Magnetos in which the primary and secondary circuits are movable with the iron core carrying them, require special care in construction to ensure adequate insulation of the windings and protection against centrifugal forces; they further require collectors to establish the various connections between the fixed and moving parts. To overcome these difficulties many experiments have been made since 1900 in order to devise a magneto with fixed windings and movable iron core. Under this category we have the "Magneta," patented in 1901, the "Saint-Romain," and the "Alterno" of the Nilmelior Company. In spite of much experimenting, none of these magnetos have succeeded in finding a place in everyday use.

At a time when high-frequency currents were being experimented with it was natural to think of employing them in the sphere of electric ignition, and Lodge, in 1904, evolved such a system, which was a successful curiosity, but was soon forgotten.

To complete this rapid survey of the history of the applications of electricity to the ignition of explosion engines we may mention the employment of statical machines, proposed by Bonetti, in 1890 (Wimshurst machine), and, later again, in 1906, by R. Esnault-Pelterie (Stato Rep.). These proposals have not led to any practical results.

Finally, a system making use of electricity as an auxiliary is the electrocatalytic igniter of Wydtz (1902). This is only a new form of a system proposed in 1879 by Sir William Siemens. A spiral of platinum wire is mounted in a suitably designed plug. A small current sent through the wire heats it; but if, now, it is plunged

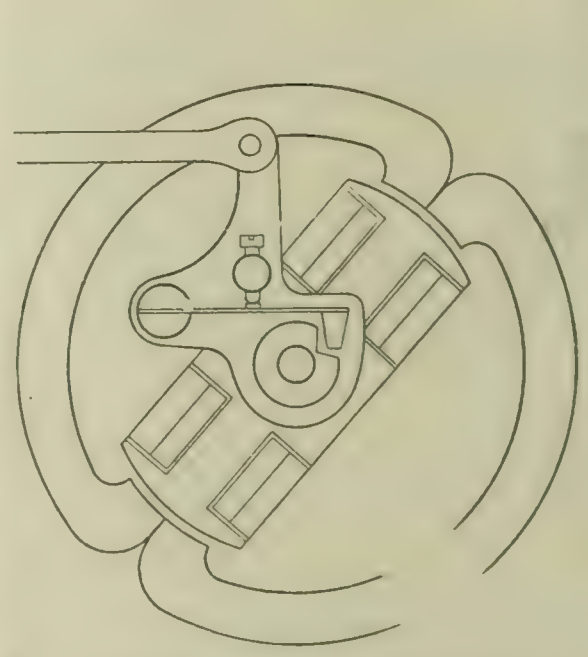


Fig. 7.—Boudeville Magneto with Double Winding on the Armature.

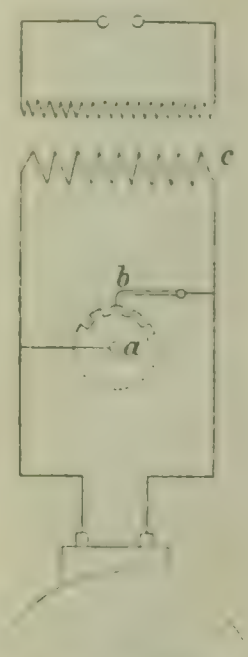


Fig. 8.—Eisemann Arrangement.

into an explosive gaseous mixture, the wire becomes red hot and fires it. By regulating the current, with the help of a rheostat, to a convenient value, the ignition may be made to take place with a greater or lesser degree of compression as may be desired, and so advance or retardation of ignition may be secured. Like the preceding, this system has not received any general applications.

General Theory of the Magneto.

Ignition is effected by magnetos according to two distinct principles: one by self-induced spark, the other by a high-tension spark.

In the first, the current generated by the magneto is broken in the cylinder itself, of the engine, by mechanical separation of two conductors carrying this current. The spark due to self-induction thus produced ignites the charge.

In the second case the current generated by the magneto is interrupted at the proper moment by a mechanical device on the magneto itself, and a second circuit of fine wire, wound over the first and primary, has induced in it a current of high tension, as a result of the rapid variation of the primary current; it is, in fact, an induction coil, in which the primary current results from the rotation instead of an external source.

We have seen also a mixed combination: the current generated by the magneto is sent into the primary of a separate coil or transformer.

In every case the most important function of the magneto is to generate this current, and it is very important to understand

* French patent No. 263,119, Jan. 16, 1897, third addition, March 17, 1900.

† French patent No. 316,228, Nov. 25, 1901.

‡ French patent No. 323,048, August 11, 1902.

thoroughly how this current is generated and how the special qualities of the magneto adapt themselves to this end.

The magneto is composed essentially of a rotor of shuttle form (Siemens H), on which are wound the primary and secondary circuits, and of a stator consisting of one or more magnets of horseshoe form provided with iron pole-pieces (Fig. 9).

The Siemens armature, dating back to before 1860, has been entirely superseded for alternators on account of the bad wave-form of voltage given by it. This defect constitutes its chief advantage from the magneto point of view. Furthermore, all efforts made up till now to replace it have entirely failed; it remains the principal and indispensable organ of the magneto.

The Siemens armature consists essentially of a soft iron core, having an H-section, a central part, N, and two shoes JJ. The outer surfaces of the shoes are cylindrical, and the whole is mounted to revolve on an axis, XX, centrally between the cylindrical pole-shoes PP attached to the limbs of the magnets AA.

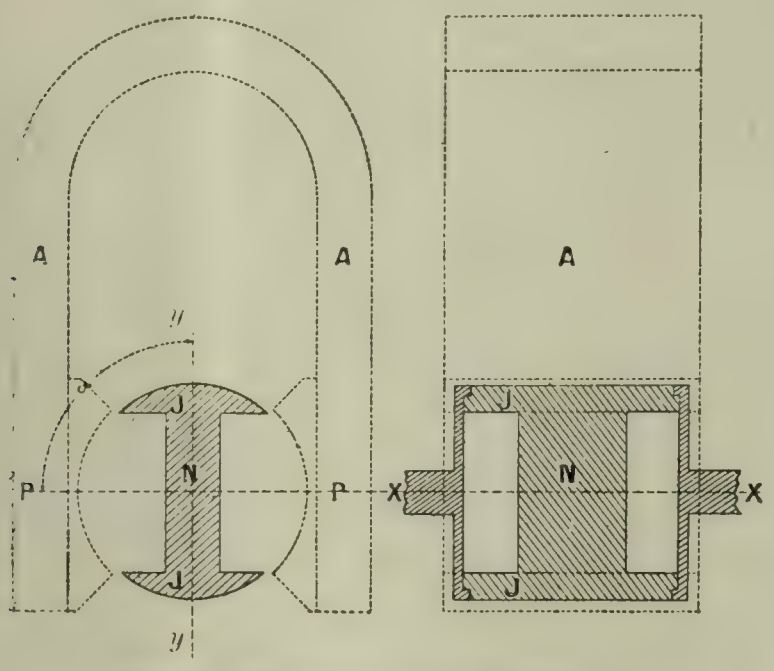


Fig. 9.—Outline of Ignition Magneto.

The coils are wound on the core N, and connected to slip rings, from which the currents are collected by suitably-disposed brushes.

Let:—

S be the transverse cross-section of the core N.

n the number of primary turns on the core.

B the magnetic induction produced in the core by the magnets; the value of a evidently depends on the position of the armature in the air-gap and on the angle B which its axis YY makes with the median line PP of the pole-pieces.

i the instantaneous value of the current.

L the self-induction (assumed constant) of the primary circuit.

R the total resistance of the primary winding.

We have the well-known equation:—

$$nS\frac{dB}{dt}=L\frac{di}{dt}+Ri, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which can be transformed to

$$2\pi mnS\frac{dB}{da}=2\pi mL\frac{di}{da}+Ri, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where m equals turns per second.

$$\frac{da}{dt}=2\pi m. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

B and i are seen to be functions of a for a given speed, and since L has been assumed constant (it actually varies considerably with a) we can deduce from (2) the general solution:—

$$i=\frac{nS}{L}B-\frac{R}{2\pi mL}\int id\alpha-\text{const.}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

With sparking magnetos the circuit is interrupted during an angle sufficiently great to allow the current to become zero. Then, at the moment of closing the circuit:—

$$i_c=0, \int_c id\alpha=0, \frac{nS}{L}B_c=\text{const.},$$

and, finally,

$$i=\frac{nS}{L}(B-B_c)-\frac{R}{2\pi mL}\int id\alpha \quad . \quad . \quad . \quad . \quad . \quad (5)$$

If the relation between B and a is known, i can be calculated, but with a Siemens armature this relation is too complex to express mathematically, and all that one can do is to determine the curve

$$B=f(a).$$

By the aid of this curve the values of $i=\varphi(a)$ can be calculated for different speeds and resistances of circuit.

This calculation has not much practical interest; it suffices generally to obtain the curve $B=f(a)$ and its derivative, in order to determine the qualities of the magneto, and to see what corrections have to be made to it.

Before studying the properties of magnetos as given by these curves, we will notice how they may be obtained. We will give three methods: (1) By variation of flux; (2) by contact method; (3) by oscillograph.

1. *Variation of Flux.*—The primary is connected to a ballistic

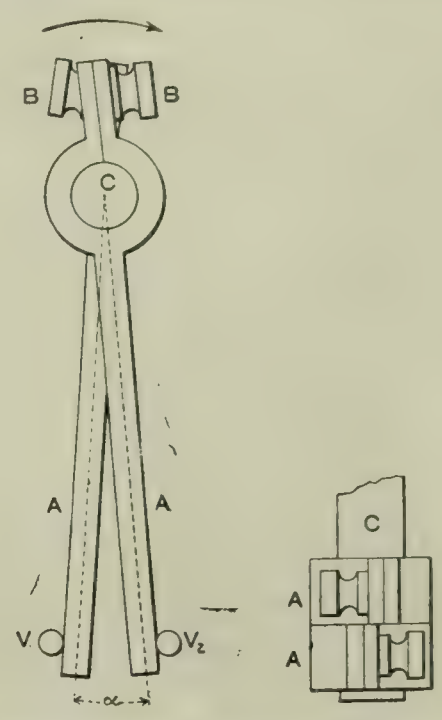


Fig. 10.—Arrangement for Experimentally Determining the Function $B=f(a)$.

galvanometer and has impressed on it small, successive, equal angular displacements (about 10 deg.) quickly given, always in one direction, and the corresponding galvanometer deflections are observed.

This operation is easily carried out by mounting two levers A, A′ on the shaft C of the magneto (Fig. 10) which can be locked in any position by milled nuts B, B′; these levers can oscillate between fixed stops V_1 and V_2. The direction of rotation being that indicated by the arrow say, the two levers are placed in contact with the stop V_2, and locked on the shaft by nuts B and B′. By sharply jerking the levers over to V_1 the armature is given an angular displacement. The throw observed, the lever A is freed on the shaft (lever A′ being held meanwhile against stop V_1) and its end brought over into contact with V_2 and locked in position on the shaft; A′ is now similarly loosened, brought over and locked, the two levers are now in contact with V_2, everything being the same as at the start, except that the armature has been displaced by the angle a. The operations are again repeated, giving a second throw, and so on.

The successive throws obtained in this manner give differences of flux or induction for each change of position of the coil by the angle

$$\epsilon=A(B_n-B_{n-1}).$$

and if the angle a has been kept very small we may write Δa for a and

$$\frac{\epsilon}{\Delta a}=\frac{A(B_n-B_{n-1})}{\Delta a}=A\frac{\Delta B}{\Delta a}. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

By plotting as abscissæ the total angle a and as ordinates the sum of the throws ϵ.

$$\Sigma\epsilon=A\sum_1^n(B_n-B_{n-1})=A(B_n-B_0).$$

we obtain the curve connecting total induction, through the armature, with the angle of diaplacement from any given starting position,

$$B=f(a). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

If, instead of plotting $A\sum_1^n(B_n-B_{n-1})$ against total a we plot simply ϵ against total a we get the curve,

$$\frac{\Delta B}{\Delta a}=\psi(a). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

The curve (8) is to a first approximation the first differential of (7). and experience shows that one can, by limiting the angle a to 4 deg. or 5 deg., obtain a quite sufficient accuracy for the study of magneto behaviour.

Fig. 11 gives an example of curves obtained in this manner.

2. *Revolving Contact Method.* If a contact is mounted on the shaft of the magneto which allows, at each revolution, a condenser to be charged and then discharged through a galvanometer (which may be an ordinary voltmeter) then, for a particular setting of the contact with regard to the armature, we obtain a current, i, which is approxi-

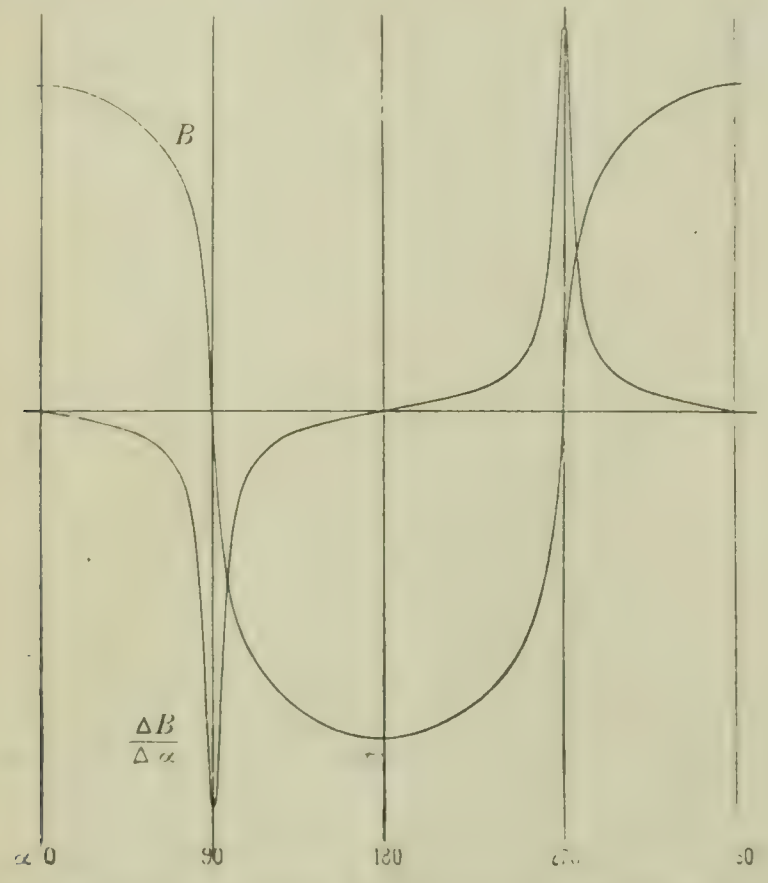


Fig. 11.—Curves of Magnetic Induction and its First Derivative

mately proportional to the instantaneous E.M.F. generated in the armature:

$$i = mnSC\frac{dB}{dt} = 2\pi m^2 nSC\frac{dB}{d\alpha} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

This is Joubert's method.

3. *Oscillograph.*—Finally, oscillographs provide a direct means of studying the behaviour of magnetos. With a very sensitive oscillograph having a high resistance in series, a curve analogous to (9) is obtained, and with a shunted oscillograph curves of current for various practical cases may also be readily obtained.

Curves of Flux. The three methods have their advantages and disadvantages. The measurement by points requires only simple apparatus and gives well-defined results; the curve of flux is exact, and the curve $\Delta B\ \Delta a$ is very nearly equal to $dB\ da$. From these two curves the shape of the current wave can be pre determined for any given case, but this calculation is very tedious, and only gives

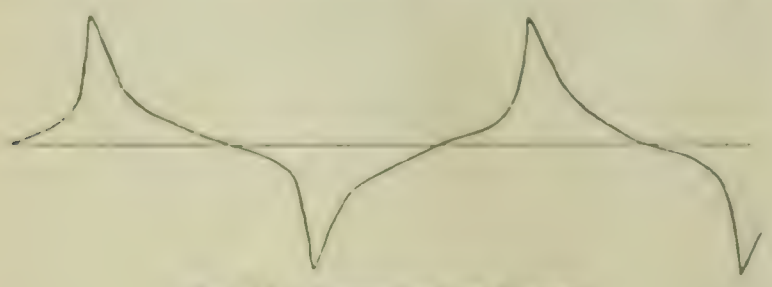


Fig. 12.—Oscillograph Curve.

results according to the assumed data. It does not give any information at all about phenomena which are functions of the speed, such as eddy currents, hysteresis and viscosity.

From this point of view the most rational method to adopt is the oscillograph, but against this must be set off the fact that it is a very costly apparatus, and also that the results given by it must be carefully interpreted in the light of various errors to which it is subject.

From a comparison of the oscillograph curve (Fig. 12) with the curve $\Delta B\ \Delta a$ in Fig. 11 a distinct difference is immediately seen, whilst the curve $\Delta B\ \Delta a$ is practically symmetrical on each side of the maximum; on the other hand, the oscillograph curve shows a considerable distortion. The reason for this lies in the fact that the oscillograph, as also the Joubert method, takes a certain amount of current from the winding, which is far from negligible in comparison with the feeble power of the magneto.

Equation (2) shows that i is only proportional to $dB\ da$, when R is very large compared to $2\pi mL$, in which case the latter term can be neglected, and the approximate equation

$$i = \frac{2\pi mnS}{R}\frac{dB}{da} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

gives the current when R is very large or when m is very small. These conditions are only the limits which can be approached, but which are never attained, so that the oscillograph curves must be corrected to the case of R=infinite if it is desired to study the characteristics under these conditions and where direct experiment is difficult.

This distortion of the curve has been sometimes attributed to hysteresis, whereas it is only due to a non-negligible current, for hysteresis is present in the method by points. Experiment shows that it is always masked by errors of measurement.

By splitting up the curve of flux one can always calculate the instantaneous values of i by the approximate formula given in (5).

The abscissæ are divided into equal small angles β (Fig. 13) and

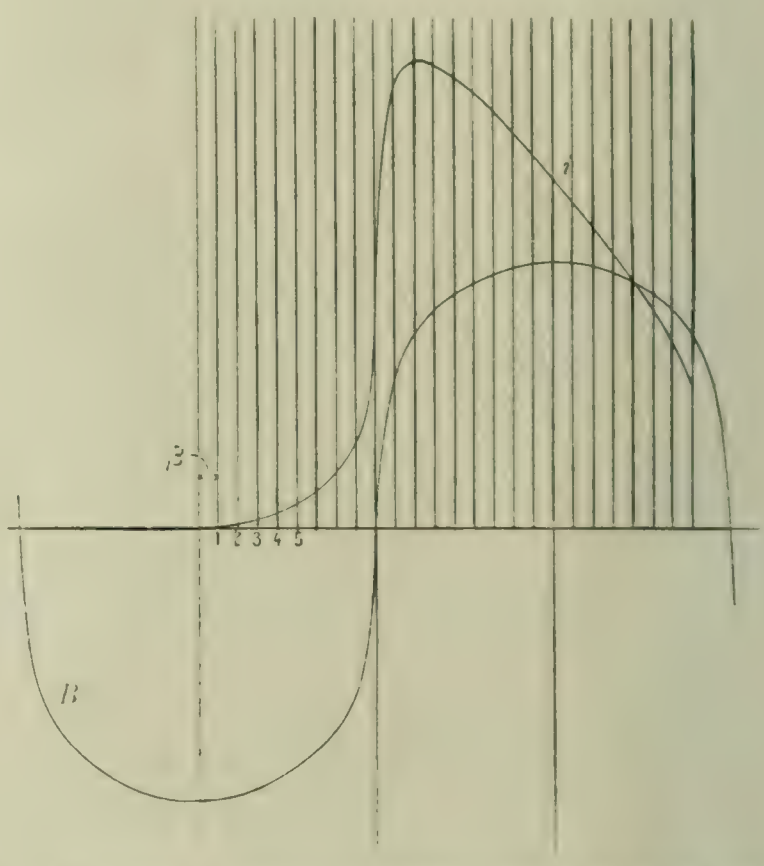


Fig. 13.—Determination of Current Curve from Flux Wave.

taking as origin the point at which the primary circuit is closed. then assuming that the current curve is straight between these intervals we get for the successive ordinates

$$\begin{aligned}
i_0 &= 0,\\
i_1 &= \frac{4\pi mnS}{4\pi mL + 3R}(B_1 - B_0),\\
i_2 &= \frac{4\pi mnS}{4\pi mL + 3R}(B_2 - B_0) - \frac{2\cdot 3R}{4\pi mL + 3R}i_1,\\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\\
i_n &= \frac{4\pi mnS}{4\pi mL + 3R}(B_n - B_0) - \frac{2\cdot 3R}{4\pi mL + 3R}\sum_0^{n-1} i.
\end{aligned} \quad (11)$$

A trial showed that the curves calculated by this formula agree exactly with those obtained with the oscillograph, when all necessary precautions are taken. As has been mentioned before, the small power of the magneto makes it difficult to connect an oscillograph in the circuit without seriously affecting the current whose curve is required, and for this reason it is often preferable to obtain the curve of flux by the ballistic galvanometer method.

Fig. 11 shows that the curves of flux and its first derivative are far from being sine curves; this, which would be a fault in most electrotechnical appliances, is of great advantage in the case of the magneto. In fact, the problem to be solved is quite different from those generally occurring in electrotechnics.

(*To be concluded.*)

CONTINUOUS-CURRENT RAILWAY MOTORS.

The following is a report of the discussion on Mr. Pannell's Paper at the meeting of the Manchester Section of the Institution of Electrical Engineers. An abstract of this Paper appeared in our columns last week :—

The CHAIRMAN (Mr. B. Welbourn) said it was not without significance that the engineering world had had presented to it within a few weeks three Papers which dealt principally with continuous-current railway working. The Papers referred to were (*a*) the James Forrest Lecture, by Mr. H. M. Hobart ; (*b*) Mr. Pannell's Paper : (*c*) the Paper to be read by Mr. Storer on March 21st. Some exceedingly valuable experimental work was being conducted in the States, which would probably have considerable influence on the character of the electrification of railways to be carried out during the next few years.

Mr. T. FERGUSON said that in describing a typical urban heavy railway service the author had emphasised the desirability of minimum weight. This was a most important point because, where coal was expensive, the annual cost of carrying an extra ton of equipment might easily reach £10. If there was room for minimising weight in designing electrical equipment, there was still more room in the case of coach building to reduce the weights of car bodies and underframes. The adoption of a motor equipment consisting of two large motors rather than four small ones had much to recommend it. Regarding an urban service, such as described by the author, it was a matter for careful consideration to decide whether it would not pay to adopt an acceleration of about 1 mile per hour per second rather than 1½ miles per hour per second, in order to use a two-motor equipment. The train weight, as stated, would render it impossible to run at 1½ miles per hour per second acceleration with a two-motor equipment having two motor cars and three trailer cars. The higher acceleration would give a lower current consumption, but the schedule indicated in the Paper was not only possible with 1 mile per hour per second, but was actually in operation on portions of the London Underground System. The saving in the cost and weight accruing from the use of the two-motor equipment was great, but not quite so great as indicated by the author on account of the continuous capacity of the 180 kw. motor being less than double that of the 90 kw. motor. With non-ventilated motors this was especially the case, as the radiating area of the motor frame did not increase in anything like proportion to its one-hour capacity. The use of the so-called "Simplex" system (*i.e.*, two motors permanently grouped in parallel to operate as a single motor) dispensed with duplication of contactors, cables, &c., on a four-motor equipment, but taking everything into consideration, the two-motor equipment was cheaper in first cost and maintenance, and it might easily show lower energy consumption per train-mile than the four-motor equipment. When standardising, on two-motor equipment especially, it was generally considered good practice to adopt the largest motor applicable to standard wheels, having due regard to preserving sufficient clearance above rail level and below the car floor, as with increase of traffic there was an invariable tendency to push up the schedule to the upmost limits of the motor capacity. The author had urged the use of fans attached to the armature shaft for increasing the continuous service rating. The speaker favoured separately driven blowers as the volume of air, and consequently the continuous rating of the motor, was considerably increased. Furthermore, the forced ventilation was still more effective in removing grit and dust from the inside of the motor. The two-motor equipment was better adapted to a forced ventilation scheme than the four-motor equipment owing to the air-duct arrangement being simpler. The author, when discussing the very important subject of shape of characteristic or speed curve of saturated versus non-saturated field motors, stated that for frequent stopping service involving rapid acceleration the non-saturated field was preferable. However, it was to be borne in mind that the non-saturated motor was heavier than the saturated motor of the same speed. With short runs it was generally better to employ the material in making a low-speed motor in order to avoid rheostatic losses during acceleration, assuming, of course, that it was not possible to make a further increase in the gear ratio. Each case required a very careful study of conditions. With short runs, although a high-speed motor with large-gear ratio was best, it was often impracticable owing to limitations as to minimum size of pinion and maximum size of gear case for rail clearance. If prepared to sacrifice clearance and take chances by using smaller pinions, much could be done to lower the energy consumption. Regarding field-controlled motors, the author showed a typical characteristic in which the ratio of full field to weak field appeared to be about 2 to 1. The speaker suggested, however, that the speed curve relation did not hold at light loads, as at 20 miles per hour the ratio appeared to be 3·8 to 1 instead of 2 to 1.

Mr. J. S. PECK considered the design of railway motors a subject of growing importance. It was interesting to know that in 1892 Mr. Lamme brought out a closed waterproof railway motor with single reduction gears, &c. Thus in one step the construction of railway motors was advanced from a very chaotic state into one which stood for many years with only minor improvements. Until the commutating pole was introduced there was no material change in Lamme's design. The ventilated design with the double or parallel flow of air represented the latest development, and, as the author had pointed out, the continuous rating had been considerably increased in consequence. This scheme had not been introduced extensively into this country, but as tramway systems increased and railways were electrified it would certainly be adopted. An attempt was made eight or 10 years ago to run railway and tramway motors with the commutator covers removed in order to secure better cooling. This idea was abandoned owing to the accumulation of dust and grit, which eventually caused insulation breakdown. A great trouble with the old design of motor was the unprotected ends of the armature windings, which accumulated dust. Modern design covered the whole end winding in a canvas cover ; also the ducts inside the armature had been eliminated or placed so that they could not possibly damage the insulation of the coils. In many armatures the insulation at the end of the slot had been reinforced so that the coil was protected at its weakest point, *i.e.*, where it left the core. Large modern motors were insulated practically throughout with mica and asbestos, which ensured good insulation even when the machine was run at temperatures exceeding 100°C. Under the heading "High voltage motors," the author had referred to 1,200 and 1,800 volts on a single commutator as though it were a very simple matter. It had taken a long time, even after the introduction of the commutating pole, to produce a motor which would operate satisfactorily even at the lower voltage and the majority of railway engineers of to-day would probably hesitate to accept 1,800 volts on a four-pole motor of ordinary construction.

Mr. JULIUS FRITH referred to the constant temptation on the part of manufacturers to make use of the fact that commutating poles had taken away sparking, in order to force up the volts per commutator bar, and at the same time to take advantage of the possibility of speed regulation, in which case, with the weakened field, all the volts would be crowded on half or even less, of the bars between brushes, and the flashing-over trouble would again appear. Regarding the question of ventilation, it was rather surprising that the advantage of the self-ventilating motor should not have been grasped much sooner. One point in its favour as compared with the separately ventilated machine was the ease with which the air could be made to apportion itself correctly between armature and field coils. There was room for improvement in the design of the fans, especially the paddle-bladed type used on motors to be run in either direction.

Mr. W. C. SCHACHER said the author had introduced a welcome change by substituting the kilowatt rating. There was no reason why such a purely accidental unit should be adhered to. Regarding the one-hour rating, which was universally adopted, this required urgent revision. This method was adopted originally when applied to heavy motors, and when ventilation, as supplied at the present time, was practically unknown. Formerly, a designer, when rating a machine, was entirely dependent upon the amount of heat radiation obtainable through the surface of the motor, and from the thermal constant some idea could be formed of the capabilities of the motor under continuous load. These conditions had changed, and in the modern motor not the slightest relation existed between the one-hour rating and the possible continuous putput. It was doubtful whether a designer obtained much support in his calculations from the one-hour rating, and, unless required for a purchaser's specification, it was questionable whether it would ever be ascertained. Taking the case of a motor built recently, this machine under the old conditions would have a one-hour rating of 200 kw. at 75°C. rise and a continuous rating of 43 kw. at 45°C. rise. Now, the motor being adapted for forced ventilation by means of air at 400 cubic ft. per minute, although the one-hour rating was only slightly increased, the continuous load was increased to 84 kw for the same temperature rise, representing an increase of 95 per cent. over the old type. In computing the value of a modern motor from the capacity point of view, which was really the determining factor, the continuous rating in kilowatts at, say, half or three-quarter voltage, appeared sufficient ; to judge it from the service point of view it was certainly necessary to have either its characteristic at hand or at least three or four points of the curve. Referring to the Paper, the author had somewhat over-estimated the kilowatt output for a given D^2L at the higher ratings. The curve shown might pass through 6,600 D^2L at 220 kw. rated output. Considerable progress had recently been made toward increasing the diameter of motor coach wheels and diameters of 42 in., or even 43½ in., were adopted. Regarding ventilation, the multiple fan or parallel system had undoubtedly many advantages over the older systems as by this method the cool air came into contact with both field and armature. The diagram in the Paper showed the flow of air in the direction from the pinion to the commutator, which presumably required a fan at the commutator end. This method had the advantage that carbon or copper dust would be ejected from the commutator without going through the machine, but on the other hand, it had been found extremely difficult to mount a fan at the commutator end and the speaker had never encountered a construction with the fan in this position.

Mr. H. ALLCOCK thought the Paper would serve to accelerate the more general adoption of direct-current electrification at pressures higher than 600 volts, and in view of the recommendations, motor designers might not only cease to oppose, but actively support, the adoption of higher working pressures on direct-current traction systems. Having reached this stage of development, progress should be rapid in view of the substantial economies due to smaller currents and reduced cost of substation plant, which had already been established in connection with high-voltage working.

Mr. W. A. BARNES referred to the author's statement that the average conditions for urban and suburban railway services were trains of 150 tons, running at a schedule speed of 16 miles per hour, with two stops per mile. Presumably this applied to underground railways and others of like nature. The conditions were very different, however, on "surface railways," especially in the case of electrification of existing steam railways. The average distance between stops could be taken approximately at 1 mile with a schedule speed of 25 to 30 miles per hour, and in consequence of the heavy duty the weight of a five-car train was increased

to 200 tons. The 16 miles per hour schedule was very little, if any, better than the steam train, and, therefore, no advantage was taken of the greatest characteristic of electrification, *i.e.*, "rapid acceleration and retardation, with consequent low ratio between maximum and average speed." The latter was necessary on busy suburban lines, where stations were placed geographically, if the required headway was to be maintained betwen trains and the number of trains per hour increased to meet traffic requirements. These conditions seriously affected the design of railway motors. The term "average initial acceleration" was not clear. If this were taken during the notching period it should, to meet the foregoing conditions, be of the order of 2 miles per hour per second, with an aggregate tractive effort at the wheel treads of 32,000 lb. Four motors per motor car were necessary in order to seeure the requisite adhesion, and each motor would be about 200 H.P. With heavy electric traction there was no saving in employing fewer motors of higher capacity as indicated by the author. Referring to the design of 1,200-volt motors, as the author had pointed out, there was very little data of the performance in practice. The new Manchester-Bury electric railway was nearing completion and employed 200 H.P. series-wound interpole motors at 1,200 volts, with shunted fields for maximum speeds. The motors had behaved very satisfactorily on test and gave promise of good results. No revolutionary changes in principle, but rather refinements in design, were required for the high-voltage motor. Ample clearance round the commutator, the avoidance as far as possible of corners and projections on brushgear to which an arc might hang and accentuate the damage done by flash-overs, the use of solid mica insulation thereby increasing the slot-space factor, were lines along which improvements had developed. The 200 kw., 1,200-volt motor, shown in section in the Paper would require considerable modification before it could be run successfully. Lubricating arrangements were not shown and this had a considerable influence on the frame design and overall dimensions. The clearances of the commutator were altogether too small, in fact, the barrel end ring was shown short-circuiting the commutator bars. The author had stated that the commutator on a 1,200-volt motor was only half that of a 600-volt motor of similar power. The point affecting the design was not the length of the copper bar on which the brushes rested, but the length of the commutator casting, and when the requisite leakage distances to earth were made, the difference in length for the two voltages was very slight. It was bad policy to bring in the ventilating air immediately over the commutator, as the brush gear necessarily formed pockets into which grit and dirt might collect. This, as a rule, was one of the weakest parts of a motor. The motor as shown was evidently of the split-frame design, although the present tendency was to use solid frames. In the event of the two halves becoming loose there would be an immediate and very detrimental effect on the bearings and bearing brackets. After long experience with the split-frame type of motor the Lancashire & Yorkshire Railway Co. had discarded them and introduced the solid frame. In order to improve what might be termed the space factor under the cars, the main pole-pieces had been placed horizontally and vertically instead of diagonally. This necessitated more carefully-designed bearings in order to obviate the possibility of the armature dropping to the bottom pole-piece. The principal details of the 1,200-volt motors in use on the Manchester-Bury line were given by Mr. Barnes.

Mr. ROGER SMITH, speaking from the general railway point of view, said the author's minimum acceleration figure of $1\frac{1}{2}$ miles per hour per second was too high, and 1 mile per hour per second was about the lowest that should be asked for. The author also referred to the free-running speed of the 600 revs. per min, motor being about 1,000 revs. per min., which represented 5,250 ft. per minute at the periphery of the armature, and seemed to imply that this was the limit. The speaker suggested, however, that in order to use the active material to the best advantage, a peripheral speed of between 8,000 ft. and 9,000 ft. per minute should be employed. If this were true the 600 revs. per min. motor was a compromise, but with a view to reducing gear losses it was satisfactory. Referring to the Paper, it appeared, therefore, that increasing speed was a measure of decreased losses. The author had confined his remarks to the series motor with "wheelbarrow" suspension and single reduction gear. Such a motor was quite useful for suburban railway service and also for goods locomotive working, provided the general speed of the motor train or goods locomotive never exceeded 60 miles per hour, but above this speed single reduction gear could not be used. The author assumed that the series direct-current motor was the only form of direct-current motor that could be employed. It was true that the series motor could withstand an overload torque better than the shunt motor and with the least commutation trouble; also it was much less liable to damage from the voltage variations encountered in railway and tramway working. There was the great disadvantage that the plain series motor was a one-speed motor for a given load. At one time all the speed variations with series motors were obtained by means external to the motor itself, namely, rheostatic and series-parallel control. This was improved by the introduction of field control, which was not modern, but only became practicable with the introduction of the commutating pole. Looking at the question from the railway point of view, the series motor locomotive was not yet comparable with the steam locomotive at speeds at which everybody's troubles began, *i.e.*, speeds above 60 miles per hour. The modern steam locomotive was such that it could give almost constant output with an enormous range of speed, from 15 or 20 miles per hour to 80 or 90 miles per hour. The output at high speeds of the series electric motor fell off very sharply. In order to obtain an electric locomotive capable of hauling fast passenger traffic it was necessary to equip it with motors quite unnecessarily powerful at low speeds, but for everything in view in this country in the way of railway electrification, *i.e.*, suburban and goods working, the series direct-current motor with single reduction gear was a most satisfactory piece of apparatus now that commutating poles and field control had been established. The development of field control might lead to the series motor being made suitable for all classes of goods service, and the economies effected in suburban service would be appreciable owing to the reduction of rheostatic losses during acceleration by the use of the short field. Field control was one of the two features recently introduced which made the direct-current motor more acceptable for railway work. The other feature was regenerative control which was being successfully applied in the United States on more than one electrified railway using direct-current series motors. The application was too recent for details to be available, but Mr. Storer would touch upon it in his coming Paper. If something less than half the energy wasted in stopping a train, due to the application of the brakes, could be returned to the supply by regenerative control, economies in suburban working would become possible. It would be interesting to know whether the extra switchgear necessary to obtain field control or regenerative control would make the equipment too complicated. Much depended upon the various railway companies standardising supply voltage. The Bury-Holcombe Brook line used 3,600 volts, Manchester-Bury 1,200 volts, and the North-Eastern Railway 1,500 volts. These experiments at different pressures would ultimately lead to the choice of the most suitable high direct-current voltage to suit the general average conditions of this country and the railways would have to adopt it uniformly. The advantages of field and regenerative control could not be realised if several different supply voltages existed. It was well to emphasise the danger of comparing motors on their one-hour rating only. Ventilated and unventilated motors could not be compared for continuous running on the basis of their one-hour rating. The same remarks applied to saturated field as compared with unsaturated field motors. The author's extract from the American Standardisation Rules did not state the temperature rises for continuous rating and it might be assumed to be 75°C. This was not so: the continuous rating temperature rises appeared in a separate table in the rules. Mr. Roger Smith stated that the author, who was at present in Canada, would reply to the points raised in due course.

HOISTING CONTROLLERS FOR LARGE ELECTRIC REVOLVING CANTILEVER CRANES.*

Summary.—In this article descriptions are given of two controllers used for the hoisting motors of the large electric revolving cantilever cranes, which have been installed in large numbers for the fitting-out of ships. Of these controllers one is of the drum-type and the other is of the magnet-switch type. Carefully-drawn diagrams of connections illustrate the article.

Certain of the large electric revolving cantilever cranes, of which there are many fine examples in this country, are intended for lifting loads which require slinging in two places. For this class of work it is customary to use two independent motors and sets of lifting mechanism, one to work in conjunction with each of the two slings, which are not necessarily equally loaded. As it is the usual practice to fit series motors on this type of crane, it is evident that some special means must be taken to ensure that the motors run at the same speed, even if not called upon to exert the same torque.

Westinghouse engineers have designed a controller which, we believe, has been largely used for this service. This controller, which is known as Type H 16 A, is designed to give the operator control of either one or other of the motors, or both at the same time, as may be required. We are indebted to the makers, Messrs. the British Westinghouse Electric & Mfg. Co. (Ltd.), for allowing us to give a description of this interesting controller, and for the loan of diagrams from which Figs. 1 and 4 have been prepared.

There are three separate drums in the controller, each of the two outer ones being capable of controlling one of the lifting motors independently of the other. The centre drum is connected so as to operate both motors in parallel at the same time and at the same speed. Mechanical interlocking gear is provided so that it is only possible to move this drum when both the outer drums are in the "off" position, and, in the same way, it is only possible to move the outer drum when the centre drum is in the "off" position.

Each of the outer drums is in reality a plain reversing controller, designed for use with a series-wound motor, and from Fig. 1 it will be seen that the diagram is similar to the one generally used for the purpose. The centre drum consists of a double-reversing drum suitable for reversing the direction of the current through the two motor armatures connected in parallel, and two sets of contacts working in conjunction with fingers connected to the two sets of resistances used with the outer drums. For mechanical reasons only the reversing drum is mounted loose on the shaft carrying the resistance contacts. It is operated by a separate handle, and is pro-

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vided with interlocking gear similar to that fitted on tramcar controllers.

In order to obtain satisfactory control over the relative speeds of the two motors when both are in use and lifting unequal loads, or unequal portions of the same load, a speed-equalising rheostat is provided. The ohmic value of the resistance in this rheostat is very low, but the current-carrying capacity must be sufficient to enable it to carry the full-load current of either motor.

When the above gear is in operation the current enters the speed equalising rheostat by the centre-pin, passes down the contact-arm and divides into two parts, each of which passes through the resistance between the arm and one end-terminal, the motor field, starting resistance, blow-out coil, one set of contacts on the centre drum, and from thence through the armature by way of the reverse-drum to the negative line. Owing to the two sets of resistance contacts being electrically connected, they form an equalising connection between the two motors, similar points in each resistance being connected.

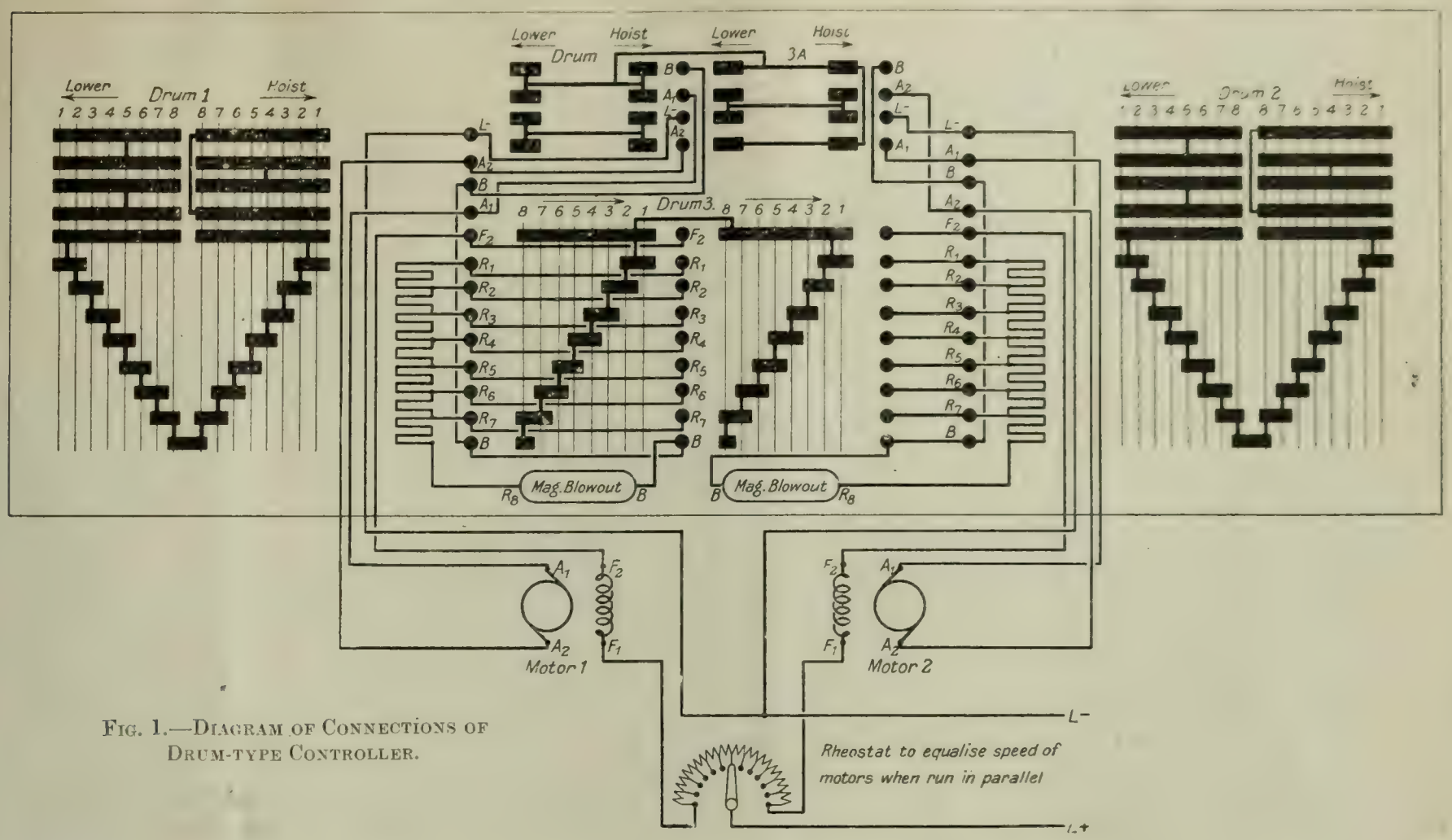


FIG. 1.—DIAGRAM OF CONNECTIONS OF DRUM-TYPE CONTROLLER.

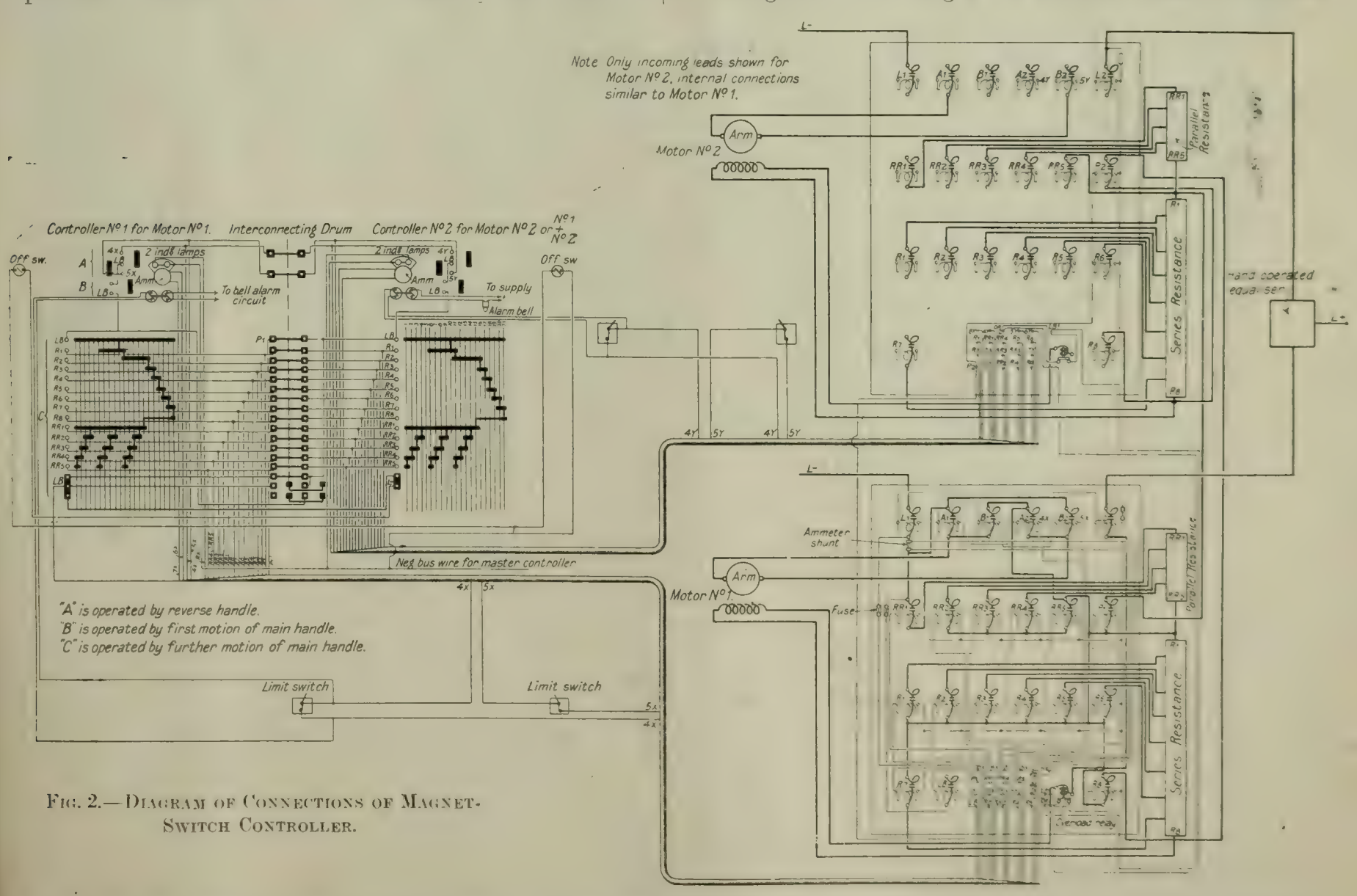
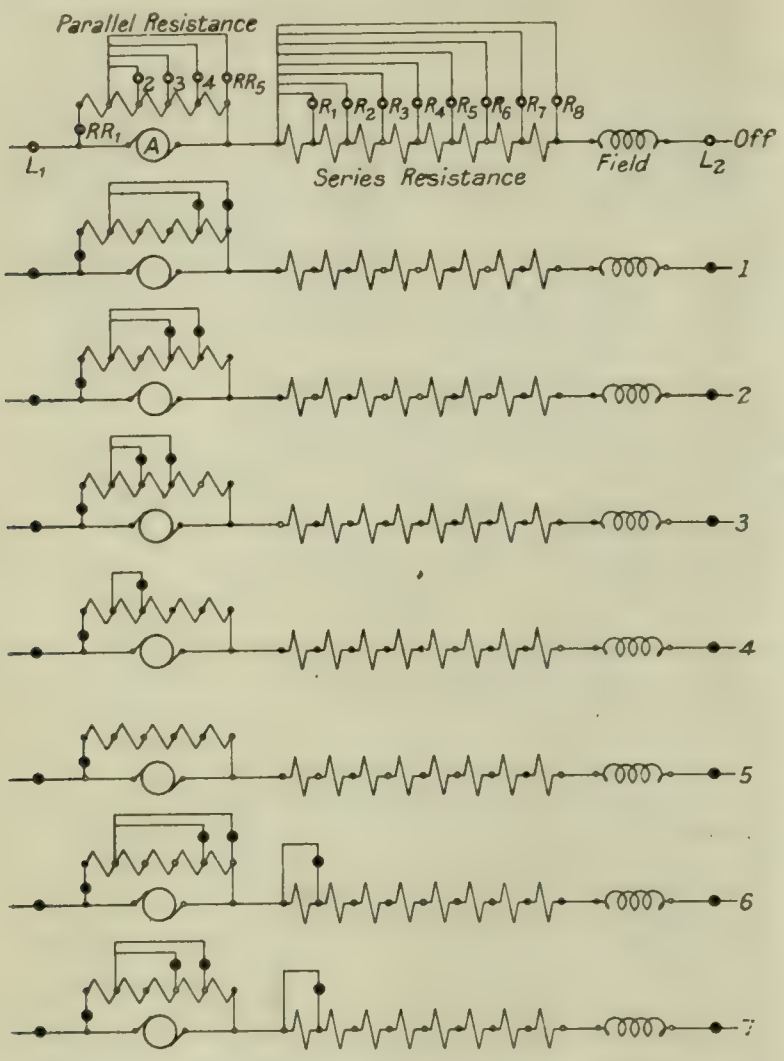
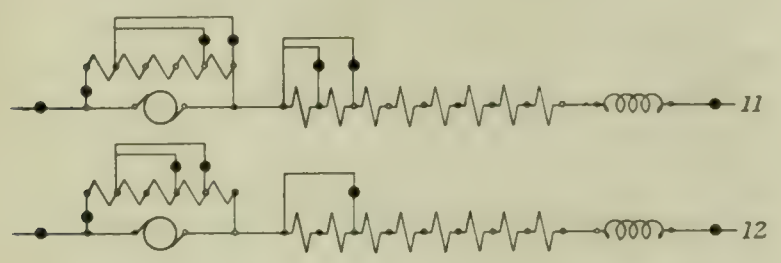


FIG. 2.—DIAGRAM OF CONNECTIONS OF MAGNET-SWITCH CONTROLLER.

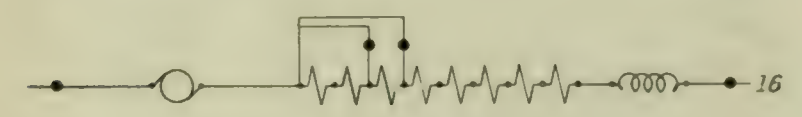
The arrangement described above is quite satisfactory in operation as long as both motors are exerting full-load torque—that is to say, when the whole of the starting resistances and the blow-out



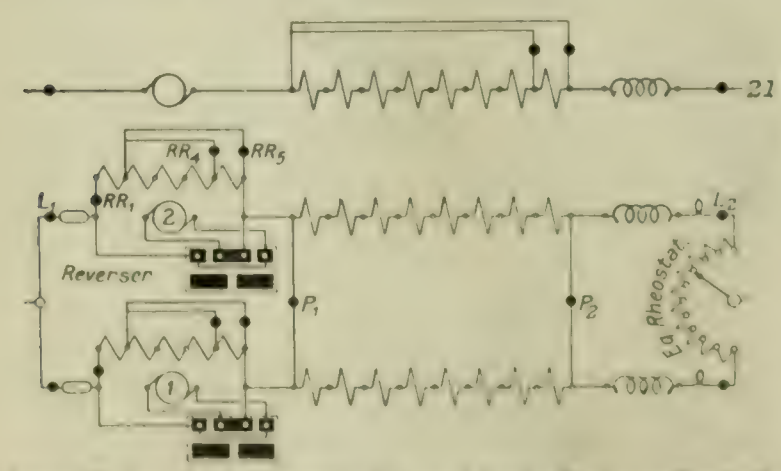
Steps 8, 9 and 10 now follow and are identical with steps 3, 4 and 5 except that series resistance contactor R_1 is closed.



Steps 13, 14 and 15 now follow and are identical with steps 3, 4 and 5 except that series resistance contactors R_1 and R_2 are closed.



The succeeding steps 17 to 21 are formed by the series resistance contactors R_4, R_5, R_6, R_7 and R_8 operating in sequence thus arriving at step 21 which is the last step. Meantime the parallel resistance contactors are all open



General diagram showing two motors in parallel and on first step of control

FIG. 3.—CONNECTIONS ON EACH OF THE SEVERAL NOTCHES OF THE CONTROLLER SHOWN IN FIG. 2.

coils are short-circuited by the controller-drums. In practice, however, it is often imperative to synchronise the motor speeds with a large portion of the starting resistance in circuit. To admit of this, two portions of the reversing drums are connected together, so as to form a suitable equalising connection that will connect points of both motor circuits which, in running, are always connected to one or other of the armature terminals, depending on the direction of rotation required. The introduction of this connection has a further advantage in so far as it forms a connection across the end of the starting resistance, so that in the event of the two portions of the starting resistance left in circuit not being equal, any influence this might have on the motor speeds is eliminated. The reason for making this connection on the reverse-drum, and not directly across either the two motor terminals or the resistance terminals, is that it is essential that it be made when both motors are in operation and are being controlled by the centre drum.

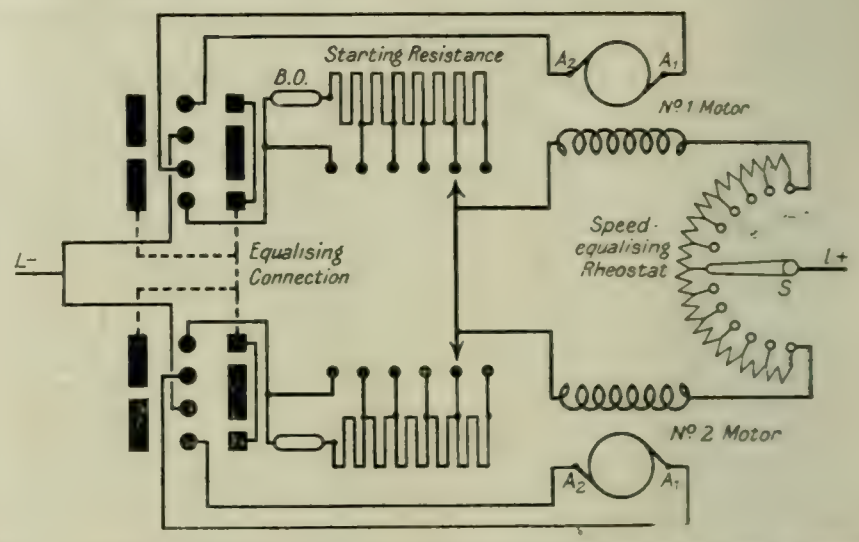


FIG. 4.—SCHEMATIC DIAGRAM OF CONNECTIONS WITH THE TWO MOTORS IN PARALLEL.

When driving the crane, if one hook is found to be rising too quickly, a movement of the speed-equalising rheostat, so as to cut resistance out of the corresponding motor, will immediately slow this machine down, and will at the same time speed up the other machine. After a little practice the crane driver is able to lift a very long object, such as a naval gun, of which a large portion of the weight is carried by one of the two slings used, and still maintain it in a horizontal position.

Fig. 1 shows the diagram of connections of the complete controller and speed-equalising rheostat, and Fig. 4 shows a schematic diagram of the connections of the two motors when the centre drum is in use. The dotted lines represent the connection between the two portions of the reverse-drum referred to above, and the main-drum is represented by a straight line ending in two arrow-heads.

Table *showing Sequence of Magnet Switches.*

SWITCH	NOTCHES.																				
	OFF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A_1 & A_2		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
LB	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
B_1 & B_2		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
R_1							●	●	●	●	●	●										
R_2												●	●	●	●	●	●					
R_3																	●	●				
R_4																		●	●			
R_5																				●	●	
R_6																				●	●	
R_7																					●	●
R_8																						●
RR_1		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●						
RR_2				●	●				●	●				●	●								
RR_3			●	●				●	●				●	●								
RR_4		●	●				●	●				●	●									
RR_5		●					●					●										
L_1		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
L_2		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
P_1		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
P_2		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Note.—Coils A_1 & A_2 or B_1 & B_2 are energised, depending on direction of rotation.
P_1 & P_2 are only closed when the motors work simultaneously from Controller No 2.

Two large cranes are under construction at the present time in which magnet-switch controllers, also of Westinghouse manufacture, are being used. A diagram of the connections of the lifting motor controllers is given in Fig. 2, and Fig. 3 shows the connections on each of the several notches of the controller. At the bottom of the diagram the two motors are shown coupled in parallel. To enable the reader to understand the diagram we give in the table above the sequence of the magnet switches. The control is effected by

means of two master-controllers, each of which in itself controls the magnet-switches in one motor circuit. When it is desired to operate the motors in parallel, a small centre interconnecting drum is moved over which prevents the operation of one controller, and arranges the connections so that the other controller operates the two motors in concert. Equalising is obtained in the same manner as with the drum-type controller described above. From Fig. 3 it will be noticed that slow lifting speeds are obtained on the first notches of the controller by resistances in parallel with the armature. By the use of this parallel resistance in conjunction with the first three steps of the controller, it is possible to obtain extremely slow speeds with a very wide range in the load on the motor.

APPARATUS FOR STARTING AND CONTROLLING ELECTRICAL RUNNING MACHINERY.*

BY C. C. GARRARD.

(*Concluded from p.* 839.)

Summary.—The apparatus dealt with consists of variable resistances to enable electric motors to be started up without taking an excessive current from the mains and without mechanical shock, and also to enable the running speed of the motors to be varied at will.

Relation between Full-load Torque and Starting-Torque.—In any three-phase induction motor with a three-phase rotor, if I be the rotor current and r the resistance of the rotor per phase then we have

$$\left.\begin{array}{l}\text{Total watts imparted to the}\\ \text{rotor by the rotating field}\end{array}\right\}=3I^2\frac{r}{s},$$

where s is the fractional slip (*e.g.*, s for a 4 per cent. slip is 0·04). This equation is quite general, and holds under all conditions (*see* Arnold, "Die Wechselstromtechnik," Vol. V., First part, p. 256).

$$\left.\begin{array}{l}\text{The part of the total watts imparted}\\ \text{which is consumed in heat is}\end{array}\right\}=3I^2r.$$

$$\left.\begin{array}{l}\text{The difference between the two is avail-}\\ \text{able as mechanical output to impart}\\ \text{a driving torque to the rotor}\end{array}\right\}=3I^2r\left(\frac{1-s}{s}\right).$$

Now, the speed of the motor is $1-s$, and the total torque imparted to the rotor is equal to the mechanical output divided by speed, and by choosing suitable units can be put at $=3I^2\frac{r}{s}$.

When running part of this torque is consumed in overcoming bearing friction.

Let I_{r2} be the current in the rotor at full-load and full-speed with slip-rings short-circuited,

r_2=resistance per phase of the rotor winding.

Then full-load torque $=3I_{r2}^2\frac{r_2}{s}$.

Let I_r be the rotor current when the full voltage is applied to the stator and the rotor is at standstill with the starting resistance R ohms per phase connected to the slip-rings.

The standstill (*i.e.*, starting) torque$=3I_r^2(r_2+R)$, since the fractional slip at standstill equals unity. If, therefore, we desire that the starting torque should equal the full-load torque we must set

$$3I_{r2}^2\frac{r_2}{s}=3I_r^2(r_2+R).$$

This equation will hold good if

$$\frac{r_2}{s}=r_2+R,$$

and if $$I_{r2}=I_r.$$

Let the voltage induced per phase of the rotor at standstill with full stator voltage applied be E_r.

Let the reactance of the rotor at standstill be X. Then

$$I_r=\frac{E_r}{\sqrt{(r_2+R)^2+X^2}}.$$

Now, the reactance of the rotor varies as the periodicity of the rotor currents which is proportional to the fractional slip.

Therefore, the reactance of the rotor at fractional slip s is sX.

We now have to calculate the full-load current when the motor is running with short-circuited slip-rings at fractional slip s. The voltage induced in the rotor is proportional to the fractional slip; therefore, at slip s it is sE_r.

Therefore, we have

$$I_{r_2}=\frac{sE_r}{\sqrt{r_2^2-(sX)^2}}=\frac{E_r}{\sqrt{\left(\frac{r_2}{s}\right)^2-X^2}}$$

but $$\frac{r_2}{s}=r_2+R.$$

Therefore, by substituting for r_2/s we have

$$I_{r_2}=\frac{E_r}{\sqrt{(r_2+R)^2-X^2}}=I_r.$$

It therefore follows that if $\frac{r_2}{s}=r_2+R$, the torque at starting (with the starting resistance equal to R ohms per phase) is equal to the full-load torque.

The value of R can be determined without actually knowing the slip from the relationships mentioned above.

Let the mechanical output of the motor, when running at full-load and speed, be P_w watts (*i.e.*, the horse-power multiplied by 746). Therefore,

$$P_w=3I_{r2}^2r_2\left(\frac{1-s}{s}\right)-F,$$

where F is the frictional loss in the bearings.

Now, we have

$$I_{r2}=I_r=\frac{E_r}{\sqrt{(r_2+R)^2+X^2}}.$$

and $$\frac{1-s}{s}=\frac{R}{r_2}.$$

$$\therefore\quad P_w=\frac{3(E_r)^2R}{(r_2+R)^2+X^2}-F.$$

Now, F is small compared to the total output and for this approximate calculation can be neglected.

Likewise, X^2 is small as compared with $(r_2+R)^2$, and can also be neglected; we, therefore, obtain

$$P_w=\frac{3E_r^2R}{(r_2+R)^2}=\frac{3E_r^2R}{r_2^2+2r_2R+R^2}=\frac{3E_r^2}{R-2r_2},$$

as r_2^2 can be neglected compared with R^2.

E_r is known experimentally or by the ratio of turns of the windings, therefore, R is at once easily calculated.

Taking a numerical example of a 10 H.P. motor having a standstill voltage per phase of 100,

$$R+2r_2=\frac{3\times100^2}{10\times746}=4{\cdot}02$$ ohms per phase which is the value to give starting torque equal to full-load torque.

Speed of Rotation of Rotor with various Resistances in the Rotor Circuit.—In the previous paragraph it was seen that if the external rotor resistance be such that the current flowing through it is equal to the full-load rotor current, then if the opposing mechanical torque be equal to the full-load torque the rotor will remain at standstill—*i.e.*, the speed will be zero. If now this resistance be gradually reduced and the opposing mechanical torque remain constant the motor will gradually rise in speed until full speed is attained with the slip-rings short-circuited.

It is interesting to determine what resistance is required to give maximum starting torque, corresponding to the chain-dot curve in Fig. 6. The maximum starting torque is obviously the maximum value of the continuous line curve in Fig. 6—viz., the maximum torque that the motor is capable of giving. This may be, say, $2\frac{1}{2}$ times the full-load torque. But in order to exercise this torque the motor must run with a larger slip, therefore, the output when running at $2\frac{1}{2}$ times full-load torque will not be $2\frac{1}{2}$ times the full-load output, but will be somewhat less. This figure is known from the design of the motor, and the

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necessary external rotor resistance can be determined from the formula

$$R+2r_2=\frac{3E_r^2}{P_w}$$

when the value above determined for P_w is inserted. It will be seen that, of course, the so found value of R is less than that required to give full-load starting torque. It follows from this that if a rotor starter has a total resistance sufficient to give full-load starting torque on its first contact, as the resistance is cut out by the starting switch the value is reached corresponding to maximum starting torque. Thus, if the motor does not start up on its first contact it must start up on one of the intermediate ones. If the opposing mechanical torque is greater than the maximum possible starting torque, then the motor will not start up at all.

Grading of Rotor Resistance.—Having determined what the total external resistance per phase is going to be we now have to divide the same up between the various contacts on the switch. We can regard this from two points of view—viz., that of a starter or that of a speed regulator.

Grading of Slip-ring Motor-starter Resistances.—The grading of the rotor resistance should be such that the fluctuations of current in going from step to step of the starter are as small and as regular as possible. This is obviously the case if the momentary proportional increase in rotor current in going from each step to the next is always the same, the starter being presumed to be kept for a long enough period on each step for

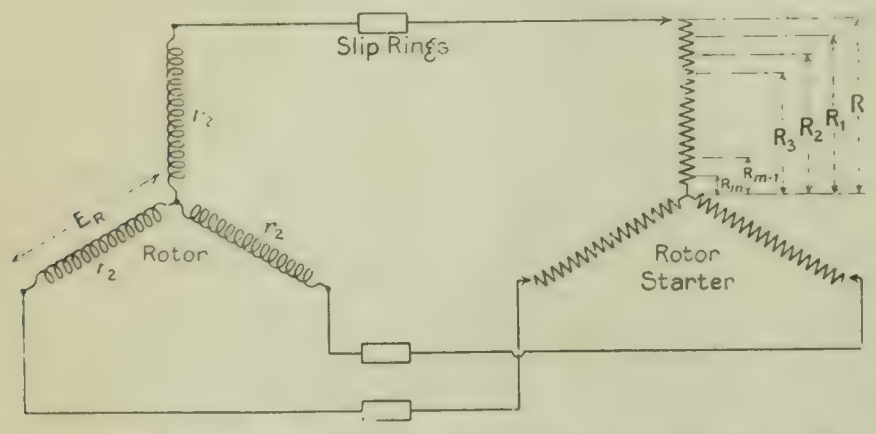


Fig. 7.—Diagram Illustrating Grading of Three-phase Rotor Starter; all Three Legs of the Rotor Starter are Graded Similarly.

the rotor to acquire its proper speed corresponding to the particular rotor resistance in circuit. If this condition be met, with the rotor current, it will likewise be the case with the stator current and the best possible starting conditions will be attained.

Referring to Fig. 7, let each phase of the starting resistance be divided as shown. It is then clear that the momentarily increased current in the rotor in going over from the first to the second stop is $\frac{R+r_2}{R_1+r_2}$ times the current flowing when all resistance is in circuit. This is by reason of the fact that the rotor voltage does not change in the moment of going from one stop to the next.*

Similarly, the momentarily increased current in going from the second to the third stop is $\frac{R_1+r_2}{R_2+r_2}$ times the normal current when on the second stop.

Now, from the foregoing these two multipliers must equal each other, and we have

$$\frac{R+r_2}{R_1+r_2}=\frac{R_1+r_2}{R_2+r_2}=\frac{R_2+r_2}{R_3+r_2}\cdots\frac{R_{m-1}+r_2}{R_m+r_2}=\frac{R_m+r_2}{r_2}=k.$$

k being a constant.

* In this calculation we are neglecting the reactance of the rotor, thus r_2 allowable as the reactance of the rotor circuit decreases in the same proportion as does the total resistance in the rotor circuit, due to the increase in speed of the rotor. Thus the impedance of the rotor circuit is proportional to its ohmic resistance.

From these equations we get

$$\begin{aligned}
R_m+r_2&=kr_2,\\
R_{m-1}+r_2&=k^2r_2,\\
R_{m-2}+r_2&=k^3r_2.\\
&\cdots\cdots\\
R_{m-(m-1)}+r_2&=k^mr_2,\\
R+r_2&=k^{m+1}r_2,
\end{aligned}$$

but $m+1$ equals the number of resistance steps in the starter $=n$, therefore,

$$R+r_2=k^nr_2.$$

This is exactly the same rule for grading previously found for continuous-current shunt-wound motor-starters, and one can proceed to divide up the total resistance of the starter in the same manner as shown there.

In the above it has been assumed that the opposing mechanical torque is constant during the whole period of starting. If the total resistance of the starter be chosen so that full-load torque is exerted on the first contact then we have

$$R=\frac{r_2}{s}-r_2,$$

s being the fractional slip.

$$R+r_2=\frac{r_2}{s}=k^nr_2.$$

$$\therefore\quad k=\sqrt[n]{\frac{1}{s}}.$$

One can proceed, therefore, when designing the rotor starter by first determining the total rotor starter resistance.

Grading of Rotor Resistance to Give any Required Speed Control.—It is clear, of course, that the speed the three-phase induction motor will run at, with any particular resistance in the rotor circuit, will depend upon the opposing mechanical torque. If the same resistance is required for starting as well as for speed control, the grading must in the first instance conform to the conditions for good starting as set forth in the preceding paragraph. Assuming this to be the case, then it must be settled whether the various resistance steps will, under the running conditions, give the required adjustment of the speed. The method of calculating this can be most readily seen if we determine the speed such a motor will run at against a specific torque and with a known resistance in the rotor circuit.

Let the external resistance in the rotor circuit be R ohms per phase, then the torque is by equation

$$3I_R^2\left(\frac{r_2-R}{s_R}\right),$$

where I_R and s_R are the rotor current and slip respectively corresponding to the resistance R.

Now,
$$I_R=\frac{E_rs_R}{\sqrt{(r_2-R)^2+(s_RX)^2}}.$$

Substituting, we get

$$\text{Torque}=\frac{3(E_rs_R)^2(r_2-R)}{(r_2-R)^2+(s_RX)^2\ s_R}$$

$$\frac{3E_r^2}{\left(\frac{r_2-R}{s_R}\right)^2+X^2}\times\frac{(r_2-R)}{s_R}.$$

Now, E, and X are constants; if, therefore, the speed regulation is with constant torque it follows that

$$\frac{r_2-R}{s_R}=\text{constant}.$$

From this we can calculate the speed at any R. If, for example, the normal slip is 4 per cent., then if $R=r_2$ the slip will be 8 per cent., &c.

It also follows from above equations that with constant torque the rotor current is constant. This enables one to determine the necessary current-carrying capacity of the speed regulator.

THE SPHERE OF THE SCIENTIFIC AND TECHNICAL PRESS IN RELATION TO TECHNICAL EDUCATION AND RESEARCH.

A discussion on this question was opened by Dr. William Garnett (late Educational Adviser to the L.C.C.) at the Institute of Journalists on Tuesday, the 14th inst.. Mr. L. Gaster being in the chair.

Dr. Garnett's address covered 19 different sections, beginning with the Technical Instruction Acts, Practical Work in Schools, the case for Scientific Research, Standardisation, National Physical Laboratory, and finally dealing with Industrial Banks and War Economies. It was advocated that education in elementary and secondary schools should be more associated with *things*, so as to develop self-reliance and resourcefulness. Latin prose he considered useful, as it led to examining closely into the meanings of words and the best forms of expression. A considerable proportion of teachers should devote a third year of training largely to practical work, so as to enable them to become acquainted with trades. Popular lectures and other means should be used to disseminate general scientific knowledge. More completely organised courses of instruction were required, leading eventually to post-graduate work. Bursaries and fellowships must be instituted for this purpose.

Regarding discoveries made by those conducting experimental research work at public expense, the profits should be taken, and divided between State, manufacturer and the scientific worker, and in order to do this some alteration in the patent law would be necessary.

Referring to the scarcity of scientific men in Government posts, the author considered that the Oxford student with his knowledge of the Humanities, especially where in official work his success depends more on his gauging what his superiors wanted, possessed a great advantage. He did not recommend that scientific specialists should be largely employed in Government offices. Referring to scientific research, he stated that a student at Manchester working for his M.Sc. degree had developed a method by which a dynamo could take a much greater overload, and now a 5,000-kw. machine was working on this principle at Salford.

Referring to the Advisory Council, there were two methods by which it might secure the necessary "touch" with industrial interests, namely, by the formation of an association, or committee of traders to advise the Advisory Council, or vice versa. Very great services might be rendered by the Press in encouraging the resuscitation of popular science as part of one's education. The Advisory Council of Research was next referred to, and it was stated this might have been welcomed, except by those who considered the scientific societies ought to be able to create all those bodies themselves.

With regard to Industrial Banks, the author considered that no private patents should hold good if it could be shown that the workers had carried out their research in public laboratories. As regards finance, he referred to Mr. Olsson in questions involving the offering of State patents to the Industrial Bank. As an alternative an annual subscription of one-tenth per cent. of all the capital of engineering concerns was suggested as providing £300,000 per annum. This, it was supposed, would pay for all the research institutions required. In this case the engineering concerns would be independent of the State. The author referred to the steps in a similar direction already being taken by the Chemical and Dyers' and Colourists' Societies in order to have a similar Association.

DISCUSSION.

Mr. A. P. M. Fleming (Westinghouse Co.), in the discussion that followed, referred to the good that would accrue from the education of employers through the technical and trade press, as to a greater appreciation of their responsibilities as employers. In Germany the benefits of technical education had been chiefly shown in electrical and chemical engineering work. In America an enormous amount of work had been done, especially by the General Electric Co. Great developments of electric lamps had taken place, and work had been done by the National Electrical Lamp Association. The Eastman Kodak Co. maintained its position by research as a producer of photographic apparatus, and the recent progress in long-distance wireless telephony was largely due to the Western Electric Co. Another new industry was that of the Bakelite Co. Referring to other concerns he mentioned the Bureau of Standards work connected with refrigerating machinery, smoke prevention, and paper manufacture, in many cases resulting in the establishment of new industries.

Referring to obstacles in the way of industrial research and co-operation of the Press, he thought that separate organs for industrial education and research would be needed.

Dealing with Dr. Garnett's suggestion as to the need for specific education to suit all grades of industrial employment, he considered that for purposes of discussion they should be divided into manual and non-manual workers. For the latter some facilities already existed, but the former education was woefully neglected, and the greater portion of juvenile labour was at present a wasted asset, since owing to the lack of suitable practical training and suitably co-ordinated education, its capacity for production was far from being developed to its utmost. It was not sufficiently realised that almost every youth in industry who commenced as a manual worker would continue as such all his life. The kind of education he had in view was the type which could be actually applied in works, and several go-ahead firms were already providing this. The fundamental difficulty was the fact that employers generally do not realise that the value of a worker can be improved by suitable training and education. It was here that the technical and trade press should endeavour to convince the employers of this fact, and realise how much greater an asset an employee can become when educated.

Prof. R. A. Gregory thought that the scientific work which had given the greatest result in the past had been carried out without a view to profit. As an example of this there was the work of Faraday. Industrial research could be left more or less to look after itself. It was the pure research that required support. Thus the work of Sir Ronald Ross on malaria was scientific work of that kind, but had produced most important results. In his opinion the Advisory Council was bad in its constitution, because the officials, and also the Committee of the Privy Council, were not sufficiently scientific. He protested against the way in which committees were formed of scientific men whose services were unpaid. He thought that more could be done by the National Physical Laboratory in the way of publications, the present publications not being so accessible or voluminous as those of the Bureau of Standards.

Mr. L. De L. Pendered, unlike Prof. Gregory, thought that the Advisory Committee would probably give satisfaction to the manufacturers. With regard to the publications of the National Physical Laboratory, it should be remembered that the Papers were mostly published in various journals. In his opinion, we ought not to rely merely on pure science, but also to encourage industrial research.

Dr. R. M. Walmesley thought that in the future we should have to look westward as well as eastward for competition, and that we ought to take Mr. Fleming's remarks to heart. Industrial research could not be neglected. With regard to Dr. Garnett's suggestion that teachers should learn trades, he (the speaker) thought that by so doing the teachers would get the idea that they knew a good deal more than they really did, and that the result might be harmful.

Mr. W. R. Cooper expressed the view that there was a great deal of research which ought to be carried on by manufacturers if they were to maintain their position, and the results of which would necessarily be kept secret. Apart from this, however, there was a great deal of industrial research on broad principles which could not be carried out by either the pure scientist or by the manufacturer. He did not feel attracted by the idea of State patents, and it was generally impracticable to license more than one manufacturer in a country. With regard to the sphere of the Press, this was essentially one of education, publicity and criticism. It was not for the Press to originate researches; that should be left to the technical societies.

Mr. Gilbert Wood proposed the following resolutions :—

"That this meeting recognises that technical education and industrial research are of great benefit to the manufacturers of this country."

"That the Circle of Scientific, Technical and Trades Journalists is prepared to assist the promotion of unity of effort on the part of the various associations and committees engaged in the study of the subject."

"That the scientific and technical Press be used as a medium for the dissemination of information of value to the industries of the country, thus bringing about a fuller appreciation of the value of technical education and industrial research."

Mr. J. S. Dow supported the resolutions. He called attention to the fact that there were actually seven universities in Switzerland, notwithstanding its comparatively small area. In America the Carnegie Institute alone spent twice as much money as the grant made in this country for scientific work. It was necessary to educate the public opinion to greater appreciation of science.

The resolutions were put to the meeting and carried, and the proceedings terminated by brief replies by Dr. Garnett and Mr. Fleming.

THE RESISTANCE OF MOIST SANDSTONE TO HIGH AND LOW FREQUENCY ALTERNATING CURRENTS.

BY N. W. McLACHLAN, B.SC. (ENG.)

Some experiments have been carried out to determine the resistance, at various frequencies, of sandstone-earth containing about 10 per cent. moisture obtained from a trench dug in the neighbourhood of the Liverpool University. The conditions under which the experiments were conducted differed from those which obtain in wireless telegraphy ; in the tests herein described, the lines of flow of the current* were parallel, a condition which does not obtain in practice.

A glass tank, 32 cm. long, having a copper plate 28 cm. square at each end, was filled with sandstone-earth taken from the cross-section of the trench, the sandstone being the same as

* The current which could be obtained was comparatively small.

that of the copper plates. The tank was mounted on two blocks of paraffin wax, this being essential during the tests with high frequency currents. Connection to the remainder of the circuit was made from terminals soldered to the copper plates.

The arrangement of the apparatus is shown in Fig. 1. The voltage across the copper plates was measured by an Ayrton and Mather electrostatic voltmeter, and the current through the sandstone by a Duddell portable thermo-ammeter reading to 100 milliamperes. The voltmeter was connected so that its capacity current did not pass through the thermo-ammeter. At high-frequencies the effect of the small spirals in the voltmeter fuses was examined by replacing them by two copper wires. The effect, however, was too small to be measured.

Alternating currents ($f=50$ $\sim$) varying from 50 milliamperes to 100 milliamperes were passed through the sandstone, and

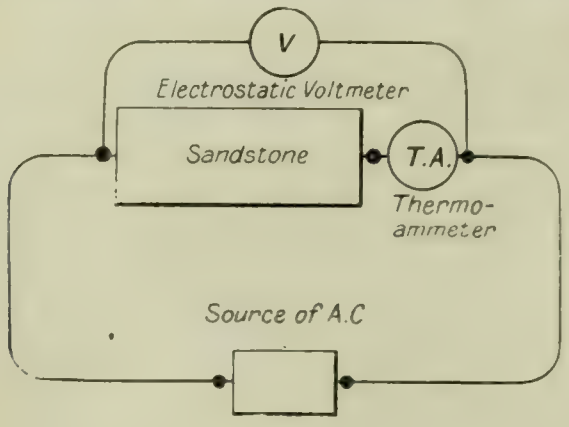


Fig. 1.

the corresponding voltages across the copper plates observed. The power absorbed by the sandstone was also measured by a watt-meter. It was found that the power factor was unity, *i.e.*, the current through the sandstone and the voltage-drop across it, were in phase.

The experimental tank was then connected in the shunt circuit of a Poulsen-arc generator†, and alternating currents of

† For the arrangement of such a circuit *see* article by the author, The Electrician, Sept. 17th, 1915.

varying frequency passed through the sandstone, the voltage drop across it being observed. The power factor in these experiments was obtained by using a slight modification of the three voltmeter method of measuring power.

Fig. 2 shows the arrangement diagrammatically. The voltage was measured across (1) the sandstone, (2) a portion of the air-core inductance (the resistance of which was negligible) in the shunt circuit of the Poulsen generator, (3) the sandstone

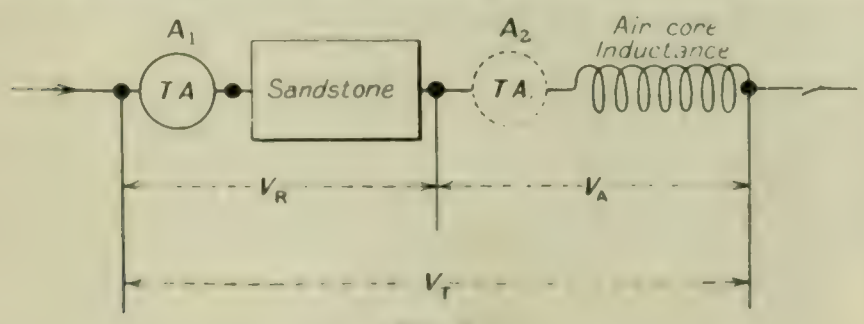


Fig. 2

A_1 = Position of Thermo-Ammeter when reading V_R and V_T
A_2 = Position of Thermo-Ammeter when reading V_A

and the inductance in series, for various currents at a given frequency. In measuring the voltage across the inductance, the thermo-ammeter was inserted between the sandstone and the inductance, and the voltmeter connected so that its capacity current did not pass through the thermo-ammeter.

For a given value of the current, these three voltages form a triangle as shown in Fig. 3‡. If the power factor of the sandstone resistance was unity, V_R would be in phase with the current I, and 90 deg. out of phase with V_A, since the voltage across the air core inductance is 90 deg. out of phase with the current through it. It was found that the angle between V_R and V_A was 90 deg., within the limits of experimental error, thus the resistance of the sandstone at high frequencies was obtained by dividing the voltage by the current.

‡ For maximum accuracy $V_A = V_R$

Experimental Results.

Current through sandstone. Milliamperes.	Voltage across copper plates.	Frequency per sec. ν	Resistance of sandstone. Ohms.	Specific resistance of sandstone. Ohms per metre cube.
70	47	50	670	164
73	49	60	670	164
77	49	2×10^5	640	157
87	56	2×10^5	640	157
72	45	3×10^5	630	154
83	53	3×10^5	640	157
77	49	5×10^5	640	157
86	54	5×10^5	630	154

The resistance of the sandstone at high-frequencies appeared to be smaller than that at low-frequencies, but in the former case there was doubtless a small capacity current which augmented the readings of the thermo-ammeter. This was due to the negative terminal of the Poulsen generator being

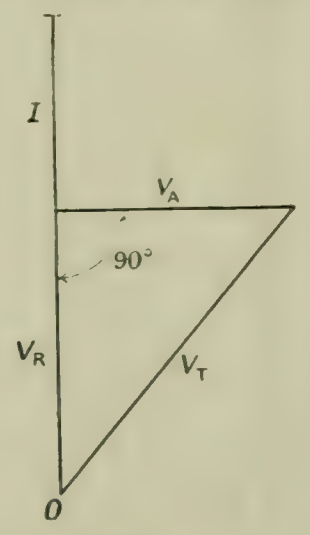


Fig. 3.

I = Current through sandstone.
V_R = Voltage drop across sandstone.
V_A = Voltage drop across inductance.
V_T = Voltage drop across sandstone and inductance.
i.e., Vector sum of V_R and V_A.

earthed, and although the glass tank containing the sandstone was as far away from earthed bodies as possible, there was a certain amount of condenser action which could not be eliminated.

On disconnecting the lead from the negative terminal of the Poulsen generator, it was found that a small charging current flowed into the sandstone. This current, however, was 90 deg. out of phase with that producing the IR-volt drop across the copper plates, and would not introduce errors of any importance.

During each test the current was maintained for about 10 minutes, but no sensible alteration in the voltage was observed.

The difference between the resistance at high-frequencies and that at low-frequencies is only 4·5 per cent. It may be concluded, therefore, that the resistance of sandstone, under the conditions defined above, is substantially the same at high-frequencies as it is at low-frequencies.

Similar results were obtained with the sandstone in a drier state. The resistance in this case was double that given in the foregoing table.

THE PROBLEMS OF COAL.*

BY PROF. H. E. ARMSTRONG, F.R.S.

After referring to coal being constantly in the thoughtful chemist's mind, and the fact that although the engineer thinks he can burn it with efficiency, chemists wickedly question his powers and still rank him with empirics. Although it might be said that "man lives by coal alone" in these days, yet the "cultured" pass it by, and a well-known schoolmaster boasted that he read Greek with his feet on the fender, when in reality the Greek author was merely the cover behind which he sheltered his love of warmth.

* Abstract of a Paper read before the Society of Chemical Industry at Newcastle on "The Problems of Coal with reference to the complete and provident utilisation of the Supplies and of Fuels generally." A preliminary discussion and scheme."

Referring to exportation of coal, he was of opinion it was a questionable policy, and it might be better to use the coal at home. Methods of cleaning coal should be improved, and it might be worth while to separate the pyrites and extract the sulphur.

Regarding carbonisation, it is to be hoped that the beehive coking oven will pass into oblivion. It is essential to realise that the volatile products are of value. Of the 200 million tons of coal we use annually, only 20 per cent. are so used that the volatile products are recovered. Ammonia made in the factory is coming into competition with the natural product, and the victory over Nature as regards madder red and indigo blue may be repeated.

Regarding raw coal, he urged the Society to advocate an enactment forbidding its use for domestic purposes, this enactment to come into force at latest 10 years hence. An inquiry should be started, based upon a tax placed on all the coal raised, to develop suitable methods of coking coal and saving all valuable products. At present there is certainly no money in such a quest, and probably much will be spent before a satisfactory method is arrived at. The public should be warned by scientific men against putting money into the hands of people promoting any fuel-saving schemes.

Referring to the attempts to make soft coke, he had made a study of the different processes. The coalite process was perfectly sound as far as it went, but almost the only constituent obtained was phenol of very high quality. Carbonisation was, however, on too small a scale, and the tar obtained was altogether peculiar, and one for which no market existed.

Dr. Beilby, at the British Association in 1913, had referred to experiments at the Cassel Cyanide Works at Glasgow. By freely exposing small cubes of coal to radiant heat at a temperature of 450°C., the gases were driven off in about an hour. It seemed reasonable to conclude that the time of exposure need not exceed one and a half to two hours. The object was to design some apparatus in which the coal could be exposed in thin layers to the action of heat. Experiments showed that the time did not exceed one and a half hours. The production of a mechanically perfect apparatus into which small coal is fed, passed through the distilling zone, and passed out through a cooling chamber, only requires development, and an apparatus using 20 tons a day and working automatically should be exceedingly economical.

As for the gas industry, they should use their resources for supplying heating and power gas, and not compete with electricity for lighting. The price of gas, except in Sheffield and Widnes, is altogether disproportionate to value. A disastrous step was taken a few years ago when gas managers secured the repeal of the sulphur restrictions; since then we have suffered from sulphurous fumes.

Returning to the subject of coking coal, a complete survey of our coal deposits should be made and certain varieties set apart, the Durham coal, for instance, as a coking coal. Engineers should also attend to the principles to which Dr. Bone has drawn attention. A profound study should be made of heating appliances, whether for solid, liquid or gaseous fuel.

A central National Fuel Board should be established, and coal removed to centres and there turned into fuel. Gasworks should disappear, and fuel and power works take their place. The industry at large and use of fuel should be absolutely under scientific control. Those firms which have already by-product recovery coking plants, and those who have special knowledge, should co-operate and establish, without further delay, a central research department to serve the purposes of the industry.

THE HIRSCH PORTABLE ELECTRIC LAMP.*

BY HIRAM H. HIRSCH.

The portable lamps described by the author consist of a hand lamp and a miner's cap lamp. The former of these consists of a storage-battery placed on an asbestos cushion in a cast-aluminium casing provided with a hinged top. The reflector unit is made up of concentric safety shells, an incandescent lamp, a safety glass, a crystal and a switch.

The battery consists of two horizontal lead plates, each about 1 in. thick, placed in the bottom of a hard-rubber jar and separated by wood and perforated hard rubber, the bottom plate being positive. The positive and negative leads extending from the battery plates are enclosed in glass tubing. The solidified electrolyte consists of a gelatinous substance developed by the manufacturers. The battery is supplied with a vent-plug, and the top of the battery is sealed with an insulating compound. Both the negative terminal and the positive terminal consist of antimonious lead.

The casing for the battery is made of cast aluminium, and the combined cover with reflector holder is made of the same material. The reflector is constructed with three concentric shells, the intermediate shell being insulated from the other two and connected to the negative pole, and the other two shells to the positive pole of the battery. The distance between these shells varies at different points from $\frac{1}{32}$ in. to $\frac{1}{4}$ in. The shells are so arranged that if the reflector should be crushed or punctured the current to the lamp is cut off by the shells being short-circuited between the battery and the lamp before the lamp-bulb can be broken. The inner shell is fastened to the screw-shell of the lamp socket, and the intermediate shell is fastened under the central contact of the lamp socket.

The incandescent lamp used is of the 2-volt 0·55-ampere tungsten-filament type, with a miniature lamp-base. The safety-glass is merely a piece of window glass $2\frac{3}{16}$ in. long, 1 in. wide, and about 0·05 in. thick, supported across the reflector-shell at the back of the crystal. The switch on the watchman's lantern consists of a screw-switch fastened to the outer case of the reflector and a knurled-head screw, which threads through the outer shell and makes contact with the spring.

The miner's cap lamp is supplied from a storage battery fitted in a cast aluminium box, and carried in the miner's belt. The box is supplied with a handle, and contains the necessary contact-springs for making contact with the battery-terminals. Through the upper part of the box the armoured cord extends. The other end of the armoured cord is fastened to the headpiece. This headpiece is similar in construction to the reflector of the watchman's lamp, and consists of an incandescent lamp, a reflector, safety-shells, a safety-glass, a crystal, and a switch. The battery is of the same construction as that of the watchman's lamp. The reflector, which is used as a headpiece, is of the same construction as the reflector provided for the watchman's lamp, with the exception of a nut which forms the central contact of the inner insulated wire which is on the inside of the armoured cord. The inner wire is negatived. The incandescent lamp used is the same as in the watchman's lamp.

The cord consists of a single piece of flexible single-braid rubber-covered wire, made up of 16 strands of No. 30 B-and-S-gauge copper wire. The outer armour consists of a single strip of formed brass, which overlaps and locks itself between succeeding turns of the strip, and is known as a flexible brass tubing. The weight of the lamp complete is $3\frac{1}{4}$ lb., and of the battery only $1\frac{7}{8}$ lb.

It is claimed that the storage-batteries are easily and quickly handled in charging, easy to take apart and repair when necessary, and all parts are quickly accessible. The sediment that tends to loosen from the positive or the bottom plate still remains part of the plate. The jarring or upsetting of the battery will not affect the plates as in the batteries having thin vertical plates. Short-circuit of the battery will not injure the plates.

The battery will not, upon short-circuit, arc sufficiently to ignite gas, black powder, guncotton, cartridge powder, alcohol, or other vapours, since the voltage drops to zero. The batteries will give an average light of 5 c.p. for about 12 hours on each charge.

* Abstract of Paper read recently before the North of England Institute of Mining and Mechanical Engineers.

Electric Illuminants.—In a Paper read at the International Engineering Congress Mr. S. H. Blake sketched the history of both arc and incandescent lighting to the present day. Referring to the Cooper-Hewitt mercury vapour lamp it was stated that owing to the bad colour value it is unsuitable except where these considerations do not matter. It has, however, a high efficiency, the consumption being only 0·72 watt per m.s.c.-p., and after 2,000 hours the diminution of light amounts to only 20 per cent. The Quartz tube lamp or high-pressure mercury arc has never been used commercially. Including losses in ballast resistances it takes 0·59 per m.s.c.-p. This type, however, is superior to the Cooper-Hewitt type, since it has more red rays and its life is from 3,000 to 5,000 hours. The Moore vacuum tube consists of a continuous glass tube about 1·75 in. diameter, varying from a few feet to hundreds of feet in length. When carbon dioxide is used in the tube the light resembles diffused daylight. Unfortunately it is not very efficient, requiring 6·32 watts per m.s.c.-p. With nitrogen in the tubes 2·05 watts are required per m.s.c.-p. Auxiliary devices are used to generate the gas required as it is used up in the tube. Referring to the gas filled tungsten lamp it is pointed out that the gain is greater with thicker filaments, owing to the reduced heat loss. Lamps of this type are being produced taking about 0·5 watt per mean horizontal candle-power.

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STANDARDISATION RULES FOR ELECTRICAL MACHINERY.

The framing of standardisation rules covering practically all types of machinery and plant is a good indication of the stability of engineering industry, and of the recognition on the part of manufacturers and users of the advantages of standardisation. The recently issued British Standardisation Rules for Electrical Machinery, and the corresponding Rules of the American Institute of Electrical Engineers, serve as an illustration of the desire to secure uniformity. A pleasing feature of the work is that there has been active co-operation between the Engineering Standards Committee and the American Standards Committee, and the Canadian National Committee of the International Electrotechnical Commission. The result of this co-operation is that on all essential points the American and British rules for the rating of electrical machinery are in practical agreement. In addition, the representative character of the sub-committee, including, as it does, representatives not only of the large spending departments of the Government and of the municipalities, but also eminent consulting engineers, together with representatives of the British manufacturers of electrical machinery as a whole, has enabled the committee to gather the collective views of the various interests concerned in a manner which hitherto has not been possible.

Although at one time the view was held that standardisation rules would tend to retard development, it is now generally admitted that the effect of standardisation is a beneficial one, both to the manufacturer and to the user. This applies equally to all industries. The purpose of standardisation is clearly set out in a prefatory note to the Rules of the American Institute of Electrical Engineers. It is stated that "in framing these rules, the chief purpose has been to define the terms and conditions which characterise

the rating and behaviour of electrical apparatus, with special reference to the conditions-of-acceptance tests. It has not been the purpose of the rules to standardise the dimensions or details of construction of any apparatus, lest the progress of design and production should be hampered."

The policy of not hampering progress is equally noticeable in the British rules. Of the 20 sections into which the rules are divided, the principal are those dealing with rating, temperature rise and its determination, and dielectric tests. Continuous and short-time rating are recognised, the two standards for short-time rating being one-hour and half-hour respectively. In some respects it is desirable to have a further clause dealing with motors, for which a one-hour rating is insufficient. For such service it is usual to select a one-hour machine, and to work it no higher than 75 to 85 per cent. of the one-hour rating. It is interesting to note that when a machine is required to work continuously under widely varying loads, and the actual cycle of duty is specified, as in the case of a winder motor, the machine may be given a duty-cycle rating. By this is meant the continuous rating which is the thermal equivalent of the cycle of duty specified. It is further provided that a machine rated in this manner shall be capable of withstanding a momentary load corresponding to the highest peak of load occurring in the cycle of duty specified.

Both the American and British rules have been based on the limiting temperatures for insulating materials agreed to at the last Plenary Meeting of the International Electrotechnical Commission, held in Berlin in 1913. In the British rules Sections V. to XI. deal with temperature rise and allied matters. The ground covered by these sections includes: Cooling air temperature, observable temperatures, temperature tests, measurement of the observable temperature and of the temperature of the cooling air, embedded temperature detectors and temperature coefficient. By observable temperature is meant the temperature determined by measurement of the resistance, or by the use of a thermometer, and the limits are given for various cases and for the several kinds of insulating material. When specifically required, embedded temperature detectors shall be employed in the case of a machine of over 3,000 kw. if wound for a rated pressure exceeding 3,300 volts.

In view of Mr. F. D. NEWBURY's research on the operating temperatures of the Niagara alternators, we are not at all certain that Clause 65 of the British rules is a fair one to impose on the manufacturer. This clause reads: "When the internal temperatures of a machine are measured by embedded temperature detectors placed between two coils in one slot the machine shall be held to comply with these rules, provided the temperature and temperature rise so measured do not exceed the limits for observable temperature and observable temperature rise given in Section VI. by more than 5°C."

When the internal temperatures of a machine are measured by embedded temperature detectors placed between the insulated coil and the iron core, the machine, if wound for a rated pressure not exceeding 5,000 volts, shall be held to comply with these rules, provided the temperature and temperature rise so measured do not exceed the limits for observable temperature rise given in Section VI.

In case the rated pressure of a machine exceeds 5,000 volts, the permissible limits shall be reduced by 1°C. for each 1,000 volts or part thereof, by which the rated pressure exceeds 5,000 volts.

As far as we are aware up to the present, such detectors have not been used to any great extent in this country. The test results given by Mr. NEWBURY indicate a much higher internal temperature than one would expect to find. Nevertheless the machine in question has been in constant operation for upwards of 20 years. Apart, however, from the question of the allowable limit, the use of an embedded temperature detector is a much more searching test than either of the two methods in general use, and it remains to be seen whether the temperatures determined in this manner can be made to conform with those set out in the rules without radical alterations in design. If on test it be found that higher safe temperatures can be used, we have no doubt that the limits will be raised.

The dielectric tests prescribed are fair to manufacturer and user alike, and are in every way satisfactory. This spirit of fairness characterises the whole of the rules, and is due, doubtless, to the co-operation of buyer and seller. Without such co-operation the effort would be wasted. The Engineering Standards Committee feel confident that the wide adoption of these standardisation rules will materially benefit the industry of this country, and this is an opinion we heartily endorse. The work is highly creditable to the Committee, and worthy of the active support, both of makers and users of electrical machinery.

If, in concluding, we indulge in a little grumbling, we do so on behalf of and unknown to the Committee. We ask, How much longer is it going to be said of us that we take with both hands what the Committee have to offer and give nothing in return? This parsimony on the part of the electrical industry necessitates a charge being made of half-a-guinea per copy for the Standardisation Rules. When we have put our house in order we hope to see these rules, and, in fact, all the reports of the Committee, obtainable at a shilling per copy, and sent out by manufacturers in much the same way as they now distribute trade pamphlets. Had we the ear of the Committee we would urge the granting of permission to manufacturers working to the rules to overprint them with their own names, and, if necessary, the translation of the rules into any language desired by our manufacturers. With the knowledge that the Committee will render a full account of their stewardship, our engineers could well afford to subscribe generously to the work carried out under the auspices of the Committee.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Diesel Engines for Land and Marine Work. By A. P. CHALKLEY, B.Sc. With an introduction by the late Dr. RUDOLPH DIESEL. Fourth edition. (London: Constable & Co.) Pp. xvii.+368. 8s. 6d. net.

The present volume represents the second complete revision since the work was first issued about four years ago. Considerable additions have been made in the section of the book dealing with Diesel motors for ships' propulsion. The number of illustrations has been nearly doubled, and besides much descriptive matter dealing with engines of new types that have been built since the last edition was published, there is an additional chapter on design. A complete review of the first edition appeared in THE ELECTRICIAN, Vol. LXXI., p. 181.

The first two chapters are devoted to the general theory of heat engines, with special reference to Diesel engines, and to the action and working of such engines. Chapters III., IV. and V. deal with construction, installing, running and testing. On many occasions we have been asked by central station engineers and others to recommend a good book on the running of Diesel engines, and we suggest to the author that the subject is sufficiently important to justify somewhat fuller treatment

than that given to it in this book, or, alternatively, another volume.

Many fine examples of Diesel engines for marine work are given, and the matter in Chapter VII., dealing with the construction of the best-known makes of marine motor, is well-found. The chapter on design contains a good deal of information and many useful tables. In a future edition we should like to see an example fully worked out. Such examples are invaluable, not only to the young draughtsman and student, but to those who are thinking of taking up the manufacture of Diesel engines. Locomotive engineers will be interested in the description and drawings of the Sulzer-Diesel locomotive built some years ago for the Prussian State Railways. In an appendix Lloyd's Rules are given for marine internal-combustion engines, and there is a further appendix containing the original patent specification. The work is well printed and profusely illustrated, and many of the detail drawings are of considerable merit. We can recommend it to anyone in search of a sound practical book on the theory, construction, operation and application of the Diesel engine.

Graphics and Structural Design. By H. D. Hess. (London: Chapman & Hall.) Pp. viii. 136. 12s. 6d. net.

The electrical engineer is found in the van of every branch of industrial progress. In order that he may move forward with confidence his training must be many-sided. Since he is first and foremost the servant of so many people, he must endeavour to think as they think. He has to be an expert in machine design and in mechanical engineering; he has to know something of civil and structural engineering, and if need be he has to be prepared to act as an architect or surveyor. It is for this reason that we welcome books of reference on these many subjects, suitable for those whose work is not too highly specialised. The book under review is such a work. It is evidently written by a man who knows what to put in and what to leave out.

From the title it might be inferred that the book deals with the graphical solution of familiar problems in structural design. This is not the case, for although graphical constructions are given the other usual methods of structural design are dealt with in considerable detail. The author is Professor of Machine Design at Cornell, and his method is that of every successful teacher, namely, the setting of problems on which students are questioned in addition to examples for the drawing board. The practice in vogue in some of our colleges of encouraging students to make highly finished copies of other people's drawings is one to be discouraged.

Some idea of the ground covered by the 22 chapters will be gathered from the following: The first six chapters are devoted to the theoretical elements of the subject. These include materials, graphics, stresses in structural frames, influence diagrams, and members subjected to tension, to compression and to bending. The remaining 16 chapters deal with the practical side of the subject. Separate chapters are given to columns, girders, trusses, steel mill buildings, frames, reinforced concrete, foundations, chimneys, retaining walls, bins, shop floors, walls and roofs, and specifications. In both sections the fully worked-out examples will be helpful not only to students of structural design but to those who, while not being specialists on the subject, have to plan and carry out extensions. To the busy man the quick solution of a problem outside his province is often imperative, and at such times the advice given in "Hess" will be worth more than the cost of the book. The diagrams have been drawn by a draughtsman and the press work is excellent.

Life Jottings of an Old Edinburgh Citizen. By the Hon. H. A. Macdonald, P.C., K.C.B. (London: T. N. Foulis.) Pp. 302. 10s. 6d.

Apart from his judicial position as Lord Justice Clerk of Scotland, Sir John Macdonald is known to many of our readers as a member of the Institution of Electrical Engineers, and as one who has played an active part in the world of anti-cyclonism. The present volume is by no means technical, but it contains some interesting reminiscences of the old days. For example, the author numbers among his schoolfellows Clerk Maxwell and P. G. Tait. An amusing account is given of the annual demonstration of laughing gas in the University chemical lectures at Edinburgh, and the opening of the telegraph office in that city. The author's father spent 18s. 6d. on a telegram, but the penny post proved the quicker of the two means of communication. Reference is made to the opinion expressed by Bunsen that the idea of having electric power on a large scale was a Utopian dream. Also the declaration of a high Post Office official that the telephone would never be used much in this country—that in the United States they had a scarcity of message-boys, but we had "plenty of message-boys and things of that sort!" The author may well observe that the most injurious person to the interests of scientific progress is often the scientific man himself. The last chapter deals with the rise of automobilism in this country, which should long remain an object lesson of the way in which a golden opportunity may be missed through the folly of those who cannot see the possibilities of a new development, and therefore do their best, it may be successfully, to crush it.

The volume is excellently printed and illustrated. It is not an autobiography as usually understood, and is therefore free from the tedium that is often characteristic of works of that kind. On the contrary, it affords excellent light reading, and gives a good idea of life and events which, to many of us, are no longer familiar.

Proctor's Useful Tables. (London: E. Le Bas & Co., Dock House, Billiter-street, E.C.) 1s.

These tables consist mainly of discount tables in a large number of steps from $1\frac{1}{4}$ up to $98\frac{3}{4}$ per cent., and in sums varying from 1d. up to £100. The results are given to the nearest penny, $\frac{3}{8}$d. (not $\frac{1}{2}$d.) being taken as the dividing line. Tables of conversion factors, equivalent measures and gauge numbers are also given. The size is conveniently small, and the tables as a whole should prove useful. Messrs. Le Bas have a limited supply which they will send out post free on receipt of 6d. in stamps per copy or 4s. per dozen.

THE USE OF CONTINUOUS CURRENT FOR TERMINAL AND TRUNK-LINE ELECTRIFICATION.*

BY NORMAN WILSON STORER.

(*Concluded from page* 848.)

Summary.—The Paper discusses the series motor acceleration and questions of control. Regenerative systems are considered, as well as the question of voltage and interchangeability.

Contact and Collector System.—This subject will be considered first because before any interchange of equipments is possible it is necessary to standardise the contact system, so that, as stated above, a car or locomotive from one line can collect current from a contact rail or trolley on any other line.

The usual contact system for all lines in Great Britain, except tramways, using a pressure of 800 volts or less, consists of some form of contact rail or rails mounted either outside of the running rails or between them. The oldest and most frequently seen is a top contact or over-running type of rail. A new form of rail having the side contact has been introduced on the Lancashire & Yorkshire Railway, the latter for use on 1,200 volts. In some cases, as in the London Underground Railways, a return conductor is also used. There will probably be no difficulty in locating the return rail so that the same collector can operate on any of them. It is also possible where the contact surfaces are properly located to have a single contact-shoe satisfactory for collecting current from either the under-running or the over-running type of rail. Such interchangeability is possible between the Pennsylvania over-running rail and the New York Central under-running rail at New York.

Where it is necessary to have the rails located at different distances outside of the running rail or at different heights, it becomes necessary to adopt a collector shoe which can be shifted easily and quickly so as to accommodate it to different conditions. The author can see no possibility for interchanging equipments between

* Abstract of Paper read at the Institution of Electrical Engineers on the 16th inst. A Paper entitled "Economics in Power Consumption of Electric Railways," by the same author, was published in Vol. LXXV., p. 799.

the top and bottom contact rails and the side contact such as used on the Lancashire & Yorkshire Railway.

The same statements hold true in regard to overhead conductors. The problem there is much simpler, because it seems to be the universal practice to locate the overhead conductor above the centre line of the track and to keep its height between certain definite limits which must in all cases clear the rolling-stock. In this case it is more a question of adopting the proper kind of contact shoe which, while being subject to many variations, is also subject to many solutions.

Motors.—It is generally well understood by all who are acquainted with electrical apparatus that a continuous-current armature has practically the same current capacity regardless of the voltage applied to its terminals, the latter being limited to a certain maximum as determined by commutation characteristics and speed. It is understood that increasing the voltage for a given current also increases the core loss, but this is largely compensated for by an increased speed which gives greater ventilation. This is especially true with the late types of self-ventilating motors. It may therefore be assumed as correct within a very few per cent. that the horse-power or kilowatt rating of a motor is proportional to the voltage applied to its armature terminals. It follows, therefore, that the normal capacity can be secured only by maintaining the normal rated voltage on the armature terminals. This, then, is the basis on which any proposition that involves interchanging equipments on different voltages must stand. It is shown that the most advantageous results may be secured if the line voltages are multiples of the armature voltages.

Examples are then given of the working of armatures on 600, 1,200, 1,500 and 2,400 volts.

Operating on 1,500 volts with four armatures in series, as with 2,400 volts, the speed and kilowatt-capacity would only be 62·5 per cent. of the normal, while on the other three voltages of 600, 1,200 and 2,400 it would be normal.

If equipments are required to operate over these same voltages, but it is found that half-speed on 600 volts is sufficient, as would be frequently the case, the armatures would be wound for 1,200 volts and full-speed would be secured with series-parallel control on 2,400 and 1,200 volts, and 62·5 per cent. of normal speed on 1,500 volts, or the risk might be taken of running the 1,200-volt motor on 1,500 volts. In this case only four armatures are needed for the equipment.

If it is required to operate at a maximum voltage of 3,000 and also at 2,400, 1,500, 1,200 and 600, it would be desirable to have at least four armatures in series on the higher voltage. These would be wound for 750 volts. The speeds for the different line voltages, then, with combinations of four in series, two in series and all in parallel, with armatures wound for 750 volts, would give full output at 3,000 and 1,500 volts, and 80 per cent. of the normal speed and output at 2,400, 1,200 and 600 volts.

If 3,600 volts is the maximum with eight armatures on the locomotive, all of the above-named lower voltages may be covered and full speed and output will be obtained only on 3,600 volts; 83 per cent. of the normal rating and speed would be secured at 3,000 and 1,500 volts, and 66 per cent. at 2,400, 1,200 and 600 volts.

With 4,800 volts on the line and four motors connected permanently in series at this voltage, full speed and output can be obtained with 2,400 and 1,200 volts, and half-speed at 600 volts; the output and speed at 3,000 and 1,500 volts will be 62·5 per cent. of normal.

It is undesirable to equip cars with more than four motors each, as the complication and cost would become too great. With the locomotive, however, it is quite practicable to operate with eight motors, as is shown by the New York, New Haven & Hartford geared locomotive, which has eight motors connected in pairs to four driving axles, and the New York Central locomotives of the latest type which have eight motors each mounted on a separate driving axle.

Double armature types of motors are next referred to and troubles from magnetic unbalancing mentioned. As far as the motors themselves are concerned, there is very little additional complication from the necessity of interchangeability on different voltages. It simply requires the use of more armatures and at a greater cost than would otherwise be necessary. Higher insulation is also required.

Control.

Various diagrams are given in the Paper showing the complication introduced by the use of several voltages. It is unnecessary to use unit switches or contactors to effect all of these combinations. They may, to a certain extent, be made by means of cylindrical or drum-type change-over switches, which are satisfactory in some cases for transferring connections when the current is off. Such a scheme is usually used for car equipments operating interchangeably on 600 and 1,200 volts. This is shown on Fig. 4, which is a standard arrangement for such an equipment. It will be noted that the change-over switch changes both motors and resistances from series to parallel or vice versa. The author refers to methods of effecting possible changes by means of unit switches. The use of unit switches exclusively for making combinations in the main motor circuits is sometimes carried to the extent of using them for reversers as well, especially for large locomotives. This has the advantage of maximum reliability and the smallest number of types of apparatus for the equipment.

Various two and four-motor equipments are then considered with regard to full control. Much the same conditions prevail where the equipments are arranged for regenerative control. Where the motors are to be operated to give regeneration when connected all in parallel, it will be necessary to have a regulating apparatus for each motor, and consequently the additional control apparatus will be very considerable, so much so in fact as to make the regenerative control of doubtful value. It must be understood that each additional switch means additional wiring for the equipment, both for the main motor circuits and for the operating circuits for the control. A bad case of complication on the Washington, Baltimore and Annapolis equipment owing to its having three operating voltages and three forms of current collector is referred to.

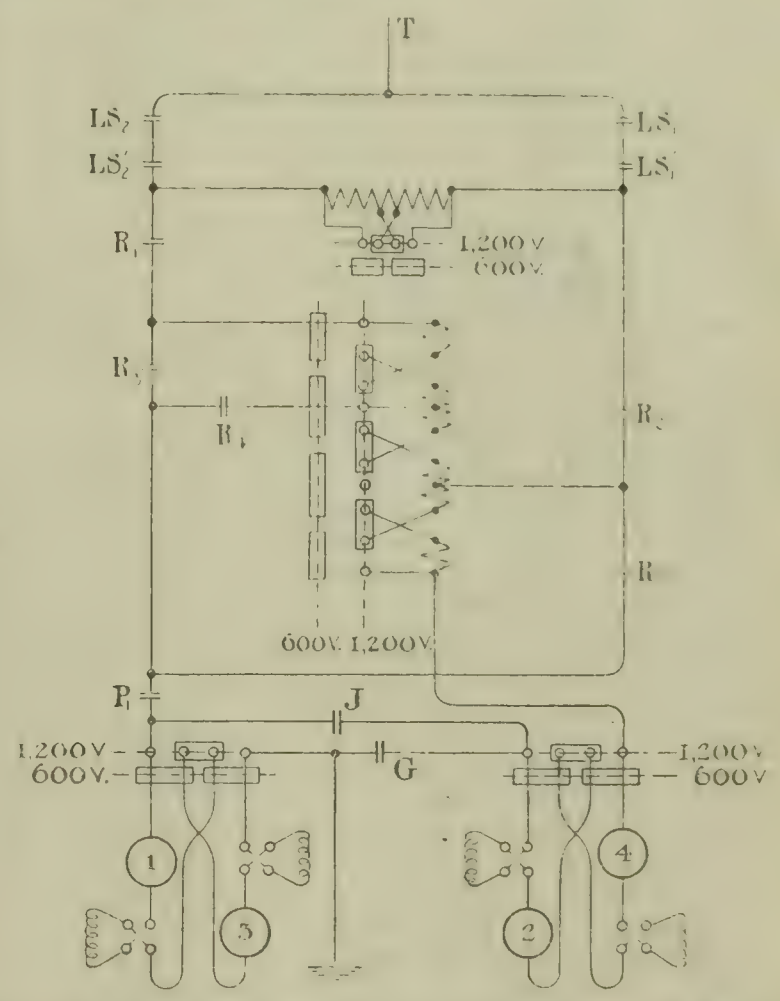


Fig. 4.—Diagram of Main Circuits for Standard H.L. Car Equipment at 600 V. and 1,200 V.

That it is perfectly practicable to operate complicated control systems satisfactorily and reliably is shown by such examples as that of the New York, New Haven and Hartford alternating-current–continuous-current locomotives which operate both from a 11,000-volt single-phase trolley and from the under-running 600-volt continuous-current third rail of the New York Central system. The author has seen many equipments operating on both alternating and continuous current and has no desire to see that method of operation extended, but the control complications introduced by such an equipment are small compared with what would be involved in operating over three or four continuous-current voltages with full speed on three of them and with several different forms of contact devices. There is no doubt that the equipments can be arranged for successful operation in this way, but the additional first cost and the cost of maintenance would be so great as to be a serious handicap to electrical operation.

Auxiliary Power Equipment.

Every electrical equipment has several auxiliaries which are usually supplied with power from the main supply circuit. On 600 volts the air compressor motor, blower motor, if any, and lights are all supplied directly from the line. The power for the control circuit is also usually supplied from the line when electromagnetic contactors are used, but where the electro-pneumatic control system is

used, the power for the control circuits may be supplied either from the main circuit or from a small storage battery. As the power for operating the magnet valves is so small and the advantages of a low-voltage train line are so numerous, it is becoming more and more the practice to use a battery, especially on train service on elevated and subway lines where the battery performs the additional function of supplying power for emergency lights and signals.

The problem of supplying the power for auxiliary circuits on equipments receiving power at several different voltages is one of the most troublesome features to be considered.

Any scheme involving operation over a wide range of voltage will necessarily complicate the equipment if it becomes necessary to operate continuously over any one of several line voltages. For the higher voltages it may be that the use of a storage battery, such as that provided on the 5,000-volt car equipment previously referred to, may prove to be the most satisfactory means. On this equipment a small capacity storage battery to which all the auxiliaries are connected is included in the driving motor circuit on the earthed side. The battery has capacity to operate the compressor, motor, lights and control circuit for a limited length of time, but ordinarily these auxiliaries take most of their current from the main motor circuit. The compressor governors are so arranged as to delay the starting of the compressor motor until the car starts, instead of coming into operation immediately on the application of brakes as is usual. The compressor and other auxiliaries thus simply shunt whatever portion of the main motor current, or all of it if necessary, is required and the battery receives or supplies the balance. The compressor can be so arranged that it will receive probably at least 90 per cent. of its operating current directly from the main circuit without the current passing through the battery, which thus floats on the line and merely controls the voltage.

For locomotive use where the auxiliaries require considerably greater power it is quite feasible to use a motor-generator to supply power to the auxiliaries. The great objection is the multiplying of switches in these arrangements.

Conclusion.

The logic of this Paper points to the necessity for the early standardisation of some of the more important features connected with electrification. The benefits of standardisation would be immediately felt not only in the greater security of the railways in embarking on a project of electrification, but in the decreased cost of all apparatus connected with it. The author suggests the Institution should take the initiative regarding this question.

Since the 600-volt system is so thoroughly established and also so well suited to the requirements of terminal electrification, it should be continued as one of the standards, at least for the present. While it is probable that but little will be done towards electrification of entire railway systems in the next few years, one other voltage should be selected that will be suitable for such service and will at least serve to direct the aim of those companies about to electrify. This voltage should be high enough to permit the heaviest drafts of power required to be collected from the overhead conductor without exceeding the capacity of a single wire or a single collector.

It is generally conceded that 1,500 volts is about the maximum voltage that can be economically used on the four-pole railway motor. Even with that it is difficult to find space for the necessary number of commutator bars and brush holders, especially for small motors. It would, therefore, be necessary to connect more than two four-pole motors permanently in series for operation with more than 3,000 volts. The type of motor used for the 5,000-volt equipment that has been mentioned previously, offers a solution for the problem which makes a very considerable increase in line voltage appear not only possible but easy in so far as commutation and commutation bars are concerned. This equipment has been described in several of the American technical journals, but a brief description of the motor may not be out of place here as the construction is quite novel and has many advantages for high voltages.

The 2,400 volt double-armature motor is referred to as a solution of the 5,000 volt line problem. In this case the motor consists of two bi polar armatures connected in series in each frame, and that the major part of the magnetic flux passes through the two armatures, their pole pieces and a short section of the yoke in series, which thus effects a great reduction in the weight of the material that would otherwise be necessary to secure the advantage of the bi-polar armatures. Each armature is wound for 1,250 volts, so that half of the line voltage is impressed on each complete motor, as is usual with high voltage equipments. So far as the commutators are concerned there appears to be no reason why considerably higher voltages should not be used if desirable. In fact, the first two motors of this type were tested with 7,000 volts on the line, *i.e.*, 3,500 volts on each motor, with very satisfactory commutation.

The author suggests that if possible the "through" lines should be differentiated from the purely suburban lines, and that the best voltage for the former should be adopted regardless of the latter; that an overhead contact wire in addition to the 600-volt third rail be placed over each track that requires full-speed operation for both equipments. The disadvantages of such a scheme are negligible compared with the complication of equipments necessitated by the interchangeable operation on several different voltages.

CORRESPONDENCE.

UNIFORMITY IN DRAWING ELECTRICAL DIAGRAMS.

TO THE EDITORS OF THE ELECTRICIAN.

The subject of "Uniformity in Drawing Electrical Diagrams" that has recently been taken up in your pages is an extremely interesting one, but at the same time one on which very divergent views are often held, and therefore one about which much may be written. In this connection I should like to endorse the view expressed by Dr. Garrard, that the Institution should publish, either through the "Journal" or in suitable pamphlet form, a list of standard symbols for drawings, and also if possible for formulæ (although the latter is a more difficult matter), that would be available for use by all electrical engineers. A suitable lead to encourage their general use would be given if their employment were then insisted upon for all Papers and articles published in the "Journal" and also in the electrical Press. Such a list should be compiled after suitable discussion with all the members of the Institution, and should be open to extension (or revision) from time to time in the same manner.

Without wishing to disparage the excellent suggestions put forward by Dr. Kapp, I must say that I would personally much prefer to see the general employment of a plain circle with a suitable index letter inside to represent *all* measuring instruments than the various shapes that he proposes, which, after all, do not convey to the mind at a glance what they are intended to represent, but must of necessity be memorised by the student, who is already overburdened with "facts and formulæ." The index letters G, A, V, W, F, &c., would seem readily to suggest the names of which they are the initial letters. The subscript letters *mc*, *hw*, *es*, *i*, *d*, &c., representing "moving coil," "hot wire," "electrostatic," "induction" and "dynamometer" types respectively, should also be standardised at the same time to use with all the measuring instrument symbols.

As you have pointed out in your Editorial comments, the symbol for a resistance may be more simply drawn as a plain zig-zag line, although *if neatly drawn* Dr. Kapp's symbol may look somewhat better. This raises the point as to the most suitable symbol for a transformer, for its coils are very much more of the nature of inductances than resistances. Dr. Kapp's symbol would, however, rather suggest the latter if a zig-zag is used for a resistance; but it is, nevertheless, frequently employed in diagrams. The same remarks apply to the field windings of dynamos and alternators. These, however, are points on which it would be desirable to obtain as many views as possible before arriving at any decision.

A number of other symbols might also be added to Dr. Kapp's list, such as those for a Morse key, telephones, &c.; while I should also like to see the symbol ⊣⊢ included for a condenser as well as ⊣|||⊢, the former being so commonly employed to represent a small condenser (as in diagrams of "wireless" apparatus, &c.), and the latter reserved for large condensers.

In conclusion, why should not λ in a circle and δ in a circle be employed to represent wavemeters and decremeters respectively, as to the "wireless" engineer these are fast becoming just as much standard measuring instruments as ammeters and voltmeters.

London, March 20. PHILIP R. COURSEY.

"THE STRANGER THAT IS WITHIN THY GATES."

TO THE EDITORS OF THE ELECTRICIAN.

May I ask your indulgence to reply to your comments on my letter, as my deafness prevents my taking part in any discussion at the Institution, where I am unable to hear what is said by one out of 100 of the members. Anyone reading your comments would think I had suggested that the President and Council of the Institution should proceed with all formality to suspend the various alien enemy members in true old Florentine fashion from the windows of the Institution building.

I also do not understand what "scrap of paper" I am supposed to be advocating should be torn up. Presumably, however, as a good deal of reference seems to have been made at the meeting to our naturalisation laws, you are of opinion that the removal of these members from the Institution roll is in some way an infringement of their rights as naturalised subjects of this country. I cannot, however, see how that can be, for naturalisation does not *ipso facto* entitle anyone to be a member of the I.E.E.

What I think most of us are asking for is simply this: Assuming that in your locality there was a family one of whose members had been convicted and hanged or otherwise suitably punished for a particularly ferocious crime, and that the other members of that family, while having had nothing to do with the actual crime, were at the same time loudly applauding its perpetrator; would you consider such people suitable for retention on your family visiting list and would you yourself care to meet them socially? I think not; and not a few of us feel like this as regards Germany and her people.

After all, the Institution is, in spite of being for mutual protection, a limited liability concern, a club, albeit devoted to the advancement of technical subjects instead of, say, politics.

Watford, March 18. M. J. E. TILNEY.

EDGE EFFECT OF PLATE CONDENSERS.

TO THE EDITORS OF THE ELECTRICIAN.

Electrical text-books usually assure students who are making a standard air condenser that if the metallic plates have an area large compared with their separation the effect of their edges may be neglected.

Having doubts on the subject, the following experiments were made. A square of lead foil having sides of 24 cm. was pasted on plate glass and placed opposite another, which exceeded it by 0·6 cm. all round, and the two kept apart by bits of glass 0·29 cm. thick.

Another similar condenser was made having the smaller plate of the same area, but in an oblong form, being 35 cm. long. This showed a capacity distinctly larger than that of the first. The increase was, however, too small to measure accurately, being only about 3 per cent.

To increase the effect another square plate, similar to that of the first condenser, was cut into four strips and fixed on the glass $2\frac{1}{2}$ cm. apart. These were joined by narrow strips and the area adjusted to that of the original square. The capacity was now found to be increased by 30 per cent.

From these and other experiments I am convinced that, with plates 1 ft. square and $\frac{1}{8}$ in. apart, the capacity is at least 20 per cent. more than that calculated from the formula $C=A/4\pi d$, an amount which can scarcely be considered negligible in a standard.

The measurements were made by the method described by me in THE ELECTRICIAN, March 5, 1909, the voltage used being as high as possible without sparking over. Similar results were, however, obtained by Fleming's revolving commutator and a voltage of 220, so that the effect observed was not due to brushing from the edges of the plates.

Birmingham, March 17. C. J. WATSON.

Royal Society.—The following Papers were read at last Thursday's meeting of this Society: "On the Main Crests of Ship Waves, and on Waves in Deep Water due to the Motion of Submerged Bodies," by George Green; and an "Investigation of Atmospheric Electrical Variations at Sunrise and Sunset," by E. H. Nichols.

PHYSICAL SOCIETY.

At a meeting held on March 10, 1916, at the Imperial College of Science, Prof. C. VERNON BOYS, F.R.S., President, in the Chair, a Paper on

"Experiments Illustrating the Flow of Heat in Conducting Sheets"

was read by Mr. S. SKINNER, M.A.

If a sheet of tinned iron be heated locally by means of a Bunsen burner or blowpipe the tin is melted for a certain distance from the heated region. On allowing the sheet to cool the resolidified tin is separated from the unmelted tin by a very sharp line of demarcation. This line gives us the equi-temperature curve corresponding to the melting-point of tin. By pushing the heating to a greater or less extent a series of such equi-temperature curves can be obtained for a sheet of any particular shape heated at any given point. The cases shown illustrated the flow of heat into a rectangular plate from a heated tongue; into a circular disc from a heated tongue; round the corner of an L-shaped strip and into the vanes of an air-cooled cylinder. The results were shown to be closely analogous to the flow of electricity in similarly shaped conductors.

Dr. R. S. WILLOWS said a similar method had already been used by Voigt and his students to compare the thermal conductivities of different metals. They employed an organic substance which melted about 41°C. and gave a very sharp line on resolidification. Their method of heating was to place the metal strip on a red-hot copper block.

The PRESIDENT asked if the change of colour of mercuric iodide could not be used for this purpose.

Mr. EZER GRIFFITHS mentioned that if a sheet of steel be heated at the centre by means of a blow-pipe, then, on cooling, a bright circular wave may be seen travelling towards the centre due to recalescence. The converse effect was said to be observed during heating. The heat-indicating paints were the double iodides of copper-mercury (scarlet) and silver-mercury (yellow). Both darkened on heating, the former at 87°C. and the latter at 45°C., the change being reversible. They could be prepared by adding a solution of $CuSO_4$ or $AgNO_3$ to a solution of KI, redissolving the precipitate and adding a solution of $HgCl_2$. Experiments involving the use of these paints are described in "Light, Visible and Invisible," by Prof. S. P. Thompson.

The AUTHOR said he was glad to hear about Voigt's experiments. He had seen the recalescence experiment mentioned by Mr. Griffiths. One trouble with paints used as heat indicators was that there was usually a considerable lag between the temperatures at which the change took place on heating and on cooling. Moreover, the line of demarcation was not very sharp.

A Paper on

"The Absorption of Gases by Quartz Bulbs,"

by Dr. R. S. WILLOWS, M.A., and H. TREVELYAN GEORGE, M.A., was read by the former.

The experiments are a continuation of those of Willows ("Phil. Mag." April, 1901) and Hill ("Phys. Soc.," December, 1912) on the absorption of gas which is brought about by electrical discharges. A new quartz bulb does not absorb air, but if it be fed with repeated doses of hydrogen—which are absorbed when an electrodeless discharge is passed—it then becomes very active. If discharges in hydrogen are alternated with those in air, the bulb can be made to absorb large quantities of either gas, and the activity with each gradually increases. The authors reject the theory of surface absorption and, in their own experiments at least, also Swinton's theory that the gas is shot into the walls and held there. It is supposed that chemical actions occur with air, and oxidation products are formed; these are reduced by hydrogen. The process is compared with the formation of the plates in a Planté cell; the absorption of hydrogen corresponding to the charging, and that of air to the discharging of the cell. Attempts to produce the same effects by chemical treatment are partially successful, particularly in fatiguing the bulb so that no further absorption takes place. The conditions under which the primary and secondary hydrogen spectra appear are also described.

Mr. A. CAMPBELL SWINTON said he was very much interested in the subject. It was true that most of his experiments were done with tubes having electrodes and there was very considerable heating. Under the bombardment of the cathode particles the inner surface of the glass may attain a very high temperature for a very short space of time. Sir J. J. Thomson had thought that it might almost become fluid and absorb the gas by ordinary diffusion. Sir J. Larmor, on the other hand, had conceived the molecules of gas to be hammered into the glass like tin tacks by the cathode particles. Some of his experiments had been done with external electrodes of tinfoil tied round the outside of the tube. He had also obtained absorption of helium which was not known to combine chemically with anything.

Dr. BRYAN described some experiments he had been making with a vacuum valve at pressures less than 1/1000th mm. Normally the electrodeless discharge will not work at this pressure, but it does so when

a current is passed through the glower (tungsten filament). Under these circumstances the pressure rises, although, after the valve has been running for some time, the current in the filament when running by itself produces a decrease in pressure."

Dr. ECCLES, referring to the failure of gold leaf in certain circumstances to absorb mercury vapour, said that some workers were using silver for this purpose. It seems to have been used successfully for reducing mercury vapour pressure down to, but not beyond, a certain limiting vapour pressure.

Dr. H. S. ALLEN said that if a tube were coated with silver by sputtering from silver electrodes, the layer so obtained was said to absorb mercury vapour very readily.

Dr. WILLOWS, in reply, said that Mr. Campbell Swinton's results with helium were not conclusive as it was not certain that they were dealing with the same phenomenon. The discharge in a tube with external electrodes was not an electrodeless discharge at all. There was still cathode ray bombardment and strong local heating. It would be interesting to see if the experiments with helium could be repeated with a true electrodeless discharge free from any electrostatic effects. He thought Dr. Bryan's results could all be accounted for by gas coming out of the metal itself. He had not used silver to absorb mercury vapour because of the difficulty of getting it free from air. Mr. Harlow about two years since showed the Society an experiment similar to the one described by Dr. Bryan.

TRADE AFTER THE WAR.

At a meeting called by the Council for the organisation of British Engineering Industry, which was held in Manchester on Tuesday, an address was given by Mr. T. C. Elder on "Engineering Industry and Public Policy." The Lord Mayor presided.

Mr. T. C. ELDER said it was misleading to use the term economic war to describe the situation that would be reached after the declaration of peace. The economic war was not something belonging to the future; we were fighting it now. It began years earlier than 1914. The German people were united in a deliberate, calculated plan for destroying British commercial and political power. If it had to be done on the battlefield they were ready as a nation in arms. If it could be done in the market place and the workshop, they were a nation in business. We had never been either. We had a small professional military force, but in business we had only "a mob of unorganised professional adventurers" in competition with a highly organised and disciplined army of industry in Germany. By a providential freak of fortune, Germany was tempted to use her other mighty machine with a "get-rich-quick" motive, but it had not swept away her commercial system. It was working to-day in spite of the blockade, and all we were doing to defend ourselves against it was to pass excellent resolutions. If the war were to collapse suddenly next week Germany would be off the mark in the commercial race quicker than any of her competitors. In these circumstances it behoved us to take a firm grasp now of certain capital facts and endeavour to draw practical inferences from them. Everybody was agreed that we could not go back after the war to business as before. Some reforms were already long overdue before the war, and, among others, the creation of a genuine Ministry of Commerce. The time had come when we ought to drop for ever the false and fraudulent antithesis between Free Trade and Protection. British engineering men must lead the way now, and must be thinking and planning, and they were entitled to the support of the Government. Their problem, broadly, was the same as that of the old Manchester school before it was taken over and sanctified and mummified by the professors and politicians, and to succeed they must live in their own century and let dead men lie undisturbed. They had no assurance whatever that the Government contemplated any general reform of our economic policy, and the repeated demand of the trading interests of the country for a Ministry of Commerce was treated with contempt by a Cabinet which contained no representative of the manufacturing industries. The engineering industry must do all that was humanly possible to help itself, but it would fall far short of what was possible if it did not organise a general association powerful enough to exert collective influence in all foreign markets, to offer authoritative counsel to the Government, to stimulate scientific research, and to bring it into closer communication with scientific progress. In conclusion, he said the question was what was to be done in the 3,000 works where munitions were being made some of which had already been warned that the demand for munitions in their cases was going to diminish, whether the war ended or not.

Dr. S. Z. DE FERRANTI said the engineering part of the question was very much tied up with the question of the trade of the whole Empire. It was also very much tied up with the question of our relations with the Germanic power. We wanted to be prepared to meet Germany on his method of fighting, and not on what we or other honourable people considered a legitimate way of acting. The case was exactly the same in trade as in the war. We had not to meet a civilised Power or a reasonable competitor, and we must organise in any way we could against him. We must leave no stone unturned to put the German in a position in which he would not be able to interfere with us. Indeed, his idea was a ring fence round the Germanic Powers, so that, so far as the people of the Allies were concerned, those Powers could not trade with us or make a profit out of us for the purpose of building up their power again to attack us.

Mr. C. H. WILKINSON said the need for immediate action. He said he agreed with the necessity of keeping the German out. If we could keep him in it would be better still.

Councillor F. J. WEST moved: "That in view of the greatly enhanced capacity of the British engineering industry, now engaged on munition work, and of the severe competition to be expected after the war, this meeting of Manchester engineers is of opinion that the organisation of the industry from within should immediately be undertaken."

Ald. WALKER, who seconded the resolution, announced that many letters of apology for absence had been received. One was from Sir Wm. Mather, who, Ald. Walker said, from the first had associated himself with the committee. The committee owed a great deal of the success they had achieved to his assistance.

The resolution was then passed, and another motion urging the Government to create a Ministry of Commerce, after consultation with representative commercial interests, was also carried.

EDUCATION ESTIMATES.

A White Paper, containing class IV. of the Civil Service estimates for the year ending March 31, 1917, which relate to Education, Science and Art, has been issued.

For the Board of Education the total allowed for administration is £203,667, against £209,551 in 1915-16; for inspection and examination £222,578, against £252,458; the grants for the training of teachers in elementary schools amount to £408,282, against £577,000; the grants for secondary schools and pupil teachers and bursars, &c., amount to £919,800, compared with £863,050. Of the total grants of £659,110 (against £731,660) towards expenditure on other aided institutions schools and classes the sum of £576,000 (against £638,000) is for technical schools, &c., and £60,000 (£59,000) for university institutions in respect of technological work. The grant to the Imperial College of Science and Technology (£30,000) is the same as in 1915-16. The sums voted for the museums, &c., are less than in 1915-16, that for the Science Museum being £13,943, against £18,892.

Of the amount set aside for technical institutions, &c. (£576,000, against £638,000), a sum of £200,000 (as last year) is for technical schools, £16,000 (against £22,000 in 1915-16) for junior technical schools and £275,000 (against £330,500) for other schools and classes.

The grants in aid of scientific investigation, &c., amount to £121,671, against £115,582 in 1915-16. The grant to the Royal Society is £23,400, against £22,425, the increase being for the aeronautical section of the National Physical Laboratory. The total of the grants for scientific and industrial research is £40,000, against £25,000. These grants are to be distributed to institutions or persons in the United Kingdom by a Committee of the Privy Council with the assistance of an Advisory Council, to promote the development of scientific research, especially in its application to trade and industry and administrative expenditure in connection therewith.

The total of the grants for universities and colleges is £292,500, against £287,000. The amounts for the University of London, the Victoria University, the Universities of Birmingham, Wales, Liverpool, Leeds, Sheffield, Bristol and Durham, the Scottish Universities, and the Colleges in Great Britain and Wales are the same as in 1915-16, but there is an additional grant of £20,500 (against £15,500) for the Welsh University and Colleges.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & PRYOR, *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 SPECIFICATIONS.

[illegible] the main contacts of the switch.

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

Commercial Topics	885	Jackson Heating Utensils	169
Imports and Exports of Electrical Manufactures	886	Fittings for Holophane Electric Glassware. Illustrated	169
Educational Notes	886	"Run-Back Preventer" Tramway Controller. Illustrated	170
Business Notices	886	The Lawrence Water Softener and Heater. Illustrated	173
Bankruptcies, Liquidations, &c.	886	Ventilating and Heating Factories. Illustrated	174
Electricity Supply	886	Companies' Meetings and Reports	890
Traction Notes	887	New Companies, &c.	893
Empire Notes	887	City Notes	894
Foreign Notes	888	Electrical Companies' Share List	894
Miscellaneous Notes	888		
Tenders Invited	889		
Tenders Received & Accepted	889		
The Round Table	167		
Industrial Lighting. Illus.	168		

COMMERCIAL TOPICS.

Economic Conference of the Allies. It was announced in the House of Commons on Tuesday that the date of the forthcoming conference of the Allies on economic subjects had not yet been fixed, nor could the programme for discussion be published at present. The President of the Board of Trade (Mr. W. Runciman, M.P.) will attend the conference as the principal representative of the British Government. The Japanese Government have been invited to send a representative to the conference, which will be held in Paris.

A conference of commercial committees of the Parliaments of the Allied countries will be held in Paris about the same time as the economic conference of the Allied Governments. According to "The Times" the following are the principal resolutions to be moved :—

1. That a preliminary entente should be established between the Allies on all legislative measures having for their object the commercial relations between the belligerents for the execution of contracts, the removal of debts, the sequestration of goods, and the deposit of patents.
2. That precautionary measures should be taken to prevent an invasion of German products after the war.
3. That a convention should be entered into for the transport of goods between nations (with a view to combating the pretensions of Germany to secure the supremacy of Europe).
4. That an international patent office should be formed.

* * * *

Enemy Trading in Australasia. The High Commissioner for the Commonwealth (the Right Hon. A. Fisher, P.C.) has received information to the effect that the Regulations under the War Precautions Act regarding enemy shareholders have been amended by making the Comptroller-General of Customs the Public Trustee, and giving him the power of delegation.

Within a month after the date of the new Regulation (or within such further time as the Attorney-General on an application made in writing within the month allows) every company incorporated in Australia shall forward to the Attorney-General a list verified by statutory declaration of the managing director, manager, secretary or other proper officer, giving the names and addresses of all shareholders in that company on Jan. 29 last who are enemy subjects, or who are naturalised persons of enemy origin, and the number of shares held by each. Declaration by naturalised British subjects making application for exemption should be made in accordance with the Imperial Act and before the person qualified to take statutory declarations thereunder.

* * * *

Exhibition of German Catalogues in London. In order that British manufacturers may have an opportunity of familiarising themselves with German methods of publicity, the Board of Trade have collected over 3,000 specimen catalogues of German origin, and these may be inspected at the Foreign Samples Section of the Commercial Intelligence Branch, 32, Cheapside, London, E.C.

The collection, which is illustrative of a great variety of industries, includes 887 catalogues of machinery. Recent additions have brought the number of toy catalogues up to 271, including the productions of most of the well-known Nuremberg toy manufacturers, and in view of the progress made by British toy manufacturers these catalogues should prove of particular interest to firms engaged in the industry. There are also 177 catalogues of fancy goods and 71 of glassware. One feature of the catalogues which is of especial interest to British manufacturers who are themselves publishing catalogues, with a view to increasing their export trade, is the number of foreign languages in which the German catalogues are printed. The Board of Trade collection includes catalogues printed in English, French, Spanish, Portuguese, Roumanian, Russian, Finnish, Polish, Italian, Dutch, Hungarian and Greek. Many are polyglot in character, and are printed in three, four and in some cases five different languages. An index has been prepared, thus rendering identification of any particular catalogue a simple matter. Copies of the index may be obtained from the Director.

* * * *

The Metric System. The first meeting of the new Board of Manchester Chamber of Commerce was held on Monday, when the officers for the current year were elected. In the course of his remarks the Lord Mayor of Manchester, who presided, urged the members of the Chamber of Commerce whenever they had the opportunity to take part in the movement for bringing about the general use of the metric system of weights and measures, because he considered that the lack of this system had sadly hampered us in international competition.

* * * *

Prohibition of Exports. The Privy Council made an order on March 16 as follows :—

The export of acetic acid, ferro-molybdenum, ferro-silicon, ferro-tungsten, salts of platinum, radium and tungsten is prohibited to all destinations. The export of X-ray apparatus to all destinations abroad other than British possessions and protectorates is prohibited.

* * * *

Prohibition of Imports. On the 21st inst. a Royal Proclamation was issued to the effect that as from March 27 the importation into the United Kingdom of motor cars for private use, chassis, motor cycles, and parts and accessories of same (other than tyres), with the exception of motor cars, chassis, accessories and parts at present exempted from import duty, is prohibited. It has been announced that additional articles will be placed on the prohibited list very shortly.

* * * *

Metropolitan Railway and Tramway Companies in 1915. The reports of all the tramway and railway companies in the London area have now been published, and show fairly satisfactory results, notwithstanding the difficulties created by the war. The total revenue of the Underground Electric Railways Co. of London was £680,700, compared with £684,600 in 1914. This company controls the City & South London, London Electric and Metropolitan District Railway Companies, the London General Omnibus, the Associated Equipment and the London & Suburban Traction Companies, and as these have entered into a pooling scheme for the interchange of traffic, &c., the results must have been beneficially affected thereby. All the companies should derive considerable benefit from the arrangement in future, more particularly in the direction of economical working. The income of the Underground Company just covers the charges, with £100 to spare, so that the carry-forward is raised by that amount to £38,600. The results of the London United and the Metropolitan Electric Tramways Companies were not, however, very encouraging. The gross receipts of the former increased by £2,295 to £330,166, but owing to the cost of the reconstruction of the line between Brentford and Hounslow, £25,000 had had to be credited to the reserve for renewals, and the arrears of dividend on the preference shares are increased by another 5 per cent. to 34¾ per cent. The sum carried forward is raised from £1,892 to £2,327. The Metropolitan, which has hitherto had a successful history, suffered a loss of £18,027 in its revenue, which amounted to £513,561. The poor result is mainly due to a strike, but the ordinary dividend is reduced from 2 to 1 per cent. The Metropolitan District and the other railway companies have had increased receipts, but the expenses were also higher. Owing, however, to the abnormal circumstances, to the absence of omnibus competition, &c., it is difficult to form a correct estimate of the position.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 13, 1916, *to* March 18, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

FOLKESTONE. *France:* Elec. carbons, 4 pkgs.; unenumerated, 8 pkgs.
GRIMSBY.—*France:* Unenumerated, 8 pkgs.
HULL. *U.S.A.:* Electrodes, 9 pkgs. *Italy:* Elec. motors, pkgs.
LIVERPOOL.—*U.S.A.:* Unenumerated, 701 pkgs.
LONDON.—*U.S.A.:* Elec. machinery, £2,013; elec. batteries, £1,916; elec. lamps, £1,970; elec. motors, £331; telephone material, £72; elec. stores, £650; wire and cable, £179; unenumerated, £1,329. *Holland:* Elec. lamps, £6,255—150 pkgs.; elec. machinery, £1,262; unenumerated, £66. *France:* Elec. meters, £160; unenumerated, £68. *Switzerland:* Elec. lamps, £185; unenumerated, £146. *Italy:* Wire and cable, £5,443. *Japan:* Elec. torches, £35; elec. lamps, £20. *Sweden:* Elec. lamps, £77

EXPORTS

TO AUSTRALASIA.—*Auckland:* Unenumerated, £126. *Melbourne:* Wire and cable, £1,438; elec. glow lamps, £328; unenumerated, £823. *Sydney:* Telegraph material, £223; wire and cable, £7,874; unenumerated, £1,018. *Wellington:* Elec. machinery, £256; unenumerated, £395. *Adelaide:* Unenumerated, £811. *Perth:* Unenumerated, £19. *Christchurch:* Unenumerated, £345. *Dunedin:* Unenumerated, £44. *Lyttelton:* Wire and cable, £88; unenumerated, £78. *Townsville:* Elec. machinery, £5,750. *Fremantle:* Wire and cable, £57. *Brisbane:* Elec. machinery, £88. *New Plymouth:* Unenumerated, £68. *Newcastle:* Elec. machinery, £2,411; unenumerated, £20.
AFRICA.—*Durban:* Elec. machinery, £626; wire and cable, £1,241; unenumerated, £2,741. *Cape Town:* Unenumerated, £234. *Port Elizabeth:* Elec. machinery, £328; wire and cable, £130; unenumerated, £674. *Beira:* Unenumerated, £27.
SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £54; unenumerated £468. *Iquique:* Unenumerated, £50. *Montevideo:* Unenumerated, £113. *Mejilloues:* Elec. submarine cable, £284. *Rio Gallegos:* Elec. machinery, £85.
CANADA.—*Halifax:* Wire and cable, £6,240. *St. John's:* Unenumerated, £361.
EGYPT.—*Aden:* Elec. machinery, £48.
MALTA.—Telegraph material, £67; elec. submarine cable, £900.
GIBRALTAR.—Unenumerated, £175.
WEST INDIES.—*Trinidad:* Unenumerated, £13
INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £23; elec. machinery, £1,588; telegraph material, £276; unmeunerated, £1,143. *Calcutta:* Elec. machinery, £261; unenumerated, £1,340. *Ceylon:* Wire and cable, £24; unenumerated, £101. *Madras:* Elec. machinery, £285; wire and cable, £30; unenumerated, £275. *Karachi:* Unenumerated, £87. *Penang:* Unenumerated, £167. *Port Swettenham:* Unenumerated, £202. *Singapore:* Wire and cable, £629; telegraph material, £302; unenumerated, £246. *Bankok:* Unenumerated, £81.
CHINA.—*Shanghai:* Wire and cable, £493; unenumerated, £1,488. *Hongkong:* Elec. machinery, £114; wire and cable, £10; unenumerated, £120.
JAPAN.—*Kobe:* Wire and Cable, £32.
JAVA.—*Sourabaya:* Unenumerated, £14.
NORWAY.—*Bergen:* Unenumerated, £346.
FRANCE.—*Paris:* Unenumerated, £892. *Boulogne:* Telegraph material, £182; unenumerated, £188. *Havre:* Telegraph material, £456. *Dunkirk:* Unenumerated, £23. *Dieppe:* Unenumerated, £1,359.
CHANNEL ISLANDS.—Unenumerated, £134.
RUSSIA.—*Vladivostock:* Elec. machinery, £1,000.
SPAIN.—*Barcelona:* Elec. machinery, £35; unenumerated, £80.
PORTUGAL.—*Lisbon:* Wire and cable, £1,204; telegraph material, £277; unenumerated, £92.

FOREIGN GOODS (duty paid and free).

Melbourne: Unenumerated, £816. *Sydney:* Unenumerated, £15. *Wellington:* Unenumerated, £52. *Calcutta:* Unenumerated, £285. *Paris:* Elec. machinery, £784; unenumerated, £10. *Madras:* Unenumerated, £230. *Cape Town:* Elec. cables, £88; unenumerated, £163. *Durban:* Unenumerated, £50. *East London:* Unenumerated, £51. *Buenos Ayres:* Unenumerated, £113. *Oporto:* Unenumerated, £11. *Shanghai;* Elec. lamps, £698. *Tocopilla:* Unenumerated, £59. *Adelaide:* Elec. lamps, £260, *Sydney:* Elec. lamps, £1,320. *Wellington:* Elec. lamps, £120.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

EDUCATIONAL NOTES.

Huddersfield Technical College.—The Corporation have decided to extend the chemistry department of the Municipal Technical College, with a view to training more students to feed the scientific and practical departments of British Dyes, Ltd.

University of Oxford.—A statute has been promulgated dividing the examination in chemistry in the final honour school of Natural Science into two parts.

Part I. will be an examination in the present subjects presented by the Board, and for Part II. candidates will be required to present records of experimental investigations carried out under the supervision of the University professors or other persons approved by the Board of the Faculty of Natural Science.

BUSINESS NOTICES.

The partnership between Geo. Hy. Hay, Walter Wm. Symper and Wm. A. Jones (trading as Sparkes Motor Garage), electrical and motor engineers, Dorset-mews North, St. Marylebone, London, N.W., has been dissolved.

Plant for Sale.—In an advertisement particulars are given of second-hand Parsons' steam turbo sets which are offered for sale.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Metallic Compositions Co. (Ltd.) is being wound up voluntarily. A meeting of creditors will take place at the office of the liquidator, Mr. J. H. Baker, 265, Gray's Inn road, London, W.C., on March 30.

A meeting to receive an account of the winding-up of the British Economical Lamp Co. (Ltd.) will be held on April 27 at Windsor House, Kingsway, London, W.C.

Mr. C. W. M. Kemp, 36, Walbrook, London, E.C, has been appointed controller to supervise the carrying out of the order to wind up the Harburg & Vienna India Rubber Co. (of Great Britain) (Ltd.). Claims to Mr. Kemp by March 30.

Claims against Jas. Wm. and Tom Whitaker Tattersall, electrical engineers, Kimberley-road, Willesden-lane, London, N.W., are to be sent by April 1 to Mr. E. S. Grey, Bankruptcy-buildings, London, W.C.

Mr. G. Bostock, 21, Ironmonger-lane, London, E.C., has been appointed controller to supervise the carrying out of the order to wind-up the Hanover Rubber Co. Claims to Mr. Bostock by April 19.

The first meeting of creditors of Jas. Reid Whitehouse, managing director of an electrical engineering company, 43, St. Andrew's-road, Golder's Green, Middlesex, will take place on March 29, at 14, Bedford-row, London, W.C., and the public examination on April 13 at the Town Hall, Barnet.

Wm. D. Birkett, factor of electrical goods, Arnside, Windsor-avenue, Whitley Bay, has been adjudicated bankrupt.

The discharge of Geo. J. T. J. Parfitt, consulting electrical engineer, 11, Priory-road, Keynsham, Bristol, is suspended for two years ending Feb. 25, 1918.

ELECTRICITY SUPPLY.

EXTENSIONS.

Aylesbury.—The Council have applied for sanction to a loan of £325 for electricity supply purposes.

Barnes.—The electrical engineer (Mr. C. S. Davidson) reports that it will shortly be necessary to extend the plant at the electricity works and that the present time appears to be appropriate for considering the type of generating plant to be employed.

Bradford.—The Electricity Committee are extending the mains from Apperley Bridge to the city boundary, at a cost of £400, and an agreement has been entered into with the Yorkshire Electric Power Co. for the supply of electricity in bulk through this extension.

Dover.—The Corporation have been authorised to borrow £3,814 for extensions of mains, &c.

Hackney (London).—The electrical engineer (Mr. L. L. Robinson) recommends the installation of an auxiliary battery for excitation purposes at an estimated cost of £465.

Poplar (London).—The L.C.C. has sanctioned a loan of £2,000 for linking up the electricity undertaking with that of Hackney, and it is proposed to advance this sum from the superannuation and pension funds, repayable within 25 years at current rate of interest.

For the December quarter there was an increase of 1,321,755 in the number of units sold, compared with the corresponding period in 1914. The net income from the sale of current shows an increase of 19·75 per cent., but the working expenses increased 50·5 per cent. The net surplus shows a decrease of £928.

Stafford.—The Council have secured land for the proposed extension of the electricity works.

Whitehaven.—It was reported to the Council last week that authority had been received for the manufacture of one 150 kw. generator for the electric generating station, but the order must not interfere with any war work which the manufacturers may have on hand.

Ald. BENNETT said the Electricity Committee would certainly have liked to have put down a larger set, but in the present position of things it would be utterly impossible to get delivery of such an order, owing to firms being engaged on war work. The reason for additional plant was that they were practically subject at any time to a breakdown; and what they were adding would only give them a total capacity of 346 kw. to meet a probable maximum demand next winter of 320 kw. It was unfortunate that they could not wait until after the war and have gone in for a larger generating set; but they were bound to act in time to provide for delays, &c. It would be impossible to get a loan, and the expenditure would have to come out of revenue.

GENERAL.

Abertillery.—The Council have increased the charges for electrical energy; the lighting rate has been advanced 1d. a unit and the power and heating scale proportionately.

Bray. The salary of the electrical engineer (Mr. W. J. M. Sowter) has been increased by £40 per annum.

Edinburgh.—On Monday the Electric Lighting Committee considered estimates for the structural and steel work of the new electric

power station at Portobello, and the Council are recommended to accept estimates amounting to £30,000.

Torquay.—The L.G. Board have recently sanctioned loans amounting to £8,646 for extensions of the electric supply mains, &c., and £3,252 for new machinery.

City of London.—At the meeting of the Court of Common Council last week the Streets Committee reported on a communication of the Charing Cross, West End & City Electricity Supply Co., asking the Council not to oppose the company's application to the Board of Trade for consent under sec. 33 of their 1899 Act, to an increase of the maximum lighting rate in the City from 5d. to 5½d. per unit during the period of the war and for 12 months afterwards.

The committee recommended that, subject to the company giving an undertaking under their seal that such increase would not be continued beyond the period mentioned, no objection should be offered to the application. Mr. C. H. Collett opposed the recommendation on the ground that it was not in the public interest. He said that in many districts there had been no increase in the electricity charges. The war might go on for a very long time, and the citizens ought to be protected against an unknown quantity. When the war closed the electricity companies would be able to recover their losses.

Without further discussion, the Court declined to adopt the report.

The City of London Electric Lighting Co. has given notice that it reserves to itself the right to increase all charges for electricity supplied to an extent not exceeding 10 per cent. as from the date of meter readings taken on or about the 31st instant. This notice will not be operative until confirmed by a further notice, to be issued not later than the 30th prox.

Edinburgh.—In order to encourage the use of electrical energy for heating and cooking, an alternative method of charging has been adopted.

From May 15 consumers will be charged a fixed number of units per annum for lighting, this quantity being determined by the size of house and number of lamps regularly in use. All consumption recorded by the meter in excess of this fixed amount will be charged at the ordinary heating rate—*i.e.*, 1½d. per unit.

Electricity in Steel Works.—At a meeting of the Shelton Iron, Steel & Coal Co. (Ltd.) last week the managing director (Mr. W. Simons), giving a résumé of the past year's work, said various extensions and improvements had been made.

As part of the scheme they had asked the Coking Company to put down an electric power plant on their property, and the Shelton Company now had a very fine modern turbo-generating electric plant, which was generating electrical energy from the waste heat, and he thought they could safely say they could generate energy as cheaply as almost in any other plant in the country. Since the date when the Coking Company was formed they had reduced their coal consumption—which was a very important matter in a large works for raising steam and for heating purposes in various departments—by approximately 30 per cent., and during the same period they had more than doubled their output of steel without any addition to the pant, but by the improvements in the existing plant.

Hampstead (London).—Owing to the restricted lighting there will be an estimated deficit of £3,528 on the current year's working of the electric supply department, and it has been decided to increase the charges to consumers by 10 per cent. for 12 months as from Oct. 1 next.

Ilkeston.—At the last meeting of the Council it was decided to increase the charges for electrical energy after the current quarter.

Ripon.—The Corporation of Harrogate, which were recently asked by Ripon City Council to state their terms for a supply of electricity in bulk at the Ripon boundary, have replied that they cannot entertain the proposition, having regard to the necessary capital expenditure and the limited amount of electrical energy that would be required at present in Ripon.

Shoreditch (London).—The L.C.C. has sanctioned the borrowing of £1,500 for house services and £500 for meters.

Sutton.—The Council have authorised Callender's Cable & Construction Co. to increase the maximum charge for current supplied for lighting from 6d. to 7d. per unit for 12 months from the 31st inst.

TRACTION NOTES.

London County Council.—On Tuesday Mr. G. H. Hume was appointed Chairman, and Capt. Theodore Prestige Vice-Chairman of the Highway Committee.

Southend-on-Sea.—It is necessary to renew the overhead trolley wire on the whole of the Leigh section, the cost of which is estimated at £1,206.

The Tramways Committee has adjourned for six months the consideration of the offer received from the Loughborough Road Car Co. to dispose of an Edison electric 'bus for £1,100.

The L.G. Board has approved of the Council retaining and erecting for their own purpose two of the 200 kw. sets manufactured for the Leigh sub-station.

Swansea.—Last week the Council decided to enter into a fresh agreement with the Swansea Improvement & Tramways Co.

The Council are at present supplying the company with a portion of the electrical energy required for traction (about 509,000 units a year), but in future the company will take the whole of its supply from the municipal station.

In the course of the discussion the majority of the members expressed themselves satisfied with the arrangement, as it would mean economy and greater profits for the Corporation. In 26 years the tramways would pass over to the Corporation, and the acquisition of the power supply would be a great advantage.

EMPIRE NOTES.

Australasia.—The following particulars of New Zealand's imports of machinery, &c., in 1914 have been compiled by Mr. Wickham, who was until recently H.M. Trade Commisioner for New Zealand.

The totals (£731,960 from the United Kingdom and £1,234,279 from all countries) include, besides various kinds of machinery, engineers' tools and electric cables and insulating materials. Under the preferential tariff the imports from the United Kingdom amounted to £463,771, and under the general tariff to £268,189; from all countries the totals under the preferential and general tariffs were £636,264 and £598,015 respectively. Under the preferential tariff electrical machinery and accessories from the United Kingdom were £147,954, and from all countries £236,163. Under the general tariff electric cables and insulating materials amounted to £123,916 from the United Kingdom and from all countries £156,005. In every line of electrical goods the U.S.A. was the chief competitor to the U.K., Germany following at a long distance. Two-thirds of the generators, motors and transformers came from the U.K., and more than half of the lamps and fittings, but in the groups of machinery where no preferential duties apply the U.K. made a poor show. Apart from insulated electric cables, barely a third of the total was British. Telephones were consistently supplied from foreign works, which, Mr. Wickham says, might easily have been supplied from works in the U.K. Germany supplied about 12 per cent. of the insulated electric cable and wire.

Orbost (Victoria) Batter & Produce Co. is seeking permission of the supreme court to amend its memorandum of association to enable it to engage in the supply of electrical energy at Orbost, Newmerella and Marlo.

Wollongong (N.S.W.) Council have received tenders for three electric light plants. These were nearly £3,000 in excess of the estimate of the consulting engineer (Mr. J. B. Rumford). The matter has been referred back to the Lighting Committee with a view to arriving at a modified scheme.

Ti Kuiti (N.Z.) Council, having been unable to secure machinery to duplicate its electrical generating plant, it is probable that an effort will be made to obtain a supply of current from the Hora Hora Falls of the Waihi Gold Mining Co., about 50 miles away.

The Tasmanian Government will erect a step-down transformer at Bridgewater, and New Norfolk will be supplied with electricity by the hydro-electric department.

At a recent meeting of Sydney Council the Finance Committee recommended that £180 be spent on a system of electrically illuminated signals for summoning vehicles at the Town Hall.

The Metropolitan Board of Water Supply and Sewerage, Sydney, have decided to spend £1,186 on an electrical installation at the pipe head for operating cranes and screens and lighting the boosting station.

The Victorian Railway Department has appointed an economy board to curtail expenditure. The electrification scheme is to be restricted and various railway works are to be held over.

Melbourne City Council have adopted a scheme for the "hire-purchase wiring" of premises in the city, and for hiring out electric motors, heating and other current-consuming devices. Steps are to be taken to obtain the necessary statutory powers to enable effect to be given to the proposals.

The "Commonwealth Engineer" says the plant of the Castlemaine Electric Supply Co. was officially opened recently, and the contract with the Council for street lighting provides for 120 lamps. The generating plant comprises a Hornsby gas engine of 108 H.P. (with producer gas plant), coupled to a 40 kw. generator. The latter has been installed temporarily pending the arrival of a 60 kw. E.C.C. generator. A storage battery is also on order. A feature of the installation is the use of steel mains, rendered necessary owing to the high price of copper and the difficulty of obtaining supplies in time to carry out the contract. Mr. P. Simmons is engineer-in-charge and Mr. Geo. W. Stewart, of Melbourne, managing director and consulting engineer.

The inauguration of the public electric lighting at Coonamble (N.S.W.) took place recently. The plant cost between £7,000 and £8,000, and comprises a Cambridge gas producer (wood fuel), serving a 107 Dudbridge gas engine, direct coupled to a Siemen's generator. The system is direct current on the three-wire system, is supplied at 240 volts for lighting and 440 volts for power. There is a Tudor battery of 240 cells for a stand-by supply. There are 31 miles of cable carried on 240 poles. The lamps used for street lighting, of which there are 64, range from 100 c.p. to

200 c.p. on the outskirts of the town, 1,000 c.p. lamps being used in the main streets. The consulting engineers are Messrs. Karz, Macnicol & Co.

Mr. J. Harding has been granted an Order-in-Council for supplying electricity in Kingaroy (Queensland).

The Mudgee (N.S.W.) Electric Light Co. has placed an order with Thompson & Co. (Castlemaine) Ppty. for a 115 H.P. high-speed engine, to be direct coupled to a 75 H P. kw. Clayton-Joel dynamo.

Northcote (Victoria) electric lighting system earned a net profit of £143 during the year ended Sept. 30 last. Receipts were £3,267. Current is taken from the Melbourne Electric Supply Co.

As the steam pumping plant at Sale (Victoria) is no longer adequate for the water supply, it is being replaced by a pair of 48 B.H.P. Hornsby suction gas engines, belted to two-stage centrifugal pumps. It is understood that the plant will be utilised at a later date in connection with the electric lighting of the town.

A school of aviation for New South Wales is to be established, and arrangements have been made with Sydney University and Technical College for the immediate commencement of training. It is estimated that £11,000 will cover the expenditure on the buildings and that the annual upkeep will cost £6,000. The services of military officers will be utilised at the school when it will not interfere with their military duties

H.M. Trade Commissioner for Australia (Mr. G. T. Milne) has reported that the hydro-electric scheme of the Tasmanian Government will probably be completed by the end of this month or early in April. In order to bring the scheme to the notice of those desirous of taking power, the Government is carrying out a publicity campaign and has made arrangements to supply demands totalling about 9,000 H.P. Works for the manufacture of carbide of calcium are also projected.

It is considered that there will be an increased demand in Tasmania for electrical fittings and appliances, and it is suggested that the time is ripe for more active steps being taken by United Kingdom manufacturers of this class of goods to bring them to the notice of consumers. The Imperial Trade Correspondent at Hobart (Mr. A. H. Ashbolt) is willing to assist firms in the United Kingdom to secure the services of reliable firms in Tasmania who would be ready to undertake their representation. Communications to Mr. Ashbolt, 23, Old Wharf, Hobart.

Canada.—The chairman of the Ontario Hydro-Electric Commission (Sir Adam Beck) announces that the Commission again recommend reductions in charges for nearly 60 municipalities in the Niagara zone.

The recommendations relate to supplies of electric current for domestic and commercial consumption, and mean an average reduction to the consumer of about 10 per cent. Power rates are also generally reduced.

India.—The Government of Bengal has sent suggestions to the Indian Mining Association (Calcutta) with regard to the prevention of electrical accidents in mines, and has informed the Association that the rapid extension of high voltage plant throughout the Province has made it impossible for the Government's electrical inspectors to exercise proper supervision.

Simla Municipality has been encouraging the use of electric heaters by offering special rates, bringing the cost down to approximately that of coal fires, with the result that heating by electricity has become very popular.

The high cost and difficulty experienced in obtaining satisfactory radiators, &c., from England has, it is stated, led to the engineer-in-charge of the municipal electrical undertaking (Mr. F. L. Milne) experimenting in this direction, with the result that radiators, water-boilers and several other types of heating apparatus had been evolved to suit individual requirements of the public. The local-made heaters are reported to be favoured by the public to such an extent that the municipality cannot keep pace with the demand. "Several types have been standardised and they are produced at a cost of half to one third that of imported heaters." The municipality give the public the option of purchasing the heaters of or hiring them. A special tariff, which includes the hire of heater and current, is proving popular.

The new 500 kw. turbine set at the Simla hydro-electric works will soon be available. The contracts for the new machinery were placed just before the declaration of war in 1914.

The original installation consisted of three 270 kw. sets and the maximum demand during the season of 1915 was 575 kw. It is proposed to work up to a maximum demand of 825 kw., which will allow of the 500 kw. set being reserved as stand by and the remaining three 270 kw. sets running at 10 per cent. overload during the hour or two of peak.

United Kingdom Trade with Australia.—In accordance with the practice that has been established for H.M. Trade Commissioners in the British Self Governing Dominions to visit the United Kingdom officially from time to time it was recently arranged that H.M. Trade Commissioner for Australia (Mr. G. T. Milne) should pay an official visit to this country.

It is announced that Mr. Milne has now arrived, and is prepared to interview *by appointment* representatives of those firms who may be able to see him in London at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall street, E.C. He will afterwards visit such trade and industrial centres in the United Kingdom as it may appear most advantageous to visit in view of applications that may be received from firms in or near these centres and from Chambers of Commerce. Firms who may desire to interview Mr. Milne should apply as soon as possible to the Director, Commercial Intelligence Branch of the Board. The reference number (C.I.B. 4,266) to should be quoted.

Among the matters in Australia in regard to which Mr. Milne is prepared to give information and advice are the appointment of agents, methods of marketing and distribution, terms of payment, names of probable buyers of British goods, statistics of imports and rates of Customs duties. In addition, contracts open to tender, &c., the Commissioners also report to the Board periodically on the nature and extent of foreign competition and other matters of commercial interest, including changes in Customs duties and regulations, financial and trade conditions, changes in regard to means of transport, and legislation affecting trade and commerce; and they furnish periodically classified lists of importers and buyers in the Dominions.

FOREIGN NOTES.

Argentina.—The "Review of the River Plate" says a decree has been issued authorising the Direccion General de Correos y Telégrafos to renew for one year the contract with the United River Plate Telephone Co. for working the private installation at the central offices.

A telephone service has been inaugurated between Jacinto Arauz and Bernasconi (Pampa Central).

The inhabitants of San Jenaro (Province of Santa Fé) contemplate establishing electric supply works.

Exports to China.—The Kwang Tung Electric Supply Co. (Ltd.), Canton, has been added to the list of firms to which goods may be consigned.

Uruguay. The new electricity supply station at Punta del Este, the popular Uruguayan seaside resort, was inaugurated recently.

The Electric Light Co. of Mar del Plata recently threatened to suspend their service owing to the municipality having failed to redeem a promissory note in their favour for $50,000 m/n. (about £4,300).

MISCELLANEOUS NOTES.

Celluloid Factory Regulations.—Under the provisions of the London County Council (Celluloid, &c.) Act of 1915, which deals with celluloid factories and stores, cinematograph films, &c., and comes into operation on April 1 next, it will not be lawful for premises to be used as a raw celluloid factory until approval in writing has been obtained from the authorities.

Customs Duties.—A Law dated Dec. 29 last contains the following provisions regarding customs duty on imports into Peru :—

The duty on the following goods (formerly duty free) is 10 per cent. *ad val.*: Tin (bars and sheets); lead (bars); copper, brass or bronze (bars and sheets); asbestos; steam boilers; tram or railway cars with motors; belting (cotton hemp, leather and rubber); injectors and ejectors; cranes.

The duty on the following is 5 per cent. *ad val.*: Zinc (bars); iron sheets (3 mm. to 15 mm. in thickness); steel wire; round wire or wire resembling ribbon.

On machines up to 100 kilos gross the duty is 10 centavos per kilo (10s. 2d. per cwt.); 100 to 5,000 kilos gross, 5 centavos per kilo (5s. 1d. per cwt.); over 5,000 kilos, 2 centavos per kilo (2s. 0½d. per cwt.).

Electrical Trades' Benevolent Institution.—We are informed that the annual general meeting of this Institution will be held at the Institution of Electrical Engineers, Victoria Embankment, on Monday, the 27th inst., at 2:30 p.m.

Military Exemption Applications.—At Gloucester last week the city electrical engineer (Mr. F. H. Corson) asked for the exemption of four employees of the electric supply department of the Corporation.

One of the claimants was exempt by reason of his occupation, another was considered to be indispensable and was given until Sept. 30. Of the other two, one, a storekeeper, was given until Sept. 30, and the other, a motorman, was given until April 15.

At Haslingden on the 16th inst., an electrician to cotton manufacturers claimed exemption as he was the only employee who could look after the electric motors. He had been engaged in munition making, obtaining a certificate from the Minister of Munitions. Application was refused.

At Bury St. Edmunds last week the manager of the electricity works and the "chief working electrician" were exempted so long as they continue in their present employment.

At Wigan a meter inspector and tester of installations was allowed three months.

More Enemy Firms Wound-up. The Board of Trade have now wound up 62 firms or companies controlled by alien enemies.

In addition to those given in our last issue, the following have been wound up: A. & G. Company, and Otto Rosenberg, 4, Charles street, Hatton Garden, E.C. (agents for Allgemeine Elektricitäts Gesellschaft); Australian Metal Co. (Ltd.), 2, Metal Exchange buildings, Leadenhall avenue, London, E.C.; Bronze-Farbenwerk Aktiengesellschaft vorm Carl Schlenk, 14, Aldersgate street, London, E.C.; Carbonite Synd. (Ltd.), 220, Winchester House, London, E.C.; Continental Tyre and Rubber Co. (Great Britain), Ltd., Thurlow place, S.W.; and Eschek, Ltd., 91/93, Bishopsgate, E.C., dealers in electrical carbons.

Motor Transport Year Book and Directory, 1916.—The motor industry is well provided with technical and practical handbooks, but hitherto there has been no financial and descriptive record of motor transport undertakings and the associated motor manufacturing concerns. This gap has been filled by the "Motor Transport Year Book and Directory, 1916," which the Electrical Press (Ltd.), 13-16, Fisher-st., Holborn, W.C, will publish shortly at 10s. 6d. net.

Statistical and other information is given regarding 350 motor transport undertakings and 300 motor manufacturing firms. A list of motor public service undertakings is given in alphabetical order according to district served; and the directory section includes the names and addresses of nearly 2,000 directors and officials of these undertakings.

Trading with the Enemy.—It is announced in an advertisement in another column that notice must be given to the Public Trustee, Mr. C. J. Stewart, Public Trustee Office, Kingsway, London, W.C., of: (1) Shares in firms or companies held by enemies; (2) property held in any capacity for enemies; (3) all bank balances held for enemies; (4) debts of £50 or upwards due to enemies. An enemy is any firm or person, irrespective of nationality, residing in or carrying on business in enemy territory.

TENDERS INVITED.

Arc Lamp Carbons.

Tenders are invited for the supply of 533,000 Arc Lamp Carbons to the City of MELBOURNE (Australia). Tender form copy of specification, conditions of contract, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders are to be sent by noon April 11. *See also an advertisement.*

Piping, Valves, &c.

MANCHESTER Electricity Committee require tenders by 10 a.m. April 1 for Low-pressure Water and Exhaust Steam Pipes, Valves, &c., and Valves for Circulating Water Pipes for Stuart-street station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Electrical and General Stores

DUNDEE Corporation require tenders by 9 a.m. March 29 for 12 months' supply of Meters and Electrical and General Stores. Specifications, &c., from the Electricity Department, Dudhope Crescent-road, Dundee.

MANCHESTER Guardians require tenders by March 29 for the completion of the Electric Light Installation at the Withington Institution. Specification from Mr. F. H. Overmann, 49, King-street, Manchester.

LIVERPOOL Select Vestry require tenders by 10 a.m. March 27 for supply of Electrical Fittings. Forms of tender from the Clerk, Brownlow-hill, Liverpool.

AYLESBURY Electricity Committee require tenders by March 25 for year's supply of Fuel and Lubricating Oils. Tenders to the Clerk of the Council.

Tenders are wanted by April 3 for six months' supply of Electric Fittings, Oils and Paints, &c., to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the Clerk and Treasurer, 19, Heriot-row, Edinburgh.

RATHMINES (Co. Dublin) Urban Council require tenders by 10 a.m. March 27 for 12 months' supply of House Service Cable, House Service and Fuse Boxes and Meters. Specification, &c., from the electrical engineer.

TOXTETH PARK Guardians require tenders by 10 a.m. March 27 for three months' Electrical Supplies. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

BRAY (Co. Wicklow) Urban Council require tenders by 8 p.m. April 4 for Stores for the electric light works and general stores. Schedules, &c., from the Clerk.

Meters.

SOUTHAMPTON Corporation want tenders for 12 months' supply of British-made Electricity Meters. Forms, &c., from the Borough Electrical Engineer.

Turbo-Alternator, Gas Producer Plant, &c.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

WANGANUI (N.Z.) Borough Council require tenders by noon May 9 for the supply and erection of Additional Plant at their tramway power house, including Pressure-type Gas Producer Plant, Gas Engine, Electric Generator and Switchgear. Specification, &c., from the Town Clerk.

Tramcars and Electrical Equipment.

DUNEDIN (N.Z.) City Council require tenders by 5 p.m. May 17 for six Electric Tramcars and sections of Cars (Bodies, Electrical Equipments and Trucks). Specifications, &c., from the Town Hall, Dunedin.

Main Switches, Fuses, &c.

The COMMISSIONERS OF H.M. WORKS, &c., are prepared to receive tenders for the supply of Main Switches, Main Fuses, Switch Fuses and Fuse Boards during one year from April 1. Forms of tender, &c., from the Controller of Supplies, 18, Queen Anne's Gate, S.W., and tenders (by 11 a.m. March 24) to the Secretary, H.M. Office of Works, Storey's Gate, S.W.

Varnish Impregnating Apparatus and Storage Battery.

The Victorian Railway Commissioners, Spencer-street, Melbourne, require tenders by 11 a.m. April 19 for the supply and erection of a Complete Plant for Impregnating Electrical Apparatus with Insulating Varnishes and Solid Compounds (Contract No. 29,678.); also a 1,000 Ampere-hour Storage Battery (Contract No. 29,743). Specifications, forms of tender, &c., from the offices of the Commissioners.

Telegraph and Telephone Material, &c.

The LANCASHIRE & YORKSHIRE RAILWAY Co. require tenders by 10 a.m. March 30 for 12 months' supply of Signal, Telegraph and Electric Fittings and Wires, Metals, Bolts, and Nuts, &c. Forms of tender from the Stores Dept., Osborne-street, Manchester.

EDINBURGH Corporation want tenders by 10 a.m. April 1 for one year's maintenance of Telephone and Electric Bell Installations for the department of the Superintendent of Works; and for one year's supply of Electrical Material, Engineers' Stores, Metals, Oils, &c., for the Electrical Engineer's Department. Forms may be obtained from the Superintendent of Works and the Electrical Engineer respectively.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (Schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General.

Submarine Electric Cables.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

TENDERS RECEIVED AND ACCEPTED.

BARNES.—The Council have placed a contract with the Tudor Accumulator Co. for the maintenance of the storage battery for 10 years at £135 per annum.

BARROW.—The Council have accepted the tender of the British Thomson-Houston Co. for a rotary converter and switchgear, at £2,760.

HORSHAM.—The Council have placed an order with the Electrical Apparatus Co. for 12 months' supply of meters.

MARYLEBONE (LONDON).—The Borough Council have accepted the tender of E. Green & Sons for the supply and erection of an economiser.

SOUTHEND.—The tender of J. Brown & Co. for the supply of 64 steel tyres, at £37. 10s. per ton, has been accepted by the Council.

COLCHESTER.—The Tramways Committee have accepted the following tenders for annual supplies :—

Williams & Co., ironmongery and general stores, oils, &c.: G. W. Allsop and P. R. Jackson & Co., electrical equipment, cars (for three months); British Insulated & Helsby Cables, overhead equipment (for three months); L. Andrews & Co., rubber and fibre (three months); Stanford & Co., castings (three months).

SUNDERLAND.—The following tenders have been accepted for annual supplies :—

Penman Metallic Packing & Engineering Co., metallic packing; Ferranti (Ltd.), e.h.t. switchgear; Willans & Robinson, governor valves; Armstrong, Addison & Co., creosoted wood troughing, &c.

WHITEHAVEN.—The following contracts for annual supplies have been placed by the Corporation :—

Doulton & Co., earthenware troughs for electrical purposes; Vacuum Oil Co., cylinder and crank chamber oil; Heathcote & Son, c.i. surface boxes; W. T. Henley's Telegraph Works Co., tapes; Dussek Bitumen Co., bitumen.

BERMONDSEY (LONDON).—The Council are recommended to accept the quotation of Chamberlain & Hookham for the annual supply of meters, and that of Venner Time Switch (Ltd.) for Type "B" time switches.

BARNSLEY.—The Corporation are recommended to accept the tender of the British Westinghouse Co. for additional generating plant at £5,146.

WALTHAMSTOW.—The Urban Council is recommended to accept the offers of the following firms to renew their contracts for annual supplies :—

Dussek Bitumen Co., joint-box compound; Chamberlain & Hookham, meters; General Electric Co., Cryselco (Ltd.) and Electrical Mfg. Supplies Co., carbon filament lamps; Geo. Angus & Co., rubber insertion; Vacuum Oil Co., cylinder oil, crank chamber oil and D.T.E. turbine oil; General Electric Co., tramway lamps; G. Angus & Co., rubber packing; W. Wood & Co., trolley heads; Anti-Attrition Metal Co., trolley wheels; Docker Bros., R. Kearsley & Co. and L. Berger & Co., paints and varnishes.

For other articles quotations will be obtained as required.

MELBOURNE (VICTORIA).—The Council have accepted the following tenders :—

Babcock & Wilcox, steel pipes, bends and valves, £465; British Westinghouse Electric & Mfg. Co., two d.c. motors, &c., £176. 10s.; British General Electric Co., one a.c. motor, &c., £131. 10s.

SYDNEY (N.S.W.)—The Electric Lighting Committee have recommended the Council to accept the following tenders :—

(*a*) H.t. cable-testing outfit (spec. 423), Australian General Electric Co., section "A," £495; section "B," (alternative tender), £621. 10s.; section "C," £785; section "D," £91. 10s. (spare terminals included). (*b*) Weather-proof copper cable (spec. 425), British Insulated & Helsby Cables, at the following rate per lb.: 7/20, 1s. 1¼d.; 7/18, 1s. ⅛d.; 7/16, 1s. 1⅛d.; 7/14, 1s. 1⅛d.; 19/16, 1s. 1d.; 19/14, 1s. 1d. Per cent. per £ variation in price of copper (price, &c., based on £90 per ton), 7/20, 0·53; 7/18, 0·54; 7/16, 0·54; 7/14, 0·64; 19/16, 0·65; 19/14, 0·69. Total cost of cable, £690.

The Committee also recommended the tender of N. Guthridge (Ltd.) for a Bruce Peebles 2,000 kw. rotary converter at £8,237 be accepted, and that the Council's resolution of Sept. 7, 1915, to accept the tender of the Westinghouse Brake Co. for a 2,000 kw motor converter be rescinded; that a contract be entered into with the British Westinghouse Co. for a steam turbine to drive an alternator (already supplied by the Australian Metal Co.) at 5,000 kw. normal or 6,250 kw. overload at £8,925 and spare parts £430; and that an order for overhauling No. 9 steam turbine be given to Willans & Robinson, the cost (consisting of the actual wages of the men, plus 15 per cent.) being estimated at £2,000.

The Committee also recommended that, with regard to the acceptance of tenders for motors for hiring out, sections "A" and "E" (spec. 382), referred back from Council of Nov. 16, 1915, approval be given for the acceptance of tenders, as follows: Section "A," Australian General Electric Co. Tender "A" (motors) for motors manufactured by General Electric Co., U.S.A., and tender "C" (starters) for starters manufactured by British Thomson-Houston Co.; Section "E," Australian General Electric Co. Tender "A," for motors manufactured by the General Electric Co., U.S.A., and tender "A" (starters) for starters manufactured by the General Electric Co., U.S.A.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

City of London Electric Lighting Co. (Ltd.)

The ordinary general meeting of this Company was held on Wednesday, Mr FREDERICK W. REYNOLDS presiding.

The SECRETARY (Mr. A. F. Harrison), having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, Mr. Braithwaite, unfortunately has had to go to America on very urgent business, and he wishes me to express his very great regret that he cannot be at our meeting to-day. I am glad to say that he has arrived there safely. I have also to explain the absence of Major the Marquess of Winchester. Probably, most of you know that the Marquess served for over three months in the first-line trenches. He was one of the very first to take service. I have ascertained that he is enjoying most excellent health despite the fatigue consequent upon the very onerous duties which he is performing as the Commandant of a base depot in France. I am sure that you will all wish him a safe and happy return after this terrible war ceases. You will observe that capital expenditure for the year has fallen to £26,000, or about half the usual amount. We hope that for the year 1916 it will be still less, as, of course, we are making every endeavour to reduce expenditure in all directions. We have written off nearly £31,000, and the net result is a reduction of about £5,000 in our capital expenditure at the end of the year. A considerable portion of the sum written off represents the value of old street lighting equipment which has now been replaced by the new system referred to in the report. Under normal circumstances the winter of 1914 would, as we hoped, have brought us many expressions of grateful appreciation for the vast improvement effected by the provision of this new system of lighting, but as you know, its brilliance has been temporarily eclipsed by lighting restrictions. I need hardly say that the dim glimmer which now makes visible the darkness of our City streets is very far removed from the warm brightness which will be there as soon as we are permitted to remove from the globes the coating of black paint in which they are now enshrouded. I see no object in giving you a detailed comparison of revenue and working expenses, as it is quite clear that in such abnormal times such a comparison can be of no real value. Everything that can be done to produce economical working is being done, and we hope that there will be some limit to the rise in prices which is so seriously affecting our business. Our chief difficulty is in regard to coal. The price has continued to rise (it is now 100 per cent. more than before the war, chiefly by reason of the increased shipping rates), and supplies have at times been exceedingly difficult to obtain. For 1915 our coal cost is £14,000 more, or about 40 per cent. more than for 1914. There is no prospect of early relief—rather the certainty of still greater expense in the present year—and therefore we must look forward to another and still larger increase in this item during 1916. Our accounts show that we are no believers in the policy of raising prices in such times as these until we have actually felt the effect of the increased cost of production, and we can claim without fear of contradiction that the time has come when we must ask consumers of electricity to take a further share of the burden, pointing out to them that this company is in no way seeking enhanced profit, but that its shareholders, both last year and this year, have submitted voluntarily to a reduction in their incomes before increasing the price of electricity. That is a principle which is applied compulsorily in the case of gas companies, except that usually the reduction in the rate of dividend follows the increase in the price of gas. We have, therefore, just given public notice of our intention to increase the price of electricity by 10 per cent. after the end of this month.

The net working result for the past year shows the balance to be about £16,000 less than a year ago. We propose to distribute £11,000 less in dividends and to provide the balance of £5,000 by reducing the carry forward to £18,000. Our chairman has on previous occasions pointed out to you that our liberal carry forward constitutes a dividend equalisation fund, and we think that the present is eminently a time when such a fund may rightly be drawn upon.

At the present time there are 168 members of the staff serving their King and country. You will see with much regret that four of them have been killed and nine wounded, and I am sure that your sympathy will go out to their relatives and friends. We have made a rule that no member of the staff who has gone to the Front shall be any pecuniary loser by doing so, and very great care and attention has been given to all these cases by our managing directors, Mr. Bailey and Mr. Bull. I now move: "That the action of the Board in supplementing the service pay of members of the Company's staff and workmen who have joined or may join His Majesty's Forces be and is hereby approved and confirmed, and that the Board be authorised to continue such payments for so long as in their discretion they may consider expedient."

Mr. J. T. REYNELL (a shareholder) seconded the motion, which was carried unanimously.

The CHAIRMAN then moved the adoption of the report and statement of accounts.

Mr. FRANK BAILEY seconded the motion.

Mr. JOHN HEDGES criticised certain items in the accounts and referred to an entry in the capital account about artisans' dwellings at Bankside.

In reply, the CHAIRMAN said, in regard to the artisans' dwellings, he could not speak very favourably as to the return on them, but they had to build those dwellings—it was compulsory. The local authority insisted on their doing so. They should not have built them with a view to getting a good return on them, for artisans generally are being well paid and they now live in the suburbs. After answering the other points raised by Mr. Hedges the motion was carried unanimously and the dividends as recommended were approved.

The retiring directors, Major the Marquess of Winchester and Sir David Lionel Salomons, Bart., were unanimously re-elected, and the auditors, Messrs. W. H. Pannell & Co. were also re-elected, and votes of thanks to the chairman and the staff terminated the proceedings.

Metropolitan Electric Supply Co. (Ltd.)

The ordinary general meeting was held on Wednesday, the Chairman (Mr. W. HARRISON CRIPPS) presiding.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said that the capital expenditure had now reached a total of £2,258,600, an increase of £30,142 over the preceding year. A large proportion of that amount had been spent in developing their rapidly-growing districts in the West, and, of course, was not yet fully productive. The bank loan had been reduced from £205,000 to £140,000. In 1914 the gross revenue was £215,500, and last year £229,200, or an increase of £14,000. That figure was certainly satisfactory, seeing that they had lost 20 per cent. of their lighting due to the restrictions. Notwithstanding that loss—which might be estimated at about £30,000 gross, and which they might hope to recover after the war—and largely increased costs, the raising of their charges by 10 per cent., and the better prices for power had given them a gross increase of £14,000, which, after paying the large extra cost, still left a small net increase. The directors hoped that the shareholders would be pleased to find that the company had more than held its own during the past disastrous war year. They had been more fortunate than their immediate neighbours, and the company was the only Western undertaking to show an actual increase of net revenue. The loss of light was compensated by a large increase of power and heating. During the lost few years the power load had more than trebled itself, and it was now considerably larger than the light supply. It was increasing rapidly, and would, with the readjusted scale of prices, be an increasing source of net revenue. In 1914 the costs amounted to £114,600, but last year they increased to £127,000. That was practically entirely due to the great rise in the price of coal. The coal question had caused the directors considerable anxiety, as not only was the price some 50 per cent. higher than it had been in ordinary times, but the coal received was of an inferior quality, and was obtained with the utmost difficulty. The reserve fund stood at the substantial amount of £337,358, after having written off the loss sustained on the realisation of certain investments. The sum now carried to resvere was the largest ever yet put by out of revenue, the amount being £27,000, against £22,000 last year. The broad thought it prudent to strengthen the reserve against unknown contingencies in this war year rather than pay the money away in dividend. After deducting all costs and paying debenture, loan and preference interest, there remained £61,977 to be dealt with, against £60,795 in 1914. The sum of £10,000 was paid as an interim dividend in August last, and the directors now suggested that a further sum of £20,000 should be distributed, making a dividend of 3 per cent. for the year. The balance carried forward was £4,977, against £3,795 brought in. The company had increased its output during the past year by no less than 2,347,634 units, supplied for power and heat, an increase of 26 per cent., and the directors estimated that at the end of the present month they would have generated 1,500,000 more units than in the corresponding quarter of 1915. The power units were sold at a far lower price than those for lighting. At the low charges made the margin of profit was small, and a fraction of a penny made all the difference between a profit and a loss, but he could assure the shareholders that the charges were now on a satisfactory footing. They could not forecast whether at the end of the war the demand for power would be increased or diminished, but they could confidently expect, with the removal of restrictions, to get back much of the £30,000 gross loss in light. With the cessation of the war, the directors looked forward with the greatest confidence to the future. The Board greatly regretted the resignation during the year of two of their colleagues—namely, Lord Avebury and Sir James Pender; but they had fortunately secured the services of Mr. Geoffrey Blackwell and Mr. G. A. Moncrieff. Mr. P. D. Tuckett, who was also appointed a director at the same time as those latter gentlemen, was unable to be present at any of the Board meetings until his return from America in January, and resigned his appointment after the second meeting he attended.

The Chairman then dealt with the present position and management of the Company. The shareholders had had a circular from a section of their number asking for a committee of inquiry into the management of the Company's affairs. The circular was signed by five shareholders, two of whom were old shareholders and had large interests in the undertaking; but it was difficult to see why any shareholders who had recently acquired an interest in the Company should sign a circular stating "that the time had come when they should take steps to protect their own interests." In his opinion the circular was neither fair nor accurate. It suggested that the drop in dividend from 10 per cent. to 3 per cent. was a consequence of the Board's policy, and a reason why three directors had thought fit to resign. Well, the reasons given by the resigning directors in their letters to the Board mentioned nothing whatever about the fall in dividend. They resigned, according to their own statements, for quite a different reason—namely, their dissatisfaction with the rearrangement of the general management and engineering departments. He wished to know also why the unique year of 1905 was selected for comparison with the present war year. The year 1905 was the last year in which they had the advantage of the Marylebone undertaking. In that year the gross revenue of the Company was £269,000. In the following year the Marylebone business, which had been sold, ceased to be any part of the undertaking; the revenue fell to £175,600, and the net loss was about £60,000, leaving approximately 4½ per cent. for the dividend of 1906. That dividend, however, with the consent of the shareholders, was increased by taking a certain amount from the sum set aside from the Marylebone award for the purpose of equalising dividends. The sudden loss of profits had, of course, been foreseen, and the most important point that the arbitrator had to decide was what compensation the shareholders would receive. The arbitrator apparently assessed the capitalised value of that loss at £662,500, and that sum was paid in cash to the shareholders. Therefore, they had had no niggardly compensation for a large part of the loss of their 10 per cent. dividend. The fair and just way of considering the progress of the company was to take the year 1906, for that was the first year in which conditions were similar to the present time. In the years 1912-13 there was a gradual improvement as the large amount of capital spent in the Western areas fructified. Then came the war, with their great loss of over £30,000 in light and an enormous rise in the cost of production. Although, however, they were slightly improving their position in 1914 before the war, shareholders should not think for a moment that all the Board were satisfied with the position. Some of them, assisted by the company's auditors, went into the whole of the figures involved in the various contracts, and came to the conclusion that they were losing heavily on some of them. The Board, of course, was responsible for the whole of those contracts, but they had relied absolutely on the figures and advice of the management. Some of the contracts were made at a time when the cost of production and the cost of material were very different from what they had become in 1914. Unfortunately those estimates in many cases did not turn out as anticipated. They had urged a complete re-arrangement of the charges and conditions as the contracts fell in, in order to meet the increasing costs and leave a fair profit, and it was unanimously decided last July that the Board thought it desirable to revert to the plan that had answered so well under the late Mr. Conacher and to set free the engineer to devote more time to his department and to again appoint a business manager. Accordingly, Capt. Rendell had been appointed general manager and was doing most valuable work for the Company. The Board had now completely re-organised the scale of charges commensurate with the increased cost of production, and that had been accomplished with scarcely any friction with the consumers, and no consumers of any importance had been lost, while many had largely increased their demand at the price now fixed. Most of the contracts had been revised and put on a more satisfactory footing, a new general manager had been appointed and the services of the engineer retained for the engineering department, and, finally, the present Board was absolutely united in their policy. As many shareholders, however, desired that a Committee of Investigation should be appointed to inquire into the administration of the affaris of the Company, the directors had no wish to oppose that desire. On the contrary, if it would in any degree lessen the anxiety of the shareholders, the directors would welcome such a proposal. He had, therefore, written to Mr. Gerald Buxton, the gentleman whose name appeared first upon the shareholders' circular, to the effect that they were willing to agree to a committee of three shareholders, not being present or past members of the Board, consisting of two shareholders nominated by the signatories of the circular and of Sir Melvill Beachcroft. A letter had been received from Mr. Gregory and Mr. Poole assenting to the Board's proposal. The Chairman concluded by moving the adoption of the report and the declaration of the dividend recommended.

Mr. GEOFFREY BLACKWELL seconded the resolution, which was carried.

Mr. R. GREGORY said when they found that there had been a steady decline in the dividend since 1905 and that there were serious differences of opinion on the board, they came to the conclusion that the affairs of the company were not altogether in a satisfactory state. They had received over 800 proxies, representing 70,000 votes, in favour of their proposal for the appointment of a committee.

Sir JOHN D. PENDER then moved: "That Mr. W. S. Poole, Mr. J. R. B. Gregory and Sir Melvill Beachcroft be appointed a committee to examine into the affairs of the company, and to report to the shareholders as to the past and future conduct of the business of the company, with power to examine the books, accounts and officers of the company, and employ such expert and other assistance as they may require for that purpose, and that the expenses of the committee and the expenses incidental to the circular of March 7, 1916, be paid out of the funds of the company, and that this meeting be adjourned until Tuesday, May 2, 1916, or such later date as may be arranged by the committee."

The motion was seconded by Mr. JOHNSTON.

Mr. P. D. TUCKETT criticised the policy of the directors, and stated that there were several features of the situation which were far from satisfactory. The main, over-riding issue which had compelled them to take action arose from the board's belief that the power load was unprofitable. That belief, he contended, was absolutely without justification.

The resolution was carried with one dissentient.

The auditors (Messrs. Deloitte, Plender, Griffiths & Co.) were re-elected, and a vote of thanks to the chairman concluded the proceedings.

AUTOMATIC TELEPHONE MFG. CO. (LTD.)—The profit for 1915 amounted to £41,868, and with £5256 brought forward, the total was £47,124. After deducting directors' fees, depreciation on patents, goodwill, buildings, plant and machinery, and writing off £3,500 for underwriting commission on shares, and £2,000 off preliminary expenses, and paying the dividend on the preference shares, the available balance is £21,174. The directors recommend payment of a dividend on the ordinary shares at rate of 4 per cent. (less tax) for the year, carrying forward £6,774. During the year several automatic exchanges have been completed and are working satisfactorily; others are steadily approaching completion, but owing to the war no new exchanges have been ordered, and the company's normal business is suffering accordingly. The factory is working almost entirely on Government work and is now a controlled establishment.

BEAULY ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the chairman (Mr. D. McGrath) said the company had made satisfactory progress during 1915. The equivalent of 110 lamps had been added, and the output had increased 10 per cent. In consequence of the regulations the street lighting had been reduced, with a consequent loss of revenue. Notwithstanding the increased costs due to high price of coal, &c., the profit was £140. After placing £75 to renewal reserve and paying a dividend of 6 per cent., a sum of £16 was carried forward.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week the chairman (Mr. A. H. Sanderson) explained that the drop in the ordinary dividend from from 7 to 6 per cent. was due to the lighting restrictions and to the increased cost of coal, &c. The lighting restrictions had been very strictly enforced in Bournemouth, and as they depended for the greater part of their revenue upon the supply of current for lighting, those restrictions had undoubtedly been responsible for the drop in their revenue receipts. The additional cost of coal and other increased charges were responsible for the increase in their charges. The directors had been compelled to increase the rates for the supply of electricity to consumers by 10 per cent. as from the commencement of the present year. The total capital expenditure under their Orders amounted to £490,623, against £487,949 a year ago. The increase was a net figure, and did not represent the expenditure for the year, as considerable sums had been written off for obsolescence of machinery, &c. By far the largest amount of capital expenditure during the year was on mains and meters, which were revenue-producing, and such expenditure was a sign of the expansion and vitality of the business. The Richmond (Surrey) Electric Light & Power Co., of which they held all the share capital, was making good progress, having decalred a dividend of 6 per cent. on the ordinary shares for the year, as for 1914. From the new generating plant at the Bourne Valley station they had derived considerable advantages. For the first three months of its working in 1914 the steam turbine plant produced a saving of 420 tons of coal, valued at over £400, and in the year under review it had reduced the coal consumption by a further 1,400 tons, valued at £1,800, which, with a reduction of £700 in the cost of repairs and maintenance, made a total saving of £2,500 in the year, or 25 per cent. of the capital cost of the plant. While the number of units sold for lighting during the year showed a reduction of 4½ per cent., the total output had increased by 4 per cent. In 1914 they sold 3,910,511 units, while in 1915 the number was 4,061,091. The applications for current received showed a small increase, but they were approximately the same for the corresponding period of the previous year.

BRITISH ALUMINIUM CO. (LTD.)—The profit for 1915, including amount brought forward, after making provision for excess profit duty and limitation of profit under control, and after charging amounts required for the service of the prior lien and debenture stocks, is £204,808, against £288,946, including £16,690 brought in. £50,000 has been set aside for depreciation (raising the fund to £250,000), £70,000 for reserve fund (against £56,000), a dividend of 7 per cent. on the ordinary shares is recommended (against 5 per cent. in 1914), and £24 791 (against £24,751) is carried forward.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—Mr. A. F. Berry, who presided at the meeting last week, stated that their profit and loss account showed that, despite increased work, they had reduced their general charges by about £1,400. They were adopting a conservative policy in recommending the distribution by way of dividend of only about one-half of the profits. He did not think they would be justified in paying more than at the corresponding time last year, but he hoped that when the war was over, and business had settled down, they might be able to resume what they regarded as their regular 10 per cent. ordinary dividend. The past year had been the most extraordinary in the history of the company. Prices of all materials had risen to unprecedented figures, while they had been under contract to supply machines at prices fixed before the outbreak of war. All difficulties had, however, been satisfactorily overcome. Great difficulties had been experienced in getting deliveries of raw materials and also in getting finished goods delivered. They had received official war service badges for the majority of their employees, but as far as possible they were making arrangements to release all single men that could be spared. It was only fair to say that they had charged no more for transformers, used so largely for war purposes, than they had charged for their products in ordinary times. As to their prospects, they had commenced the year 1916 with a little less in orders than at the beginning of 1915, when a lot of work was held over at the end of 1914, consequent on the war. Up to date their orders were about the same in extent as of the same period in 1915. At the moment Treaty cookers were looked upon by some as an economy, while others regarded them as luxuries. They were, however, improving designs and getting out fresh articles for which they believe there was a good demand. War experience had proved that the most convenient and economical way of driving machinery was by means of electrical power; war, by compelling the installation of electricity in so many factories, had put forward the clock of electrical development some five years, and they should reap the benefit from the fact that works, having had an opportunity of appreciating the value of electricity, would apply it still further.

BRITISH ENGINE, BOILER & ELECTRICAL INSURANCE CO. (LTD.)—At the recent meeting the chairman and managing director (Mr. R. Chas. Longridge) presided, and commented on the substantial growth in income from inspection charges and premiums in all the principal departments of business. This amounted to £117,112, against £112,465 in 1914, and, as this occurred in the first year of the management of Mr. Harry M. Longridge, had given the directors great satisfaction. The result was the more gratifying, having regard to the disturbance of business conditions and the absence of 44 of the staff serving with the Colours. The profit showed a slight reduction owing to increased cost of repairs and to a war bonus payment to staff. Provision was made for carrying £5,000 to reserve for current risks and writing £7,250 off investments and furniture, leaving £11,521, and, after providing for final dividend of 6s. and bonus of 4s. per share, the total funds amount to £177,025.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The profit for the year 1915 amounts to £295,132, and with £119,380 brought forward the total is £414,511. Deducting directors' and debenture trustees' fees and remuneration to works committee (£5,915), interest on first and second debenture stock (£32,500), depreciation on buildings, plant, &c. (£25,000) and special depreciation on plant and machinery (£10,000), transferring £50,000 to reserve account, £8,500 to special reserve account and £5,000 to first mortgage debenture stock redemption account, paying the dividend on the preference shares to Dec. 31, 1915 (£30,000) and the interim dividend on the ordinary shares to June 30, 1915 (£25,000), the balance available for dividend is £222,596. The directors recommend payment of a further dividend of 10s. per share on the ordinary shares, making with the interim dividend already paid a total of 15 per cent. for the year 1915, together with a bonus of 2½ per cent., which will absorb £62,500, carrying forward £160,696. The company was made a "controlled" establishment from Aug. 18, 1915. The volume of trade during the past year has been well maintained, the result being an increase in profit of £17,703.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1915 states that £3,000 has been transferred from reserve fund to net revenue and £9,656 appropriated to depreciation and sundry reserve accounts, and recommends a final dividend on the ordinary shares at rate of 11 per cent. per annum, making 10 per cent. for the year (less tax), carrying forward £6,011.

BRUCE PEEBLES & CO. (LTD.)—At the recent meeting the chairman (Mr. F. E. Andrew), in moving the adoption of the report, said they had considerably re-arranged their works and also added to their buildings and machinery. There was a popular idea that all Government orders carried an excessive amount of profit. That, at any rate as far as they were concerned, was a long way from being the case, and the margin on which they had accepted work had certainly been a moderate and most reasonable one.

CLYDE VALLEY ELECTRICAL POWER CO. (LTD.)—At the meeting on Wednesday it was reported that the profit for the half-year ended Dec. 31 was £47,466; amount brought in was £12,430, and £25,000 transferred to contingency fund for depreciation, &c. (making £150,000). It is recommended to transfer to special reserve £5,259, writing off balance of costs of Acts, 1901, 1904 and 1912 (£8,353), to pay dividend on preference shares to April 30, 1916 (£9,000), and to carry forward £12,613, increase of over £1,000. The amount carried to contingency fund has again been increased in view of the continued exceptional conditions. In the latter half of 1915 there was an increase of £31,400 in gross receipts and of £9,800 in net revenue. For the entire year the gross receipts were £199,500, compared with £148,400, and the net revenue £90,000, against £68,300. Of the available surplus £43,700 (or £18,700 more than in 1914) has been transferred to contingency fund; £18,400 (against £10,000) has been written off Parliamentary costs, thereby extinguishing that item; and £9,500 (£5,200) has been transferred to special reserve.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The accounts for the year 1915 show, after providing for the dividend on the preference shares, a balance of £46,941. 12s. 2d., which the directors propose to apportion as follows: Dividend on ordinary shares at 5 per cent. per annum, of which 2 per cent. was paid as an interim dividend on Oct. 1 last (£3,232. 15s.), and a bonus on ordinary shares of 2 per cent. (£1,293. 2s.); provision for depreciation of Stock Exchange securities (£5,231), placing £5,000 to reserve fund, and carrying forward £32,184. 15s. 2d., subject to a special taxation of profits for years 1914 and 1915. Both the dividend and bonus on the ordinary shares will be paid tax free. An amount of £10,000, balance of a loan of £30,000 from the Eastern Telegraph Co. has been paid off since the date of the last report. The company's cables and landing-lines in connection with them have continued in good working order throughout the year.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The profit during the year 1915 amounted to £161,109. 9s. 9d. Deducting directors' and auditors' fees, debenture interest, income tax and amount written off for depreciation on buildings and machinery (£56,585. 8s. 2d.) and adding £69,119. 18s. 6d. brought forward, the total is £173,643. 19s. 1od. The sum of £4,680. 2s. 6d. has been transferred to reserve in respect of depreciation of war loan and other trustee securities, £25,000 to reserve account, the year's dividend on the preference shares absorbed £9,000, and interim dividend on ordinary shares £10,000, leaving an available

balance of £125,263. 17s. 4d. The sum of £30,000 was voted to staff pension and benefit fund, and the directors recommend payment of a final dividend on the ordinary shares of 10 per cent. (less tax), making 15 per cent. for the year, and also a bonus of 10s. per share (less tax), which will require £40,000, leaving to be carried forward £55,263. 17s. 4d. A reserve has been made in the accounts in respect of the liability of the company for the years 1914 and 1915 for special taxation. It has been necessary to considerably increase the sum written off for depreciation on machinery, as much of the plant has been run night and day on Government work, and new machinery, some of which will be useless after the war, has been purchased at inflated prices. The shareholders will be asked to vote £30,000 to establish a staff pension and benefit fund. Of the company's employés 551 have joined H.M. Forces, and allowances, where necessary, have been made to their dependents.

P. R. JACKSON & CO. (LTD.)—The gross profit for 1915 was £18,050, and after payment of debenture interest, &c., and allowing for depreciation, and after adding amount brought forward, the balance is £12,561. An interim dividend for the June half-year on the cumulative preference shares was paid in October and the directors recommend a dividend for the second half-year and also a dividend of 7½ per cent. on the ordinary shares (against 6 per cent. in 1914), writing off goodwill account £3,000, leaving to be carried forward £3,750.

LONDON & SUBURBAN TRACTION CO. (LTD.)—The chairman (the Right Hon. C. B. Stuart-Wortley, K.C., M.P.) stated at the meeting last week that their income for the past year was £122,430, an increase of £3,851 over 1914. The full 5 per cent. dividends on the preference stock absorbed £80,158, leaving to be carried forward £3,482. The absence of any dividend on the ordinary stock brought home to them all the fact that in 1915 the country was at war during the whole year. There had been a great all-round increase in the prices of materials and the cost of labour. Coal by rail had gone up 13 per cent., while sea-borne coal had gone up 34 per cent.; timber 50 per cent., glass 90 per cent., copper 50 per cent., wood blocks 31 per cent., and steel tyres 20 per cent. All the subsidiary companies were interested in some of those commodities and some were interested in all. In some cases prices were still rising. Their companies had had to put up with irregular deliveries as well as enhanced prices. Besides the increased cost of labour the operating companies had had to contend with a great depletion in the numbers of their men. The war had kept all their subsidiary companies busy with duties which were more or less indispensable to the State. Some of them were daily carrying thousands of munition workers to and from their work, while others were supplying electric power to factories. The three companies that supplied light and power sold between them, in 1915, 42·3 millions of units, against 39·6 millions in 1914. On the three tramway companies the main effect of the war had been to reduce the number of car-miles run to an extent sufficient to increase the sum received per passenger in the face of a decrease in the number of passengers. The undistributed profits of their seven companies were £41,582 (£118,812, against £77,230) better in 1915 than in 1914, and had that sum been distributed in dividends it would have given 2 per cent. on the ordinary stock of the London & Suburban Co., so that in the second year of the war the position was a good deal better than it might have been.

LONDON UNITED TRAMWAYS (LTD.)—The operation of the company's undertaking during 1915 resulted in gross receipts amounting to £330,166. After adding balance from 1914, and deducting all expenses chargeable to revenue, including an appropriation of £25,000 to reserve for reconstruction and renewals, there remains £2,327. 6s. 11d., which the directors recommend should be carried forward. During the year the reconstruction of the line between Brentford and Hounslow, commenced in 1914, was completed. The entire cost of the work has been charged against reserve for reconstruction and renewals.

At the recent meeting the chairman (Mr. W. M. Acworth) said the advantage that should have accrued from reduced expenditure had been, in a measure, counterbalanced by the increased cost of material and by the granting of a war bonus to the employés. By the end of 1915 over 50 women were in their service, while up to the present time that number had increased to about 120. The women had proved themselves satisfactory, and he thought that before very long the number of their women conductors would be considerably increased. The increase in passengers was 1,711,000, while the decrease in car-mileage was 1¼ million miles.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—The gross profit for 1915 was £22,498. After debiting interest and London office expenses, making provision for debenture stock sinking fund, and transferring £6,000 to depreciation and renewal fund, there remains £11,031. With £3,258 brought forward the total is £14,288. 19s. 5d. It is proposed to appropriate £6,000 to payment of dividend of 6 per cent. per annum on the preference shares and £3,435. 12s. to payment of dividend of 6 per cent. per annum on the ordinary shares, to write off balance of cost of issue of new preference shares (£581) and to carry forward £4,272. The traffic receipts showed an increase of 6·4 per cent. upon 1914.

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.)—The annual meeting was recently held, when the chairman (Mr. W. J. New) said that during the year the load connected had increased from 815 kw. to 883 kw. There was a total of 307 H.P. in motors taking a supply from the company's mains. The revenue, after adding £767 brought forward, was £3,241, and after providing for £955 debenture interest, £2,286 was available for distribution. A dividend at rate of 3 per cent. per annum was declared, £900 was placed to reserve for renewal of plant, and £786 carried forward.

MERSEY RAILWAY CO.—At the recent meeting it was reported that the auditor had certified that the revenue available for paying interest on the debenture stocks amounted to £21,442, compared with £21,279 for 1914. Interest at 4 per cent. was paid on the 1866 stock, 3 per cent. on the 1871 and 1882 3·5 stocks, and 1 per cent. on the "B" debenture stock, the balance carried forward being £164. As the renewal fund was £22,066, and it seemed to them that they were able to maintain their works and plant in the best possible order, they could reduce the usual allocation of £2,000 to £1,000 a year, which they had done.

NORTHERN GENERAL TRANSPORT CO. (LTD.)—The revenue for 1915 amounted to £38,741. 5s. 7d. Adding £4,230. 3s. 10d. brought forward and deducting administration and general expenses, loan and debenture interest (£4,808), and a provision of £6,536 for renewals, £27,298 remains, of which £1,372 has been applied to sinking fund for redemption of debenture stock, and the directors recommend a dividend at rate of 6 per cent. for the year on the preference and ordinary shares, leaving to be carried forward £5,777.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO. (LTD.)—The accounts for 1915 show net revenue of £75,471, and with £4,676 brought forward the available sum is £87,214. After transferring £2,000 to debenture reserve fund and £15,000 to renewals reserve, a dividend of 6 per cent. and a bonus of 4 per cent. is recommended, carrying forward £6,013.

STEWARTS & LLOYDS (LTD.)—After setting aside £100,000 for depreciation, the directors recommend the following dividends for the half-year ended Dec. 31:—6 per cent. per annum on preference shares, 10 per cent. per annum on the preferred ordinary shares; and for year ended Dec. 31 dividend of 2s. and a bonus of 6d. per share on the deferred shares, placing £60,000 to general reserve, £10,000 to employés' benefit reserve, and carrying forward £100,000.

WEMYSS DISTRICT TRAMWAY CO.—Including balance brought forward, the profit for 1915 is £5,774, after paying interest on mortgage debenture stock and placing £200 to fund for redemption of that stock. The 6 per cent. preference dividend absorbed £1,746, and the directors propose a dividend of 7½ per cent. (less tax) on the ordinary shares and an additional 1½ per cent. on the preference shares; also to carry £2,000 to general reserve, and £940 forward. The traffic receipts are £14,062, against £15,845. So far as possible the company is employing women, and there are no male conductors.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES

R. BARTON, ADAMSON & CO. (LTD.) (143,235)—Reg. March 8, capital £2,000 in £1 shares, to carry on the business of manufacturers and repairers of motor and electric cars, vans, and motor and electric carriages of all kinds, aeroplanes and aircraft and components thereof, &c. Private company. First directors are R. Barton Adamson (managing director and secretary) and E. H. Stodart. Reg. office: Sandringham Works, Enfield Highway, Enfield, Middlesex.

CATON ELECTRIC SUPPLY CO. (LTD.)—(143,150.)—Reg. Feb. 29, capital £2,000 in £1 shares (1,000 6 per cent. cumulative preference), to carry on at Caton and elsewhere the business of an electric light and supply company. Private company. First directors are C. H. Best and N. A. Foster. Reg. office, 72, Market-street, Bradford.

COMELY & MORTON (LTD.) (143,202).—Reg. March 6, capital £2,000 in £1 shares, to carry on the business of mechanical engineers, manufacturers and designers of and dealers in oil, steam and gas engines, founders, electrical engineers, electricians, manufacturers of motor cycles and cars, &c., and to adopt an agreement with A. Comely. Private company. First directors are A. Comely and T. K. Morton (both permanent). Reg. office: Midland Garage, Belgrave-road, Torquay.

NOTTINGHAM ENGINEERING CO. (LTD.) (143,144.)—Reg. Feb. 28, capital £2,030 in £1 shares, to carry on the business of manufacturers of the component parts of machinery, aircraft and munitions of war, tool makers, electrical and mechanical engineers, &c. Private company. First directors are F. B. Johnson, J. King and G. Fisher.

UNITED BRITISH WOLFRAM CO. (LTD.) (143,162).—Reg. Feb. 25, capital £1,000 in £1 shares, to carry on the business indicated by the title. Private company. First directors are A. Argles and J. W. Bryan. Secretary: W. David. Reg. office: 34, King-street, Cheapside, E.C.

MORTGAGES AND CHARGES.

BOURTON-ON-THE-WATER ELECTRIC LIGHT & POWER CO. (LTD.)—Issues on various dates from Oct. 15, 1913, to Feb. 11, 1916, of £250 debentures, parts of a series of which particulars have already been filed.

FARINGDON ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on May 15, 1914, of £300 (as collateral security with bankers for loan), and on Feb. 11, 1916, of £1,100 debentures, parts of a series of which particulars have already been filed.

T. W. HEATH (LTD.)—Particulars of £1,000 debentures, created Jan. 14, 1916, have been filed, amount of present issue being £300. Property charged: Company's undertaking and property, present and future. No trustees.

RECEIVERSHIP.

"FLOAT" ELECTRIC CO. (LTD.)—Notice of appointment of W. J. Maxwell, 56, Moorgate-street, E.C., as receiver by Order of Court, dated Feb. 18, 1916, has been filed.

CITY NOTES.

MEMORANDA (March 22).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57⅜ Consols Pay Day, April 5. Stocks and Shares Ticket Days, March 28 and April 12. Pay Days, March 29 and April 13. Price of silver, 27⅞d.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—At an extraordinary meeting last week's resolutions were passed transferring the head offices and control of the company from London to Bombay.

BRAZILIAN TRACTION, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 1½ per cent. has been declared for the current quarter.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The board have decided to pay a dividend on the preference shares for the year ended Dec. 31, 1915, at rate of 7½ per cent.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—A quarterly dividend of 1¾ per cent. has been declared for the quarter ended March 31.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—A quarterly interim dividend of 2s. per share (payable March 31) has been declared.

HASTINGS & DISTRICT ELECTRIC TRAMWAY CO.—A dividend of 6 per cent. has been declared on the preference shares for the past year; £1,000 has been added to depreciation fund, £1,500 written off suspense account, and £766 carried forward.

ROBEY & CO. (LTD.)—The profit for 1915 was £40,266, against £27,191 in 1914, and after providing for depreciation, &c., and paying debenture interest, a dividend of 5 per cent. (tax free) is recommended, £28,170 being carried forward.

SCOTTISH TUBE CO. (LTD.)—A dividend of 5 per cent. has been declared on the ordinary shares for the year 1915.

VICTORIA FALLS & TRANSVAAL POWER CO. (LTD.)—The net earnings (including those of the Rand Mines Power Supply Co.) for the quarter ended December amounted to £190,295.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date, March 21, the following as the present basis prices of

New Metals.	per lb.
Solid Drawn Brass Tubes	17d.
Solid Drawn Copper Tubes	18½d.
Brazed Copper Tubes	18½d.
Brazed Brass Tubes	19d.
Brass Wire	16½d.
Copper Wire	18d.
Rolled Brass	16½d.
Brass Sheets	16½d.

	per ton.
Copper Sheets	£148 0 0
Spelter	£92 0 0

	per ton.
English Lead	£37 0 0
Antimony	Nominal.

Old Metals.	per ton.
Clean Copper Scrap	£102 0 0
Clean Brass Scrap	£62 0 0
Braziery Copper Scrap	£90 0 0
Old Lead	£29 0 0
Old Zinc	£70 0 0
Hollow Pewter	£120 0 0
Black Pewter	£80 0 0
Gun Metal	£87 0 0

Mr. A. Joseph, Earl-street, London-road, Southwark, London, S.E., quotes under date March 21, the following approximate prices of Scrap Metals:—

	per ton.
Aluminium Cuttings	£112 0 0
Clean Mixed Brass	£66 0 0
Clean Copper	£96 0 0
Braziery Copper	£80 0 0
Gun Metal	£80 0 0

	per ton.
Old Lead	£31 0 0
Tea Lead	£29 0 0
Old Zinc	£62 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

Mr. Joseph can supply solder at the following prices per ton: Plumber's Solder (in bar or strip), £80; Commercial Tinman's Solder, £115; Blowpipe Solder, £120.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, March 21. The greatest care is taken in compiling these figures but the difficulty of verification is now much increased.

Shs.	Last Dividend	Name.	Price, Tues., March 21.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9⅞	7 11 10	Mar, Sept
10	4½%	†Do. 4½% Cum. Pref.	9½	4 15 8	Feb, Aug
10	6%	†Do. 6% Cum. 2nd Pref.	10⅞	5 16 4	Feb Aug
5	10%	Brompton & Kensington Ord.	7⅛	7 1 7	Mar, Sept
5	7%	Do. 7% Pref.	7	5 0 0	Mar, Aug
St.	4%	Central Elec. Supp. C. Deb. St.	80	5 0 0	..
St.	4%	Charing Cross West End & City Debs.	79½	5 0 11	Jan, July
5	2/3	Do. 4½% Pref.	3	7 2 7	..
5	5%	Do. Ord.	3½	7 7 10	Aug, Feb
10	4½%	Do. City Pref.	7⅛	8 9 5	Jan, Dec
5	4%	Chelsea Elec. Supp. Co. Ord.	4½	4 6 6	Mar, Sept
St.	4½%	Do. do. Deb.	87	5 3 5	Jan, July
10	9%	City of London Elec. Lt. Ord.	15	7 11 7	Feb, Aug
10	6/0	Do. 6% Pref.	19⅞	5 15 0	Mar, July
St.	5%	Do. 5% Deb St.	97½	5 2 6	Jun, Dec
St.	4½%	Do. 4½% Debs.	87	5 12 6	Jun, Dec
10	7%	County of London Ord.	13⅛	6 11 9	Mar Sept
10	6%	Do. 6% Pref.	10	6 0 0	Feb, Aug
St.	4½%	Do. 1st Deb.	89	5 4 2	Jan, July
St.	4½%	Do. 2nd Deb.	87	4 12 9	My, Nov
St.	4½%	Edmundson's Elec. Supp. 4½% Debs.	75	6 0 0	July
5	7%	Kensington and Knightsbridge Ord.	14	7 0 0	Feb, Aug
St.	4%	Do. Deb St.	79½	5 1 5	Jan, July
5	6%	London Elec. Supp. 6% Pref.	41	7 10 0	..
St.	4%	Do. 4% Mort. Debs.	80	5 0 0	Jan, July
5	3½%	Metropolitan E. Supp. Ord.	2½	8 7 2	Mar, Aug
St.	4½%	Do. 1st Mort. Deb.	88	5 11 6	Jan, July
St.	5%	Midland Elec. Corpn. 1st Mort. Deb. St.	99	5 1 0	Jan, July
..	6%	Newcastle & Dist. E.L. 6% 2nd Deb.	99½	6 0 6	Mar, Sept
St.	5%	Newcastle-on-Tyne E.S. 5% 2nd Mt. Deb. St.	91⅛	5 9 3	Mar, Sept
1	6%	North Metropolitan E.P. Supp. 6% Pref.	1	6 0 0	Apl, Oct
4	5%	South London E.S. Ord.	3⅛†	6 10 7	Mar, Sept

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shs.	Dividend	Name.	Price, Tues., March 21.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	5⅛	6 17 8	Feb, Aug
5	7%	Do. do. Pref.	5⅛	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1⅛†	7 2 3	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5½	6 7 3	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80½	6 4 3	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	72½†	8 6 1	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	67⅜	5 10 10	..
St.	4%	Do. do. Assented Def. Ord.	67½	5 18 0	..
St.	4½%	Do. 4½% Pref.	99⅜	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93½	4 5 9	Jan, July
St.	4%	City & S. London Deb.	66	6 1 3	May, Nov
St.	5%	Do. Pref. 1896	62½†	8 0 0	Feb, Aug
10	1½%	London Electric Ry. Ord.	1¾†	6 13 4	Jan, July
St.	4%	Do. 4% Pref.	64½†	6 4 9	Mar, Sept
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23½	4 6 0	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74⅜	4 13 9	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82⅜	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83½	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	18	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	72†	6 5 0	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	108½	5 10 7	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	71½	5 11 11	Jan, July
St.	4%	Do. 4% Guar. Stock	68†	5 18 6	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2⅝	5 3 0	Apl, Oct
1	6%	Do. 6% Pref.	1½	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1⅜	4 4 3	Mar
100	5%	Do. Prior Lien Debs.	89½	5 13 0	Jan, July
1	6%	Do. 6% Pref.	⅞	6 15 3	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11	6 16 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5⅜	5 15 8	Jan, July
1	6%	British L.M.Ericsson Mfg. Cm. 6% Pref.	⅞†	6 15 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2½	6 13 4	April
100	6%	Do. 6% Prior Lien Debs.	102½	5 17 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	63	6 7 0	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11½	6 14 9	Jan, July
5	2/6	Do. 5% Pref.	4⅛	6 1 3	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	⅜	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	⅛	..	Feb, Aug
St.	4%	Do. 4% Deb.	59	5 4 3	Jun, Dec
1	6%	Elec. Construction Ord.	⅞	8 6 11	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	71	5 12 8	Jan, July
..	10%	General Electric Ord.	11	9 1 10	July
10	6%	Do. 6% Pref.	9½	6 3 1	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14⅛	7 0 4	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4⅛	4 14 9	..
St.	4½%	Do. 4½% Do.	87⅛	5 2 9	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9⅛	10 17 8	Feb, Aug
10	5%	Do. Pref.	7⅛	6 16 9	Apl, Oct
100	4%	Do. 4% Debs.	99½	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	33⅛+	7 3 3	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1⅛	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	⅝	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	79½	5 0 8	Jun, Dec
100	4½%	Do. 4½% 2nd Debs.	99	4 11 0	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	50½	7 18 5	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	99	6 1 2	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21⅛	6 16 4	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70	5 14 3	Ja.Ap.Jly.O
10	5%	Cuba Submarine Ord.	7⅛	6 1 8	May, Nov
10	10%	Do. 10% Pref.	12	8 6 8	..
5	5/0	Direct Spanish 10% Pref.	7⅛	6 13 4	..
10	4%	Direct United States	5⅞	6 1 9	Ja.Ap.Jly.O
St.	7%	Eastern Tel. Co. Ord.	127⅛	5 11 1	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	63	5 9 8	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77⅛	5 2 9	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77	5 3 11	Feb, Aug
10	7%	Do. Ord.	12⅜	5 9 3	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	34½	6 8 6	Ja, My, Jly
25	13%	Indo-European	49½	6 10 4	May, Nov
1	10%	Marconi's Wireless Tel. Co.	1⅛	5 3 3	April
1	7%	Do. 7% Pref.	1⅜	4 1 6	July
10	1%	West India & Panama Ord.	1⅜	9 4 3	May Nov
10	6%	Do. 1st Pref.	7½	7 12 11	May, Nov
10	7%	Western Telegh. Co.	12½	5 8 9	Mr,Jly,O,Dec
St.	4%	Do. 4% Deb. St.	76½	5 4 1	Jun, Dec
..	4½%	Western U. 50 yr. Bds.	99½	4 10 3	May, Nov.
		Telephones.			
1	7½d.	Monte Video Tel. Exn. Ord.	⅜	6 12 5	Nov.
1	10%	*Oriental Telephone Ord.	1⅛	5 12 6	Apl, Oct
St.	4%	Do. Db St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	83	5 8 5	Jan, July
5	8%	United River Plate Ord.	5⅞	6 15 5	Apl, Oct
5	5%	Do. 5% Cum. Pref.	4⅛	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	84½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust	10½	5 17 1	Sp,De,Mr,Jn
10	6%	Do. 6% Pf.	9⅞	6 0 6	Sp,De,Mr,Jn
100	5%	Mackay Companies' Common	80⅛	6 4 7	Ja,Ap,Jly,O
..	4%	Do. $100 Pref.	69½	5 14 9	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 16 9	Apl, Oct
		Colonial and Foreign Electric Supply, &c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4⅜	6 7 2	Mar, Sept
St.	5%	Do. 5% Debs.	95½	5 4 9	Jun, Dec
10	6/-	Bombay E. S. & T. 6% Pref.	10⅛	5 17 1	..
St.	4½%	Do. 4½% Debs.	87½	5 2 10	Jan, July
5	9%	Calcutta E. S. Corp. Ord.	6⅞	7 5 5	May, Nov
5	5%	Do. 5% Pref.	4½	5 11 11	Mar, Sept

* And 13⅓% bonus. † Ex dividend or interest.

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CONTENTS OF THE CURRENT NUMBER.

NOTES 895
Arrangements for the Week .. 898
Magnetos for Electric Ignition. By H. Armagnat. Illustrated.—*Concluded* 899
The Use of Continuous Current for Terminal and Trunk-Line Electrification. *Discussion* 902
Construction of Lecture-Room Oscillograph. By H. G. Crane and C. L. Dawes. Illustrated 904
Dry Cells. By W. R. Cooper, M.A., B.Sc. Illustrated 906
Sir J. J. Thomson on Radiation from Atoms and Electrons. Illustrated 910
TRUNK LINE ELECTRIFICATION 912
REVIEWS 913
Wireless Telegraphy [Zenneck].
On the Relation of Imports to Exports [Peddie].
The "Practical Engineer" Electrical Pocket-book and Diary, 1916.
Annuaire pour l'An 1916.
The Postmaster-General's Annual Report 914
CORRESPONDENCE 916
Meter Testing (J. Williams).
The I.E.E. and Enemy Members.
Electrical Trades' Benevolent Institution 916
PARLIAMENTARY INTELLIGENCE 916
LEGAL INTELLIGENCE 917
The "Electrician" Commercial and Industrial Section .. 919-928

NOTES.

I.E.E. Council Nominations.

THE notice has just been issued giving the nominations for the new Council of the Institution of Electrical Engineers, these nominations being those put forward by the present Council. The nominations stand as follows :—

PRESIDENT.

C. P. Sparks.

VICE-PRESIDENTS.

(*Two vacancies.*)

R. A. Chattock. Dr. A. Russell.
J. S. Highfield. Roger T. Smith.

HONORARY TREASURER.

J. E. Kingsbury.

ORDINARY MEMBERS OF COUNCIL.

(*Two vacancies.*)

C. Bright, F.R.S.E.	W. A. Chamen.	W. H. Patchell.
F. Gill.	J. Christie.	H. F. Proctor.
G. H. Nisbett.	H. Dickinson.	G. S. Ram.
W. Ll. Preece.	Prof. T. Mather, F.R.S.	R. J. Wallis-Jones.
	G. W. Partridge.	W. B. Woodhouse.

ASSOCIATE MEMBERS.

(*Three vacancies.*)

F. W. Crawter.	*H. H. Harrison.*	*W. R. Rawlings.*

ASSOCIATES.

(*Two vacancies.*)

J. O. Callender.	*J. Devonshire.*	J. Hunter Gray.

The names printed in italics are the nominations for the vacancies which will occur. The hon. treasurer retires annually and is eligible for immediate re-election.

IT will be seen that Mr. SPARKS retains the Presidency for another year. Mr. CHATTOCK is nominated as a new Vice-President, but Mr. HIGHFIELD is put forward for re-election, being already a Vice-President of the Institution. Mr. KINGSBURY'S name appears for the first time on the balloting list as Treasurer, though he already fills this position, as he was appointed by the Council last year on the death of Mr. HAMMOND. Of the ordinary members of Council, Mr. GILL has already served, when he was chief engineer of the National Telephone Co. New blood is introduced by the nomination of Mr. BRIGHT, who is well known in the world of submarine telegraphy, of Mr. NISBETT, engineer and manager of the British Insulated & Helsby Cables (Ltd.), and of Mr. PREECE, the consulting engineer. As there are only two vacancies in this part of the Council a ballot will be necessary. The members nominated to represent the Associate Members are Mr. CRAWTER, of the Chloride Co., Mr. HARRISON, of the Automatic Telephone Manufacturing Co., and Mr. RAWLINGS, the managing director of Messrs. Rawlings Bros. To fill the two vacancies for representatives of Associates, the Council have nominated Mr. CALLENDER, assistant manager of Callender's Cable and Construction Co., and Mr. DEVONSHIRE, the managing director of the London and Suburban Traction Co. Last year we pointed out that there had been a tendency in recent years for members to favour electricity supply engineers unduly, and that in order to secure balance there should be a larger number of representatives of manufacturing interests. From the list now presented it will be seen that this defect is being rectified. Whether the outside membership at the present time of stress will feel that they have time to put forward further candidates remains to be seen, but in any case we think that a representative Council should be obtainable from the nominations that have been proposed.

The Metropolitan Company.

THE general meeting of the Metropolitan Electric Supply Co. last week was unusual in that it resulted in the appointment of a Committee of Investigation. During the past year some of the directors have resigned, and some of the shareholders have felt that the recent progress of the Company has been unsatisfactory, even when the effect of the war has been taken into account. Merely from the report of the proceedings it is difficult to form an opinion on such a subject, and we should not care to express any views on the rights and wrongs of the case without having much more information at our disposal. We should, however, like to emphasise the soundness of some of the views put forward by Mr. PHILIP TUCKETT, one of the directors who has retired. Mr. TUCKETT pointed out at the meeting that if 1½d. per unit is an average cost, then it does not follow that a price of less than 1½d. per unit is unprofitable for a power load. It is very unfortunate that this fact is often not understood by the layman. The confusion probably arises from the fact that in a generating station electrical energy for all classes of load is generated at the same time. Yet if two stations were erected side by side, and one was supplying a load having a load-factor of 100 per cent., and the other a load with a load factor of 15 per cent., it could be very clearly demonstrated that the cost per unit in

the first case would be very much lower than the cost per unit in the second, other things being equal. Therefore, the energy supplied to a consumer with a higher load factor can be sold at a lower rate than that supplied to a consumer with a lower load factor. This argument is not invalidated when the two stations are combined into a single station supplying a mixed load. It follows, therefore, that a power load having good load factor may be very profitably supplied at a price considerably less than 1½d. per unit, whereas a lighting load might show a loss when charged at, say, 2d. per unit. These facts are familiar enough to the electrical engineer, but to the layman they present a difficulty, and will continue to do so unless he is prepared to rely upon technical opinion for his guidance. The extracts read at the meeting from reports to the Board are entirely at variance with present-day experience, and we must confess that we have perused them with astonishment. The supply of electricity is essentially a competitive business in that there are other means of supplying power, heat and light. If a neighbouring undertaking can afford to sell at much lower rates, then there is need for reflection and inquiry. No raising of prices can give permanent prosperity if such prices are materially above what may be described as market prices. Lastly, the power load at low prices—far from being harmful—has been the salvation of electricity supply. In our opinion, any policy which assumes the unimportance of the power load and disregards the fundamental principles underlying tariffs as dependent on power factor and diversity factor can only end in disaster.

The Royal Society and Scientific Co-operation.

From a note which appears elsewhere it will be seen that the Royal Society has asked a number of scientific societies to join them in forming a conjoint board for the purpose of organising scientific effort in this country. In a matter of this kind it is no doubt an advantage to have joint action which shall be widely representative; but if we may judge by the published list of societies sending delegates to the conference which was held last week, we fear that the basis so far adopted is rather too wide to prove effective. We think that in this connection a distinction should be drawn between abstract science on the one hand and applied science on the other. From the point of view of education and scientific work, abstract science may be the more important; but it is well known that the pure scientist is apt to look upon the application of science as being of small importance, whereas for the future of this country applied science is actually of supreme importance. With these divergent views, it seems to us that a conference is not likely to work in harmony or to produce very useful results when it includes such purely scientific societies as the Royal Anthropological Society, the Royal Astronomical Society, the Royal Geographical Society, the Geological Society and the London Mathematical Society, together with such technical societies as the Institution of Civil Engineers, the Institution of Electrical Engineers, and the Institution of Mechanical Engineers. We suggest that it would be better to have two distinct conferences, one for pure science and the other for applied science, delegates to both conferences being sent by those societies which deal with both pure and applied science. Moreover, we think that such societies as the Iron and Steel Institute, the Institute of Metals, the Institution of Mining and Metallurgy and the Faraday Society should also be represented; and it has been stated in the papers that there is no representative of agricultural science, which seems a mistake. It may be, however, that the list published in the daily Press is not complete. By splitting up the conference into two sections, as we suggest, it appears to us that the strongest and most useful effects would be produced.

The Postmaster-General's Report.

The annual report of the Postmaster-General, of which we give some account in another column, very naturally deals largely with the effect of the war upon the telegraph and telephone services in this country. At a time when there is a dearth of trained staff, the telephone has been found to be a very useful accessory to the telegraph, and is now used as a substitute at 7,350 sub-offices. The work of delivering telegrams has also been facilitated by the use of the telephone. The chief progress made in telegraph work during the year seems to have been the increasing use of high-speed printing telegraph machines, the extension of Baudot working and the increased use of Wheatstone tape machines. There has also been an increased use of phantom telegraph circuits superimposed on telephone trunk and junction circuits. In regard to telephones, the war has had a marked effect on development, new orders having fallen off to the extent of about 27 per cent., whilst the number of subscribers giving up the telephone has increased. Local telephone traffic has also declined by some 7 per cent. On the other hand, there has been a considerable extension of the telephone system. The number of new exchanges opened in localities not previously served telephonically was 232 during the year 1914-15, as compared with 184 in the previous year. Public call offices to the extent of 2,136 were opened, and the number of exchanges connected directly with the general trunk system was increased by 76. The number of additional trunk circuits completed was 507, involving an addition of 40,727 miles of wire. It appears that there are now seven automatic telephone exchanges at work, which are giving satisfactory service, and similar exchanges are being installed at Blackburn, Dudley, Grimsby, Leeds, Paisley and Portsmouth. It may be concluded that considerable progress has been made under disadvantageous circumstances, and that when peace comes once more the working of these exchanges should enable a settled policy to be adopted in regard to automatic working.

Resistance of Sandstone.—*Erratum.*—Paragraph at foot of page 875 should read: "A glass tank 32 cm. long having a copper plate 28 cm. square at each end, was filled with sandstone earth taken from the trench, the cross-section of the sandstone being equal in area to one of the copper plates."

Canada's Coal.—The "Colliery Guardian" states that the production of coal in Canada does not nearly supply her demands, and that the *per capita* consumption has almost doubled in the last 10 years. In 1910 this latter was 2·869 tons, and the coal consumed was 20,678,199 tons, of which 10,438,123 were imported.

Voluntary Help for Munitions.—There is at the present time a need for volunteers to superintend the transfer of marks on shell bar. The work can be easily carried out, and does not require technical knowledge. Moreover, it does not necessarily take up much time, and can be arranged to suit the convenience of those who undertake it. Readers who are willing to assist in this way in the London area should communicate with us, when we shall have pleasure in forwarding the names to the proper quarter.

Resistance of Networks of Conductors.—In the current issue of "Wireless World," Prof. J. A. Fleming, F.R.S., deals with the problem of finding the resistance of a cube formed of wires between the diagonal corners. He shows in this case that by applying the ordinary rules for networks and writing out the equations the result is quickly obtained in determinant form. There is no doubt that it is a matter of some importance

to be able to use mesh equations readily, and the chief confusion seems to arise from the signs. In the article in question the student will find several worked-out examples, and these should be helpful to those who have difficulties with such problems.

Locomotive Weights.—The "Electric Journal" refers to this question and states there are two types of locomotives, viz., one with all the locomotive weight on the driving, the other with a portion of the weight carried on bogie trucks. Switching of freight services require a locomotive capable of working near the slipping point of the wheels without exceeding the overload capacity of the electrical equipment. The minimum weight of locomotive may be determined from the weight of trailing load, average car speed, and other factors, including adhesion. The first step is to find the total draw-bar pull under the worst conditions.

Corps of Royal Engineers (Wireless Section).—We understand more officers are required for the above branch of the service. Candidates should forward their applications to Major A. Handley, R.E., O.C. Wireless Training Centre, St. Martin's-gate, Worcester. It is essential that candidates should have a thorough knowledge of the theory and practice of wireless telegraphy; and in sending their applications candidates should state fully their training and experience, and whether they have had any previous military service. The term of service will be for the period of the war, and successful candidates will be required to serve at home or abroad.

The Personal Equation.—In a recent issue of the "Proceedings" of the National Academy of Sciences there is a Paper on "Personal Equation and Steadiness of Judgment in the Estimation of the Number of Objects in Moderately Large Samples," by J. Arthur Harris. The experiments comprised 15,000 estimates by three observers, and extended over two years. Observations were made of the personal equation and steadiness of judgment. Regarding the former, it seems to be remarkably little influenced by experience. Steadiness of judgment, on the other hand, is unmistakably influenced by previous experience. Apparently the "scatter" of the individual estimates about their mean value becomes less as time goes on.

Natural Gas.—In a Paper read before the Society of Petroleum Technologists, Dr. J. A. L. Henderson classed these gases as follows: (*a*) Those associated with coal deposits, (*b*) those associated with bituminous shales, and (*c*) the hydro-carbon gases associated with volcanic regions. He considered it strange that nothing was done to save some of the gas given off in our coalfields, which amounts to many tens of millions of cubic feet a day in Great Britain. The Chinese are said to have used this fuel on a large scale 2,000 years ago. During the last 35 years development has taken place in America, Hungary, Roumania and Russia. In 1913 natural gas held sixth place amongst mineral products in the United States. Natural gas is an ideal fuel for industrial and domestic purposes, and possesses twice the heating power of ordinary gas.

Heat Losses from Electric Steel Furnaces.—Messrs. W. H. Wills and A. H. Schuyler, in a Paper read before the American Electrochemical Society, investigated the heat losses due to gases issuing from charging doors and tap holes, and also the losses due to conduction. With a furnace taking 300 kw., and working at a temperature of 750°C., the loss was 44 kw. from the doors or openings. From observations made of the heat carried away from the electrodes by cooling water and conduction through the electrodes the losses from this course were determined, and amounted to from 6 to 7·5 per cent., with inputs varying from 200 kw. to 300 kw. By suitable closing devices the door and tap hole losses can be reduced, but the loss from electrodes cannot be reduced so long as graphite is used for this purpose.

Chisels.—Mr. H. Fowler, in a Paper before the Institution of Mechanical Engineers, states that the three implements of the hand worker, viz., the chisel, the file and the hammer have been neglected. The chisel has not received the attention its importance warrants. There appears to be no method of systematically testing chisels, other than the hardness test of Brinell. A standard method of treatment was employed by the author, the chisels were quenched to a depth of $\frac{1}{2}$ in. to $\frac{3}{8}$ in. in water, then immersed and cooled off in linseed oil. The oil tank was cooled by a cold water tank. After this treatment the chisels have a dead hard point and a tough shaft. They are then tempered on the point "bit down." This is done by immersing them in another oil bath at about 215°C. They are removed at intervals and tested with a file and cooled off in sawdust. Foremen and others confirm the opinion that this is an improvement.

Electric Winding in Australia.—Mr. J. F. Dent, in a Paper read before the Electrical Association of Australia, describes two electric winders in use in New South Wales. One at the Abermain Colliery is connected through gearing to a 105 H.P. direct-current 250-volt motor, and is used to draw coal from the bottom to the top seam. Only single-deck cages holding one skip are used, and the control is by a reversible controller. The other winder, at Richmond Main, is direct coupled to an 800-volt 800 to 1,850 B.H.P. direct-coupled motor, and is fitted with over-speed and over-winding gear, also compressed air brakes. The control is Siemens-Ilgner, a flywheel converter set being installed. This set consists of an alternating-current 3,300-volt motor, driving a direct-current 800-volt 720 kw. generator to supply current to the winding motor. A flywheel which can be put in and out of gear is used, and the winder works on the Ward-Leonard system on light loads. Double-decked cages holding four skips are used.

Atmospheric Electrical Variations at Sunrise and Sunset.—Among the Papers read recently before the Royal Society there was a Paper on the above subject by Mr. E. H. Nichols. Observations were made for a period of 15 minutes before and 15 minutes after both sunrise and sunset, using the Wilson compensating gold-leaf electroscope for conductivity and earth-air current, and two Ebert electrometers for measuring the positive and negative electric charges. The results show a decided uniform decrease in the value of the electrical quantities throughout the sunset period, but the solar effect at sunrise is not at all pronounced. The potential curves for Kew Observatory were analysed for the years 1912 and 1914 for the 30-minute period at sunrise and sunset, and monthly means obtained for 5-minute intervals, these being corrected for diurnal variation. There is a general increase in the potential at both sunrise and sunset, being more noticeable in the winter months, but there is no evidence of any sudden change. It is possible that the electrical variations observed may be of assistance in elucidating the problems of wireless transmission.

Alternating Stress Tests.—In a Paper read recently before the Royal Society Mr. W. Mason gave the result of tests on speed effect and recovery in slow-speed alternating stress tests. Repeated cycles of equal direct and reverse torque were applied to mild steel specimens of tubular form, and systematic measurements made of the range of the corresponding torsional strains. The speed of application of the cycles was varied between 2 and 200 per minute. After a considerable number of cycles at 2 per minute, the range of non-elastic strain was reduced about 50 per cent. on change of speed to 200 per minute, the range of torque being unaltered. Similarly, if a specimen had endured a considerable number of cycles at 200 per minute, the range of non-elastic strain was immediately increased by 50 to 75 per cent. at change of speed to 2 per minute. If the latter speed was maintained, the augmented range of strain decreased quickly at first, then more and more slowly. This recovery is compared with the reduction of range of strain due to a period of rest. The author attempts to account for these variations of strain on the hypothesis of alternate production and hardening of "mobile material" in the steel.

Application of Electric Power to Mining.—In a Paper on "The Application of Electric Power to Mining Work in the Witwatersrand Area, South Africa," Mr. J. Norman Bulkley states that the total steam turbine capacity installed in the Brakpan, Simmer Pan, Rosherville and Vereeniging stations is 204,200 kw. These are supplied by the Victoria Falls and Transvaal Power Co., and its subsidiary the Rand Mines Power Supply Co. The Randfontein, East Rand Proprietary and Kleinfontein Group all supply their own power, amounting to about 52,000 kw. With regard to pumping, fortunately most of the Witwatersrand mines are comparatively dry, 10,000 gallons per hour units in duplicate generally being sufficient to handle all the water. The East Rand Proprietary Mines, however, require pumps of 60,000 gallons per hour capacity. Most of the pumps are electrically driven, and the motor drives generally through belting to the pump, as it is found this lowers the maintenance costs. Step-down transformers are used where the voltage is high, the high-tension cables being taken down the shaft. Owing to the lower prime costs, several centrifugal pumping plants working on high heads have been installed, one at the Durban Roodepoort Deep Gold Mining Co. having a head of 2,490 ft., and each pump being fitted with a 550 H.P. motor.

Scientific Co-operation.—A conference has been convened by the Royal Society to consider the desirability of establishing a Conjoint Board of Scientific Societies to organise scientific effort in this country. A meeting was held last week, when delegates from the following societies attended to confer with the President and Council of the Royal Society :—

Royal Society of Edinburgh, Royal Society of Arts, Royal Anthropological Institute, Royal Astronomical Society, Royal College of Physicians, Royal College of Surgeons, Royal Geographical Society, Royal Institution, Institution of Civil Engineers, Institution of Electrical Engineers, Institution of Mechanical Engineers, Institution of Mining Engineers, Institution of Naval Architects, Institute of Chemistry, Society of Chemical Industry, British Association, Chemical Society, Geological Society, Linnean Society, London Mathematical Society, Physical Society, Physiological Society, Zoological Society.

The following resolution was passed unanimously :—

This meeting considers that it is desirable to establish a Conjoint Board of Scientific Societies for the purpose of :—

1. Promoting the co-operation of those interested in pure or applied science ;

2. Supplying a means by which the scientific opinion of the country may, on matters relating to science, industry and education, find effective expression ;

3. Taking such action as may be necessary to promote the application of science to our industries and to the service of the nation ;

4. Discussing scientific questions in which international co-operation seems advisable.

It is announced that a committee was appointed to draft a scheme for giving effect to the resolution and to report thereon to a future meeting.

Optical Appliances in Warfare.—Mr. C. R. Darling, in the "Journal" of the Society of Arts, has a Paper dealing with field glasses and telescopes, searchlights, periscopes and range finders. In addition, signalling lamps and heliographs come in for consideration.

Referring to the Zeiss prismatic binoculars, it is pointed out that in the ordinary Galilaen telescope the field of view and magnification is small, and cross wires cannot be introduced, since the image produced is a virtual one. In the prismatic type the long focus object glass can be used in a short focus body, consequently the magnification, which depends on the ratio of the focal lengths of object glass and eyepiece, is increased. A real image of the object is formed, and greater stereoscopic power is obtained. When telescopes are used as gun sights, a sighting wire is placed in the focal plane of the object glass, and when the image coincides with the mark, the aim is correct.

This method of sighting is preferable to that in which a back and fore sight is used, as in that case the eye cannot be focussed on all three at once. Similar sights can be applied to rifles. At night the lines or pointer are illumined by a small electric lamp. For searchlight work the Mangin reflector is described, also methods of producing diverging beams. In this connection the following holds good : The diameter of the illuminated area is proportional to the diameter of the crater : it is independent of the area of the mirror, but inversely proportional to the focal length of the mirror. The intensity of illumination varies directly with the area of the mirror, and is inversely as the square of the distance. Rangefinders are discussed, and the accuracy of the Barr & Stroud rangefinder is stated to be 2·5 per cent. at 5,000 yds. De Chalmot, in the discussion which followed, referred to a pamphlet published by Mr. Cheshire, of the Ministry of Munitions, which gave much information on these questions. Mr. Cheshire mentioned that the Barr & Stroud rangefinder was superior to anything produced on the Continent.

OBITUARY.

F. W. LACEY.—The death of Mr. F. W. Lacey, M.Inst.C.E., borough engineer of Bournemouth, occurred on Friday last. Among the public works and improvements for which he was responsible was the construction of the permanent way of the local electric tramways. Mr. Lacey was 60 years of age.

JOHN LLEWELLYN.—The death is announced of Mr. John Llewellyn, assistant electrical overseer at Birkenhead Dockyard for the past 10 years.

TREVOR DUESBURY.—We regret to record the death of Mr. Trevor Duesbury, formerly borough electrical engineer of Sutton Coldfield. He joined H.M. Forces and went to France in October, but his health broke down, and he died at the Wharncliffe Military Hospital, Sheffield, on March 3.

PERSONAL.

ROYAL ENGINEERS (T.F.)—The following appointments have been made :—

London Electrical Engineers : F. C. Raphael (from Anti-Aircraft Corps, R.N. Air Service), Lance-Corp. C. W. Salt, Spr. E. H. Duckworth and Spr. F. Harris to be Second Lieutenants (on probation).

ARRANGEMENTS FOR THE WEEK.

FRIDAY, March 31st (to-day).

ROYAL INSTITUTION.

5.30 p.m. At Albemarle-street, W. Discourse by Prof. A. Fowler, F.R.S., on "Spectroscopy."

SATURDAY, April 1st.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, W. Lecture by Sir J. J. Thomson, P.R.S. on "Radiations from Atoms and Electrons." (Lecture IV.)

MONDAY, April 3rd.

WESTERN SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At Merchant Venturers' College, Bristol. Paper on the "Hire and Maintenance of Continuous-current Motors," by Mr. H. Joseph.

TUESDAY, April 4th.

ASSOCIATION OF SUPERVISING ELECTRICIANS.

8 p.m. At St. Bride Institute, Bride-lane, E.C. Paper on "A.C. Motors," by Mr. H. C. E. Jacoby.

MANCHESTER SECTION, INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Engineers' Club, Manchester. Paper on "Recent Researches on X-Rays," by Sir E. Rutherford, F.R.S.

RÖNTGEN SOCIETY.

8.15 p.m. At the Institution of Electrical Engineers, Victoria Embankment, W.C. The following Papers will be read : "A Chronograph Constructed to Work with the Electroscope," by Mr. P. J. Neate ; "The Enclosed Tungsten Arc as a Source of Ultra-Violet Light," by Mr. B. H. Morphy and Mr. S. R. Mullard ; "Experiments with a Coolidge Tube," by Mr. E. Schall, B.Sc. ; "A New Modification of the Ionisation Method of Measuring X-Rays," by Mr. H. E. Donnithorne. Exhibition of Plates showing "Experiments with the Coolidge Tube in Radiography," conducted by members of the staff in the radiographic department at the Cancer Hospital.

THURSDAY, April 6th

FARADAY SOCIETY.

8 p.m. At the Royal Society of Arts, Adelphi, W.C. Lecture on "The Making of a Big Gun," by Dr. W. Rosenhain, F.R.S., illustrated by cinematograph films.

FRIDAY, April 7th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, W. Lecture by Sir J. J. Thomson, P.R.S., on "Radiations from Atoms and Electrons." (Lecture V.)

ENGINEERING INSTITUTIONS' VOLUNTEER TRAINING CORPS.

Officer Commanding. Lieut.-Col. C. B. CLAY, V.D.

Orders for week commening April 3rd, 1916 :

Drills : 6.25 to 7.25 ; 7.25 to 8.25 p.m.

Monday, April 3rd.—Sections 1 and 2, Technical : Sections 3 and 4, Squad and Platoon. Signalling Class and Recruits.

Tuesday, April 4th.—School of Arms, 6 to 7 p.m.

Thursday, April 6th.—Shooting for Sections 1 and 2 and Signalling Class.

Friday, April 7th.—Sections 3 and 4, Technical ; Sections 1 and 2, Squad and Platoon. Signalling Class and Recruits.

Saturday, April 8th.—Uniform Parade at 2.45 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 45, Regency-street, S.W.

Sections for Shooting, parade at Miniature Ranges.

Unless otherwise ordered, all parades at Chester House.

Members who have not yet been measured for uniforms must call on Samuel Bros., Ludgate hill, as soon as possible.

MAGNETOS FOR ELECTRIC IGNITION.*

BY H. ARMAGNAT.

(*Concluded from p.* 868.)

Summary.—After dealing with the history and development of the magneto, the author considers the general theory underlying its action. This is developed in detail, equations being given embodying the theory, and illustrated graphically.

Explosion engines have a very extended range of speeds, and the magneto must furnish the igniting spark under all conditions at the proper moment; moreover, it must produce ignition when the engine is turned over by hand. These extreme conditions require the current furnished by the magneto to be sufficiently intense at starting, when the speed of the engine is perhaps 40 turns a minute and not to be excessive when the speed reaches 2,000 revs. per min., a range of speeds having a ratio of 50 to 1.

The behaviour at very low speeds is given approximately by equation (10). At very high speeds equation (5) may be written

$$i_m = \frac{nS}{L}(B - B_c), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

B_c being the value of the flux density at the moment when the primary is short-circuited, and B the value at the moment considered.

The result to aim at is, therefore, that the current at break when the speed is very low, i_0 at m_0, be sufficient, and that the value i_m, at the highest speed considered, be not excessive. From (10) and (12) we obtain the equation

$$\frac{i_0}{i_m} = \frac{2\pi m_0 L}{R} \frac{dB_r/da}{B_r - B_c'} \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

from which it is easily seen that the greater the ratio

$$\frac{dB_r/da}{B_r - B_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

the lower is the limit of speed m_0 of successful operation.

The ratio (14) indicates an important property of the magneto, and, if the limiting case is taken of the ratio of maximum dB/da to maximum B, the characteristic coefficient Z is obtained, where :—

$$Z = \frac{\text{max. } dB/da}{B_{\text{max.}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

We shall return to this factor further on.

It is not sufficient, however, that the maximum current attain a certain limiting value; the further condition must be satisfied that this value be obtained for a position of the armature constant with regard to the pole-pieces, otherwise it will be necessary to vary the position of break for each speed in order to make it coincide with the position of maximum current.

This variation of position of armature with regard to the pole-pieces for maximum current would really occur if the resistance of the armature were negligible with regard to mL at high speeds, for the maximum current i_0 (10) occurs at the moment when the rate of change of flux is a maximum and will be 90 deg. in advance of the maximum current i_m at high speed represented by the maximum value of the flux Φ. Between these two limits it would be necessary to advance constantly the ignition in order to produce the breaking of the primary circuit at the right moment.

The limiting case given in (12) is never realised in practice, and fortunately the resistance of the primary is such that the maximum current is always induced in the neighbourhood of the reversal of flux. Fig. 14 gives curves of current calculated by points, for an ordinary magneto, of which the flux curve was determined experimentally. The currents have been calculated for speeds varying from 0·6 to 40 revolutions per second; the coil being on short-circuit —*i.e.*, under normal working conditions before the spark—and with the closure of the primary occurring at the moment when the flux is a maximum. It is seen that for a range of speeds from 1 to 66 the primary current varies from 3·2 to 13 amperes only, a ratio of 1 to 4. The coil on which this experiment was made had a resistance of 0·57 ohm and a mean self-inductance of 0·012 henry.

To obtain the same current at low speeds from a sinusoidal flux wave it would be necessary to have (10),

$$nSB_{\text{max.}} = 49 \times 10^6,$$

whereas with the Siemens H-armature the same result is obtained with a value of

$$nSB_{\text{max.}} = 10{\cdot}4 \times 10^6.$$

One may say, therefore, that the employment of a Siemens armature reduces by five times the real power of the magneto.

* Translated and reproduced with slight abbreviations, by kind permission of the editor of "La Revue Electrique."

Effect of the Moment of Closure.—Since the ignition magneto always operates in an intermittent manner it should be designed to produce the maximum effect at the moment of useful working—*i.e.*, at the instant when the break of the primary produces the spark. To this end the closing of the primary is a matter of some importance.

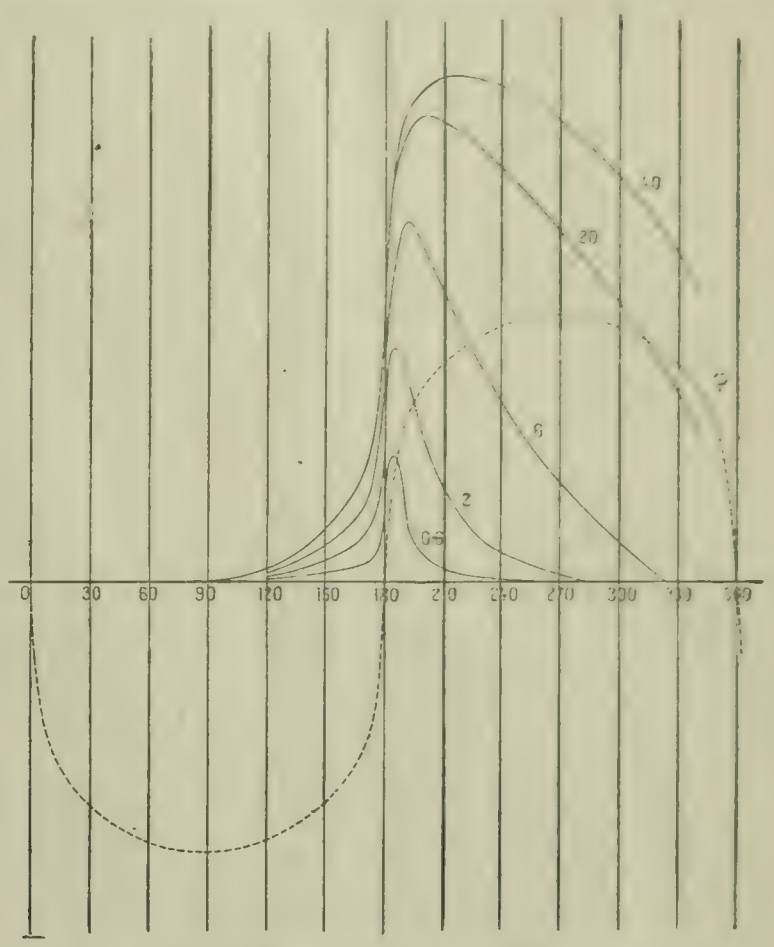


Fig. 14.—Current Curves of an Ignition Magneto.
B_m=13,700. s=4·75 cm.^{2} n=159 turns. R=0·57 ohm. L=0·012 henry.

At very slow speeds the influence of closing is practically nothing, the maximum current is always produced when dB/da is a maximum, and all that is necessary is that the circuit be closed for a sufficient time before this point is reached; it may also be closed for a considerable time beforehand without affecting the value of i.

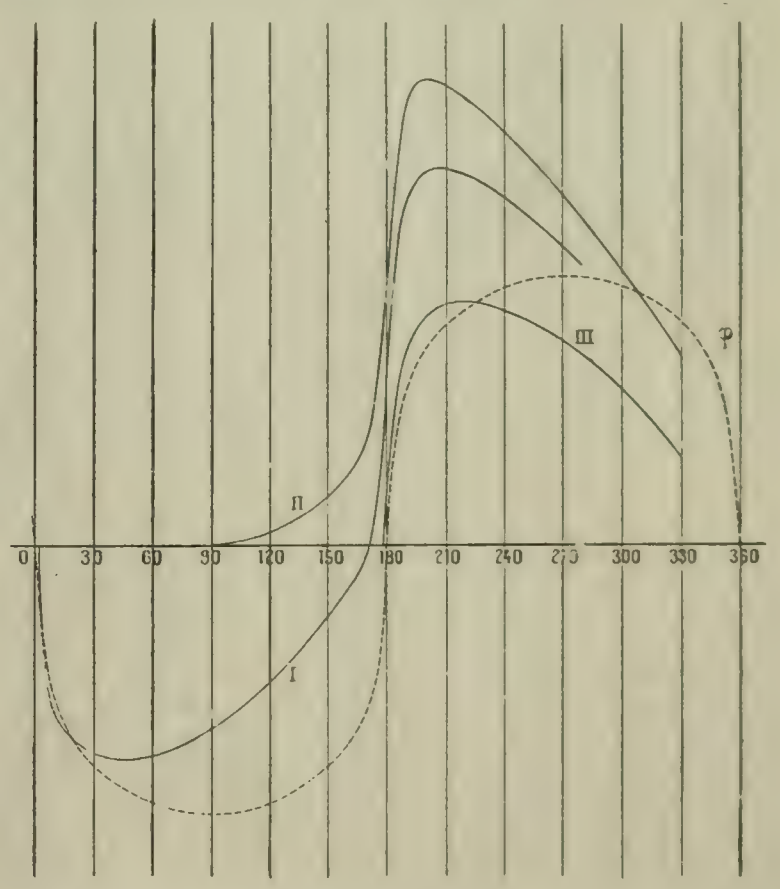


Fig. 15.—Curves showing the Relation between Current Intensity and Maximum Flux.

At high speeds this is not the case, and if one wishes to obtain the greatest possible current at break one must be careful to close the circuit at the moment when the flux is a maximum. This is well shown in Fig. 15, where the curves I. and III. indicate current when the

circuit is closed at positions of zero flux, while II. refers to closure when the flux is a maximum. These curves are calculated from equation (5) for the same case as those of Fig. 14 for the speed $m=20$.

The current may vary between these limits, and it is seen that the best result is always obtained when the moment of closure lies in the region 0 deg. to 90 deg. for the spark near 180 deg., and is the best possible at 90 deg.

This point being established, it would seem that there is no difficulty about fixing once for all this point at 90 deg.; in reality practical conditions sometimes impose that the circuit remain closed during more than one turn, with the somewhat paradoxical result that the useful current diminishes as the speed increases. In other cases, on the contrary, it is desirable to reduce the period of short-circuit. This results in a reduction of the output. Finally, in magnetos having a secondary winding the secondary current has a reactive influence sufficient to disturb the regime outlined above; it generates sparks itself sometimes before the primary break takes place. Each case must be examined on its merits when working out any particular example.

Since the variation of maximum current as a function of the time of closure only occurs noticeably at high speeds, it may be thought of small account, as the current is then nearly always more than necessary; as a matter of fact, however, it must not be forgotten that in spite of the considerable volume of the magneto relative to its output, it is a machine in which heating must be guarded against, and although a premature closure of the circuit can reduce the current at break, it has the grave defect of greatly increasing the root-mean-square value of the same, and, therefore, of the heating.

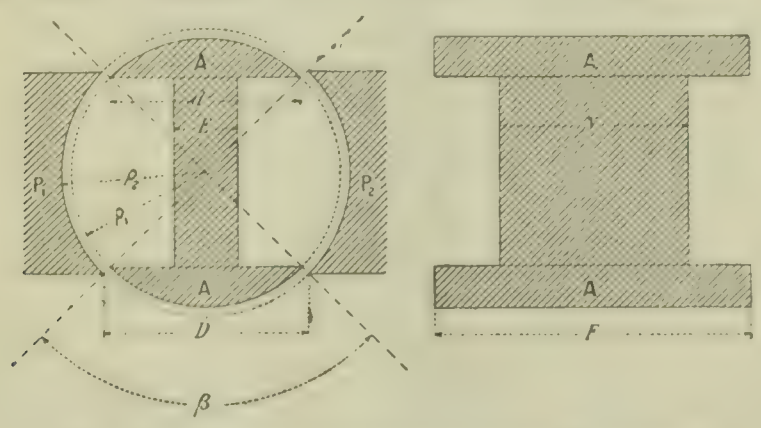


Fig. 16.—Section of H-armature and Pole-pieces.

Practical Values of the Coefficient K.—This coefficient depends entirely on the magnetic circuit, and as indicated in equation (13) it is proportional, in the limit, to the ratio of the current at very low, to that at very high, speeds.

In the case of a sinusoidal flux wave the value of Z is 1, one of the few cases for which it is possible to calculate this quantity. For want of a better way of determining with sufficient accuracy the maximum value of dB/da on magnetos, it must suffice to make use of the approximation furnished by the direct measurement of the variations of flux ΔB for angles $a\Delta$,

$$Z = \frac{\text{max.}\,(\Delta B/\Delta a)}{\text{max.}\,B}, \qquad \ldots\ldots\ldots \quad (16)$$

substituting the direct throws ϵ (6) of the ballistic galvanometer, proportional to variations ΔB, and replacing Δa by $2\pi/p$, where p=number of observations made during one revolution. We get

$$Z = \frac{p}{2\pi} \frac{\text{max.}\,\epsilon}{\frac{1}{2}\sum^{+\Phi}_{-\Phi} \epsilon}. \qquad \ldots\ldots\ldots \quad (17)$$

From a great number of measurements made on good magnetos of different makes the coefficient Z was found to lie between the limits 4·5 and 7.

Various magnetos not differing very greatly in this respect, what are the quantities which vary sufficiently to cause such differences in performance as exist? Small differences in the disposition of the various parts forming the magnetic circuit can give rise to considerable variations in the form of the flux curve. In general the polar pieces P_1 and P_2 subtend the same angle as the shoes AA of the armature, β equal to 90 deg. (Fig. 16), and as the air-gap $\rho_2-\rho_1$ is very small, the width d of the shoes is practically equal to the space D between the edges of the pole-pieces. It is preferable to have a small overlap $d>D$ rather than making $d<D$. When the overlap is small, about 1 mm. for ordinary sized magnetos, the ratio Z remains nearly constant and the "locking" of the armature between the pole pieces is reduced.

On the other hand, when $d<D$, say, 1 mm. or 2 mm., it causes a dimple to be produced in the curve dB/da (Fig. 17), and the value of Z is reduced to 3, at the points of maximum flux; such a magneto whilst giving quite a good spark at normal speeds, is weak for starting up. The failure of a great number of models is due to nothing more than this fault.

The air-gap $\rho_2-\rho_1$ should be reduced to the limits necessary for mechanical clearance, and is often less than 0·2 mm. If it is reduced much below this value there is risk of the armature touching the pole-pieces on account of the wear and tear on the bearings.

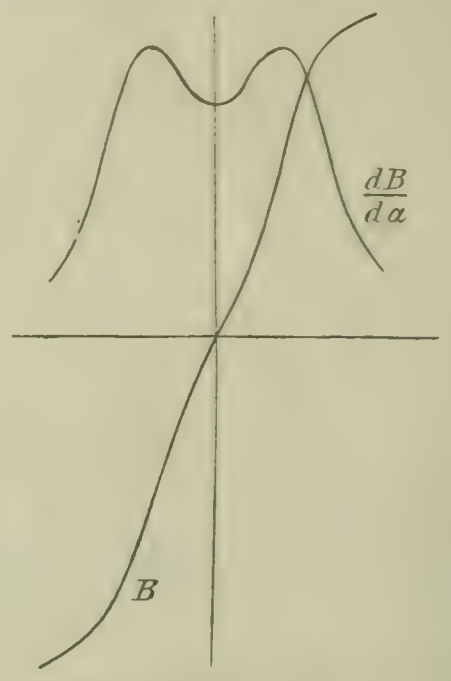


Fig. 17.—Curve of dB/da showing a Dimple when the Width of the Shoes is Smaller than the Space between the Pole-pieces.

If the air-gap is increased it gives rise to another defect; the flux is diminished a little, but what is more serious, the maximum dB/da is greatly reduced, which results in a large reduction of the value of the coefficient Z.

The example (Fig. 18) which refers to two air-gaps of 0·2 mm. and

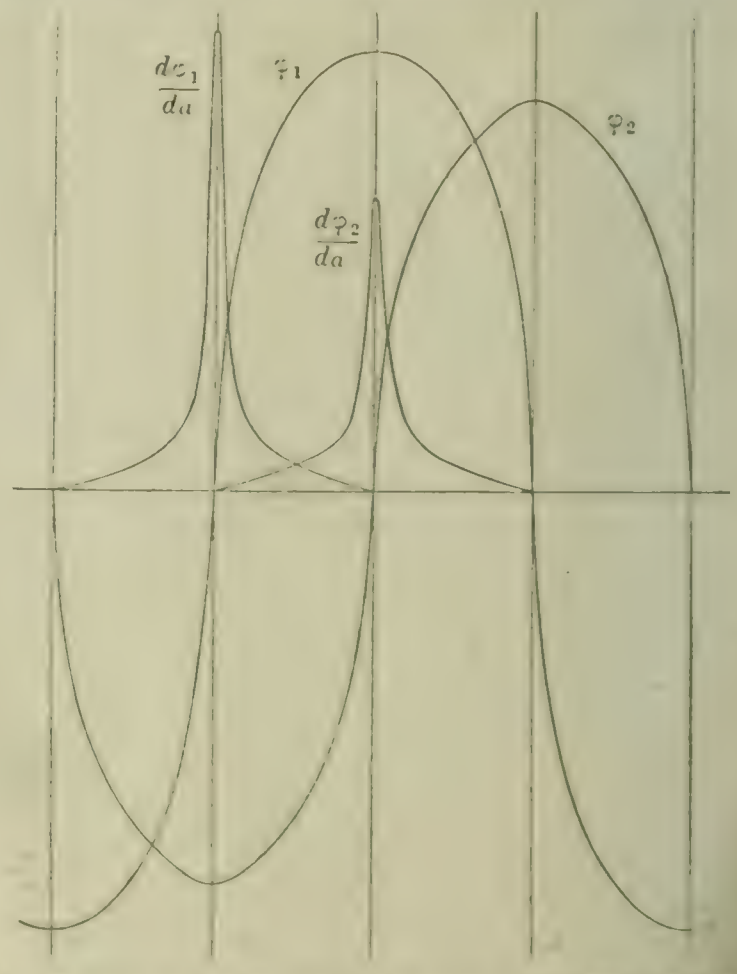


Fig. 18.—Effect of the Width of Air-gap on the Curves of φ and $d\varphi/da$.

0·45 mm. respectively, the radius of the armature being 28 mm. is conclusive in this respect. To make the diagram clearer the two curves have been displaced 90 deg. relatively to each other. They show that for an armature of radius 28 mm. the maximum flux is equal to 63,500 maxwells in the case of the 0·2 mm. air-gap, and only falls to 56,400 for a gap of 0·45 mm., but at the same time Z falls from 5 to 3·8. This shows the importance of a small air-gap.

Magnetic Circuit.—The length of air-gap being fixed by mechanical considerations and the necessity of securing a suitable shape to the flux curve, we now proceed to consider the rest of the magnetic cir-

cuit. The power of the magneto being, as we shall see, a function of the maximum total flux $SB_{max.}$, it follows at once that the values of the two quantities S and $B_{max.}$ fix the problem, and in reality only one of these is variable, namely, the section S, for $B_{max.}$ depends on the iron.

In practice it is better not to push the value of $B_{max.}$ too high, on account of the harmful effects of hysteresis ; it may be kept considerably below the saturation value. Numerous measurements show that for armatures of good quality sheet iron a value of $B_{max.}$ equal to 12,000 or 13,000 may be taken. (For cast iron it is difficult to obtain greater flux densities than 9,000 or 10,000.) This value may seem rather high, but it is measured as the total flux embraced by the coil and includes, of course, the air flux which passes between the core and the coil.

The only remaining variable to be determined to fix the power of the armature is the section S of the core

$$S=NE,$$

N and E being the thickness and length of core as indicated in Fig. 16.

The shoes AA should naturally have a considerably greater surface s than NE,

$$S=\rho_1\beta F,$$

for it will be impossible to obtain in the air-gap a flux density of the same order as $B_{max.}$ A priori, it would seem of advantage to make the ratio s/S as great as possible, but this is unnecessary ; in fact, if the sectional view of the armature is considered it will be seen immediately that an increase in this ratio can only be obtained by extending the shoes further from the core in such a direction that the path of the magnetic flux will be increased in length and large magnetic leakage will take place outside the windings and will, therefore, be wasted.

In practice it is sufficient to make the ratio s/S approximately equal to 6, giving an air-gap flux of about 2,000 gauss.

It only remains to determine the dimensions of the magnets. As is well known, the best magnets only give at the neutral point, and on short magnetic circuit an induction of 7,000 gauss, and on the average it is advisable to assume 5,000, which, on account of faults, may reduce the effective value of the magnets to about 3,000 ; they should on this assumption then have a total section of approximately four times the section of the armature core. Calculating on this basis the results are certain, and if care is taken to eliminate faulty magnets the section may be reduced.

The M.M.F. of the magnets being so great, they need not have a very great length ; there is considerable latitude in this direction, and generally constructional considerations, available space and weight, determine this dimension. Very long magnets have no special advantages since the magnetic circuit is nearly closed, and, therefore, length will not assist greatly to prevent demagnetisation. Usually the magnets have a length of five or six times the armature diameter ; this proportion having been arrived at by trial and error as a convenient one, this being the case also for the proportions of the cross-section.

The question whether the magnets can be demagnetised by the current in the armature has often been asked and answered in various ways ; as a matter of fact, it is a question of the particular magneto, and no general answer can be given. Magnetos are intentionally designed to give a current which is broken at the most favourable moment—that is to say, when the axis of the armature is perpendicular to the lines of force of the magnet—and it is quite clear that the field produced by the current can have no influence on the magnets in this neutral position. This is not always realised, but it happens sometimes that the setting of the contacts on the magneto is such that the break occurs after the position of zero flux, and in this case the current can operate to demagnetise the magnets. In addition to this the current does not always cease suddenly, but sometimes forms an arc which prolongs it, causing the same harmful effects as a late break. When one attempts to calculate the M.M.F.s acting it is seen that those of the armature are nothing like equal to that of the magnets, but are not of different order of magnitude ; it is, therefore, desirable to look into this matter.

The best safeguard in this respect would seem to be to make certain that the break does not occur after the point of zero flux.

Available Energy.—The ignition magneto being a generator which functions intermittently, it is of chief interest to determine the power available at the instant of break independently of the output as an alternator, which is quite a different quantity.

Neglecting the small current in the primary following the spark we see that at each break there is set free an amount of energy

$$W=\tfrac{1}{2}Li_r^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

We can determine W for two limiting cases, speed infinitely small and speed infinitely great. Expressing the self-induction L and the resistance R of the coil in terms of the dimensions of the coil, we have

$$L=bSn^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

and

$$R=an^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

Substituting in (10) the value of dB/da obtained in (16), we have

$$i_r=\frac{2\pi mnSZB_{max.}}{R}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

whence

$$W=\frac{2\pi^2bm^2Z^2}{a^2}SB^2_{max.}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

or, inserting total flux in place of $B_{max.}$,

$$\Phi_{max.}=SB_{max.}$$

$$W=\frac{2\pi^2bm^2Z^2}{a^2}S\Phi^2_{max.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

From this equation it might seem desirable to reduce the $B_{max.}$ and increase the S, but actually it is better to retain $B_{max.}$ at a value of approximately 12,000, for the factor a in equation (23) also depends on the section of the core, being greater for an increase in its section.

For case of the infinite speed we can use the value of i as given by equation (12) :—

$$W=\frac{S}{2b}(B_r-B_c)^2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

or as a maximum, assuming $B_r=-B_c$,

$$W=\frac{2S}{b}B^2_{max.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

The two expressions (22) and (25) both indicate that (for a given weight of copper) the output at break is independent of the number of turns, and it can only be increased by increasing S, since from other considerations $B_{max.}$ must not be allowed to vary much. This forms a very useful factor in designing magnetos. We speak here of the section S, but the interesting factor is really the volume of the iron ; it is implicitly included in the section S, for a practical relation exists between S and s the polar surface, which is itself a function of the diameter of the armature.

The question as to what energy is necessary to produce ignition in an explosive mixture is one on which opinions are very much divided, but it may be remarked that the expressions (22) and (25) give good agreement when applied to magnetos, as indicating interesting limiting values necessary in practice.

As an example, we may indicate the limiting practical values in use by the following two examples :—

For light motor cycles the small magnetos have a weight less than 2·5 kg., and they give at starting a spark sufficient to ignite when the speed of rotation is as great as 1 per second. The energy per spark under these conditions, obtained from formula (22), is then of the order $W=0{\cdot}007$ joule. On the other hand, the most generally used magneto on four-cylinder automobiles, when running at maximum speed, gave according to equation (25) :—

$$W=1{\cdot}2 \text{ joule.}$$

The first value is insufficient to ensure regular firing of the engine, but the second is certainly unnecessarily large : it would seem established that with an amount of energy equal to 1 joule per spark, ignition is always perfectly assured ; any irregularities occurring in the running may be looked for elsewhere than in the magneto.

These calculations only refer to the maximum energy available in the magneto at break, and may be considered to apply to a machine having an external transformer, but in high-tension magnetos, as also in low-tension machines, in which the terminals of the plug or igniting device are permanently connected to the magneto, it may happen that after the spark at break has occurred the current is prolonged because of the E.M.F. directly generated by the rotation of the armature, which, though small, is not negligible, and this is a possible explanation of the fact often observed, that high-tension magnetos are more efficient for equal size than those with a separate transformer.

The power necessary to run the magneto under working conditions is made up of the power represented by $W\times$number of sparks per second plus all the electrical and mechanical losses. Few decisive* measurements have been made in this direction, but it is probable that only a small proportion of the mechanical energy put into the magneto appears in the spark ; in other words, the magneto considered as an electrical generator has a very indifferent efficiency.

Variation of Self-Inductance.—Up till now we have considered the self-inductance of the coil to be independent of its position in the magnetic field. Actually, it varies considerably both with the current in it and with its position in the field. The assumption of constant self-inductance allows of calculating approximately the value of i on the basis of a coil resistance which is not negligible, and this is all the more true for the determination at break when all the effects occur during such a small angle that L may be considered quite constant.

* *Translator's Note.*—In an excellent article by Mr. A. P. Young in the "Automobile Engineer" of March, 1915, results are given of tests on the "overall efficiency" of magnetos.

To indicate this change, a curve was obtained on a magneto of the self-inductance, for different positions of the armature, using a steady alternating current. It is seen from Fig. 19 that the self-inductance is a maximum when the core is perpendicular to the axis of the polar pieces—*i.e.*, when the flux through it due to the magnets is zero. From numerous measurements made it may be concluded that the self-inductance varies in the ratio 1 : 2 in passing from the position of maximum to that of zero.

An approximate value of the coefficient b (19) for ordinary magnetos is 150×10^{-9} for $B=0$, and 75×10^{-9} for $B=$maximum, the value of L being then expressed in henrys.

Locking Couple.—When the armature core is vertical, the corners of the shoes are opposite the corners of the pole-pieces, as in Fig. 16, and the strong attractions then acting render a large couple necessary to turn the armature through this region. The force F acting in the direction of the lines of force is proportional to the square of the total flux Φ and inversely proportional to the section σ, the field being assumed constant over the whole section,

$$F=\Phi^2/8\pi\sigma. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (26)$$

We require to know the tangential component of this force dF/da. We know that Φ is a function of a, or $\Phi=f(a)$. Therefore,

$$\frac{dF}{da}=\frac{dF}{d\Phi}\cdot\frac{d\Phi}{da}=\frac{\Phi}{4\pi\sigma}\cdot\frac{d\Phi}{da}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

In a well-proportioned magneto having d and D very nearly equal but with $d>D$, the curves of flux (Figs. 11, 14, 15) show in the region of flux reversal that $\Phi/\sigma=$const. in consequence of which the maximum attractive force should be obtained when $d\Phi/da$ is a maximum.

The tangential component thus calculated is considerable, and if the net couple were not due to a difference between opposing forces at opposite ends of the shoes it would be practically impossible to

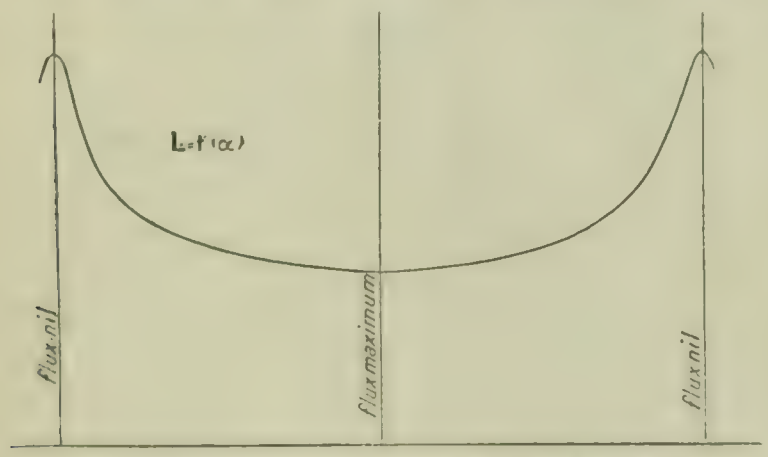


Fig. 19.—Curve of Self-inductance of Primary.

turn the armature round. With ordinary magnetos the calculation shows that the tangential force is of the order of 40 kg. on each corner.

If the magneto were perfectly symmetrical, without hysteresis, and the condition $\Phi/\sigma=$ constant also fulfilled, the two attractions would be always in equilibrium, and it would not be possible to tell from the turning couple when the armature passed through the neutral position. In practice the turning effort is considerably increased at this point, often giving rise to mechanical reactions which are harmful to the magneto.

One of the principal causes of this fault is to be found in the bad shape of the shoes and pole-pieces, where, as in Fig. 17, the position of maximum tangential force is before the point $\Phi=0$, that is to say, at a point where one of the corners of each shoe is more engaged in the pole piece than the other, the opposing forces are then very different, and the total couple cannot but be large.

These considerations have been made with a view of indicating the lines along which researches might be made, the outcome of which will certainly result in improvements in the design of magnetos.

Up to the present it would seem that in the case of the low-tension magneto with break in the cylinder it operates as a self-induction traversed by a current, and in the case of the low tension magneto as the primary of an induction coil, both of which are thus resolved into known cases.

The preceding remarks concerning the magneto as a generator of current do not seem to have been made before, and it seemed to me desirable to publish them separately, looked at from this point of view.

References: "Magneto Ignition," by J. F. Henderson, B.Sc., "Proc. Inst. Automobile Engineers," January, 1915, with discussion by Mr. A. P. Young, February, 1915, also "Automobile Engineer," March, 1915, by Mr. A. P. Young.

THE USE OF CONTINUOUS CURRENT FOR TERMINAL AND TRUNK LINE ELECTRIFICATION.

The following is a report of the discussion on Mr. Storer's Paper at the Manchester and Birmingham meetings of the Institution of Electrical Engineers recently. An abstract of the Paper was given in our issues of the 17th and 24th inst. :—

Mr. C. H. Merz said Mr. Storer had been responsible for many features of interest in single-phase and direct-current working in the United States. The bright idea of the double armature was largely if not entirely due to him. It was of great advantage in high-voltage work. Its application to service so quickly was characteristic of our American friends. It was extraordinary that more had not been done until recently with re-generation, considering its advantages from the point of view of wear and tear. The only places where it had been used to any great extent were Italy and Switzerland, where it had been used with great success and commercial advantage, but he thought there was no case of its use in this country on stopping services. The use of high voltage should simplify its adoption as the dynamotor or similar apparatus could be economically used for exciting the fields of the series motors so as to obtain the generation. He agreed that the series motor was not likely to be abandoned, and with high voltages and with the use of dynamotors or motor-generators it should not be necessary. Most railway men would admit that we must take as one standard 600 volts, as so large an amount of work had been done on it, the third-rail system at that voltage. Also we must have a higher standard. He believed it would not be many years before there would be an enormous amount of electric railway work in this country, even on main lines, particularly perhaps the goods traffic. For this traffic they would require a higher voltage than 600, but he did not think the matter so simple as Mr. Storer suggested. In the United States, with long distances and, comparatively speaking, less dense traffic than in this country, they had to go to pretty high voltages, probably 3,000 had been adopted on a large scale, and he supposed their standard voltage eventually would not be less than 3,000 for main-line work. But 3,000 could not be used with the third-rail in this country, where clearances between the rolling stock gauge and the structure gauge were very small. The question whether third-rail or overhead line would be the standard for main-line work must be decided first. If third-rail was not going to be used it would be well to go to a higher standard voltage. The L. & Y. Railway was running a third-rail system at 1,200 volts, he believed with success, and no doubt it would be possible to use the same design of third rail for 1,500 volts, so that 1,500 in that case would be a good upper standard. He doubted whether 1,500 would be quite high enough for overhead main-line work for the country as a whole. Standardisation was much to be desired from the manufacturers' point of view, but he doubted whether matters would be hastened on by saying now whether 1,200 or 1,500 or 2,500 or 3,000 should be the upper standard voltage.

Mr. Roger T. Smith said the author criticised a Paper he (the speaker) wrote by saying that in comparing the performance of an electric locomotive with series motors with the performance of steam locomotives he did not do justice to the former. His (Mr. Smith's) criticism was confined to train loads on British railways and to fast passenger services, under which conditions he stated that no electric locomotive had then been built which, between the speeds of 70 and 80 miles per hour, could give 1,100 h.p. which was being given every day by steam locomotives. On page 3 of his Paper Mr. Storer showed that the Pennsylvania 4-4+4-4 articulated locomotive, which weighed 140 tons, could give 1,200 h.p. at 76 miles per hour. He (Mr. Smith) had prepared a slide (which was shown) from Fig. 3 giving the characteristics of that locomotive. One curve showed the normal field and the other the full field plotted with speed as against tractive effort at the rims of the wheels. Against it he had shown the curves of a G.W. Railway 4-60 steam passenger loco. using only saturated steam, and the characteristic of the steam loco. was that from about 15 miles up to 80 miles an hour it practically gave constant output. It weighed 75 tons. The electric loco. weighed 140 tons, and to give 76 miles an hour it must give 4,000 h.p. Its cost would be nearer four than three times that of the steam loco. His criticism meant that if you got the speed the cost was out of proportion to the result. For goods and mineral traffic the series characteristic was admirable, because such high speeds were not necessary. The author dealt with improvements in the plain series motor, including field control and regenerative control. Unfortunately we had yet no particulars of the regenerative control used by the Westinghouse Company. Under some circumstances field control and regenerative control seemed the two features needed if the series motor was to do what the railway people wanted. For the four motor equipment the author showed that eight switches were essential for field control, and for field and regenerative control together 20 switches might be required. Then there would be complications of switchgear and equipment if even two voltages had to be worked over by the same equipment. He agreed with Mr. Merz that we could not yet say what our standard voltage ought to be. On the L. & Y. Railway we had 3,000 volts, on the N.E. Railway 1,500, again on the L. & Y. 1,200 (between Manchester and Bury). Mr. Aspinall's 1,200 volt protected third rail, referred to by Mr. Merz, was quite satisfactory. Under recent conditions the snow formed a ridge over the slot, and seemed to protect the vertical face of the third rail, from which collection took place, keeping it dry. Nothing had been done in this country which committed us to any one voltage further than for suburban working. The author's summary of the problem to be solved might be restated thus: We had

to choose the most convenient pressure for suburban working by third rail, and if lines could not be set apart for that, we had to choose the best pressure for main-line working with overhead and to equip the line with both where necessary. As Mr. Merz said, Aspinall's third protected rail could be used for 1,500 volts, and in many districts where the air was impure and charged with chemicals and where there were considerable lengths or a considerable number of rather small gauge tunnels, the third-rail was absolutely necessary. Assuming that 3,000 volts was a satisfactory higher voltage to be used with an overhead conductor, if the 1,500-volt motors using the third-rail at 1,500 volts could work in with such higher voltage and give full speed and full power on equipments working at the two voltages and could do that with the least complication of additional switchgear for those other features which were assumed to be essential (regenerative control and field control) that would go a good way towards a solution of the problem.

Mr. C. H. LYDALL said Mr. Storer raised the question as to what range of speed could be obtained at a given output. The more useful method, he thought, would be to see what range of speed could be obtained with a constant tractive effort or what range of balancing speed could be obtained by field control—speed on the level, neither accelerating nor retarding. He had worked out from a speed curve in the Paper for the Pennsylvania locomotive a few figures which might be interesting. He had supposed a 900-ton train. He made the variation of speed for 1,200 H.P. constant output as from 42 to 76 miles per hour (an increase of 80 per cent.). Taking a constant tractive effort of 10,000 lb., corresponding to 1,200 H.P. on 42 miles per hour, the increase was from 42 to 60 (=42 per cent.). The balancing speed for that 900-ton train was raised from 42 to 54 miles per hour (28·6 per cent.), contrasted with 42 to 76 (=81 per cent.). In order to consider this from another point of view, he took the figure of 1,600 H.P. output, and the figures corresponding to that were 36 to 60 per cent. in the speed variation for constant output (=66 per cent.). For a tractive effort of 16,700 lb. the increase was 36 to 49 miles per hour (=nearly 36 per cent.). For that 1,670-ton train on the level, the speed increase would only be from 36 to 40 miles per hour (=28 per cent.). The corresponding figures for a locomotive (which was not in existence, and very likely never would be), for which he worked out the design—a 3,000 H.P. 1,500-volt locomotive—instead of having 50 per cent. field shunting, which was the case with the Pennsylvania locomotive, it had only 40 per cent. field shunt. The figures in that case were: Constant output of 1,800 H.P., speed 63 to 90 miles per hour, 11,000 lb. tractive effort constant from 63 to 78 miles per hour, or with a 500-ton train 63 to 74 miles per hour. The last increase was only 17 per cent. The Pennsylvania locomotive was shunted 50 per cent., and in this high-voltage locomotive it would be 40 per cent.; the balancing speed was 28 per cent., as against 17 per cent. for the higher voltage locomotive. In the one case the increase of balancing speed was not nearly so great as in the other. He came to the conclusion that with high-voltage motors it was not so easy to produce a special characteristic speed curve as it was for a 600-volt motor, the reason being, he thought, that with the higher voltage motor it was necessary to have considerable pole-span to get in the necessary number of commutator segments between brushes. It also necessitated considerable saturation to avoid excessive distortion and tendency to flash over at the brushes. In this country there were several voltages to take into account in considering the most favourable line voltage to adopt, and these had been enumerated by Mr. Merz and Mr. Roger Smith; but the voltage of the single-phase line on the Brighton Railway had not been mentioned. If steps were taken to produce interchangeability of traffic all over the country that voltage had to be taken into account. To make the problem complete, a locomotive should be suitable for running at full speed on 600 volts with third-rail collection and on 1,500 volts direct current and 6,000 volts single-phase with overhead collection and regeneration in all cases. Mr. Storer had not given any information about cost. The cost of a locomotive or motor coach varied with the voltage adopted. It was necessary to try and arrive at a balance between the saving of cost of copper in the distribution system and the extra cost of the rolling stock involved by raising the voltage. A comparison between a 1,500-volt motor and insulated only for 1,500 volts, and a motor of the same capacity (375 H.P.) insulated for 3,000 volts, would show a great increase in cost in the latter case. Although a 1,500-volt equipment could operate satisfactorily with a 1,500-volt compressor motor, it would not be satisfactory to try and put in a 3,000-volt compressor motor for compressing the air. There was a considerable jump in the size of the dynamotor or other converter used for supplying current to that compressor motor. The other details all wanted a great deal of working out, but the total cost would be substantially greater with 3,000 volts than with 1,500. With regard to Mr. Storer's suggestion that the Institution should suggest a solution of the problem as to standard voltages for the whole country, he doubted whether there was at present sufficient information available. He did not think the railway engineers were prepared to supply the necessary data. It was necessary that the railway engineers should be convinced by experiments that long-distance traffic, either goods or passenger, worked electrically was practicable and more economical than haulage by steam locomotives.

Mr. H. W. FIRTH said the speed characteristic of the ordinary series motor and the very wasteful way in which that motor was accelerated and retarded had been dealt with by Mr. Storer, with whose remarks he associated himself. He would like the author to make it clear whether he was hopeful of regenerative braking for motor coach equipment. With regard to the question of standard voltage, we must do nothing that would militate against the universal interchange of main line equipment. It was not satisfactory enough to say we must have a standard main line voltage and a standard direct-current voltage, and that there the line of demarcation must cease. The equipment of one railway must be interchangeable with that of another, and it must be capable of running the suburban voltage of its own or any other railway. Around London and other places there were connecting lines between big main lines, and these connecting lines were largely suburban passenger carrying lines, but in times of emergency such as these and also for goods working in normal times those lines were used by the present goods and main line locomotives. Therefore, the author's suggestion that we must have a separate main line voltage and a separate lower voltage for the suburban working was not one which would commend itself to the railways. In many cases it was not a matter of practical politics to separate the main line and suburban working. So far the speakers had agreed largely with the contention of the author that we were anchored firmly about 600 volts for heavy suburban traffic. The question should be seriously considered before assuming that we must be tied down to that voltage, although the Manchester to Bury equipment tied one practically to an upper limit of 1,200. The question should be considered on its merits, and one should not be afraid to consider it simply because there was a large amount of 600-volt work in operation. If the Manchester-Bury section was highly satisfactory there was no reason why 1,200 or 1,500 volts should not be adopted for the lower standard. They should not be tied to a lower any more than to a higher limit at present.

Dr. S. P. SMITH said the author claimed that the series motor was the best motor for the work it had to do, and many of them would agree on the strength of recent comparisons with the shunt motor. During the last few days there had been ice and snow on the rails, and it could be well imagined that the shunt motor would have fared badly. He would like the author to make clearer the matter of the use of the series motor for large outputs. If it was necessary to get speeds of 75 miles an hour it was also necessary to get very large outputs at those speeds, and he was afraid field control there would not help much on main line work. It seemed the series characteristic for field control or series-parallel was not sufficient. It looked as if a motor with the characteristics of the alternating-current motor would be necessary. An excellent series of curves was published a year or two ago for the Lötschberg locomotives. The motors were single-phase, 15 cycles, a family of curves could be got which would give almost any power on any desired speed within the working range of the motors. It seemed to him main line motors would have to be considered in that direction. With regard to regeneration it was very good to have Mr. Storer's authoritative figures as to the improvement that could be expected with field control. They showed that the energy consumption would be reduced by some 20 per cent., and that was a thing to be jumped at if possible, but one wondered how regenera tion was going to be applied to the present motors on bogies used on local railways. Those had very small clearances and they were almost as large as possible for the space. When the machine was regenerating it was developing heat. At present the motor, during the braking, got a fair period of rest. Did Mr. Storer propose to adopt forced ventilation? If so, he would like to know how. For locomotives regeneration probably would not be of much use except with regard to saving in tyres, brake blocks, and so on. Energy sent back to the station might be troublesome. Where there was dense traffic it could all be used, but where traffic was sparse the disposal of it was a problem. The experience of American engineers was probably not a happy one with regard to different voltages, but it seemed the author solved the problem in a way that appealed to British engineers when he said, "It has many advantages to have your main line voltage and your suburban voltage quite independent." The third rail could be used for suburban traffic and overhead high tension continuous current or single phase for the main lines. It could be quite independent, because the rails would act as a return in either case.

Mr. H. M. SAYERS said the experimental work done in this country with regenerative control on traction motors had mostly been done on tramways, and he was afraid one must say that although a great deal of ingenuity had been shown and much money spent on it, it had resulted in failure. One reason, as Dr. Smith had said, was that the motor had no time to cool, and the limitations of space were felt as severely on tramways as on railways. That trouble was a serious one on the hilly lines where Mr. Raworth's regenerative motors were tried. Another point was that a regenerative motor had to have a shunt characteristic, whether it was got by shunt winding or by field control or by separate excitation. There was one way in which a shunt characteristic motor could be used as an elastic speed motor with considerable promise, and that was by introducing between the motor and the wheels a speed torque gear. The Hele-Shaw and the Williams-Janney speed gears appeared to be very promising in that direction. If such gear were used the weight of the motor would not be on the axles, which would result in economy in wheels, bearings, rails, &c.

Mr. J. S. PECK said he would leave most of the questions to Mr. Storer. With regard to standardising, we had not gone far enough yet. We had not experience enough to settle upon a standard voltage, but it might be possible to adopt some temporary standards. We had 600, 1,200 and 1,500 volts, and 3,500 on a small experimental line. Suppose the 1,200-volt system turned out to be very satisfactory to the company that installed it, would not that company insist on going ahead with that voltage, although it might be the consensus of opinion that that was not the most desirable voltage. He thought it might be advisable now to adopt, as far as possible, certain standards, say, 1,200 and 2,400 volts. That would be better than drifting around with everybody choosing his own voltage. With regard to Mr. Firth's question, he understood that regeneration with motor coaches was quite feasible. Mr. Storer had introduced an interesting arrangement in his 5,000-volt system for obtaining current for his auxiliaries. He used a battery which went to earth and which could be of 50, 100 or any voltage. The energy went through the battery as well as through the motor. If the current flowing through the arma-

ture was just sufficient to supply the load on the auxiliaries no current flowed through the battery. If the current was more than was required by the auxiliaries part went through the auxiliaries and part through the battery, so that the battery was charged up. That arrangement was working satisfactorily. Mr. Storer put a double control valve on his compressor motor so that when current was flowing through the main motors the compressor motor started up with a small drop in pressure, say, from 100 lb. to 90 lb. With regard to overheating by regeneration, most modern motors would stand some increase in temperature because they were insulated with practically indestructible material—mica and asbestos.

DISCUSSION AT BIRMINGHAM.

Dr. C. C. GARRARD said Mr. Storer's Paper appeared to be largely a plea for standardisation of railway equipments in this country, and the suggestion was made that this matter should be taken in hand by the Institution of Electrical Engineers. Mr. Storer was of a somewhat sanguine temperament if he thought that this would be done. The Institution had no standardisation committees or any other machinery whereby this and other problems could be dealt with, and decisions arrived at representing the considered view of the British electrical engineering profession, although the American Institution of Engineers had them. It was true that we had in this country the Engineering Standards Committee, upon which committee our Institution had representatives, and towards the support of which our Institution contributed. He considered that the Standards Committee covered too wide a field, and those problems should be tackled by the Institution, and so progress would be accelerated.

Mr. F. W. CARTER said that he was pleased to see the author emphasised the necessity of using series motors for this work. There was in some quarters even now a disposition to argue in favour of shunt or separately excited motors, but from an operator's point of view the series motor was the only thing possible. The author, in speaking of field control, said that "this is once more being employed where the service conditions justify its use." He would like to have from the author a more explicit statement of the service conditions which he considered justified the use of field control, and if he (Mr. Carter) gave his own views on this point he trusted that the author would not consider himself relieved from furnishing his. He then wrote down an equation connecting the revolutions of the armature with the speed and size of driving wheels. Flash-over troubles were referred to. It was also shown that if the motor was designed for a larger gear ratio than given by the equation the armature speed would pass beyond desirable limits. On the other hand, if less, the motor was not used to the limit of its capacity. Now this applied whether the motor was designed for operation with a single field or for field control. If a particular motor was taken with a particular gear, the operation with full field and with reduced field led to characteristics such as were shown in Fig. 2, in which with reduced field the speed was higher throughout and the tractive effort lower throughout than with full field. For a particular service, however, the comparison between motors must be based on the assumption of approximately similar characteristics on the normal fields, such as were shown in the Paper. If it was desired to compare the operation of a particular motor with and without field control, then, in order to bring the two systems of curves approximately into coincidence, as in Fig. 1 of the Paper, it was necessary to use a greater gear reduction for the field-control motor; but from the discussion given above it would be clear that in this case either the field-control motor ran to a higher speed than was desirable or the saturated field motor could be improved by re-designing it so as to satisfy the equation given above—that was to say, either the gear reduction was too great in the field-control motor or too small in the other. The comparison between field-control and saturated-field motors should not be made on the basis of using the same motor in the two cases, but on the basis of the best motor a designer could offer in the respective cases. Under these conditions the field-control motor would be somewhat heavier and more expensive than the saturated field motor. To sum up the advantages of field control were as follows: (*a*) There was a saving of energy as explained by the author: (*b*) for locomotive hauled trains there was an increase of flexibility which was not only desirable but necessary in many cases; (*c*) for multiple unit trains it frequently enabled an otherwise unsuitable motor to be employed by using it nearer to the limit of its mechanical capacity; (*d*) it enabled trains to meet special speed restrictions outside the ordinary schedules. The disadvantages of field control when comparison was made on the above basis were: (*a*) The motors were heavier and more expensive; (*b*) they were slightly worse in operation on account of the weakened field; (*c*) the control equipment was heavier and more complicated. In many cases field control had not shown sufficient advantage over the ordinary series parallel control to justify its use. At the same time it was frequently a valuable feature of which advantageous use could be made. In speaking of regenerative control the author had mentioned a system which was not yet in commercial service, but which was in course of development. The Chicago, Milwaukee & St. Paul locomotive, as the author was doubtless aware, already made use of a system of regenerative control, which appeared to be very similar to that indicated by the author: the field was separately excited by means of a generator which was itself excited by two opposing field windings, one, the main winding, which might be in shunt with the line and was adjustable by means of rheostats, and the other, a series winding, which carried the main current of the motor, and which opposed the shunt field when the motor was regenerating. The effect of the series field was to oppose any rush of current to the motors by bringing down the voltage on the separately-excited generator. There was, of course, much more in the arrangement than this, and particularly in the controlling devices, but the above described generally the self-regulating feature of the system. The author brought out very clearly the complications introduced in running trains over lines with a number of different voltages, and furnished a good argument for avoiding such a multiplicity of voltages. Almost anything in this line could be done by suitable motors and a sufficiently complicated control arrangement, but he felt sure that the simpler arrangements appealed more strongly to the railway engineer. With regard to the author's conclusions, whilst standardisation was highly desirable from some points of view, he could hardly blame the railway companies if they were indisposed to admit this at the present time; the advantage in the way of higher continuous-current voltage were too recent to justify them in concluding that we had reached finality, and, in fact, the system using 5,000 volts of which the author gave some description was only of last year's development. He was pleased to see that the author referred to the 600-volt system as not only being thoroughly established but as being so well suited to the requirements of terminal electrification that it should be continued as one of the standards, at least for the present. This was the oldest system in use for operating railways, and there was always a disposition, when something newer appeared, to consider that it was superior to the older and necessarily superseded it. If, however, the question of electrifying such a system as the London Underground Railways came up at the present time, the sound considerations given by the author, where he said, "the determining factor in the entire question will, of course, be the cost, not only of the original installations but the cost of operation and maintenance," would lead to the same solution as was arrived at by the Underground Railways Co. at the inception of their project. In this country the main lines and the local lines were very largely distinct, and if one system of operation were considered best for local service and another system for main line service, the two systems would be largely concerned with separate tracks; if a different system of line conductors were considered desirable for the two classes of service, the few lines which it would be necessary to equip with both systems of line conductors would add little to the cost of the installation, as compared with the additional expense that would be incurred in adopting an unsuitable system of operation either for the main line work or for the local work, in order that a single system of operation could be employed throughout the railway.

CONSTRUCTION OF LECTURE-ROOM OSCILLOGRAPH.*

BY H. G. CRANE AND C. L. DAWES.

Summary.—A description is given of a simple and readily-constructed oscillograph sufficiently accurate for most lecture-room purposes. The adjuncts are fully described and illustrated.

It has been found that the ordinary oscillograph is not adapted for demonstration purposes in the lecture room, owing to the comparatively small amplitude of the wave images. Because of this limitation of the ordinary oscillograph as a lecture-room device, the writers have developed an instrument that is capable of projecting upon the screen images of alternating current and voltage waves without appreciable distortion. Further, these wave projections are of such magnitude that they may be readily seen at distances of 200 ft. and more from the screen.

Owing to the high degree of flexibility required by a lecture-room instrument, in the instrument under discussion, the arc-lamp with its optical system, the magnet and the vibrators, the rotating mirror and its driving motor, are each mounted upon a separate stand and can be readily adjusted to the desired height or position above the base. The shunt and the multiplier are also separate units. This arrangement has one other great advantage from the teaching point of view. The student sees each element essential to the operation of an oscillograph in its simplest form, and, further, he sees at a glance the relation that each part bears to the operation of the oscillograph.

The units of the instrument are mounted upon their respective standards by means of sliding clamps. Suitable hand screws hold the clamps in position upon the upright rod of each standard. This construction allows each element to be raised, lowered and adjusted to any desired position. The total height of each standard is 24 in.

In order that the wave images projected upon the screen may be bright enough to be seen clearly some distance away a very intense source of light is required. To obtain such a light it has been found necessary to design a special arc-lamp. This arc-lamp is enclosed in a cylindrical iron casing, and the arc is formed between two pencil carbons arranged at right angles to each other. The carbons are fed by hand through grooved rollers, one being fed from the rear and the other from beneath the cylindrical casing. The arc will burn for 15 minutes without attention. The horizontal carbon is positive, and from its crater comes the light that is utilised in the

* From the "Electrical World," slightly abbreviated.

instrument. An adjustable diaphragm containing a small circular orifice is set in front of the crater of the positive carbon. The size of this orifice determines the cross-section of the beam of light that is thrown upon the screen. Because of the existence of a hot positive crater just behind this orifice it has the appearance of a small incandescent circle. The light from this circle passes through an achromatic lens mounted in the front of the cylindrical casing. This lens gathers the light coming from this incandescent circle and compresses it into a small bundle of parallel beams of high intensity, which is admirably suitable for projection purposes. This feature of the arc-lamp, together with its portability, makes it very useful in connection with other experimental or optical work requiring concentrated and parallel beams of light.

Vibrator Element of the Oscillograph.—In designing the vibrators it is necessary to maintain natural frequency and degree of damping high enough to ensure reasonable accuracy in reproducing circuit conditions. It was found that the higher optical efficiency and the greater simplicity of air-damped vibrators more than compensated for the slight errors introduced by insufficient damping. Fig. 1 shows the details of a vibrator element.

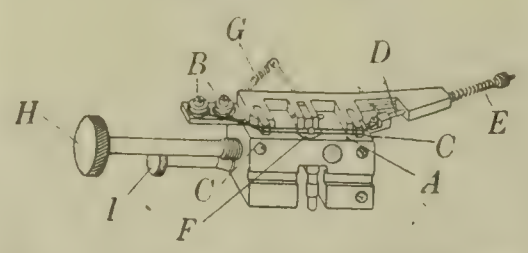


FIG. 1.—A VIBRATOR AND ITS MOUNTING.

A phosphor-bronze filament, A, extends from the base of one of the binding posts B over the ivory bridge C to the small ivory pulley on the rod D, and back again over the bridge to the other binding post. The ends of the filament are clamped to the binding posts by small machine-screws and washers. This method of holding the filament has been found superior to the usual method of soldering because of the facility with which the filament may be replaced without the use of any tools other than a screwdriver. The rod D passes through a hole and is then encircled by the spring E, which keeps the filament at a constant tension. This tension may be adjusted by means of a small knurled-nut. A small plane-mirror, F, about $\frac{1}{16}$ in. square is cemented across the two sides of the filament at the centre point of the bridge. To obtain an amplitude of vibration of 12 in. each side of the zero line at a distance of 10 ft. from the screen, these vibrators each require about 200 milliamperes.

The vibrator is suitably attached to a swivel pin, which is so mounted that the vibrator can be turned in two directions at right angles to each other. A spring, G, pulling in a 45 deg. direction, holds the vibrator against both its vertical and its horizontal stops. By means of the knurled-head H the vibrator may be rotated around a horizontal axis, and by means of the knurled-head I it may be rotated about a vertical axis. These adjustments allow the spot to be brought to any desired position upon the screen.

By actual test we have found that the natural frequency of this type of vibrator ranges from 1,500 to 2,000 cycles per second, depending upon the degree of compression of the spring E (Fig. 1). Therefore, the vibrator will respond with a fair degree of accuracy to harmonics as high as the nineteenth in a circuit having a fundamental frequency of 60 cycles per second, and also to telephone frequencies which average 800 cycles per second. The higher natural frequencies are obtained by increasing the filament tension and are therefore at the expense of the sensitivity or amplitude of vibration. The errors due to the temperature coefficient of expansion of the filament are made small by making the filament fairly heavy, and thereby reducing the I^2R loss.

Special Vibrator for Telephone Work.—A special vibrator has been developed for telephone work. It is necessary that such a vibrator have a specially high natural frequency in order that it may follow accurately the currents of telephonic frequencies. Therefore, a lighter filament, a smaller mirror and a closer spacing of the filament on the bridge are used, thus reducing the moment of inertia of the moving system. As only one vibrator is ordinarily required for a telephone circuit, the air-gap of the magnet may be materially reduced, and thus increase to a certain extent the flux density in the gap. This further increases the sensitivity. This type of vibrator requires about 100 milliamperes to produce an amplitude of 1 ft. on a screen 8 ft. from the vibrator.

Pole-pieces and Rotating Mirror.—In Fig. 2 the vibrator units are shown attached to the iron pole-pieces of the magnet. These two-pole pieecs are held together by means of two brass straps S S. A small auxiliary mirror, M, is mounted upon a small movable brass block. This block is free to turn in a horizontal or in a vertical direction as desired, and is adjusted by means of a small curved rod, R; it is held stationary in the desired position by friction. This mirror projects a zero-line constantly upon the screen, eliminating the use of an extra vibrator for this purpose. The magnet is excited from 110 volts direct-current, and takes about 0·3 ampere. It weighs about 25 lb. The pole-pieces (Fig. 2) are held to the core of the magnets by two bolts, one in each piece, making it easy to remove them. The connecting wires are brought to substantial binding posts on the base of the standard as shown in Fig. 5.

The rotating mirror (Fig. 3) is composed of eight plane mirrors arranged to form an octagonal prism. It was found that a prism having less than eight sides could not be used without producing a very marked distortion of the wave along the time axis. This mirror requires the most careful workmanship in its construction. If it is not almost perfect mechanically, the wave upon the screen will be very unsteady in position, and the image shown will be subject to a very pronounced lateral flickering. The mirror revolves about a vertical axis, being driven by a small synchronous motor through a system of gears (G, Fig. 3) at a speed of 75 revs. per min.

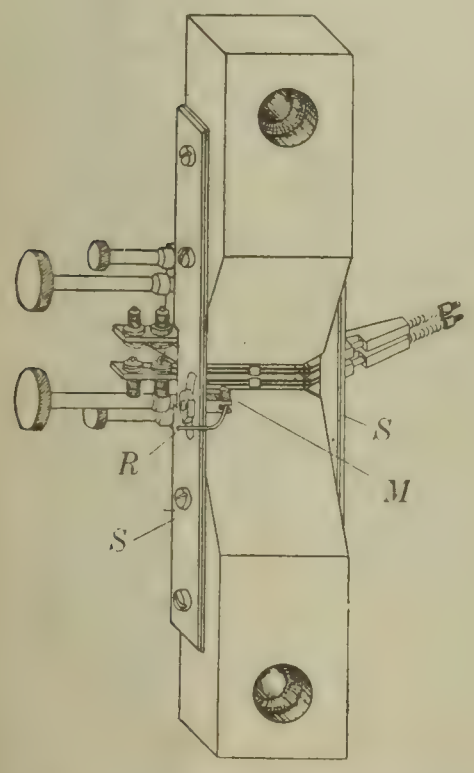


FIG. 2.—VIBRATORS AND POLE-PIECES ASSEMBLED.

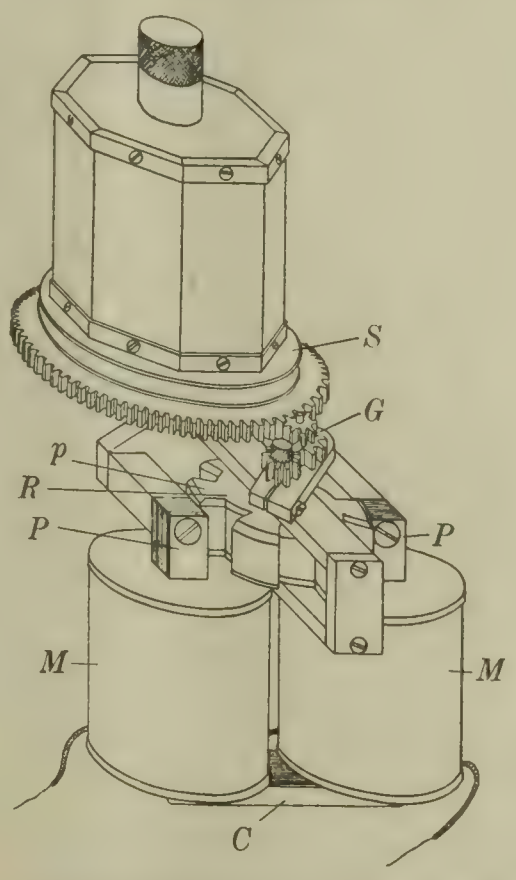


FIG. 3.—SYNCHRONOUS MOTOR AND ROTATING MIRROR.

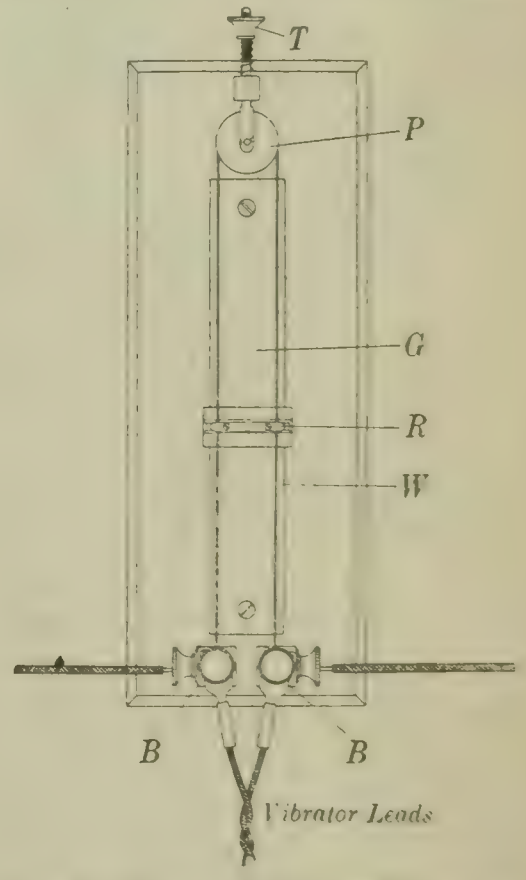


FIG. 4.—SHUNT FOR CURRENT VIBRATOR.

at 60 cycles per second. In the assembled instrument the rotating mirror is protected from dust and injury by a stationary cylindrical shield having a vertical slot just large enough to permit the vibrating beam of light to pass in and out again. A grooved pulley, S (Fig. 3), allows the mirror to be driven by a belt from a source of power other than the synchronous motor. This method of drive is necessary in telephone work and in many other instances where sufficient or suitable power cannot be obtained from the same source as that from which the vibrators derive their current.

Construction of Motor-driving Mirror.—The construction of the synchronous motor shown in Fig. 3 has been made very simple, but at the same time the motor is very effective. Two coils M M are wound upon a U-shaped core, C. These coils are designed to operate upon a 110-volt circuit at frequencies varying from 25 to 60 per second, an iron rotor, R, having six projecting poles *p* rotates between the poles P P of this alternating-current magnet. The motor operates upon the well-known principle that the magnetic circuit tends so to conform itself that its permeance is a maximum. When the flux between the poles P P is at its maximum value it pulls the rotor R around, so that a projecting pole on the rotor lies directly in front of each of the poles P P. However, when the flux is passing through its zero value and therefore exerting no pull upon the rotor, an interpolar space is presented to the poles of the magnet owing to the inertia of the rotating system. This type of motor is very sensitive to the shape and depth of these poles; if they are not correct geometrically the motor will hunt or fail to develop sufficient power. This particular rotor has six poles, giving it a synchronous speed of 1,200 revs. per min. at 60 cycles per

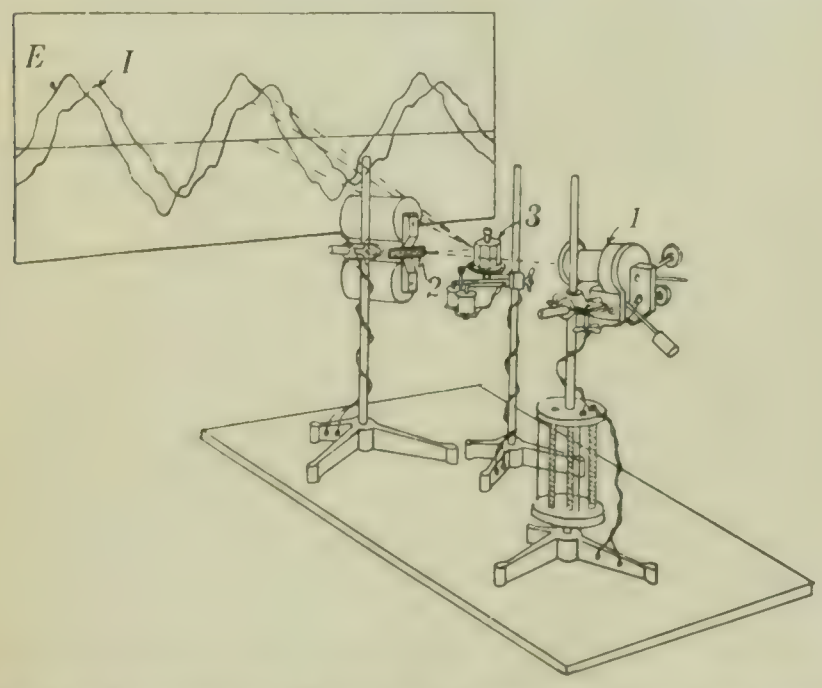


Fig. 5.—Mounting and Method of Operation of Lecture-room Oscillograph.

second. It is started readily by turning the large gear on the mirror by hand until the motor pulls into step.

Multiplier and Shunt.—The multiplier consists of high-resistance, zero temperature coefficient wire wound doubly in one layer upon a glazed aluminium tube. The resistance can be varied by moving a slider along the scraped portion of the wire on the top of the tube. The slider short-circuits adjacent turns, thus making it possible to vary the resistance between terminals any desired amount. The multiplier has a range of from 250 volts to practically zero volts. This method of varying the resistance allows very rapid and close adjustments to be made.

The shunt is shown in Fig. 4. Two binding posts, B B, are mounted upon a polished wooden base. A resistance wire, W, is connected between the binding posts, passing over a pulley, P. By means of the thumb-screw T the wire can be drawn to the desired tension. A bridge, B, designed to slide along the brass guide G, short circuits the two sides of the wire W, thus changing the resistance between the binding posts B B. The circuit wires and the current vibrator leads are both connected to the binding posts B B, but to different thumb-screws. By changing the position of the bridge B the amplitude of vibration may be increased or decreased as desired.

The shunt is ordinarily designed to carry a maximum current of 10 amperes, but it will produce a full-scale deflection with a current as small as $\frac{1}{2}$ ampere. Intermediate adjustments are, of course, easily obtained. The distinct advantage of a shunt of this type is that if the bridge B should make poor contact or even become separated entirely from the wire W the shunt does not become open-circuited, thus causing the entire current to pass through the vibrator, burning it out.

Fig. 5 shows the approximate positions of the oscillograph units when arranged for projection upon the screen. The light projected from the arc lamp 1 in small parallel beams strikes the two vibrator-mirrors and the auxiliary or zero-line mirror at 2. It is then reflected to rotating mirror 3, which draws the vibrating beam into a wave and reflects it on the screen. Good results may be obtained if the screen is not more than 12 ft. from the rotating mirror. Under these conditions the amplitude of vibration is about 12 in. each side of the zero line. If a sharper and clearer image is desired the screen may be moved nearer the mirror, but the amplitude of vibration is proportionately reduced.

DRY CELLS.*

BY W. R. COOPER, M.A., B.SC.

Summary.—The author gives an account of recent investigations on dry cells and the materials that are used. He then refers to various methods of testing.

Since the outbreak of war greater interest has been taken in this country in the manufacture of dry cells, the supply now being inadequate to the demand in certain directions. For this reason it may be of some interest to give a short account of the modern dry cell, and of the testing of dry cells.

General Description.

The container, which is round or rectangular in form to suit the conditions of the user, is made of sheet zinc and forms the electro-positive element. This has the advantage that a water-tight vessel is obtained, this vessel being protected mechanically by a pasteboard casing. Sometimes an earthenware or glass container is used, a sheet of zinc in cylindrical form being placed within the container. The only advantage of this method seems to be that the insulation is better, which may be desirable if a larger number of cells are required in series.

The zinc is sometimes amalgamated. From the point of view of local action this does not seem to be important, but amalgamation appears to prevent the forming of crystals and consequent pitting of the zinc.

The carbon may be a plate or it may be round. It is surrounded by a paste made up of manganese peroxide and carbon, with some graphite to decrease the internal resistance, and electrolytic constituents and water. The proportion of graphite is regulated partly by the cost and depends also on skill in manufacture. The exact composition is not disclosed by makers and depends upon the service required, but it is stated that an average mixture is made by taking—

Manganese peroxide	10 lb.
Carbon or graphite, or both	10 lb.
Sal ammoniac	2 lb.
Zinc chloride	1 lb.

Sufficient water is added to this mixture to make it into a suitable paste.

A formula given by H. K. Richardson† as being commonly used in the United States is as follows, expressed in parts, presumably by weight:—

Manganese peroxide (85 per cent. MnO_2)	100
Ground coke	80
Artificial graphite	20
Sal ammoniac	20
Zinc chloride (30° Bé)	7

The carbon and the depolarising paste surrounding it must be regarded as a composite electrode. The depolar-

* From a forthcoming edition of "Primary Batteries." [Copyright.]

† "Metallurgical and Chemical Engineering," Vol. X., p. 531, 1912.

ising action takes place at the outer surface of the paste and progresses inwards as the cell is discharged.

Between the depolarising paste and the zinc is what may be called the "electrolytic paste." It is generally white, and is made up of flour,* plaster of Paris, sal ammoniac and zinc chloride, with enough water to form a paste. Sometimes a transparent gelatinous paste is used.

In actual manufacture, the depolarising paste may be held firmly round the carbon by means of a sack, forming a "sack element," thus permitting good contact to be obtained with the carbon by the application of a fair pressure. This sack is then placed in the container and the electrolytic paste is run in.

Provided the electrolyte is sufficient there is no advantage in having a thick layer of electrolytic paste. In fact, in American cells this is cut down so far as to consist merely of a few layers of pulp board or blotting paper moistened with the electrolyte. It must be remembered that the depolarising paste also contains electrolyte and this will diffuse as the other becomes used up. An advantage of

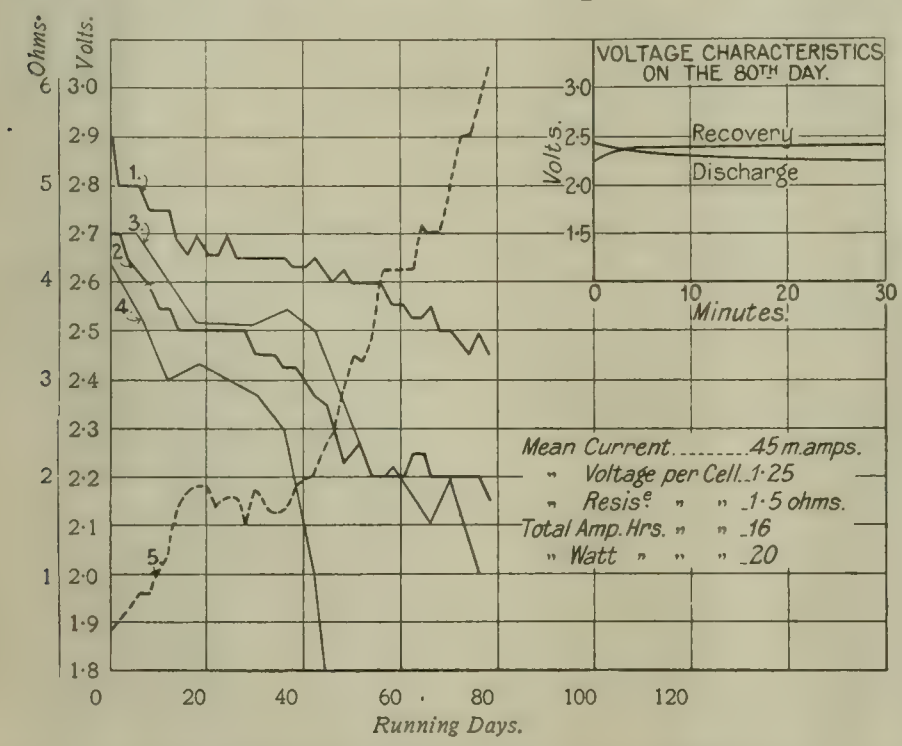


FIG. 1.—POST OFFICE TEST OF TWO DRY CELLS IN SERIES. (Lucas.)

Discharge at 45 m.a. for 5 hours (average) per day.
(5½ hours on five days a week and 2½ hours on Saturdays.)

Curve 1 shows E.M.F. after intervals of rest (*i.e.*, morning readings).
Curve 2 shows E.M.F. immediately after 5½ hours' discharge (*i.e.*, evening readings).
Curve 3 shows E.M.F. after placing battery on 4-ohm circuit for one minute (after interval of rest, taken on Mondays only).
Curve 4 is similar to curve 3, but test was made after period of discharge.
Curve 5 shows mean daily internal resistance as determined by tests before and after each discharge.

the blotting-paper method is that the container can be easily lined therewith; the paper is soaked by running in electrolyte, which is poured out again after a few moments; the carbon can then be placed in position and the depolarising paste can be rammed in so as to obtain good contact. Except in America, however, this method has not found favour, although it is cheap.

According to Richardson,† paper for this purpose generally consists of 75 per cent. ground wood pulp and 25 per cent. sulphite fibre, the thickness being 0·040 in. It must be highly absorbent so as to take up enough electrolyte, but the pores must be so fine that the carbon and graphite particles cannot migrate through them under the influence of electro-capillary forces.

Some means must be adopted of preventing the carbon and the depolarising paste from touching the bottom of the zinc container.

* In regard to substitutes for flour, *see* a note in THE ELECTRICIAN, Vol. LXXV., p. 375, 1915. Glass, wool, sawdust, gelatine, starch, Kieselguhr and water glass are mentioned.

† *Loc. cit.*

Judging from the Leclanché cell, it might be thought that sal ammoniac would be all that would be necessary for the electrolyte. It appears, however, that zinc chloride minimises local action, and it also, no doubt, keeps the cell from drying up. To prevent the latter, the cell is always finished off with a bituminous or other seal. Further, if zinc chloride is in excess the ammonia gas due to the action of the cell is converted into ammonium chloride, and does not cause trouble through forcing an exit; on the other hand, insoluble zinc hydroxide is thus formed which is harmful from the point of view of internal resistance.

Since the cell in action gives rise to ammonia it is desirable to provide some means by which this gas may escape, and for this reason a vent tube is generally provide. And objection to this has been pointed out by J. G. Lucas, namely, that the escaping gas carries moisture with it; thus the cell dries up and the internal resistance increases.* Mr. Lucas carried out intermittent tests at constant current for 5 hours (average) per day. Fig. 1 shows the results obtained with cells as supplied by the manufacturer and pro-

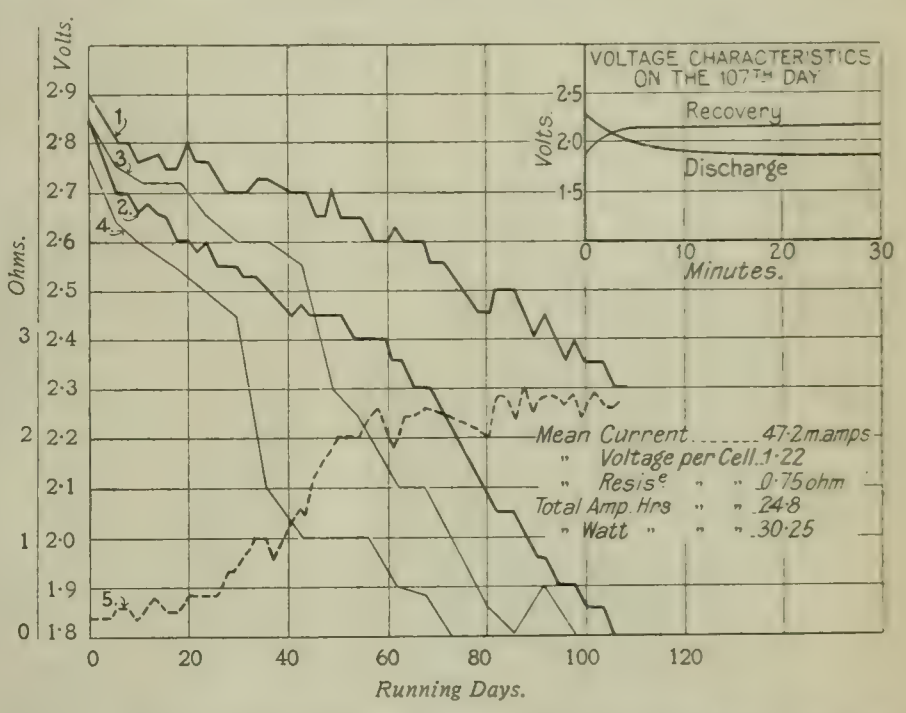


FIG. 2.—POST OFFICE TEST OF TWO DRY CELLS IN SERIES PROVIDED WITH A SEALED EXPANSION CHAMBER. (Lucas.) Compare with Fig. 1.

Discharge at 47·2 m.a. for 5 hours (average) per day.
(5½ hours on five days a week and 2½ hours on Saturdays.)

Curve 1 shows E.M.F. after intervals of rest (*i.e.*, morning readings).
Curve 2 shows E.M.F. immediately after 5½ hours' discharge (*i.e.*, evening readings).
Curve 3 shows E.M.F. after placing battery on 4-ohm circuit for one minute (after interval of rest, taken on Mondays only).
Curve 4 is similar to curve 3, but test was made after period of discharge.
Curve 5 shows mean daily internal resistance as determined by tests before and after each discharge.

vided with a vent. Cells of the same kind were then taken and a rubber expansion chamber was fitted to each cell so that the gas could pass into the chamber but could not pass right away. The results with the modified cells are shown in Fig. 2. It will be noticed that the internal resistance, instead of reaching a high value, ceases to rise after a time.

In both these diagrams curve 1 shows the E.M.F. just before the daily run and curve 2 shows the E.M.F. immediately after the run. Curve 3 gives the E.M.F. immediately after putting the cells on a 4-ohm circuit for one minute after the interval of rest, and curve 4 the corresponding figure after the daily run. The dotted curve shows the internal resistance. "Running days" means the days under test (*i.e.*, excluding Sundays).

If the ingredients of the depolarising paste are very fine the gas may have difficulty is escaping and the cell may burst. The fact that a cell has burst is indicated, if not otherwise evident, by a rapid rise of internal resistance.

For small discharges with long intervals (such as may be

* "Proceedings," Institution of Post Office Electrical Engineers, 1910.

required in Post Office work) the rise of internal resistance is a serious objection to some types of dry cell. This is illustrated by Fig. 3, which is also due to Mr. Lucas. It will be seen that after 150 days the internal resistance began to rise rapidly and was also considerably higher after each day's discharge than before the discharge, giving rise to two curves. From this it would seem either that diffusion occurred with difficulty after a time, or that gas was formed during the day and was dissipated during the night.

The rise in internal resistance is a troublesome feature of dry cells. It is not due simply to the drying out of a cell. In fact, this is probably only a minor cause, since the voltaic action of the cell itself gives rise to water. It is more probably due to the formation of insoluble double chlorides and basic chlorides which take up water in their formation and which restrict the available path for the current. It is noticeable, however, that the current from an old cell often rises for a time when the cell is placed on circuit, showing that the internal resistance is reduced by the water that is liberated. Another feature of ageing is the lowering of the E.M.F.

From the point of view of cost of operation the rise of internal resistance may be important because it may set a limit to the life of the cell. Thus, referring to Figs. 1 and 2, Mr. Lucas computes the inclusive cost per watt-hour for Post Office work in the case of the cell whose internal resistance rises rapidly as being 0·6d., whereas the cost for the cell whose internal resistance rises slowly is only 0·37d.

the zinc container. To facilitate connecting up cells, special devices are sometimes used, such as the Fahnestock connector, supplied by the National Carbon Co. (U.S.A.), and illustrated in Fig. 4. Another American device is the Patterson connection, shown in Fig. 5. The top of the cell is provided with a screw thread so that it will screw into a large Edison socket. In the case of a battery, a number of these sockets are wired together and it is only necessary



Fig. 4.—Fahnestock Terminal.



Fig. 5.—Patterson Screw Top for Dry Cell.

to screw the cells home to secure connection. Ignition batteries are conveniently fitted up in boxes in this way. Cabinet outfits are made up on this plan to give up to 150 amperes at a low voltage.

Materials.

The manganese peroxide (mainly from the Caucasus or Japan) usually contains 85 per cent. of MnO_2. The carbon

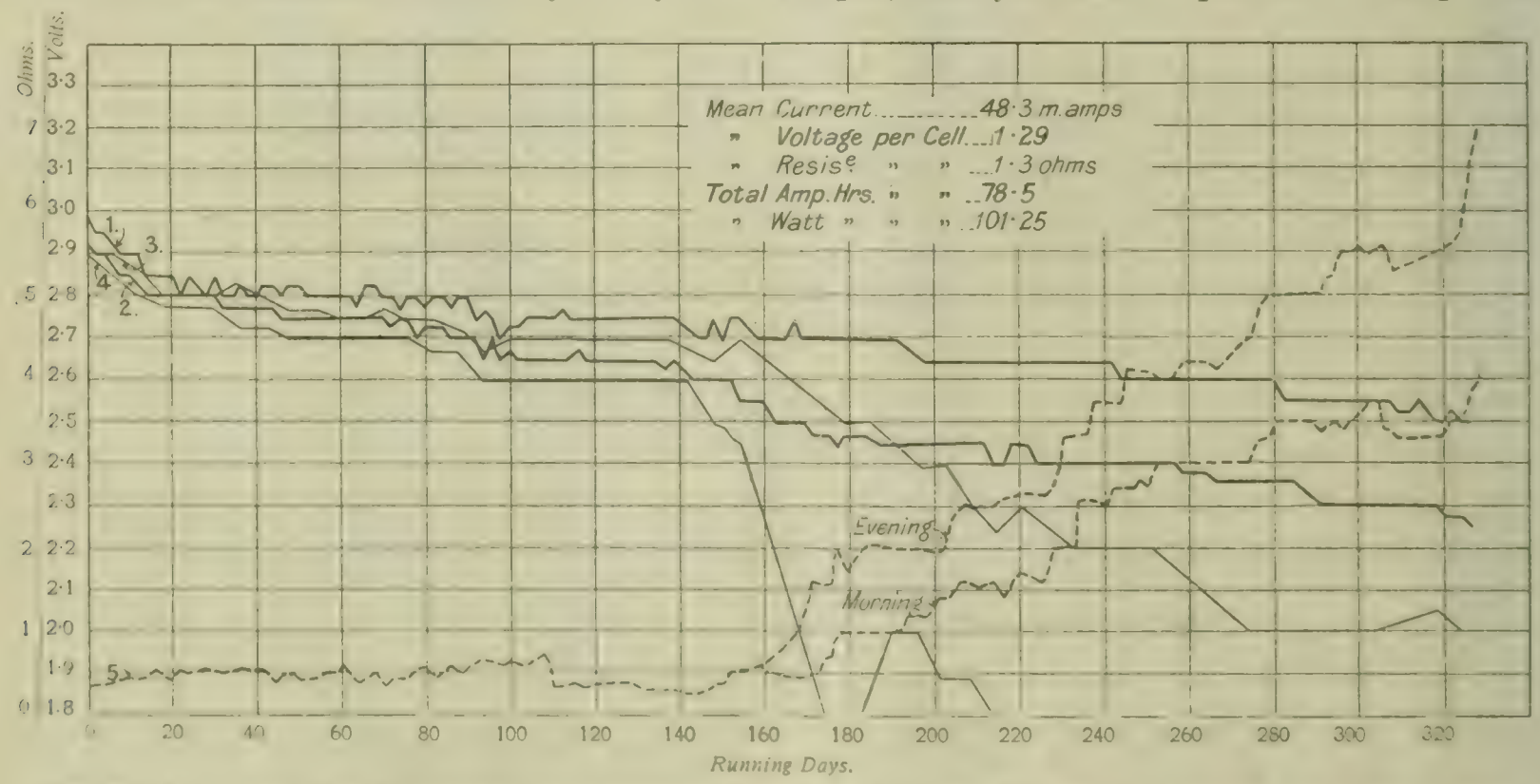


Fig. 3.—Illustrating the Undesirability of having a Large Dry Cell for a Small Current, and the Rapid Rise in Internal Resistance after a Certain Period. (Lucas.)

Discharge (148·3 m. a. for 5 hours (overload) per day.

(5) Discharge 5 hrs (for 4 days a week and 2) hours on Saturdays.

Curve 1 shows E.M.F. after
Curve 2 shows E.M.F. immediately after
Curve 3 shows E.M.F.
Curve 4
Curve 5 shows
tests before and after each discharge.

These figures are an estimate of the total cost involved so long as the battery remains in use, and includes interest on capital, establishment charges, freight and handling, labour, supervision, travelling, materials and estimated value to cover the physical deterioration of permanent parts, if any.

Except for the vent tube, dry cells are always hermetically sealed by means of a bituminous or resinous seal.

The carbon terminal is usually one of the varieties used in Leclanché cells. The zinc terminal is generally a wire, but American makers prefer an acorn-head post soldered to

that is used is retort carbon, coke, petroleum coke and other varieties of various qualities freed from iron by magnetic separation. Graphite may be natural or artificial (mostly that known as Acheson Ba2), but more usually the best qualities of natural graphite, such as that from Ceylon, is employed.

Both the sal ammoniac and zinc chloride must be free from impurities, particularly from iron, otherwise local action results. Local action also occurs if copper passes into solution, since it then becomes deposited on the zinc;

in fact, copper is the most harmful impurity in this respect. It might be thought that local action would also occur on account of the solder, but since lead and tin, the constituent metals, have high "over voltages" (*i.e.*, they require considerably more than the P.D. due to the decomposition of water to liberate hydrogen), such action does not take place. Some local action may also arise if the carbon and the depolarising mixture are both in contact with a thin layer of the electrolyte paste, the zinc being on the other side of this layer. Messrs. C. F. Burgess and C. Hambuechen* state that the P.D. between the carbon and the mixture is 0·176 volt. Consequently it is better to surround the bottom of the carbon with the mixture if the zinc is sufficiently near to form part of the path carrying the resulting current.

Desiccated Cells.

It is well recognised that dry cells deteriorate if they are in a hot place considerably more quickly than if kept in a place that is cool. It is not surprising, therefore, that such cells are found less satisfactory in tropical than in temperate climates. For this reason cells have been devised which are not only dry by name but dry in actuality, and may thus be called desiccated cells. Substantially, these cells are dry cells in which powders are used instead of pastes. Consequently, they can be kept indefinitely without deterioration, and when they are required for use the necessary water can be added. This is a very great advantage; but, on the other hand, such cells do not in all cases have as long a life as the corresponding dry cells.

The "Extra Sec" Cell.—This cell, which is made by the General Electric Co., may be described as a G.E.C. dry cell modified to take advantage of the above principles. A section of the cell is shown in Fig. 6. A tendency towards American practice is seen in that a thick layer of absorbent paper is used for lining the zinc container. The space between the paper and the carbon is filled with the depolarising mixture. The carbon is in the form of a perforated carbon tube, so that when water is poured into this tube it percolates through the perforations and saturates the depolarising mixture; the latter is made up with exciting salts, so that the necessary electrolyte is produced when the water is added.

According to data published by the Company, the life of this cell is not so high as that of the corresponding dry cell. As to what is the explanation of this shorter life it is difficult to say with certainty. Possibly it may be due to the fact that the lower oxide produced by the reduction of the manganese peroxide is more bulky. Since the paper is much less yielding than the white paste or gelatinous electrolyte used in dry cells, the resulting pressure may be high enough to force the moisture out of the paper and to form the impurities from the zinc into a layer of somewhat high resistance, thus shortening the life.

The Dura Cell.—The Dura cell, which is made under a patent by Messrs. Siemens Brothers & Co., is more of the wet-cell type. As will be seen from Fig. 7, a sack form of carbon element is used, and the space between this and the zinc container is filled with a powder consisting of ammonium chloride and a gelatinous substance which forms a paste when moistened. There is a considerable space between the top of the sack and the seal. The latter consists of two layers of cork, the lower one of which closes the zinc vessel and the upper one the outer case, the space between these two layers being filled with a resinous material. A vent tube is provided, and also a corked tube, through which water is added. The cell is charged by pouring in water until the cell is full. It is then allowed to stand for a few hours, when any water that has not been absorbed is shaken out and the tube is re-corked.

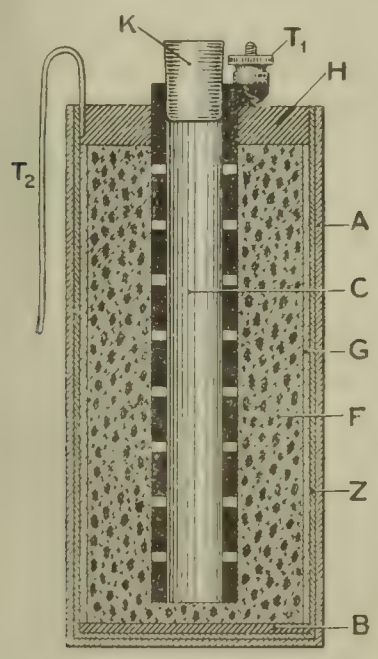


Fig. 6.—Section of the "Extra Sec" Cell.

A=Cardboard case. H=Bituminous seal.
B=Insulating layer. K=Rubber cork.
C=Carbon tube. Z=Zinc.
F=Depolarising paste T_1=Positive terminal.
G=Layer of absorbent paper. T_2=Negative terminal.

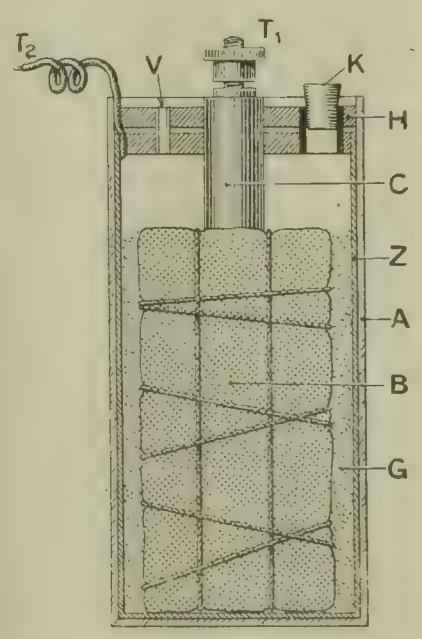


Fig. 7.—Section of the Dura Cell.

A=Cardboard case. K=Cork stopper.
B=Sack element. V=Vent tube.
C=Carbon. Z=Zinc.
G=Excitant powder. T_1=Positive terminal.
H=Cork seal. T_2=Negative terminal.

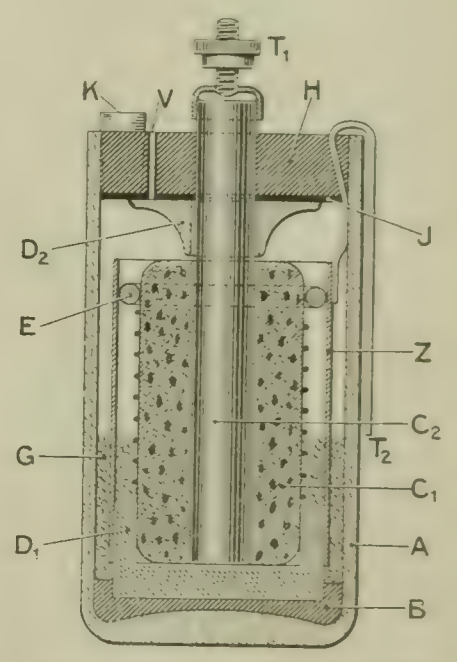


Fig. 8.—Section of H. 2.O Cell.

A=Glass jar. H=Bituminous seal.
B=Layer of compound. J=Waxed cardboard washer.
C_1=Sack element. K=Cork.
C_2=Carbon. V=Vent tube.
D_1=Porcelain base. Z=Zinc.
D_2=Porcelain ring. T_1=Positive terminal.
E=Rubber ring. T_2=Negative terminal.
G=Excitant crystals.

The H. 2.O Cell.—This cell, which is rather more complicated in its construction than the other examples here described, is made by the Ediswan Co. As shown by Fig. 8, a glass jar is used as a container. Into the bottom of the jar is run a little bituminous compound, which serves to fix a porcelain cup. The latter acts as a support for the sack element. The cylindrical zinc is separated from the sack at the bottom by the porcelain cup, and at the top by a rubber ring. Above the sack is a porcelain ring, which carries a waxed cardboard washer for supporting the bituminous seal. A vent tube is provided in the seal. An unusual feature is the strip terminal connection to the zinc, which is of lead; the other terminal is fixed by means of a brass cap. The cell contains a certain quantity of crystals and only requires the addition of water.

(To be concluded.)

* "Trans." American Electrochem. Soc. Vol. XVI., p. 97, 1909.

SIR J. J. THOMSON ON RADIATION FROM ATOMS AND ELECTRONS.

The subject of the series of six lectures by Sir J. J. Thomson, O.M., P.R.S., delivered at the Royal Institution on Saturday afternoons, commencing on March 11, was "Radiation From Atoms and Electrons." In what follows we give an abstract of the first three lectures.

The main object of the study of radiation, Sir Joseph said, in opening his subject, was to form an idea as to the mechanism at work within the atom when radiating, and he would, in the first lecture, consider the principal difficulties which were experienced in interpreting the radiations with respect to the vibrator emitting them. Up till about 20 years ago it had been believed that the occurrence of interference bands in experiments with white light implied a great regularity in the vibrations of the luminous source. But Rayleigh had shown that this study was not non-ambiguous, and it was now universally held, the lecturer thought, that the regularity of interference bands had nothing to do with the vibrations, but depended upon the peculiarities of the instrument used and of the medium through which the vibrations had passed before being received. This was demonstrated in various ways. Two rubber tubes were suspended from the ceiling of the hall. Striking the lower part of the one tube sharply with the edge of the hand, Sir Joseph showed that the disturbance travelled up the tube and was reflected back, a hump being seen to travel up and down several times while keeping its shape unchanged. It was not a wave-motion; only a short length of the tube was disturbed at any moment, and there was no tendency for the motion to spread. Acoustically it was something like the crack of a whip or pistol-shot, which had no musical note in it. When a man standing at the proper distance in front of a flight of steps clapped his hands or discharged a pistol, the noise would be of very short duration; but the steps at regular intervals successively reflected the disturbance back, and the noise came back to the ear as a musical note, the pitch depending upon the number of steps, but not on the duration or period of the original disturbance, which, indeed, had no period. Similarly, the character of the rolling thunder did not depend upon the instantaneous crack produced by the lightning discharge, but upon the reflecting clouds. In order to illustrate the influence of the steps in the rubber-tube experiment, the second tube had been weighted in its upper portion by four or more lead rings encircling the tube. When this tube was struck like the former, the hump was reflected back from each weight and spread out into a wave, so that a considerable length of the tube was seen to vibrate at any moment. If we now imagined, in the place of the steps, a grating of opaque and transparent parts at regular intervals, light falling on the grating would be sent back in a succession of separate disturbances which might interfere with one another, and the interference would depend upon the grating, but not at all upon the original source of light which might be quite irregular or a mere pulse. The interference, therefore, would not give any clue as to the nature of the source of light.

The case of the prism was analogous but more difficult. There a disturbance passed through a refracting medium which transmitted different disturbances at different speeds. To illustrate this case, Sir Joseph first made use of Kelvin's "wiggler," a long wire (suspended from the ceiling) to which horizontal wooden cross bars were attached in a sort of spiral arrangement. When the bottom bar was twisted, a whole series of waves was seen to travel up the "wiggler," the wave length increasing with the distance from the bottom bar. The waves produced in water by a falling stone afforded a better illustration. In his studies, Kelvin had started from a hump somehow produced in water: that hump, Sir Joseph exemplified by a slide, would be a valley next moment, and ring waves would travel outward. After a certain time the water at the centre of the disturbances would appear flat, the waves near it short and low; the main wave, higher and longer, could be seen farther out, and the waves beyond that would be longer, shallower and faster. Similarly, an irregular pulse of light would spread out in a prism into a large number of regular waves, the number of waves increasing as the length of the optical path through the glass increased. The easiest way of analysing light was by Fourier's theorem, though it looked a paradoxical way. Any disturbance whatever could be represented by a series of waves superimposed upon one another. Even an abrupt noise might be represented by the superposition of the musical notes sent out by several tuning forks of different pitches. It appeared strange that a momentary noise should be analysed into a series of continuous waves, but the waves would interfere with one another, and the combined result of the waves would be a noise, followed by silence and by a repetition of the noise, and so on. The above-mentioned water hump of Kelvin's could be analysed in the same way. Now, the peculiarity of water, glass and some other media was that the speed of the travel of the waves depended upon the wave-length. It was not so in air, for otherwise the enjoyment of a concert would be impossible, nor was it so in the first rubber tube, where all the waves travelled at equal speeds and hence retained their shapes. But in water and glass the longer waves travelled faster; hence the longer waves came up to the front and left the shorter ones behind, and the separation became the more perfect the longer the path (or the more glass there was); finally, the leading waves might be monochromatic.

In order to exemplify these features Sir Joseph made a thin stream of water flow down a plate of glass which was more or less induced to alter the velocity of flow. A knob projected from the middle of the glass, opposing an obstacle to the flow; that knob turned the current back, and when the velocities of the original and of the reflected currents were equal, a system of stationary waves was set up which could be seen by projection. But these waves, Prof. Thomson explained, were not gravitational waves (as in the sea, where long waves travelled faster than short ones), but surface-tension waves, whose short ripples were faster than the long waves. When the speed of the downward flow of the water was increased, the ripples came up more closely to the knob and to one another, because the reflected wave was then of shorter length. On the other hand, the waves became indistinct and vanished, when the speed of flow was reduced below a limit, because the propagation of waves over a water surface required a certain minimum speed. Thus it was the medium (the water) which decided whether or not the disturbance would be propagated, and so it was with the glass of the prism.

In a sense the prism coloured the light by separating the train of waves, and if it were not for that effect, Sir Joseph could not understand how the eye could receive the sensation of colour from a disturbance lasting a fraction of a vibration only, just as it was not possible for the ear to pick out one particular note unless several of its complete vibrations reached the ear. Sir Joseph added that we knew little about the mechanism of the eye, but he did not believe that a blind man could guess the dimensions of a room simply by clapping his hands, as had been asserted. The prism did more than it was credited with in text-books. It was mathematically correct to say that it disentangled the mixed-up colours. That would not apply to a pulse, however; but the prism actually prolonged the time which a disturbance lasted, especially if the optical path were long. For that reason, however, the prism, like the grating, could not inform us as to the regularity of the original disturbance.

Yet some cases of interference studied by Michelson stood apart, because in them the optical path (through glass) was very short. Reference to a simple case of acoustic interference would make that clearer. A sensitive flame was placed between a source of sound and a mirror so as to receive both the direct and the reflected sound waves. Two waves, although they might arrive at the same moment, had not left the source at the same moment, because the reflected wave had a longer way to travel, and the time interval would increase with the difference in the distances travelled. Michelson now observed an interference, which could be balanced, of green mercury light in cases where the time interval was equivalent to 540,000 vibrations. That experiment had been supposed to imply that a mercury atom would sustain its vibrations with a persistence that it vibrated after half-a-million vibrations exactly as vigorously and under the same conditions as before. That was not the whole story, however, Sir Joseph thought. The radiation could not be explained with reference to a single atom. There were other atoms surrounding it, colliding with it, and thus disturbing its vibrations. Yet the disturbances would not be considerable if the intervals between successive collisions were large by comparison with the time required for half-a-million vibrations. A large number of atoms, Sir Joseph suggested, were forced into tune by their mutual influences. As the one atom ceased to radiate another began, and that it started in phase was due to the respective radiation itself. In order to illustrate that interference effects accumulate and become stationary, Sir Joseph finally dipped two wires, each attached to a tuning fork, into a trough of mercury: a beautiful system of interference ripples was set up.

Referring again, in the second lecture, to the Michelson experiment, Sir Joseph said that interference would not be possible if there had been any irregularity in the long wave train or amplitude of the mercury light. If that light had passed through many prisms, the regularity, if not originally present, might yet have been produced by the length of path through the glass: that length had been very small, however. But the regularity was perhaps, after all, due to the medium surrounding the mercury atoms, *i.e.*, mercury vapours. If that medium possessed very intense dispersive power, the regularity

of the wave-train could be explained by that dispersion, and there was reason to ascribe an altogether inordinate dispersion to mercury vapour. The curve AB of the diagram, Fig. 1, explained the ordinary relations between refractive index (and hence dispersion) as ordinate and frequency as abscissa; as the frequency rose the refractive index became greater. That held for glass and many other substances, but not for substances which showed anomalous dispersion and were also known to give out peculiar light of their own. In their case the rule held up to a certain frequency C. If the frequency of the light waves increased very slightly then, the refractive index shot up almost into infinity DE; and if the frequency were still raised, the square of the refractive index became negative, and the light did not pass at all; with still further increase of the frequency, the refractive index also increased again, remaining smaller, however, than it had been before, as at FG. These peculiarities could be explained by the model of Prof. Wilberforce, of Liverpool (Fig. 2). In a rigid frame nearly 3 metres

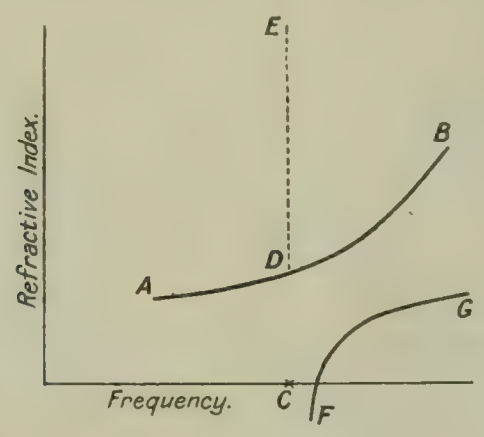


Fig. 1.

in length, two systems of brass balls $A_1 \ldots B_1 \ldots B_{12}$ (21 balls in the model, only a few shown in Fig. 2) are connected in series by spiral springs; they are further held by spiral springs from above, and by rods or wooden frames (within which heavy pendulums, all equal, are suspended by strings) jointed in the bottom bar of the big frame; the balls can oscillate in a horizontal plane (out of the plane of the paper) so that the line AB becomes sinuous, the whole suspension system taking part in this oscillation. The oscillations are excited by pushing and pulling ball A_1 in unison with the beats of a metronome. When A_1 was oscillating at frequency 84 per minute, the whole line AB was a sinuous wave, but the wave-length was shorter in II. than in I.; at frequency 95 the wave in II. was still shorter and the pendulum near B_1 oscillated more than the others; at 110, the natural period of the pendulums had been exceeded, B_1 and its pendulum took up almost all the energy, and the wave did not travel

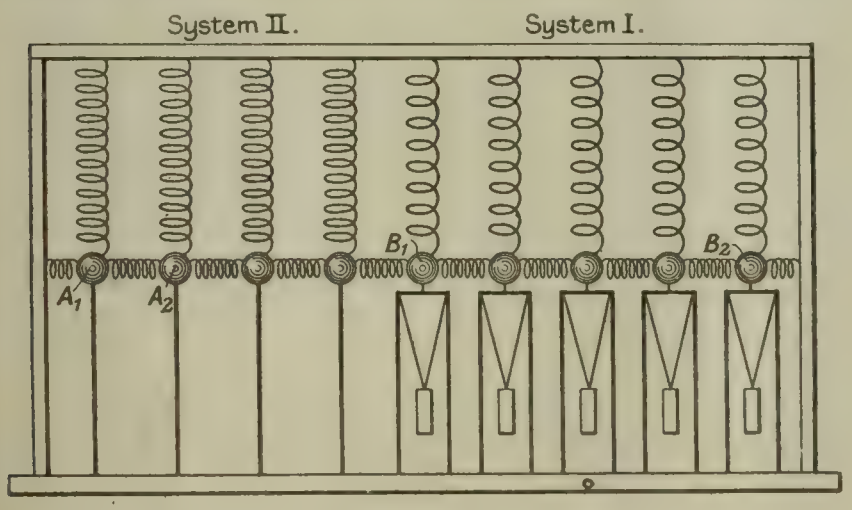


Fig. 2.

beyond B_1; at 127, this was accentuated, B_1 pendulum jerking violently, the further balls remaining at rest; at 168 the wave travelled again into II., where the wave was now longer than in I., and the pendulums, which had first oscillated in the same direction as their balls, now swung forward when their balls were moving back.

At a certain frequency a very slight increase in the frequency made a very great difference in refraction and dispersion; that was when resonance between the incident light and the natural period of the atoms of the medium was attained. If the model had been oscillated at exact resonance it would have flown to pieces, Sir Joseph remarked; but he would exemplify resonance by another model. To the lower end of a spiral spring, weighted in its middle and suspended vertically, was attached a rod which was itself jointed below to a point near the centre of a disc turned at variable speed. At slow rotation the weight moved up and down in phase with the crosshead; at high speed the forced vibrations of the spring weight were again smooth, but not in phase with the crosshead; at an intermediate speed, which corresponded to the natural period of the spring, the vibrations became very violent jerks; at this period the weight absorbed energy from the system, a point to which Sir Joseph subsequently reverted.

Two optical illustrations of these features, due to R. W. Wood, of Baltimore, were then shown. A glass bulb contained iodine vapour at very low pressure; the vapour was almost invisible in the warmed bulb until light of a particular wave-length (not other light) made the bulb shine in a luminous fog. Another bulb contained sodium vapour which formed a mirror on the inside glass wall; the mirror disappeared when the bulb was heated over a Bunsen burner. From a Méker burner, in which salt was burning, yellow sodium light was then made to fall on the bulb; there was intense reflection inside from the spot struck by the rays outside, and a glow of the sodium vapour beyond that spot. Wood, the lecturer added, had placed a triangular screen painted with magnesia inside the bulb; the white magnesia was an excellent reflector, but when that sodium glow was excited by sodium rays from outside (as described) the reflection and dispersion by the sodium vapour (at a pressure of 0·001 mm.) became so strong that the magnesia mirror could no longer be distinguished because the sodium vapour reflected its own light (but not any other) more strongly than the magnesia, which was a good reflector in general.

Coming back to the Michelson experiment, Prof. Thomson asked his audience to suppose that each mercury atom made a few oscillations only, giving rise to a certain disturbance, which could be analysed into a series of waves moving at different velocities. The particular mercury vapour light, having infinite refractive index and dispersion and hence practically no velocity (for the velocity was inversely proportional to the index), would then be separated from the other waves left behind. Thus, one had no clue as to regularity of the original waves in the presence of vapour, and to obtain information as to the regularity one had to work in another way. The only thing that could not be analysed by Fourier's theorem was an absolutely indefinite train of simple waves, perfectly regular in all respects. Such a train of, say, 1,000 wave-lengths of Na light, having neither end nor beginning, could not be analysed, unless we added other waves to it, which would, in the spectrum, give additional lines or satellites near the sodium line. If that additional light had also about 1,000 vibrations the satellite would be close to the line, or the line would merely appear broadened. With a train of only 10 vibrations or 1 vibration, line and satellite would distinctly be separated, the further the fewer waves. A gain or loss of a few waves (1 or 3, *e.g.*) during the period of the excitation would give rise to the most important Fourier components; a gain of one wave would, with 1,000 original waves, produce a satellite within 1 in 100,000 of the line. The general effect would be a broadening of the spectrum lines, and the fineness of a line was a measure of its regularity. The actual breadth of a line, Rayleigh had demonstrated, could be deduced from the Doppler effect, since the light on the one side of the line would be a little faster and on the other a little slower than the mean velocity.

(*To be continued.*)

Breakdowns in Colliery Electric Plant.—Mr. R. Devine, at a recent meeting of the Scottish Branch of the Association of Mining Engineers, referred to some breakdowns of electrical apparatus. The first case referred to was that of a motor controlled by an oil-immersed switch and rotor switch, of the liquid variety. A short circuit took place between two of the trip coils, but by separating them with a piece of mica the motor was enabled to run as usual. The motor was a 3,000-volt three-phase machine driving a pump and requiring 200 H.P. Another fault was in the barrel of a controller for a 50 H.P. open-type three-phase motor, having a short circuit between phases. A fault also occurred on a bitumen three-core cable owing to the heat of the place softening the bitumen and allowing conductors to make contact. At another colliery there was a shaft exciter on the turbo-alternator, and earth lamps on the exciting switchboard to indicate a fault. Sometimes one of the lamps on the machine side burned more brightly than the other, showing an earth on the machine side. The intermittent fault was due to the leads from the slip-rings having become saturated with oil, presumably destroying the insulation. When they were replaced the fault was cleared.

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TRUNK LINE ELECTRIFICATION.

The Paper by Mr. N. W. STORER on "Trunk Line Electrification," which was read recently before the Institution of Electrical Engineers, brought forward the subject of standardisation of electric railway equipment. This problem is one which has somewhat troubled the minds of railway engineers since railway companies have shown a tendency to electrify their lines on different systems, but, so far, the matter has not received very serious attention. Undoubtedly a decision ought if possible to be reached before much more progress is made, but at the present moment we doubt whether sufficient data are available to enable any decision of value to be taken.

The question in all its aspects is much broader than might be thought from the Paper read by Mr. STORER, who makes the tacit assumption that continuous current will necessarily be used on trunk lines. This may or may not be the case. For the moment we have three general systems—namely, continuous-current, single-phase and three-phase As regards the first two, single-phase is at a disadvantage in the weight of the motor equipment ; but in the overhead line it shows a lower first cost, and, if transmission from the power house is by single-phase current, this is true also of the sub-station plant. Single-phase transmission, however, implies single-phase generation, which is more costly in first outlay. On the other hand, if three-phase generation is adopted so as to reduce the outlay on generation and transmission line to a minimum, then rotary plant becomes necessary in the sub-stations. If three-phase is used in generation it becomes a question whether the same system should not also be used on the locomotives, thus giving uniformity throughout. To this there is the objection that double overhead conductors are then necessary, but as a set-off against this there is a certain simplicity and uniformity, and regenerative braking becomes a simple matter. Due to this last named feature, the three-phase system has found favour in Italy and Switzerland, but it has practically remained unnoticed in other countries. We do not feel convinced that this policy is quite justified.

Passing from these systems we come to distinctions that

are due to methods of collecting the current. We already have in use for low voltages in this country both third-rail and third and fourth rails. For high voltages an overhead wire becomes essential from the point of view of safety, thus introducing another variant. In most cases it would not be difficult to provide the necessary gear for through running as far as the collection of current is concerned, if this were all that would be necessary.

Lastly, there is the question of voltage. This is a more difficult point, though we think it is less serious than it would be on suburban lines, nor can it be compared in its effect with the broad and narrow gauges. The effect of the latter was felt on all the rolling stock, whereas, in the working of electrified main lines only, the locomotives would be unable to pass from one system to another. It is not an uncommon thing to change the steam locomotive at certain points of a journey at present, and a similar change could still be effected at the junction of different systems, if no agreement were reached as to a common system.

It would obviously be a great mistake to decide upon one particular voltage before the advantages and disadvantages of other voltages had been fully realised. Suppose, for example, that a decision had been enforced five years ago. At that time it would have been a choice between 600 volts continuous-current and, say, 6,600 volts alternating-current, and it is very doubtful which of these two systems would have carried the day. It is not merely a question of suburban traffic, but of trunk-line electrification also. In the case of the former there is not much doubt that 600 volts would have been generally adopted, and in the case of trunk-line electrification alternating-current would probably have received strong support. At the present day, however, continuous-current at higher voltages has proved itself worthy of serious consideration and it is much more difficult to say exactly how the position stands. In this country the bulk of the electrification has been carried out at 600 volts continuous-current, but there is now 1,200 volts on the Manchester and Bury line, 1,500 volts on the North Eastern Railway and 3,500 volts used experimentally on the Lancashire and Yorkshire Railway, all of which are continuous-current. It is certainly impracticable to have locomotives capable of running on all these voltages at will, and apart from this there is the single-phase system of the London-Brighton Company at 6,600 volts. There is no question that any decision on the matter should be arrived at by the railway engineers themselves, and this we cannot expect until much more experience has been gained.

Another point emphasised in the discussion on this Paper was that of regenerative braking. There is not much doubt that this method of braking has received less attention in this country than it deserves, but it is equally certain that it presents some difficulties. If motors on existing lines are to be used in this way then they must be larger for a given equipment. Unfortunately, it is by no means easy to provide larger motors, on account of lack of room, at least on motor coaches. It would seem, therefore, that if satisfactory working is to be secured means must be adopted to obtain more efficient ventilation so that more work can be obtained without risk of over-heating. Assuming that equipments can be provided for regenerative working, the whole problem is one of balancing up the gain in running costs against the increased cost of equipment. In main-line working there is not much to be said for regenerative braking in this country, although it is most important in mountainous countries, such as Italy and Switzerland. In suburban running, however, where the stops are very frequent, it may well be that this form of braking would prove to be worth the extra expenditure. There would not merely be a saving in electrical energy but also a material saving in brake rigging, brake blocks and probably in the rails themselves. This question was discussed in the recent James Forrest lecture by Mr. H. M. HOBART, who gave interesting figures and pointed out that the modern motor for locomotive equipment with forced ventilation is so much lighter than the earlier self-cooled motors that the provision of the increased output that is necessary does not present any difficulty.

REVIEWS.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.]

Wireless Telegraphy. By Dr. J. ZENNECK. Translated from the German by A. E. SEELIG. (London: Hill Publishing Co.) Pp. xx.+443. 17s. net.

Few students of radiotelegraphy need to be introduced to "Zenneck." His works on the subject are classics, and need, therefore, neither to be recommended nor reviewed. To many, however, these works have remained closed books, due to the fact that they appeared in the German language. On this account Mr. Seelig's able translation of the work which has, on more than one occasion, been referred to as *the* text-book, will be welcomed. Rather than take the risk of distorting the author's precise meaning the translator has in places retained a very literal translation in preference to adopting the customary phraseology. When tempted to add something to or modify the original (as, for instance, in connection with recent high-frequency apparatus) the translator tells us that he finally decided to let Zenneck be Zenneck, and the work loses none of its value on this account.

The book is divided into 14 chapters, of which the first five deal with natural oscillations of condenser circuits, open oscillators, high-frequency circuits, coupled circuits and resonance curves. Chapter VI. is devoted to the antenna, and in the next three chapters transmitters of damped and undamped oscillations, and high-frequency machines are considered. The propagation of waves over the earth's surface is treated in Chapter X. In the remainder of the book the author succeeds in compressing into 130 pages a large amount of information on detectors, receivers, directive telegraphy and radiotelephony. From beginning to end sound common sense has been shown not only in the selection of matter, but in the balancing of the several sections. We are glad to note that without undue prominence or bias, the author gives clear and brief descriptions of the commercial apparatus made by firms on the Continent, since by this time the apparatus made in England is, or should be, fairly well known.

Two other features of the book deserve unstinted praise. These are the bibliography and the diagrams. In the former, reference is made to a large number of important contributions to the literature on the subject, and, in addition, lucid notes are here given on various points connected with the theory of the subject. The diagrams do credit to the text as well as to the publishers, who, by the way, have reached the high-water mark in the art of book illustration. The whole of the press-work of the book leaves nothing to be desired.

On the Relation of Imports to Exports. By J. TAYLOR PEDDIE, F.S.S. (London: Longmans, Green & Co.) Pp. v.+88. 2s. 6d. net.

This is a small volume of which more than half is devoted to the subject of the title. While giving credit to the position acquired by our great banks, the view is taken that there are forces of British industry which should be re-established in this country as the one and only effective means of creating new forms of wealth after the war. Some allusion is made to the way in which Germany has obtained control of certain industries, as, for example, in the handling of minerals in the Australian Commonwealth. It is pointed out that we have

something to learn from German methods of developing foreign trade through the influence of her banks, and that if our system were sound it should be possible for us to maintain a greater population in Great Britain and Ireland than 48,000,000 people. The prosperity of a country depends, in the opinion of the author, more upon the efficiency of its internal than its external trade, and it is possible for the internal trade of a country to render the greater part of its external trade unnecessary and yet be wealth-productive. There is no doubt that the subject is very complex, and requires a good deal more than superficial study. The second part of the book deals with foreign exchange, and is beyond the scope of THE ELECTRICIAN.

The "Practical Engineer" Electrical Pocket-book & Diary, 1916. (London: The Technical Publishing Co.) Pp. iv. + 646. 1s. 4d. net.

In the present edition of this well-known pocket-book many of the tables have been re-cast, and the specifications of copper conductors have been brought into agreement with those of the Engineering Standards Committee. Sections have been added relating to telephones and first aid in accidents. Instruments and apparatus are stated to have been carefully brought up to date, and a method of calculating the flow of heat through furnace walls, based on Ohm's law, has been introduced for the benefit of designers of electric heating and cooking apparatus. The standards for electrical machinery of the Engineering Standards Committee have been revised in accordance with the October report of last year.

Annuaire pour l'An 1916. Publié par le Bureau des Longitudes. (Paris: Gauthier-Villars et Cie.) Pp. vi. + 502. Fr. 1.50 net.

The present edition of this well-known volume, which first appeared in 1796, contains, in addition to the usual matter, some 87 pages on "La pression barométrique moyeune et le régime des vents en France," by M. G. Bigourdan, and a "Notice sur le Commandant Guyou," by M. Emile Picard, whose death is a great loss to the Bureau des Longitudes and to the French Marine. Although for several years an invalid, Guyon never ceased to participate in the work connected with these bodies, particularly in those portions relating to navigation and nautical astronomy.

THE POSTMASTER-GENERAL'S ANNUAL REPORT.

From the report which has just been published we give the following extracts dealing with points of interest to our readers:

Telegraphs.—During the year ended March 31, 1915, 91,179,000 passed over the Post Office wires. Since the outbreak of war the military and naval traffic has been extremely heavy. Not only has the number of Government telegrams materially increased, but there has also been an increase in the number of words per telegram, owing to the fact that military and naval messages are longer than the average business telegrams. The increase in the number of telegrams sent during 1914-15, compared with the previous year, is about 4·5 per cent. The revenue from this source, after making deductions, amounts to £2,984,942.

The European crisis at the end of July, 1914, and the subsequent declaration of war, threw a large amount of work on the telegraph staff. In addition to the abnormal increase for a few days in the number of private telegrams, preconcerted arrangements were brought into operation for the rapid transmission of naval and military telegrams, all telegraph offices being kept open day and night for 48 hours after mobilisation was ordered.

The prearranged scheme for facilitating rapid telegraphic communication between London and all places of naval importance in the United Kingdom included the despatch of some 300 Post Office telegraphists to the various naval signal stations and other establishments, and the equipment of many special circuits of which only the necessary lengths of wire were maintained in time of peace. Since August, 1914, many additional circuits have been provided to meet the growing needs of the various centres of naval activity, these circuits being made up so far as possible, by utilising reserve wires or by altering the equipment of existing wires, including those used for commercial messages, so as to enable them to carry a greater amount of traffic.

The Post Office engineering staff have also been largely employed since the outbreak of war in providing telephone and telegraph lines for military defence purposes in the country, and for the control and administration of the new armies, and the use of the telephone system for these purposes has thrown a considerable amount of work and responsibility on the staffs of the Post Office Exchanges.

The number of Telegraph Offices open on March 31, 1915, was 14,222 (including offices at railway stations, &c.), as against 14,152 last year, an increase of 70.

Since the outbreak of war telegraph facilities have not been provided at temporary Telegraph Offices on racecourses. A great many telegraphists have left for service with the colours, and staff could not be spared to attend. Telegrams are dealt with at existing offices in the neighbourhood of the courses, but the number of racing telegrams is much fewer than it used to be.

In consequence of the changed conditions it has been necessary to make alterations in the hours during which telegraph business is transacted. The hours have been extended in many places in order that the telegraph service may be available day or night for military or naval purposes. The hours have been curtailed in some places where the small amount of business transacted and the shortage of staff rendered such a course desirable.

The difficulty of handling the additional traffic has been enhanced by the withdrawal of a large portion of the telegraph staff for military or naval service. Various devices have had to be adopted to make good the deficiency thus caused. Temporary staff has been employed, additional operators have been trained, retired officers (including married women) have been recalled, and positions not requiring manipulative skill have been filled by persons not proficient in telegraphy.

The substitution of the telephone for the morse sounder as a telegraph instrument has proved specially helpful in view of the dearth of trained staff. Care has been taken to use telephone circuits for the transmission of telegrams only where this could be done without prejudicially affecting the telephone system, but the relief afforded to the telegraph system can be gauged from the fact that the telephone is now in use as a substitute for the telegraph at 7,350 sub-offices.

The use of high-speed printing telegraph machines purchased from Messrs. Creed, Bille & Co. has set free a number of telegraphists who would otherwise have been employed on manipulative work. A new instrument manufactured by the Western Electric Company, similar in design to the Murray multiplex, has been installed on the London-Manchester route, on which the Murray instrument is already installed, and has given good results. It provides for eight channels on one underground circuit, four in each direction, worked by means of type keyboards, and prints the telegrams ready for delivery to the public. Baudot working has been extended, and is now in force between London and Birmingham, London and Liverpool, and London and Glasgow, and it is about to be introduced on the London-Brighton route. The Creed machines are used extensively for the transmission of press news, and experiments are being carried on at Manchester with a view to the production of extra copies from the typed slip. In addition to this use of type-printing machines there has been an increased use of Wheatstone, with type-keyboard perforators, in order to reduce the amount of morse key signalling, thus minimising the numbers of skilled staff required. With this method of telegraphy, typewriters are used for writing up both press and ordinary messages.

The difficulty of delivering telegrams by hand has been enhanced by the scarcity of messengers. As a consequence delivery of telegrams by telephone has been of special advantage not only to the Post Office, but also to the public, more particularly where the addressees live at long distances from the Post Office. The use of the telephone system by the public in connection with the despatch of telegrams has steadily increased. The delivery at night of urgent telegrams by trunk telephone has been developed. This arrangement has proved specially useful for military and naval purposes. Delivery by post of telegrams which are received too late for transmission to their destination by telegraph has been extended, and many telegrams are now delivered by post from London before the local Telegraph Office is open. This service has afforded some relief to the telegraph and messenger staff, and the delivery of telegrams has been accelerated.

Since the outbreak of war a telegram has been despatched from London each Saturday night to every Telegraph Office open on Sunday morning, where it is posted in the window. A large number of Post Offices, not themselves telegraph offices, which can be reached by morning mail have been included in the arrangement. The telegram is prepared by the Press Bureau and is a summary of the war news, being especially designed for distant country offices out of the reach of daily newspapers.

The extension of the underground telegraph lines from Chelmsford to Colchester, which had been projected, has not been carried out, as owing to the war there has been difficulty in obtaining transport for the cable. The section of the work will be finished next year, but no further extension will be proceeded with for the present.

The storms which were experienced during the winter of 1914-15 broke down many telegraph wires, but, except in the West of Ireland, telegraphic communication with the storm areas was maintained by alternative overhead or underground routes. The repairs were somewhat retarded by succeeding storms and by shortage of staff owing to the large withdrawals of skilled workmen in connection with the war.

The use of "phantom" telegraph circuits, superposed on telephone trunk and junction circuits, has been extended. A number of aerial wires have had to be withdrawn from their normal use for military purposes, and in many instances it has only been possible to maintain the public service by the use of "phantom" circuits. A second superposed circuit which will be worked with Wheatstone automatic apparatus is being installed between London and Southampton. The arrangements which had been made in Scotland to utilise "phantom" circuits between the more important centres, in the event of a breakdown of the aerial wires, have proved their value in actual practice.

In consequence of the restrictions imposed on the use of abbreviated

addresses in telegrams from abroad there has been a decrease of nearly 35 per cent. in the number of new addresses registered during the year; the number of addresses which have been cancelled has increased. The total number of addresses registered on March 31, 1915, was 81,546, as against 83,632 on March 31, 1914, a decrease of about 2·5 per cent.

A sum of about £2,000 has been spent during the year in improving the coast communication system, by means of which the earliest possible information is to be supplied to the lifeboat authorities and others of vessels shipwrecked or in distress.

The coast communication system has been extended to 47 new watch huts, which the Board of Trade have provided for men engaged in watching for signals from vessels in distress on parts of the coast not ordinarily under observation by the coastguard.

The number of foreign telegrams sent to and from the United Kingdom during the year (exclusive of telegrams dealt with entirely by cable companies) was 9,421,000, a decrease of 2,050,000 as compared with the preceding year.

During the year reductions have been made in the rates for ordinary telegrams to the Belgian Congo; Republic of Colombia; Comoro Islands; Dutch East Indies; Fiji Islands; French Guiana; French Guinea; Ivory Coast; New Zealand; Norfolk Island; and Sandwich Islands.

Communication has been established by means of wireless telegraphy with the Falkland Islands, Flinders Island (Australia), Macquarie Island, New Britain, Samoa (Apia and Tutuila), and with additional places in the Amazon Company's territory, Brazil; and telegrams are now accepted for these places.

Wireless Telegraphy.—Between April 1 and July 31, 1914, 326 new licences had been issued under the Wireless Telegraphy Act for experiments or the reception of time-signals, while 131 licences for experimental stations had been cancelled or had expired. In 26 cases permission to conduct temporary experiments was given by letter. On the outbreak of war, there were in existence 2,158 licences for private land stations as compared with 1,963 on March 31, 1914. No licences for fresh stations have since been issued, and all existing stations, except a few required for Government work, have been dismantled. Private apparatus generally has been taken into Post Office custody for the period of the war. Under the Defence of the Realm Regulations measures have been taken to prevent the use of unauthorised wireless apparatus.

At the end of July, 1914, there were 942 merchant ships registered in the United Kingdom carrying wireless apparatus under licence from the Postmaster-General, as compared with 879 ships on March 31, 1914. The number of radiotelegrams dealt with at the Post Office Coast Stations between April 1 and July 31, 1914, was 26,145 (21,911 inwards and 4,234 outwards), as compared with 19,942 during the corresponding period of the previous year—an increase of about 31 per cent.

Telephones.—The outbreak of war has naturally seriously affected the telephone side of the Post Office work, and regard must be had to this fact when considering the telephone statistics and expenditure for the year ended March, 1915, which embraced eight months of the war period. Except for a serious destruction of telephone plant caused by storms in the winter, and disturbances due to the bombardment of coast towns and air raids, the standard of efficiency has been well maintained in spite of exceptional demands made upon the staff for war purposes.

So far as the development of the service from the point of view of the number of stations is concerned, new orders have fallen off to the extent of approximately 27 per cent. since war was declared, whilst the number of subscribers giving up their telephones has increased by 29 per cent. On the other hand, nearly 10,000 circuits have been provided specially for the Naval and Military authorities and other Government Departments for emergency purposes.

The number of telephones owned by the Post Office and in use on March 31, 1915 (exclusive of those provided specially for the temporary use of the Naval and Military authorities), was 796,347, made up as follows:

	Exchange Stations.	Private Wire Stations.	Total.
London	253,436	13,939	267,375
Provinces:—			
England and Wales	384,591	24,834	409,425
Scotland	87,832	5,436	93,268
Ireland	23,706	2,573	26,279
United Kingdom	749,565	46,782	796,347

The Post Office was also responsible for the maintenance of 2,289 telephones which are the property of subscribers. It is estimated that during the year 815,000,000 effective calls were originated, a decrease of 2·3 per cent. as compared with the figures for the previous year. The average number of calls per telephone per day was 2·97. Since the outbreak of war local telephone traffic has declined by some 7 per cent., but the increase in the number of trunk calls has been slightly above the normal, chiefly owing to the large number of emergency calls on behalf of the Naval and Military authorities.

Notwithstanding the fact that large numbers of the engineering staff have joined His Majesty's Forces, that others have been largely employed on the provision of emergency circuits for the Naval and Military authorities, and that it has been necessary to restrict capital expenditure as much as possible, the number of new exchanges opened in localities not previously served telephonically during the year 1914-15 was 232. This compares with 184 new exchanges in the previous year and 55 in 1912-13. Of the new exchanges, 189 were opened in England and Wales, 32 in Scotland, and 11 in Ireland. The total number of exchanges open on March 31, 1915, was 3,052. During the year 1914-15, public call offices to the number of 2,136, or 231 more than in 1913-14 were opened. Of these, 1,531 were provided with full trunk line facilities, and 123 with restricted trunk facilities, the remaining 482 being opened for local service only.

During the year 1914-15 the number of exchanges connected directly with the general trunk system was increased by 76; and 570 additional trunk circuits were completed, involving an addition of 40,727 miles of wire (exclusive of spare wires). The number of trunk calls increased by 2,614,587, or 6·89 per cent. as compared with the previous year. At 34 towns where separate trunk and local exchanges had existed for many years the exchanges were amalgamated, the trunk service being much improved thereby. Separate trunk and local exchanges now exist at 83 towns only, as compared with 293 at the time of the transfer of the National Telephone Company's undertaking in 1912.

Owing to the war the provision of additional trunk lines, and more particularly the provision of new underground telephone cables, has been hampered, but nevertheless considerable progress has been made. New cables have been laid and brought into use between London and Guildford, London and Slough, and between Sheffield and Barnsley. The new cables between London and Birmingham, London and Brighton, Glasgow and Edinburgh, and between Newcastle and Sunderland, mentioned in last year's report, are nearly completed, and will be brought into use shortly. Numerous works of this character already in hand are being completed as rapidly as circumstances will permit, but no new works of the kind are being undertaken. An accelerated trunk service, similar to that introduced last year between Liverpool and Manchester, was introduced between Bradford and Leeds; and a very satisfactory increase of traffic ensued. A similar service was also introduced on a large number of minor trunk routes.

The Anglo-Continental Services have been suspended since the beginning of the war.

Automatic Telephone Exchanges are now working at the General Post Office (London), Accrington, Chepstow, Darlington, Epsom, Hereford and Newport, and are giving a satisfactory service. Similar exchanges are being installed at Blackburn, Dudley, Grimsby, Leeds, Paisley and Portsmouth. Owing to various difficulties caused by the war, the introduction of automatic exchanges has not proceeded so rapidly as was anticipated, and it is not yet possible to judge whether a wide expansion of automatic working would be justified.

During the year ended March 31, 1915, a continuous telephone service was introduced at 73 exchanges where previously the service had been restricted; and the number of exchanges which are at present without a continuous service has thus been reduced to 357 out of a total of 3,052 exchanges. Continuous service has also been provided at many rural Call Offices to enable the Naval and Military authorities and the Police to obtain, in addition to telephonic communication, direct connection at any hour of the night with important telegraph offices. During the year 849 stations of this class were installed, the total number of stations working on March 31, 1915, being 2,265. No new work of this kind is being undertaken.

In addition to those mentioned in last year's Report, Committees have been formed at Barrow, Bournemouth, Chatham, Grimsby, North Staffordshire, St. Albans, Southend-on-Sea, Tunbridge Wells, and Watford, the total number of centres thus represented being now 49.

The following figures show the estimated extent to which the telephone is being used for sending telegrams and express or ordinary letters:—

	1913–14.	1914–15.	Increase per cent.
Telegrams	6,834,000	7,748,000	13·4
Express Letters	226,400	191,000*	15·6* Dec.
Ordinary Letters	6,300	6,700	6·3 Inc.

The number of telegrams delivered by telephone in 1914-15 represented 4·87 per cent. of the total number of telegrams delivered, as compared with 5·13 per cent. in 1913-14.

The receipts in respect of private telephone lines amounted to £263,108 only, as compared with £308,784 in 1913-14, the reduction being principally due to rebates in connection with lines temporarily taken over by the Naval and Military authorities.

Revenue.—The net revenue account for Post Office telegraphs for 1914-15 shows a deficit borne by the Exchequer of £1,249,281. With reference to this amount it is stated that the cables have been largely used for war purposes, and it is not possible to estimate the cost of the services rendered. Also an expenditure of £98,884 was incurred in respect of Post Office employees serving with the colours. In the account for telephones the deficit for the year is £107,042, and it is stated that this amount is an inflated one, as since the war the telephone service to the Continent has been used for war purposes. Also the telephone service has been largely used in transmitting telegraph messages, and an expenditure of £70,216 was incurred in respect of the employees serving with the colours.

*Telephone Express delivery has been suspended in London since August, 1914.

CORRESPONDENCE.

METER TESTING.

TO THE EDITORS OF THE ELECTRICIAN.

In a note in THE ELECTRICIAN for the 17th inst., you stated that meter testing was essentially work for women. This may be the opinion of some engineers who have never had actual experience with meter problems, but the more one looks into the skill and technical knowledge required of an efficient meter tester, the more fallacious does such a point of view appear.

An up-to-date meter-testing department is usually well equipped with expensive substandard instruments, and no superintendent would be so lacking in ordinary judgment as to hand these over to the tender mercies of novices. The women, to which you refer would not be able to distinguish between "amperes," "volts," "watts" and "units," so that they would, no doubt, connect the current coils of the substandards, &c., across the pressure mains, overload the series coils, or subject the shunt coils to over-potential.

Experienced engineers are very often puzzled with the question of polarity on current and potential transformers, as well as the phase rotation of three-phase systems, and it would be impossible for inexperienced women to understand such terms.

Mistakes in phase rotation and polarity result in the following :—

1. Alteration to the calibration of three-phase watt-hour meters.
2. Incorrect indications on power-factor meters.
3. Synchronising of machines out of phase.
4. Reverse current or balanced protective gear would operate on a healthy circuit.

And so on.

Another point that you appear to have overlooked is the fact that a large number of meter testers are also good mechanics, and a faulty meter or instrument very often requires the attention of a skilled man to rectify the mechanical defects.

Meter testers very often have to install complicated polyphase meters or instruments on site, in order to guard against the mistakes which are frequently made by engineers, who have not specialised with this class of apparatus. I can assure you that supply companies could not afford to run their testing departments on the lines you suggest, for the following reasons :

1. The meter calibrations would not be reliable ; this would result in loss of revenue and friction with consumers.
2. The output of repaired and tested meters would be reduced to vanishing point.
3. Considerable risk of shutting down station plant and feeders due to mistakes in connections, as explained above.

J. WILLIAMS.

[Nothing in our correspondent's letter makes us alter our opinion on the subject of meter reading. He appears to be confusing house-meter testing and reading with repairs and technical matters. That many of the latter are of an elementary kind is shown by the above notes on phase-rotation and polarity. As such they could be dealt with by the really indispensable men. We are inclined to think that Mr. Williams underrates the ability of the women of this country. If boys in secondary schools can quickly be taught to distinguish between amperes, volts, watts and units, we believe that women could be equally quickly taught. It must not be forgotten that with a month's training they can make reliable shells.—EDS. *E.*]

THE I.E.E. AND ENEMY MEMBERS.

TO THE EDITORS OF THE ELECTRICIAN.

The mass of printed matter and unnecessary paper that I have received from the Institution of Electrical Engineers, dealing with "Enemy Members," and "Council Nominations," shows that those who are responsible for the circulars, &c., do not understand the first principles of patriotism, which apparently looms so large on the reply card.

I am asked to state my views on certain questions which at first sight seem to show that electrical engineers in general, and the Council in particular, are super patriots. Is this really so? I wonder how much foreign-made machinery the members of the Council and other electrical engineers in high positions have been responsible for ordering. The patriotism of those in high places would impress me more if it took the practical form of purchasing British machinery, and of refraining from wasting my hard-earned subscription in unnecessary paper, instead of asking for my opinion on a matter which is *ultra vires*.

March 28th. A.M.I.E.E.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The annual general meeting of this Institution was held on Monday at the Institution of Electrical Engineers, London, Lord Vaux of Harrowden presiding.

In moving the adoption of the committee's report and accounts, the CHAIRMAN said it was deemed inexpedient to hold the usual festival dinner in 1915, and the absence of that was reflected in the accounts. The income from subscriptions and donations was £584. 19s. 6d., against £3,139. 10s. in 1914, the reduction being partly due to the calls of other charities in consequence of the war. The total income of £886. 4s. 6d., including dividends and income tax recoverable, was not altogether unsatisfactory, but in view of the calls which would come after the war it was totally inadequate. It was hardly to be expected that when the armies were disbanded the numerous members of the industry would be at once absorbed into civil employment. £389. 6s. 6d. was invested last year in war stock. Grants paid amounted to £148. 17s. 4d. (compared with £252. 13s. in previous year), the reduction being due to the fact that the committee had less difficulty in finding employment for those requiring assistance. It was hoped that those who had not yet responded to the appeal sent out by the president, Sir David Salomons, would now do so. Sir David had accepted the position of trustee, which he occupied jointly with Mr. Hirst and Mr. Eck. There was a falling off in the number of collectors. The list of their returns was given on p. 21 of the report and accounts (total £65 15s. 6d.). Every electrical firm should feel it their duty to appoint one member of their staff as collector, to collect contributions and induce his colleagues and other employés to become members. It might become necessary some day to restrict the benefits of the Institution to its own members. The number of members was extremely small. The conditions of membership were set out on a card which would be sent to firms who would hang it in their offices. Management expenses, £114. 0s. 7d., were £65 less than those of the previous year. Printing, postage, &c., £84. 19s. 6d., was necessarily greater, because of the sending out of the appeal previously mentioned. Mr. W. B. Esson had become a life governor, and it was hoped his example would be followed by many others. The total of the investments was £8,116. 7s. 6d. in the 1915 accounts, but a further £200 war stock had been purchased since the beginning of the current year. The investments must be increased very much to enable many pensions to be paid. The Institution had benefited by only one legacy.

He expressed the regret of the officers and committee at the death of Mr. H. G. Byng, who was killed at the front. Mr. Byng had been a staunch supporter and a life member of that institution.

Mr. JUSTUS ECK (chairman of the Committee) seconded the motion, and said the reduction of the number of collectors to five from five times that number was unfortunate. They could hardly look forward to holding a festival dinner this year, and he hoped those who had collected before would renew their activity to compensate for the want of the festival. With regard to the new excess profits tax, he believed that subscriptions to that institution would be considered expenses, and if a firm subscribed £500 they would only be taxing themselves to the extent of £250. It was gratifying to note that the grants during the year had been nearly all to dependents of people who had been engaged in the industry. He suggested that all who had influence with municipal corporations should try to induce them to look after their men and their men's dependents. It was not fair for them to pass their men on to that Institution to look after when they had done nothing to aid the funds.

The report and accounts were then adopted.

On the motion of Mr. T. E. GATEHOUSE, the following members of the Committee of Management were re-elected : Mr. Justus Eck, Mr. E. F. Johnson, Mr. F. A. Lundberg, Mr. W. C. Mountain, Mr. F. H. Nalder, Mr. E. A. Nash, Mr. W. B. Rawlings and Mr. L. G. Tate. A vote of thanks for past services was accorded Mr. H. Oppenheimer, who did not seek re-election.

The hon. auditors (Messrs. Price, Waterhouse & Co.) were reappointed, and votes of thanks to them and to the hon. solicitors (Messrs. Sugden & Hextall) were passed.

Certain alterations in the rules proposed by the Committee were adopted on the motion of Mr. W. B. Esson, and will come up for confirmation at another meeting. These alterations are only intended to make the rules clearer, and not to alter them substantially.

A vote of thanks to Lord Vaux of Harrowden closed the proceedings.

PARLIAMENTARY INTELLIGENCE.

Registration of Firms Bill. The second reading of this Bill took place in the House of Lords on the 21st inst.

LEGAL INTELLIGENCE.

T. W. G. Budgett v. Stratford Co-operative Society.

On the 23rd inst. Mr. Justice Bray and a special jury heard this action by plaintiff, head foreman in the electrical department of the Stratford Co-operative & Industrial Society, Ltd. (and now serving in the Army Service Corps), against the Society claiming a declaration that he is entitled to recover during the period that he is with the Forces half wages from the Society. Defendants denied any contractual obligation.

Mr. Powell, K.C., and Mr. Preedy were Counsel for plaintiff, and defendants were represented by Mr. Rose-Innes, K.C., and Mr. Morle.

Mr. POWELL, K.C., said the action was of great importance. Soon after the outbreak of the war the defendant Society, like a good many other concerns, decided to do what they could to induce men to join the Army and the directors passed a resolution that they would pay to men enlisting wages as follows: Half wages to married men, half wages to single men with dependents on them, and 5s. a week to single men without dependents, it being provided that the money should be invested in the Society's capital. Notices were posted up to this effect, and plaintiff, with numerous other servants of the Society, enlisted. Plaintiff was married, with three children, and he was the head of the Society's electrical department. Mr. Budgett told Mr. Banks, the secretary of the Society, that he thought of joining the Army, and Mr. G. Banks told plaintiff that of course the notice applied to him as well as to the other employees, and a form of authority was written out for plaintiff's wife to receive half wages. Mr. Banks gave plaintiff an excellent character. Plaintiff joined the mechanical transport section of the A.S.C. Some time after plaintiff had gone his wife read a letter asking if her husband had joined up, and she kept it until Mr. Budgett came home, and then he replied giving the facts and said he felt much hurt at the inquiry that the Society had made. Somebody on the Committee (said Counsel) must have got the idea that he was likely to do better, and the Committee wrote to him asking what his pay was and what allowance he was making to his wife. He replied that he enlisted at 6s. per day and was paying his wife 4s. 6d. a day. On May 26 the Committee met, and the result was that Mr. Banks wrote to plaintiff to say that the Committee had decided not to grant the war allowance in his case, as by joining the Colours he had benefited his position as compared with the post held with the Society. Plaintiff appealed for reconsideration of his case, saying that his wages before the war were £2. 10s. a week and he enlisted at 6s. per day, so that he was no better off, and if they could not pay him half wages he asked them to make up the difference. The Committee declined to depart from their previous decision. Mr. Powell, concluding his address to the jury, suggested that some firms had arranged to pay men joining the Forces half wages, believing the war would be over soon, but as it had lasted longer than they thought they found they were having to pay more than they expected. If there had been any legal obligation on plaintiff to join the Army the notice of the Society would not be a promise that could be enforced, but there was no legal obligation at the time at all, and the act relative to single men had not then been passed.

Mr. ROSE-INNES, on behalf of defendants, said that the notices were undoubtedly posted up, but in order to make the notices a contract, there must be acquiescence, and plaintiff was distinctly told that the notice would not apply to his case, but only to the cases of men who suffered financial loss by joining the Army.

The evidence of plaintiff, who was at a camp, was read in court. He deposed that he told Mr. Banks he wished the money should be paid to his wife, and Mr. Banks promised that this should be done. The separate allowance to his wife was £1. 3s. 6d. per week, and he allowed her 4s. 6d. per day out of his pay. Mr. Banks never told him that he was not entitled to half wages, and he (Mr. Budgett) suggested that the action of the Society was the outcome of petty spite by some of the members.

Mr. ROSE-INNES, K.C., said that the object of the notice exhibited by defendants was to secure that if a man joined the Army he should not be out of pocket by so doing. The authority given by Mr. Banks to plaintiff's wife was to draw dividends upon a share in the Society and not to draw half wages. In fact half wages for six weeks were paid on an authority in plaintiff's handwriting, but that was a mistake.

Mr. GEO. L. BANKS, secretary of defendant Society, said that plaintiff told him that he proposed to join the A.S.C. (mechanical transport), and witness told him that if he did so he would get more than a soldier's pay. Mr. Budgett said he would get 6s. a day, and witness said "If that is so you will not be entitled to the half wages allowance provided by the Committee," and plaintiff answered "I quite understand that."

Cross-examined, WITNESS said the war allowance had not been granted to men joining since May, 1915, because of the prohibitive cost.

The jury eventually found that plaintiff was not informed before he enlisted that he would not receive the allowance mentioned in defendant's notice, and upon that plaintiff was given judgment with costs.

Mr. Justice BRAY said that the only legal question in the case was whether that was a good contract between plaintiff and defendants, and he was satisfied that it was a good contract, and that there was ample consideration for the money. He made the declaration claimed by plaintiff, viz., that he (plaintiff) was entitled to £1. 2s. 6d. per week and judgment would be entered for him for what was due to date, with costs.

Hurt v. Mayor, &c., of Sheffield.

On Monday a Divisional Court (Lush and Rowlatt, JJ.) heard the appeal of the Corporation of Sheffield from a decision of the Sheffield County Court in this case.

Plaintiff, a tramcar driver, had recovered judgment for £1. 16s. 10d., which he had claimed as an amount payable to him for one week's wages in lieu of holidays, or, alternatively, as damages for breach of contract. He had been a driver in the employment of the Corporation for many years, and was dismissed from that position in August, 1915. The Corporation had passed a resolution that employés in their service for more than 12 months should have one week's holiday in each year. Hurt's last holiday was at the end of June, 1914. It had been the practice to give the holiday at some time in each year from April to October, and an employé who had had his holiday early in one year could not object to being required to wait until a late period in the following year, although more than 12 months might have elapsed since his last holiday.

Mr. MACMORRAN (for appellants) said that it was a test case. He argued that the resolution of the Corporation was only a private resolution, and was not a term of its contract with its workmen. The fact that it had been the practice to give a holiday was no proof that the practice had become a term of the contract. In any event, even if there was a binding contract to give a holiday, appellants still had a right to dismiss at a week's notice, and they had exercised that right in the case of respondent. Respondent could not have claimed a holiday as a legal right even on his own contention before October, and he was dismissed in August.

For respondent, Mr. SHORTT submitted that the granting of the holiday was a term of the contract; it was an equivalent to an advance of wages and was accepted as such by the men and their union.

In giving judgment, Mr. Justice LUSH said that, with all respect, he thought that the County Court Judge was wrong. Even assuming that, as the terms of the resolution had been communicated to the employés' union, those terms had created a contractual obligation, it only meant that in each calendar year—not in each year of a man's service—an employé who had been with the Corporation for more than a year should be entitled to a holiday. But that only applied while the employment lasted, and if it was brought to an end in a legal manner there was no breach of contract in not paying for a holiday week. The appeal must, therefore, be allowed, with costs.

Mr. Justice ROWLATT agreed. He said that the County Court Judge had assumed that a man who had served for 51 weeks was entitled to 52 weeks' pay, but there was no evidence of any such contract.

Leave to appeal was given.

British Thomson-Houston Co. (Ltd.) v. Stonebridge Electrical Co. (Ltd.)

Mr. Justice Younger has delivered his reserved judgment on the summons taken out by plaintiffs for further and better particulars of defendants' particulars of objection to plaintiffs' patent. Defendants pleaded that the patent was bad by reason of both common and public knowledge, and plaintiffs, while admitting that the authorities were against requiring particulars of common knowledge, contended that for them to come to trial without particulars of the public knowledge relied upon would be embarrassing.

Mr. Hunter Gray represented plaintiffs and Mr. Frost defendants.

Mr. HUNTER GRAY contended that there was a difference between common and public knowledge. Common knowledge was what was known to be in the possession of every person in a particular trade or business; it was something that everybody was supposed to know. On the other hand, public knowledge was only something that was available to everybody who desired to possess it. There were many books to be obtained at public libraries that were never seen by the majority of the public, but the facts those books contained were public knowledge. No particulars of common knowledge were required, and in fact there was a decision of the Court of Appeal that particulars of common knowledge should not be given in a patent action. The object of particulars was to cleverly define the issues between the parties, and where a patent was alleged to be bad because certain knowledge was to be found in some document then, he argued, particulars of the document should be given. Defendants ought not to be entitled to say the patent was bad by reason of common or public knowledge. Defendants must either drop the public knowledge or give particulars of it. Common knowledge could not be proved by any specific document, because everybody was supposed to know it, and so plaintiffs could not be taken by surprise. But public knowledge was a very different thing.

Mr. FROST (for defendants) submitted that there was no such distinction to be drawn between common and public knowledge as that attempted to be drawn by Mr. Gray, because public knowledge was common knowledge there it was enough for defendants to say it was public knowledge that tungsten could be drawn and it was not necessary to give page and passage in some document because if not they would not have clearly defined the issue. When they were dealing with the question of a specific matter, that was to say, taking tungsten in a particular form and by passing it through dies, converting it into wire it was enough to say that plaintiffs were not the first persons who were aware that that could be done, and by doing it they were doing nothing that could be described as an act of invention.

Mr. GRAY was heard in reply and his Lordship reserved judgment.

In delivering judgment his LORDSHIP said that plaintiffs sought to restrain an alleged infringement of letters patent granted to them in 1906 for an invention of a process and apparatus for dealing with tungsten in the manufacture of electric lamps. Defendants denied infringement and alleged that the patent was bad, pleading that it was anticipated by both common and public knowledge. The summons asked that defendants should give further particulars of their objections, and should say what they relied on as common and what as public knowledge. In other words plaintiffs asked that defendants should identify what matters they said were common knowledge and what were public knowledge. In his

opinion plaintiffs were entitled to the particulars they asked for. Defendants had very ingeniously, for the first time, endeavoured to set up a pleading describing as common knowledge that which really was public knowledge. It had been laid down that particulars should not be relied upon as to what was common knowledge to a particular art or science, and for the obvious reason that it was in the interest of the public that both time and expense should not be unduly extended. In his opinion, however, when a defendant pleaded public knowledge, if particulars were not given, a burden would be laid upon plaintiff, and he would come into Court unprepared to meet the case that was made against him. He thought, therefore, plaintiffs were entitled to the order that they asked for, and the costs of the summons would be theirs in any event.

Mr. FROST asked for leave to appeal, which was granted.

Agreements with German Companies.

On Monday Mr. Justice Bray heard an action by the Lancashire & Yorkshire Private Telephone Co. (Ltd.) against the Telefon und Telegraphenbau Gesellschaft (G.M.B.H.) and Hugo H. Fuld, of Frankfort-on-Main, for a declaration that certain agreements between them and defendants were determined by the outbreak of the war. Defendants did not appear.

Mr. GIVEEN (for plaintiffs) explained that defendants were manufacturers of an apparatus for telephonic intercommunication in works and offices, and prior to the outbreak of war they secured the formation in this country of companies to acquire from them, and let out on hire in different parts of the United Kingdom, the apparatus and accessories. Plaintiffs entered into agreements with defendants to deal solely with the latter's apparatus within a specified area for 35 years, and to pay the defendants a royalty. In consequence of the war it was impossible to carry out the contracts, and plaintiffs asked for a declaration that they were determined by the war.

Mr. F. T. JACKSON, managing director of plaintiff company, stated that he had disclosed to the Public Trustee Mr. Fuld's interest in the company and the amount due to defendant company for instruments supplied. Plaintiffs had hired out a number of instruments, and to keep them in order it was necessary to have spare parts, but it was impossible to get those from Germany, and plaintiffs must have power to enter into contracts with English firms.

His LORDSHIP: Is that one of the things you are prohibited from doing under the agreement?

WITNESS: Yes.

His lordship made the declaration asked for.

In a second action, brough by the I.T.C. (Ltd.) against the Telefon und Telegraphenbau Gesellschaft (G.M.B.H.) and Mr. Hugo Mayer, a similar declaration was made. It was stated that in this case the area covered by the company was London and practically the South of England.

There was also a third action brought by the New System Private Telephone Co. (Ltd.) against the Deutsch Privat Telefon Gesellschaft, in which his lordship made a declaration in similar terms.

Heeman v. Edwards Bros.

On Monday Mr. Justice Shearman heard the settlement of the action Heeman v. Edwards Bros., in which the plaintiff claimed damages for alleged slander.

Mr. HAROLD SIMMONS (for plaintiff) said the action had been settled. Plaintiff answered an advertisement and saw a man named Davis, who offered him a situation provided he deposited £25. A business in electrical fittings was opened at Kentish Town and Mr. Heeman was appointed manager at £2. 5s. a week. Davis was an agent for defendants for the supply of electrical appliances, and the business, as far as Counsel knew, was really carried on by means of deposits from other people. Davis gave orders to defendants in the name of plaintiff, and when plaintiff's salary became in arrear Davis persuaded him to purchase the business, most of the purchase price being the arrears of salary and plaintiff's deposit. In April, 1915, defendants wrote to Mr. Heeman for payment of the debt for appliances ordered by Davis which plaintiff, naturally repudiated, and correspondence ensued in which it was suggested that plaintiff had improperly obtained the goods. Since then they had realised the position in which plaintiff was when the goods were ordered and they now desired to withdraw all imputations against plaintiff. The record would be withdrawn, each party to pay their own costs.

Counsel for defendants agreed to the settlement, remarking that when defendants wrote the letters they believed what they said was correct. Since then they had realised that they had been wrong.

His LORDSHIP allowed the settlement to be recorded and said he thought the difficulty arose through a misapprehension.

Farrell v. Bloxam.

In the County Antrim Courthouse last week, before Mr. Justice Pim and a special jury, this action for the recovery of damages for slander was heard.

Plaintiff (Mr. A. B. Farrell) was the late superintendent of the electric supply station, Belfast, and he sought to recover £1,000 damages from Mr. F. W. Bloxam, city electrical engineer, for alleged slander and defamation of character. Charges of neglect of duty were made against plaintiff by defendant, with the result that plaintiff was dismissed at a week's notice. This dismissal was afterwards confirmed by the Electricity Committee, and plaintiff alleged that he had never had an opportunity of replying to the Committee in respect of charges made by Mr. Bloxam against him.

A member of the Council who gave evidence for plaintiff said he understood that defendant and plaintiff were so bitterly opposed to one another that there was practically little hope of harmonious working between them. He agreed to Mr. Farrell's dismissal, because he knew that Mr. Bloxam had a very difficult situation to face in December when the full output of the station would be needed for the requirements of the public. There was no suggestion that Mr. Farrell was not able to do the work, but that the manner in which he acted was a grave source of danger to the station.

For the defence, His Lordship was asked to rule that the alleged slander was spoken on a privileged occasion, and also that there was no evidence of actual malice.

The Judge ruled that the words were spoken on a privileged occasion, but refused to rule on the question of malice, and the case for the defence was then opened.

In his evidence Mr. Bloxam said he was chief engineer of the Belfast Corporation electricity undertaking since 1907, and prior to that he had been chief assistant to Mr. M'Cowen. The plant under his control was valued at £450,000, and he had the oversight of a staff of 250 men. Plaintiff had been a member of the staff since shortly after witness went to Belfast. In 1912 the position of chief assistant became vacant and two members of the staff (plaintiff and Mr. Croft) were candidates. The latter was appointed, and he (witness) believed that plaintiff was disappointed at not getting the post. Witness was then examined and cross-examined at some length upon the management of the electric supply undertaking, the fire at the power house and other matters relating to the administration of the department.

After the conclusion of the evidence for the defence and the addresses of counsel, his Lordship summed up and left the following questions to the jury:—

1. Did the defendant speak the words complained of?—Yes.
2. Did he speak them honestly believing that same to be true?—No.
3. Did the said words mean that the plaintiff had been guilty of gross misconduct and negligence in the discharge of his official duties and was incompetent and unfit to be superintendent of the electrical station, and was deliberately interferring with the harmonious working of the said Belfast electrical station?—Yes.
4. Were the words spoken maliciously?—Yes.
5. What damages, if any, should the defendant be paid?—£500.

His Lordship gave judgment accordingly.

Workmen's Compensation.

In the City of London Court last week, before Judge Atherley-Jones, K.C., Mrs. Tyrell, widow of Edward A. Tyrell, sued the Smithfield Markets Electric Supply Co (Ltd.) for compensation for the death of her husband, an assistant engine driver. Defendants paid £300 into Court, and the judge apportioned the money between the widow and the children. Defendants had been paying Mrs. Tyrell her late husband's wages in full until the date of the hearing.

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. MEWBURN, ELLIS & PEYCE, Chartered Patent Agents, 70 and 72, Chancery-lane, London W.C.

Wherever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 SPECIFICATIONS.

5,849 E[illegible]. E[illegible] (4/15.)

23,380 DIXON. Telegraph and like signalling systems. (5,12,13.)

1915 SPECIFICATIONS.

[illegible]

1916 SPECIFICATIONS.

[illegible]

COMMERCIAL & INDUSTRIAL SECTION.

CONTENTS.

COMMERCIAL TOPICS	919	**Electric Vehicle Progress Supplement—No. 26.**	
Imports and Exports of Electrical Manufactures	920	An Attractive Passenger Electric. Illustrated	1*
Business Notices	920	Congestion at Railway and Marine Termini. By A. Jackson Marshall	2*
Bankruptcies, Liquidations, &c.	920	Electric Bath Chairs	3*
Electricity Supply	920	An All-British Commercial Battery Vehicle. Illustrated	4*
Traction Notes	921	Tipping Dust Van at South Shields. Illustrated	6*
Empire Notes	921		
Foreign Notes	922		
Miscellaneous Notes	922		
Tenders Invited	923		
Tenders Received & Accepted	923		
The Round Table	175	Municipal Accounts	924
Self-Contained Paraffin Electric Generating Set. Illus.	176	Companies' Meetings and Reports	925
StorageBatteryCatalogue. Ill.	176	New Companies, &c.	927
A Case of Evolution. Illus...	180	City Notes	928
The Use of "Axial" Lamps. Illustrated	180	Electrical Companies' Share List	928

COMMERCIAL TOPICS.

Our Government and Technical and Business Training.

In an interesting speech at the recent meeting of the shareholders of Hadfields Limited, the Chairman (Sir Robert Hadfield), after referring to the work of the Ministry of Munitions, said that our system of government at times seemed to be framed on not very scientific lines. For example, this was a technical age; yet as far as he was aware we had not a single representative of the technical business men in the Government. Some of our great engineers could have been well called in to give their counsel at a time of stress like the present. The present terrible war was most certainly a technical one, and demanded all the best efforts of science and technical knowledge, whether as regards military, mechanical, electrical, chemical, or any other branch of engineering. Yet, to the best of his knowledge, the Cabinet did not contain a single representative of any of those important branches. That being the case, a radical departure was called for in our method of government, and that quickly. Surely, therefore, it was more than ever necessary to appoint three separate and distinct Ministers—a Minister of Commerce, a Minister of Science, and a Minister of Air. The enemy was well represented in this respect, and he could personally vouch for the fact that the head of Krupps had for many years personally reported every fortnight, by actual attendance or correspondence, direct to the head of that Empire as to the progress of the work at Essen. A man may be educated, but not necessarily scientific. Mere education alone, therefore, did not necessarily fit the man for an important post in the Cabinet. He felt sure he represented the views of the business men in Sheffield when he said that if Mr. Asquith did not give us a Minister of Commerce the business men and men of commerce in this country would rise in protest.

Our Ambassadorial and Consular services needed serious revision. The diplomatic career should be open, not to any particular clique or set, but to the ablest among us who would force their way upwards by ability. Much of the cause of the present crisis had been owing to our being most inefficiently supplied with information, whether diplomatic, consular, or commercial. It was not easy to determine during the war our exact and definite course on the question of fiscal policy. To interfere with the free exchange of products and adopt Protection pure and simple would, he felt sure, be a mistake. He did not say we should make no change; there would be many drastic changes, but we must not forget the main point in view should be to continue the policy of thoroughly sound trade built upon rock, and not upon sand. That trade of our Allies and Dominions ought to represent an enormous increase in the future, with the enemy out of the way, as we will certainly not trade with him There was no one who will now say that we do not want some changes within the Empire, but we are determined to give the enemy no chance, and Englishmen will not trade with Germany, whether protective tariffs exist or not. What we do want more than anything else is proper trade organisation, but we do not want German trade methods in this country, with their palpable dishonesty of purpose.

With much of what Sir Robert Hadfield said we are in entire agreement, but we doubt the wisdom of creating so many new Government departments, involving the appointment of hundreds of additional civil servants, &c. A Ministry of Commerce, with a properly equipped up-to-date staff, could no doubt do much for British commerce and trade, and as we have repeatedly urged, a thorough re-organisation of our consular service is also required, but the legal shackles upon progress and industry must be removed and we must have less of the hasty, ill-digested legislation of recent years. Our system of education will have to be modified; more time will have to be devoted to science and engineering in our public schools and universities and less time spent on the study of the classics.

* * * *

British Industries after the War.

The President of the Board of Trade (Mr. W. Runciman, M.P.) has appointed two Committees to consider the position of certain important British industries after the war, especially in relation to international competition, and to report what measures (if any) are necessary or desirable in order to safeguard that position.

For the iron, steel and engineering industries the Committee will be composed of the following: Sir Clarendon Hyde (chairman), Mr. A. Balfour, Sir Hugh Bell, Bart., Mr. A. J. Hobson, Sir Hallewell Rogers and Mr. Douglas Vickers.

The Committee on the shipping and shipbuilding industries is as follows: Sir Alfred Booth, Bart. (chairman), Prof. W. S. Abell, Sir Archibald Denny, Bart., Sir Edward Hain, Capt. H. P. Hooper, Mr. James Readhead and Mr. Oswald Sanderson.

Communications relating to these Committees should be addressed to Mr. Percy Ashley, the Board of Trade, Whitehall-gardens, S.W.

* * * *

Canadian Trade and Manufactures.

It is reported that Ontario manufacturers are benefiting to a considerable extent by the exclusion of enemy manufactures from the world's markets. Certain trade and business houses are enjoying a business boom by reason of the increased market for their products. Incandescent light bulbs, which were formerly imported from Austria in large quantities, are now manufactured in Toronto, where practically all the bulbs used in Canada are made. Electric light shades and globes are also being made to supply Canadian demands. There is evidence that the manufacturers and business houses of Ontario are now busier than before the war, and there should be increased opportunities for British manufacturers and exporters to open up and develop trade with Canada.

* * * *

British Cable Makers in 1915.

The British Insulated and Helsby Cables has had a very successful year, notwithstanding the difficulties caused by the war. The volume of trade during the year 1915 seems to have been well maintained, for the result is an increased profit of £17,703. The net earnings have shown steady progress in recent years. The profit was £295,131 in 1915, against £277,428 in 1914 and £247,351 in 1913, and the aggregate gain for the past five years was nearly £152,000. The ordinary dividend is 15 per cent., as in 1914, but there is a bonus of 2½ per cent., making a total of 17½ per cent., against 15 per cent. in 1914. Ample provision has been made for depreciation, reserve, &c., and the balance-sheet shows the company in a very strong financial position. We are pleased to note from the speech of Mr. James Taylor, J.P., who presided at the meeting on Monday, that the company has been occupied with certain new manufactures, which they hope to continue after the war, and that they have also been successful in extending their foreign trade. The maintenance of our exports is of vital importance to us as a nation, and the directors are to be congratulated on the success which has attended their efforts in these times of stress and difficulty.

The other cable manufacturers would also appear to have had a very good year. W. T. Henley's Telegraph Works Co., after making

full provision for reserve and depreciation (including special depreciation on machinery and plant run night and day on Government work), is able to pay a dividend of 15 per cent. for the year, together with a bonus of 10s. per share. The distribution is, therefore, at the rate of 25 per cent. against 20 per cent. in 1914. This is an excellent record, especially in view of the fact that 551 of the company's staff and workmen have joined H.M. Forces. Messrs. W. T. Glover & Co. are paying 5 per cent. as in 1914, and adequate provision has been made for reserve and depreciation; £6,500 has been placed to debenture redemption funds, and after transferring £20,000 to reserve and writing down certain quoted investments to their estimated values, about £11,000 was carried forward.

IMPORTS AND EXPORTS OF ELECTRICAL MANUFACTURES.

From March 20, 1916, *to* March 25, 1916.

In view of the increased interest which is being taken in the subject of the importation into and the exportation of Electrical Manufactures from the United Kingdom, we resume our weekly lists. (*See also* note at foot of Exports.)

IMPORTS.

LIVERPOOL.—*U.S.A.:* Electrodes, 53 pkgs.

LONDON.—*U.S.A.:* Elec. machinery, £2,810; elec. lamps, £669; elec. motors, £725; telephone material, £116; wire and cable, £11; carbon candles, £85; elec. switchboards, £631; unenumerated, £3,870. *Holland:* Elec. lamps, £3,687—30 pkgs.; telephone materials, £197. *France:* Carbon candles, £2,180; unenumerated, £2,180. *Switzerland:* Elec. lamps, £45; carbon candles, £226; elec. meters, £62; unenumerated, £136. *Italy:* Elec. machinery, £522. *Japan:* Unenumerated, £105. *Sweden:* Elec. lamps, £669—32 pkgs. *Canada:* Unenumerated, £140.

SOUTHAMPTON.—*France:* Unenumerated, £40.

EXPORTS.

TO AUSTRALASIA.—*Auckland:* Elec. machinery, £916; unenumerated, £83. *Melbourne:* Wire and cable, £215; elec. machinery, £224; unenumerated, £403. *Sydney:* Wire and cable, £170; elec. machinery, £44; unenumerated, £754. *Wellington:* Elec. machinery, £12; wire and cable, £119; unenumerated, £954. *Perth:* Elec. lamps, £265; unenumerated, £247. *Christchurch:* Elec. machinery, £47; unenumerated, £56. *Dunedin:* Elec. machinery, £99. *Lyttelton:* Unenumerated, £192. *Brisbane:* Elec. machinery, £169; wire and cable, £697. *Cairns:* Unenumerated, £10.

AFRICA.—*Durban:* Elec. machinery, £92; wire and cable, £407; unenumerated, £309. *Cape Town:* Unenumerated, £600. *Port Elizabeth:* Elec. machinery, £206; unenumerated, £141. *Napier:* Wire and cable, £246; unenumerated, £9. *Zanzibar:* Unenumerated, £31.

SOUTH AND CENTRAL AMERICA.—*Buenos Ayres:* Wire and cable, £2,580; telegraph material, £355; unenumerated, £1,251. *Rio Gallegos:* Wire and cable, £30; unenumerated, £111. *Valparaiso:* Elec. machinery, £187; unenumerated, £489. *Punta Arenas:* Unenumerated, £61. *Demerara:* Elec. machinery, £1,200; unenumerated, £18.

ADEN.—Unenumerated, £3.

EGYPT.—*Port Sudan:* Unenumerated, £22. *Suez:* Telegraph material, £271.

MAURITIUS.—Unenumerated, £18.

INDIA, CEYLON, INDO-CHINA AND STRAITS SETTLEMENTS.—*Bombay:* Wire and cable, £306; unmeunerated, £1,433. *Calcutta:* Elec. machinery, £108; wire and cable, £321; unenumerated, £3,380. *Ceylon:* Unenumerated, £64. *Madras:* Unenumerated, £206. *Karachi:* Unenumerated, £20. *Singapore:* Elec. machinery, £289; unenumerated, £197. *Bankok:* Wire and cable, £263; unenumerated, £260. *Kilindini:* Unenumerated, £29. *Rangoon:* Wire and cable, £109.

CHINA.—*Shanghai:* Wire and cable, £233; unenumerated, £178. *Hongkong:* Unenumerated, £40. *Dalny:* Unenumerated, £63.

JAPAN.—*Yokohama:* Unenumerated, £140.

JAVA.—Submarine cable, £10,668. *Batavia:* Unenumerated, £521.

HOLLAND.—*Amsterdam:* Wire and cable, £113; unenumerated, £83. *Rotterdam:* Unenumerated, £331.

FRANCE.—*Paris:* Wire and cable, £75; unenumerated, £192. *Havre:* Unenumerated, £52. *Dieppe:* Unenumerated, £247.

DENMARK.—*Copenhagen:* Unenumerated, £20.

RUSSIA.—*Vladivostock:* Unenumerated, £1,686.

ITALY.—*Genoa:* Wire and cable, £246; unenumerated, £444.

MOROCCO.—*Centa:* Unenumerated, £20.

PLAJOE.—Unenumerated, £14.

FOREIGN GOODS (duty paid and free).

Bombay: Unenumerated, £378. *Brisbane:* Unenumerated, £115. *Wellington:* Unenumerated, £211. *Calcutta:* Unenumerated, £32. *Paris:* Unenumerated, £147. *Madras:* Unenumerated, £61. *Lyttelton:* Unenumerated, £65. *New York:* Unenumerated, £503. *Port Elizabeth:* Unenumerated, £10. *Samarang:* Unenumerated, £36. *Valparaiso:* Unenumerated, £110. *Amsterdam:* Unenumerated, £83. *Havre:* Unenumerated, £77.

IN TRANSIT.

Hongkong: Elec. lamps, £192.

NOTE.—The large number of items in these official returns under the misleading heading "unenumerated" relate to what is described as "electrical goods" and "electrical materials."

BUSINESS NOTICES.

The private consulting offices of Mr. S. G. Castle Russell M.I.E.E., consulting electrical engineer, have been removed to 17, Sherborne-lane, King William street, London, E.C.

The partnership between Alfd. Graham, Joseph A. L. Dearlove and Edwd. A. Graham, electrical engineers, St. Andrew's Works, Crofton Park, and Kilmorie Works, Forest Hill, London, S.E., has been dissolved so far as concerns Joseph A. L. Dearlove, who retires from the firm. Debts by Messrs. A. & E. G. Graham, who continue as Alfd. Graham & Co.

Plans submitted by the British Thomson-Houston Co. for the erection of a new print room and store room additions, at their premises in Neasden-lane, Willesden, have been approved by the Urban Council.

Mr. J. Russell Thornbery informs us that for personal and family reasons he has converted the business of Griffiths Bros. & Co., and Daniel Judson & Son, of which he was the sole proprietor, into a private limited company, under the style of Griffiths Bros. & Co. (London), Ltd. The name of Daniel Judson & Son will continue to be used for that branch of the business. No further capital is being asked for; no capital is being withdrawn and no debentures are being issued. No change is being made in the personnel or conduct of the business.

Plans lodged by the London Electric Firm for the erection of a factory in Brighton-road, have been approved by Croydon Council.

A subscriber writes from Paris that he is in a position to effect sales in the following lines: Motors (a.c. and d.c.), magnets for instruments, instrument transformers and mica and varnish.

John Wm. Willoughby and Edwd. Wilcox, electrical engineers' plumbers, &c., 44A, Trafford-road, Salford, have dissolved partnership. Debts in respect of the electrical engineers' and contractors, portion of the business by Mr. Wilcox.

Mr. A. Grant, manager of the Canadian British Insulated Co. (Ltd.), which has been liquidated voluntarily, has been appointed manager for India of British Insulated & Helsby Cables (Ltd.).

Amendment of Patent.—The Quasi-Arc Co. (Ltd.), Caxton House, Westminster, seeks leave to amend specifications Nos. 1,274/1912 and 11,079/1912, granted to A. P. Strohmenger, for "Improvements in or relating to electric arc welding."

Plant for Sale.—In an advertisement particulars are given of second-hand Parsons' steam turbo sets which are offered for sale.

Plant Wanted.—An advertiser wants a 50-kw. to 100-kw. generating set, gas or oil engine, with continuous-current dynamo.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding-up of the Candelaria Land, Mining & Power Co. (Ltd.) will be held on May 2 at Caxton House, Westminster, London, S.W.

A receiving order has been made on a creditor's petition against G. F. M. Cornwallis West, Automobile Club, Pall Mall, London, S.W. Mr. F. S. Salaman, 1 and 2, Bucklersbury, London, E.C., has been appointed trustee, to whom claims should be sent.

A meeting to receive an account of the winding-up of the South American Cable Co. (Ltd.) will be held at 25, Rue de Clichy, Paris, on April 18.

A meeting to receive an account of the winding up of the Parana Power Synd. (Ltd.) will be held on May 3 at the offices of Messrs. Ellis & Co., 1, Cornhill, London, E.C.

The Light Electric Motor Co. (Ltd.) is being wound-up voluntarily, and Mr. D. B. Laurie, 430, St. George's-road, Glasgow, has been appointed liquidator. A meeting of creditors will be held on April 6 at the offices of Messrs. Hamilton & Callander, 100, West Regent-street, Glasgow.

ELECTRICITY SUPPLY.

EXTENSIONS.

Accrington.—The Corporation have decided to proceed with the proposed extension of the electricity works, as the present is overloaded, and there is an increasing demand for electrical energy for power.

Ipswich.—The Council have authorised the purchase of an induced draught fan for the electricity works, at a cost of £850.

Plymouth.—Cable extensions estimated to cost £324 were authorised at last week's meeting of the Electricity and Street Lighting Committee.

West Ham.—The Corporation are recommended to apply for sanction to borrow the following sums for the electricity department:

£3,000 for mains; £5,000 for transformers; £11,000 for cables, &c.; £4,500 for linking up connections; and £3,275 for generating station.

It is proposed to defray £1,000 for electricity meters direct out of revenue.

The Corporation is also recommended to adopt a coal clause in connection with the supply of current to the tramways department, the rate of payment for which was fixed in 1913 (when the price of coal was 11s. 6d.

per ton) at 0·75d. per unit. The clause will operate as and from Nov. 1 last.

Woolwich.—The Finance Committee of the Borough Council disagrees with the suggestion of the Treasury that the expenditure of £3,290 on mains, transformers, &c., should be met from the rates, particularly having regard to the heavy charges which have already fallen on the rates in connection with the electricity undertaking.

Application is to be made to the L.C.C. for sanction to borrow £24,785 for a 3,750 kw. turbo-alternator, boiler, switchgear and accessories, £2,330 for transformers, switchgear, &c., and £385 for mains.

GENERAL.

Birmingham.—The question of the operation of the coal clause in electric power agreements was considered by the Electric Supply Committee last week.

In some of the early agreements with consumers there is no coal clause, but it was reported that Messrs. Cadbury had intimated that, although their agreement did not include the clause, they would voluntarily pay for current at the rates in force under the newer agreements, and the Committee expressed the hope that other high-tension consumers would follow this example.

Chelmsford.—Consumers of electric current have been notified by the Electric Supply Corpn. that, owing to the increased cost of coal, &c., the company find it necessary, as from the end of this quarter, to require a minimum payment for electricity at rate of 8s. 1½d. per quarter for any quantity up to 15 units, or for cash payment 7s. 6d. Any supply after the first 15 units will be charged at 6d. net per unit.

Church Stretton.—The Urban Council consented to the Church Stretton Electric Supply Co.'s application for a provisional electric lighting order for the supply of electricity within the urban and rural districts.

Dartford.—The Council have increased the charges for electric current by 20 per cent.

The L.G. Board are to be asked to sanction a loan of £1,076 to meet a deficit on the extension of the electricity works.

Dover.—The Council have adopted a new standing order not to trade with Germans after the war.

Electricity in Collieries.—In connection with the developments at the Thorncliffe Collieries of Messrs. Newton, Chambers & Co. an accommodation shaft is being sunk near Wentworth Station, on the Midland Railway.

The electric winding engine now in course of erection is stated to be the first one used in South Yorkshire, and is being supplied by the British Westinghouse Electrical & Mfg. Co.

Haslingden.—Accrington Corporation, who are under agreement to supply Haslingden with current in bulk, have agreed that Haslingden may obtain a supplementary supply from Rawtenstall Corporation.

Itchen.—The Council have asked the Board of Trade to extend the period of their electric lighting order until three years after conclusion of the war.

Southampton.—The Electricity Committee proposes to increase the charges for lighting, power and heating by 10 per cent., as and from the midsummer meter readings, and for supplies to the tramways department, as and from April 1 next.

The estimated deficit on the undertaking for the ensuing year is £3,684, against a deficit of £3,102 for the current year.

Willesden.—The Electricity Committee has sanctioned an expenditure of £100 for the purchase of motors for hiring purposes.

The committee proposes to extend the existing service line in order to give an additional supply of current at the Dollis Hill House Convalescent Hospital for the purpose of electric treatment.

TRACTION NOTES.

Blackpool.—The Tramways Committee is considering the question of renewing the leases of Dickson-road tramway to Blackpool & Fleetwood Tramroad and the Blackpool & Lytham Tramways Companies.

There is a feeling in favour of the Corporation working all sections within the borough when the leases expire two or three years hence, but arrangements may be made for through running.

Coventry.—The Tramways Committee recommends the Corporation to increase the salary of the engineer and manager of the undertaking (Mr. T. R. Whitehead) from £500 to £600 per annum.

Edinburgh.—The Tramways Committee have appointed a sub-committee to consider the expediency of appointing a tramways manager and also the establishment of a tramway department.

Glasgow.—The Refuse Removal Sub-committee recommend the Corporation to purchase two 2-ton Edison electric vehicles for the collection of the city refuse.

Ilford.—As the Edison electric battery tower wagon, which was purchased by the Urban Council in 1913 proved very satisfactory, the tramways manager has decided to purchase an electric 2-ton wagon for permanent-way use.

L.C.C. Tramways. The L.C.C. have applied to the Board of Trade for an order to extend the time limited under their Act of 1909 for the construction of the junction line to connect the existing tramways in Mitcham-road with those in Southcroft-road, Wandsworth.

In the current year's L.C.C. (Money) Bill, for regulating expenditure on capital account and loans for year ending March 31, 1917, provision is made for the purchase, construction, reconstruction and equipment of tramways; the provision of buildings, power stations, machinery and rolling stock; the purchase of lands and other purposes in connection with Acts relating to tramways, &c.

L.C.C. Tramways and Omnibus Competition.—At the meeting of the London County Council last week Mr. G. H. Hume, chairman of the Highways Committee, stated that negotiations were proceeding with the London General Omnibus Co. for mutual arrangements to prevent duplication of passenger transit services in London; but the committee were taking care not to commit the Council in any way.

Tramways for Goods Traffic.—In a communication to the Press, Mr. P. Kenyon, of Southport, suggests that the tramway systems of Yorkshire and Lancashire should be linked up and put to more profitable use by the provision of tram-tractors and trailers to deal with traffic with which the railways either cannot or will not cope.

West Ham.—It is proposed to defray the cost of doubling the Connaught-road terminus track (970) and making good the carriage way of Beckton-road (£350) out of revenue.

EMPIRE NOTES.

Australasia.—At a recent meeting of Melbourne Council a letter was received from the British Westinghouse Co. stating that the 5,500 kw. turbo-generator on order from them could not be supplied at the agreed time.

As the growth of the demand for current for next winter is likely to be less than originally estimated the non-delivery of the plant will not cause serious difficulty.

In the local press it was stated recently the scheme for the harnessing of the Wairoa Falls (N.Z.) for hydro-electric purposes was approaching completion. The power is to be used for the supply of electricity to the town of Whangarei. The work has been undertaken by a local cement company. The scheme comprises the tapping of the Wairoa River just above the Wairoa Falls, and conducting a large body of the water to a power house on the riverside 1½ miles lower down. The power house is designed to accommodate turbines of 6,000 H.P., 3,000 H.P. plant being installed at the outset. A feature of the scheme is an automatic weir on the overflow of the big dam. The installation of this weir, which consists of two 44 ft. gates which rise and fall automatically with the flood water, is the result of a demand by the Public Works Department that arrangements should be made in the river for the discharge, in flood-time, of more than 30,000 gallons of water per second.

It has been officially announced that the work of constructing the new underground railway in Sydney would be commenced during the current month (March), and it is expected to be completed by the end of 1919. The electrification of the existing suburban railways has been undertaken by the N.S.W. Government Railways and Tramways Department in conjunction with the underground railway scheme of the Public Works Department. The two schemes will cost about £6,000,000, plus £600,000 for rolling stock. It is understood that owing to the difficulty in securing regular supplies of steel and other material, little work beyond shaft sinking and excavation work will be put in hand for some time.

Act No. 2,794 of the Victorian Legislature (dated Dec. 23, 1915) authorises the raising of £3,500,000, of which £3,000,000 is to be applied to the construction of railways and tramways and works connected therewith. Act No. 2,796 (also dated Dec. 23 last) sanctions the issue of loans to the extent of £3,110,000 for works in connection with the construction and maintenance of railways. Of this £800,000 is allotted for additions and improvements to way and works: £800,000 to rolling stock, equipment, machinery and other works; £50,000 for purchase of stores: £800,000 for electrification of Melbourne suburban lines; and £660,000 for construction of new lines, including rolling stock, &c.

The "Australian Mining Standard" says Laidley (Queensland) Town

Council is considering the question of electric lighting and has asked the Queensland Farmers' Co-operative Co. to submit an estimate.

Warwick (Queensland) Council has accepted the tender of the Electric Energy Supply Co., at £4. 4s. per 180 c.p. lamp per annum for lighting the town.

The report of the Electric Light & Power Supply Corpn. (Balmain, N.S.W.) for the six months ended Oct. 31 last states that the war has had the effect of diminishing the output in some of the factories connected to the supply and a number of small power users have had to close their works. The total sales have, however, increased. The number of consumers was 3,268 (increase 357). Cost of fuel, oil and electrical stores increased nearly 20 per cent. A contract has been placed for the erection of a coal conveyor at the power house. The profit was £13,539, and a dividend at rate of 8 per cent. per annum (£5,776) has been paid and £3,223 carried forward. The directors have substituted half-watt nitra lamps for flame arc lamps in Newtown and Balmain, with satisfactory results.

The report of the Shire of Hampden for the year ended Sept. 30 last shows the revenue from the electric supply stations at Camperdown and Terang £2,240 and £1,374 respectively. After allowing for interest, depreciation, &c., the balance of £834 brings the net revenue account to date up to £1,904. The electrical engineers are Messrs. J. A. Colman and J. S. Smyth.

Canada.—The Government of the Province of Ontario propose to control the electricity supply in Central Ontario by the purchase of the Seymour Companies at a cost of $8,350,000. The transaction includes the 22 subsidiary companies.

India.—"Indian Engineering" says last year the move made by the Municipal Council in the direction of a separate scheme for electric lighting at Ootacamund, the hill capital of the Madras Presidency, was suspended in consequence of the possibility of the Government scheme rapidly maturing.

The Government has now intimated that there is little prospect of the Government scheme materialising, and the Council is taking active steps in the direction of lighting the Station electrically. Inquiries were made into the possibility of employing suction gas plant to be utilised with the enormous quantities of fuel available on the Nilgiris. Amongst others consulted on this matter was Mr. Jackson, of Siemens Brothers Dynamo Works, Madras. Mr. Jackson will shortly visit the station with an expert of the Campbell Gas Engine Co.

The "Madras Mail" states that it has been decided to light the buildings of the Bangalore City Railway station by electricity. Plant is now to be put down in the Bangalore City station grounds, and it is expected that the current from this installation will be extended to the Bangalore Cantonment station.

South Africa.—The "South African Mining Journal" states that electrical materials are being purchased as fast as they are received in Johannesburg.

FOREIGN NOTES.

Argentina. The "Review of the River Plate" says 352,352,831 passengers were carried on the tramways in the City of Buenos Aires (owned by the Anglo Argentine, Lacroze, Port & City & Southern Companies) in 1915, compared with 370,807,741 in 1914. Receipts were $33,738,900 m/n (= about £1,466,900), compared with $35,926,347 (= £1,562,000).

The output of the Cia Alemana Transatlantica de Electricidad in 1915 was 77,800,444 units for lighting (against 79,941,956 in 1914), 29,499,454 (against 28,858,911) for power and 62,060,209 (against 61,902,005) for traction.

It is stated that the municipality of Buenos Ayres has ordered the electrical power houses at Avellaneda, Alcorta and Matadores to be shut down.

Public electric lighting has been inaugurated at Anatuya (Santiago del Estero).

The Municipal Commission of Buenos Ayres recently sanctioned a concession for a new public telephone service. The concession was applied for by Senor Alex. S. Isaurralde, who asked for authority to instal in the city a telephone system destined principally to newspaper telephone service. The concession is for 70 years, and the concessionaire will pay the municipality 6 per cent. of gross receipts during the first 30 years and 12 per cent. during a subsequent 20 years should the period be extended. The concession will be forfeited if within three years the first section of the telephone service be not put into working, or if the installation should cease to be worked for two years during the period of the concession. The maximum price for use of each principal apparatus to be $10 per month and $5 per month for subsidiary apparatus in the same house.

Ecuador. A Decree has been published authorising the Executive Power to proceed without delay to make arrangements for the construction of a railway (an electric railway if convenient) between Quito and Esmeraldas. The first section to be constructed will be from Quito to Ibarra.

The Municipality of Daule have been authorised to instal electrica plant for the public lighting of that town.

Iceland.—A consular report from Seydisfford for 1914 states that the electric supply station is working well.

It supplies electric current for lighting the town, and many persons now cook by electricity.

A station was built in 1914 to supply electrical energy in the Westmann Isles.

MISCELLANEOUS NOTES.

Exports to China.—On March 21 the Foreign Office issued a further list of persons and firms in China to whom British goods may be consigned, amongst whom are the International Import & Export Co., Shanghai & the Oriental Press, Shanghai.

Exports to Switzerland.—The War Trade Department announce that arrangements have been made with the Société Suisse de Surveillance Economique to enable small parcels of certain goods on the list of articles consignable to them to be exported from the United Kingdom to Switzerland without an acceptance certificate from the Société being first obtained.

On the parcels the words "via the International Postal Parcels Bureau, Vallorbe," should be written after the name of the Société, and the name of the ultimate consignee must be given on the despatch note or Customs form and on the parcel. Parcels of such goods (up to 11 lb. gross) can be sent by parcel post after obtaining a licence from the War Trade Dept., and copying certain particulars from the licence on to the back of the Customs declaration form supplied by the Post Office.

Parcels of such goods not sent by post and not exceeding 22 lb. gross, for which licences must be obtained in the same manner, must be sent via Dieppe and Vallorbe, the particulars from the licence being copied in these cases on to Customs form S 45 A.

The goods to which the above provisions apply include celluloid electric batteries and parts, salts of thorium, cerium and other rare earths, titanium metal and salts, and vulcanised rubber in sheets.

Legacy for Technical Education.—The late Mr. Thos. Taylor left £1,000 to the Mayor, aldermen and burgesses of Ashton, the income to be applied for scholarships or prizes for promoting and advancing the knowledge of electrical science among the students at the Heginbottom Technical School.

Military Tribunal Case.—At Southwark Tribunal on Monday Messrs. Bardette & Co., electrical and mechanical engineers, applied for the absolute exemption of three electrical improvers.

The men had already been put back 10 groups, and Mr. Ferne (on behalf of the application) pointed out that the Minister of Munitions had stated that men in this trade should be kept in the country. The men were all skilled or semi-skilled in electrical fitters' work.

The applications were refused.

More Enemy Firms Wound-Up.—The Board of Trade have now issued 72 Orders for the winding-up of firms or companies controlled by alien enemies.

These include, in addition to those given in previous issues of THE ELECTRICIAN: United Berlin & Frankfort India Rubber Co. (Ltd.), manufacturers of rubber goods, &c., 11A, Upper Thames-street, London, E.C.; Knoll & Co. (Ltd.), chemical manufacturers, 8, Harp-lane, Great Tower-street, London, E.C.; Langbein Pfanhauser Works (Ltd.), electroplaters, chemists and engineers, 23, Great Hampton-street, Birmingham; Ship Carbons (Ltd.), dealers in carbons for electric lamps, 5, Chancery-lane, London, E.C.; Schoen Bros., electrical agents, 29/30, Cock-lane, Snow-hill, London, E.C.; Fischer Ball and Bearings Co., Carlton House, High-street, Birmingham.

Munitions Establishments.—The Minister of Munitions announces that 259 additional establishments have been declared controlled establishments, making a total of 3,337 establishments controlled under the Munitions of War Acts.

Trading With the Enemy.—On March 24 the Privy Council issued further lists of persons and firms with whom trading by persons in the United Kingdom is prohibited.

These include the following: *Argentina and Uruguay.*—Allgemeine Elektricitats Gesellschaft, Gasmotorenfabrik Deutz, Orenstein & Koppel. *Brazil.*—Gasmotorenfabrik Deutz. *Peru.*—Hardt, Engelbert & Co. *Netherlands East Indies.*—Braunschweig. Maschinen bananstalt, Arthur Koppel, Orenstein & Koppel, Siemens & Halske Allgemeine Gesellschaft, Siemens-Schuckert Werke & Sourabaya Ohefabrick (all of Sourabaya). *Philippines.*—Manila Import Co. *Portugal.*—Allgemeine Elektricitats Ges (Thomson Houston Iberica) Oporto and Siemens Schuckert Werke, Ltda (Lisbon). *Spain.*—Continental Tyre Co (Ltd.) (Madrid), Hassenstein & Vogler (Barcelona) and Sociedad Espanola Korting (Barcelona).

TENDERS INVITED.

Arc Lamp Carbons.

Tenders are invited for the supply of 533,000 Arc Lamp Carbons to the City of MELBOURNE (Australia). Tender form copy of specification, conditions of contract, &c., from the Agents for the City Council, Messrs. McIlwraith, McEacharn & Co. Ppy. (Ltd.), Billiter-square-buildings, London, E.C., to whom tenders are to be sent by noon April 11.

Electrical and General Stores

Tenders are wanted by April 3 for six months' supply of Electric Fittings, Oils and Paints, &c., to the Midlothian and Peebles District Asylum, ROSSLYNLEE. Forms of tender from the Clerk and Treasurer, 19, Heriot-row, Edinburgh.

BRAY (Co. Wicklow) Urban Council require tenders by 8 p.m. April 4 for Stores for the electric light works and general stores. Schedules, &c., from the Clerk.

Turbo-Alternator, Gas Producer Plant, &c.

The NEW SOUTH WALES GOVERNMENT Railways and Tramways Department invite tenders for the supply and erection of a 2,500 kw. Turbo-Alternator for the Zarra-street (Newcastle, N.S.W.) power house. Specification (No. 470) from the Electrical Engineer, N.S.W. Government Railways and Tramways, 61, Hunter-street, Sydney. Tenders to Chief Commissioner for Railways and Tramways, Phillip-street, Sydney, by noon May 3.

WANGANUI (N.Z.) Borough Council require tenders by noon May 9 for the supply and erection of Additional Plant at their tramway power house, including Pressure-type Gas Producer Plant, Gas Engine, Electric Generator and Switchgear. Specification, &c., from the Town Clerk.

Wiring, &c.

DUBLIN Housing Committee require tenders by noon April 6 for the Electric Lighting of Beresford-street and Church-street Dwellings, and Trinity Ward Dwellings. Specifications, &c., from the City Electrical Engineer.

Tramcars and Electrical Equipment.

DUNEDIN (N.Z.) City Council require tenders by 5 p.m. May 17 for six Electric Tramcars and sections of Cars (Bodies, Electrical Equipments and Trucks). Specifications, &c., from the Town Hall, Dunedin.

Varnish Impregnating Apparatus and Storage Battery.

The Victorian Railway Commissioners, Spencer-street, Melbourne, require tenders by 11 a.m. April 19 for the supply and erection of a Complete Plant for Impregnating Electrical Apparatus with Insulating Varnishes and Solid Compounds (Contract No. 29,678.); also a 1,000 Ampere-hour Storage Battery (Contract No. 29,743). Specifications, forms of tender, &c., from the offices of the Commissioners.

Telegraph and Telephone Material, &c.

The Deputy Postmaster-General, Melbourne, requires tenders by 3 p.m. April 18 for supply of 8,500 Fuses (schedule 1,299) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Dept. Specification from the Deputy Postmaster-General, Melbourne.

Tenders are invited up to April 15, 1916, for the supply, delivery and erection at Rockhampton Telephone Exchange (State of Queensland) of a Common Battery Multiple Switchboard (Schedule 362), or an Automatic or Semi-automatic Switchboard and Associated Apparatus (Schedule 361), for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department.

Tenders will be received until 3 p.m. April 26 by the Deputy Postmaster-General, Brisbane, for supply at Toowoomba Exchange (Queensland) of five Sections of Trunk Line Switchboard (Schedule 342) for the AUSTRALIAN COMMONWEALTH Postmaster-General's Department. Specifications, &c., from the Deputy Postmaster-General.

Submarine Electric Cables.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. April 10 for the supply, laying and maintenance for six months of six 11,000-volt Submarine Cables (each 400 yds. long) across Darling Harbour. (Contract No. 424.) Specification and form of tender from the City Electrical Engineer, Sydney.

Motors and Transformers.

WARRINGTON Electricity and Tramways Committee require tenders by noon April 11 for supply of Motors and Transformers. Specifications from Borough Electrical and Tramways Engineer.

Car Lighting Material, &c.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. April 26 for Car Lighting material, including i.r. Cable, Switches, Lamp Cartridge Fuses, Plugs, Sockets, &c. (contract No. 29,784); and by 11 a.m. May 10 for Motor Generator and Accessories for Battery Charging of Baggage Trucks, also Switchboard and Connections (contract No. 29,796). Specifications from the Commissioners' Offices, Spencer-street, Melbourne, Victoria.

Sub-Station Equipment.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by 11 a.m. April 26, for the supply of Electrical Equipment and Accessories for sub-station for the Sandringham–Black Rock tramway (contract No. 29,762). Specifications and forms of tender from the Victorian Railway Commissioners, Melbourne.

TENDERS RECEIVED AND ACCEPTED.

SYDNEY.—*Correction.*—We are informed that the tender of N. Guthridge (Ltd.) has been accepted by Sydney Council for a 2,000-kw. Peebles motor converter, to be manufactured by Bruce Peebles & Co. (Ltd.) under the Peebles-La Cour patents, and not for a rotary converter as stated in our last issue.

TODMORDEN.—The following tenders have been accepted by the Corporation :—

Yates & Thom, boiler, £784 (10 tenders, ranging from £783 to £1,030), and piping, £293 (four tenders, from £293 to £355); J. Procter (Ltd.), mechanical stokers, £104 (six tenders, from £95 to £180); T. Sugden (Ltd.), two superheaters, £169 (five tenders, from £169 to £210).

BARNSLEY.—The following contracts have been placed by the Corporation :—

Willans & Robinson, turbine, £2,509 and condenser £2,150; British Insulated & Helsby Cables, cables and feeders, £2,241; Dick, Kerr & Co., alternator, £1,980.

SOUTHAMPTON.—The following tenders have been accepted by the Tramways Committee for annual supplies :—

Dibben & Sons, screws, 52½ per cent. off for iron, 33⅓ per cent. off for brass, files, 50 per cent. off; Burt, Bolton & Hayward, pitch, £1. 10s. a ton; J. C. Munday & Co., creosote oil, £5 a ton, carminette, £22; Butcher & Co., transfers, £40. 12s.

ABERDARE.—The Urban Council have accepted the following tenders for one year's supply of cables, meters, electric lamps, &c. :—

Callender's Cable Co., cables; British Westinghouse Co., meters; Sykes & Sugden, joint boxes, &c.; Jno. Davies, ironmongery, &c.; Vacuum Oil Co., oils, &c.; Pilkington Bros., glass.

ILFORD.—The Electricity Committee has decided to extend the present contracts for annual supplies for 12 months on the following terms :—

W. Lucy & Co., house service fuse boxes, 25 per cent. increase; joint boxes, 4 per cent. increase or decrease with every 10 per cent. variation in ruling price of pig iron; Cryselco Limited, Electrical Mfg. & Supplies and London & Rugby Engineering Co., incandescent lamps, on present terms; Ferranti Limited and Electrical Apparatus Co., meters, at present ruling prices as quoted. The British Thomson-Houston Co. declined to enter into a contract for 12 months, and orders will, therefore, be placed for their type of meter as required.

WILLESDEN.—The U.D.C. has been recommended to accept the tender of Watson, Marsh & Co. (Ltd.) for re-wiring Block D at the borough hospital.

WARWICK (Queensland).—The Council has accepted the tender of the Electric Energy Supply Co., at £4. 4s. per 180 c.p. lamp per annum for lighting the town.

BATTERSEA (LONDON).—The Borough Council is recommended to accept the tender of Callender's Cable & Construction Co., for 12 months' supply of bitumen to the electricity department.

Government Contracts.—The following tenders were accepted by the British Government Departments during February :—

War Office.—Cable and wire, electric: S. S. Abelson & Co., British Insulated & Helsby Cables, Connolly Bros., W. T. Henley's Telegraph Works Co., Hooper's Telegraph & India Rubber Works, India Rubber, Gutta Percha & Telegraph Works Co., Johnson & Phillips, St. Helens Cable & Rubber Co. and Siemens Bros. & Co., electric cables and wires; Peel-Conner Telephone Works and Siemens Bros. & Co., ebonite; Austin Motor Co. (1914), generating sets; Brimsdown Lamp Works, British Thomson-Houston Co., Foster Engineering Co., Pope's Electric Lamp Co. and "Z" Electric Lamp Mfg. Co., electric lamps; V. G. Middleton, electric lighting at officers' mess, Dover; G. E. Taylor & Co., electric lighting at Portland; Mann, Egerton & Co., erection of power house, &c., Thetford.

Post Office.—Siemens Bros. & Co. and Western Electric Co., telephone apparatus; W. G. Fye & Co., India Rubber, Gutta Percha & Telegraph Works Co. and Park Royal Engineering Works, testing apparatus; British Insulated & Helsby Cables and W. T. Glover & Co., telephone cable; Taylor, Tunnicliff & Co., insulators.

Commonwealth Contracts.—The following tenders have been accepted by the Australian Government Departments :—

Postmaster-General's Dept., Melbourne.—Western Electric Co., 15 strip indicators, £3. 2s. 6d. strip of 10; 50 ditto, £1. 12s. 6d. strip of 10; 50 strips, jacks, 7s. 6d. strip of 20; 50 ditto, 5s. 9d. strip of 10; 500 switching keys, 6s. each; 750 listening and ringing keys, 3s. 6d. each; 30,000 duranoid pegs, 5s. per 100; 200 plugs, 1s. 8d. each; 2,500 pairs protectors, 55s. strip of 20; 10,000 protectors, 3s. 6d. each; 100 resistances, 1s. 2d. each; 300 ditto, 1s. 1¼d. each. British General Electric Co., 2,000 lamp caps, 6d. each; 1,000 ebonite caps, 54s. per 100; 300 mierophone chambers, 5s. each; 200 nuts 5s. per 100.

Postmaster-General's Dept., Sydney.—Western Electric Co., 200 miles wire, £16. 10s. per mile; 25,000 jointing sleeves, 11s. per 100; 5,000 ditto, 17s. 3d. per 100; 14½ miles cable, £494 per mile; 1½ miles ditto, £634 per mile; 5 miles ditto, £778 per mile; 11½ yds. ditto, £920 per mile; British Insulated & Helsby Cables, 4 miles cable, £1,185 per mile. W. T. Henley's Telegraph Works Co., 35 miles wire, £12. 6s. per mile; 50 miles ditto, £9. 11s. 6d. per mile; 3½ miles cable, £101 per mile; 9½ miles ditto, £132 per mile; 9½ miles ditto, £165 per mile; 33¾ miles ditto, £228 per mile; 9½ miles ditto, £298 per mile; Jas. Paton & Co., 50 miles wire, £9. 5s. per mile; Ramsay, Sharp & Co., one bridge megger, £36. 12s. 6d. Haes & Eggers, 14-volt meters, £7. 15s. each.

Postmaster-General's Dept., Perth.—Chas. Atkins & Co., overhead and underground cables, 6s. 10d. per yard, 2s. 7½d. per yard, £61 per mile, and 9s. 9d. per yard. Bullers (Ltd.), 100 bolts, nuts and washers, 9d. each; 2,000 bolts and nuts without washers, 3d. each; 2,000 brackets, 1s. 8d. each; 7,000 insulators, 1s. 8½d. each; 100 ditto, 3s. 2d. each. British Insulated & Helsby Cables, 12 cwt. copper wire, £120 per ton; 2½ cwt. ditto, £132 per ton; 4,399 ft. cable, £2,150 per mile; 4,245 ft. ditto, £1,180 per mile; 3,368 ft. ditto, £670 per mile; 5,013 ft. ditto, £474 per mile; 5,400 ft. ditto, £95 per mile. Western Electric Co., 1,175 yds. cable, £1,630 per mile; 243 yds. ditto, £1,334 per mile; 870 yds. ditto, £1,108 per mile; 320 telephones, £1. 9s. 3d. each; 7 miles cable, £1,048 per mile; 4 miles 1,602 yds. ditto, £748 per mile; 284 yds. ditto, £490 per mile; 2,800 bridle rings, 3s. per 100; 3,500 ditto, 5s. 2d. per 100; 750 ditto, 6s. 6d. per 100. General Electric Engineering Co., 2,000 dry cells, 3s. 5d. each. J. Bartram & Son, 25 testing sets, £10 each; 50 dividing switches, £1. 4s. each; 10 telephones, £4 each; 10 ditto, £4. 13s. 9d. each; 50 ditto, £4. 5s. 10d. each; 50 ditto, £2. 14s. 10d. each; 86 translators, 14s. 10d. each.

Postmaster-General's Dept., Adelaide.—Western Electric Co., 20 flexiphones, £2. 13s. 8d. each; A. S. Langford & Co., internal-combustion engine and dynamo, £271; Bridger (Ltd.), increasing capacity of storage batteries, £396. 13s. 9d.

Postmaster-General's Dept., Brisbane.—Western Electric Co., 270 fuses, £15. 17s. 6d.; 15,000 micas, 16s. 6d. per 100; 5,000 ditto, 17s. 6d. per 100; 50 strips protectors, strips of 13 pairs, £3. 2s. 6d. each; 1,000 double-pole protectors, 4s. 6d. each; 15 strips protectors, strips of 105 pairs, £18. 10s. each; 15 strips protectors, strips of 160 pairs, £44. 10s. each; 4 lb. wire fuse, £10. 2s. 6d. per lb.; one megger, as per schedule No. 347 (item 9); 1,144 yds. cable, £133 per mile; 8,068 yds. ditto, £365 per mile; 440 yds. ditto, £508 per mile; 2,912 yds. ditto, £631 per mile; 177 yds. ditto, £1,037 per mile; 99 yds. ditto, £671 per mile; 176 yds. ditto, £139 per mile; 3,368 yds. ditto, £628 per mile; 1,487 yds. ditto, £1,766 per mile; 1,026 yds. ditto, £1,766 per mile; 4,844 yds. ditto, £403 per mile; 494 yds. ditto, £184 per mile; 550 yds. ditto, £187 per mile; 500 opal caps, 15s. per 100; 25 green ditto, 21s. per 100; 400 red ditto, 16s. 8d. per 100; 1,500 trouble caps, 7s. 6d. per 100; 375 caps, 3d. each; 40 strips jacks, strips of 10, 6s. 6d. each; 50 strips, strips of 20, 42s. each; 50 holding keys, 3s. 6d. each; 25 ringing keys, 3s. 6d. each; 32 switching keys, 3s. 6d. each; 30 ringing and listening keys, 4s. 6d. each; 100 knobs for keys, 5d. each; 150 lamps, 7d. each; 500 ditto, 7d. each; 350 number plates, 25s. per 100; 10 plugs, 1s. 9d. each; 3 polechangers, £6 each; 2 relays, 7s. 6d. each; 10 ditto, 18s. 6d. each; 25 resistances, 1s. 3d. each; 200 distributing rings, 1s. 9d. each; 25 fibre sleeves, 3d. each; 10 strips lamp sockets, strips of 10, 10s. 6d. each; 200 arresters, 4s. 3d. each. Jas. Paton & Co., 1,500 cords, 2s. 6¾d. each; 1,500 jacks, 9d. each; 1,000 ditto, 11d. each; 20 strips ditto, strips of 20, 16s. 6d. each; 50 microphones, 6s. 5d. each; 500 plugs, 1s. 5½d. each; 100 ditto, 2s. each; 10 relays, 9s. 11d. each; 350 ditto, 8s. 2d. each; 500 jacks, 11d. each. British Insulated & Helsby Cables, 2,300 cords, 1s. 7½d. each; 1,280 plugs, 11d. each; 8 resistance coils, 19s. 4d. each; 100 Morse resistance sounders, 13s. 4d. each; 4 artificial lines, £19. 16s. each. India Rubber, Gutta Percha & Telegraph Works Co., 60 detectors, £4. 10s. each; 10 galvanoscopes, 20s. each. W. T. Henley's Telegraph Works Co., 6 miles wire, tinned copper, £10. 6s. per mile; 440 yds. switchboard cable, £204. 5s. per mile. Wm. Adams & Co., 330 accumulators, £263.

Western Australia Government Tender Board.—Denny Bros., motors, for the water supply, £2,515; Agent-General (London), accumulator cells for Railway Department, £343. 10s.

Department of Home Affairs, Melbourne.—Joseph Bakewell, electric lighting at Cessnock Drill Hall, £32.

New Zealand Government Contracts.—*For Public Service Stores Tender Board.*—Elec. Construction Co., 10,000 dry cells for telephones, £514. 14s. 4d.; Turnbull & Jones, 5,000 yds. cable, £653. 10s.

Public Works Dept., Wellington.—Indiarubber & Gutta Percha Co. (Christchurch), (sec. 53) transformers, £949. 8s., (sec. 57) insulators, £210. 3s., (sec. 58) insulators, £210. 3s.; Jolley & Son, (sec. 54) transformers, £705. 0s. 4d., (sec. 55) ditto, £571. 19s. 8d.; National Electrical & Engineering Co., (sec. 56) insulators, £474.

FINANCIAL MATTERS.

COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Co. (Ltd.)

The ordinary general meeting was held on Wednesday. Sir Jonty Denison Pender, K.C.M.G., the Chairman, presiding.

The SECRETARY (Mr. Fred. Thos. Dodds) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, I am not going to detain you very long, but I will just amplify one or two items of the accounts. The expenses for 1915, compared with 1914, show a considerable increase—£4,337. The increase at the Company's head office, or £215, but at the stations, both in this country and abroad, there was an increase of £4,097. This, you will understand, is chiefly on account of the normal increases under the head of salaries and also for additional payments which had to be made on account of the very large extra traffic we have had to carry. The income tax shows an increase of £1,600, not only on account of the extra profits, but also owing to the higher rate on which it has had to be charged. We do not present in these accounts any actual figures with regard to the excess profits tax, which has to be paid not only for 1915, but also for the year 1914. The amount so far has not been settled, but your Board have kept this point in view in the amount of the carry forward of £32,184, as you have seen in the accounts. Now, with regard to the apportionment of the balance left after the income tax has been paid, as well as the interest on the balance of the loan for redeeming the 4½ per cent. debentures, that money was advanced by the Eastern Telegraph Co., and I will refer to it presently. The amount you have to deal with is £49,941. 12s. 2d., and we propose to deal with it in the following way: We place £5,000 to the reserve fund, and £5,230 has been set aside to the investment fluctuations fund. The latter fund now represents the total depreciation on the securities to date, which amounts to something like 21 per cent. Then there will be the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 5 per cent. on the ordinary shares, together with a bonus on the latter of 2 per cent. This will leave £32,184. 15s. 2d. to be carried forward. You will notice that the sum of £10,000, being the balance of the £30,000 sent us by the Eastern Telegraph Co. to pay off the 4½ per cent. debentures, now disappears from the accounts. We have been fortunate this year in connection with repairs, but we cannot look for the same good fortune every year. We have had no repairs whatever, and, therefore, no costs to meet for hiring a ship to maintain our communciations. With regard to the increase in the revenue, it is entirely due to the competing route (that is, the land route), at the present time being practically non-existent, and I can say without hesitation that the postal and telegraph departments

of both the British and the French Governments must appreciate the work which the Direct Spanish Co. is doing in so efficiently carrying on this communication, because if the work were thrown on them at the present time I do not think they could do it. Their lines are so fully occupied with the traffic interchanged between this country and France that I do not think they would be able, at any rate, to carry the Spanish traffic with the same facility and the same speed with which the Direct Spanish Co. is doing it. However, directly the war is over and we return to normal conditions, this competition over the Channel cables through France to Spain will start again, and very likely with renewed energy, because I think that every Government department will be glad to earn all the revenue it can. However, that competition has always been carried on by the postal and telegraph departments of the British and French Governments in a perfectly straightforward and honourable way. With these remarks I propose that the report and accounts now presented be and are hereby received and adopted.

Mr. FRANCIS ALEXANDER JOHNSTON seconded the motion, which was carried unanimously.

The CHAIRMAN then moved that the dividends and bonus recommended be declared.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was carried unanimously.

The retiring director, Mr. Francis Alexander Johnston was re-elected, and Messrs. Deloitte, Plender, Griffiths & Co. were re-appointed auditors for the year 1916.

A vote of thanks to the Chairman concluded the proceedings.

W. T. Henley's Telegraph Works Co. (Ltd.)

The ordinary general meeting was held on Wednesday, Mr. SYDNEY GEDGE, M.A. (the Chairman), presiding.

The SECRETARY (Mr. A. E. Salmon) having read the notice convening the meeting, and Mr. CORNISH having read the auditors' report,

The CHAIRMAN stated that 551 of the Company's men had joined the Forces. He regretted to state that 10 had been killed, 30 had been wounded, two were missing, and seven were prisoners, or 49 in all out of the 551. He was sure they would all sympathise with the Earl of Galloway in the loss of his second son, and in the fact that his eldest son was still a prisoner. Dealing with the accounts, he stated that of the £10,000 set aside last year to provide for the dependents of the Company's employees who had joined the Forces £4,333 had been spent, and he hoped that the balance would suffice for the purpose intended. The Company had made a larger profit in the past year than in the previous year. The Government orders executed by the Company of course, had been given, and were still being given, preference over all other orders, theirs being a controlled establishment. They had not been able to accept all the private orders which had been offered to them. The Directors were enabled to recommend the payment of a dividend and bonus of 25 per cent. for the year, or 5 per cent. more than was paid in the previous year. He was sure it would be recognised that the Company was excellently managed, and they were very grateful to the whole of the staff. The profit last year was £161,000, or about £41,000 more than that of the previous year. About £42,000 had been written off for depreciation on machinery, &c. A large amount of new machinery had been placed in the works owing to the Government orders. Last year they increased the reserve account by £20,000, but this year they were increasing it by £25,000, raising the reserve to £260,000, while the ordinary capital of the Company amounted only to £200,000. A sum of £30,000 had been set aside for the proposed staff pension and benefit fund. Ample provision had been made also for any claim which might be made on them in connection with the excess profits tax. He concluded by moving the adoption of the report and accounts.

The MANAGING DIRECTOR (Mr. Geo. Sutton, M.I.E.E.) said: The circumstances of the year's trading has been so abnormal that they do not call for the dissection which is usual for me to submit to the shareholders at these annual meetings. The course of events has been extraordinary in the country, and that is, of course, reflected in our business; but I will explain briefly the changes which the war has made on the business and its results on the balance-sheet. First there is the fact that the plant of the Company has been principally used for the production of materials for war purposes; secondly, the reduction in the demand and our inability to meet the demand that does exist for cables for the home and colonial commercial trade; and, thirdly, there is the feature of the greatly increased demand from foreign—that is, neutral—countries. I will deal with those three points in order, as the manufactures of the Company enter into every phase of modern warfare. On land and on sea and in the munition factory the electric cable is a necessity, and it is in the direction of electric cables that the Company has devoted its energies. Although we are a controlled firm, it is not to be supposed, as many persons may suppose, that we are making shells. As regards the home trade and the reduction in the demand for cables for commercial purposes, there has been a great falling off in the usual home and colonial demand for wires and cables apart from cables required in connection with the war. I can only say that this Company has devoted resolutely all the capacity it can to the national necessities, and has turned aside orders which have been sent to us from our usual commercial customers. We are doing that every day, and are thus losing custom, and shareholders may think that we are also losing goodwill. I do not think we shall do so. I believe that we shall not suffer the loss of their orders because of our inability to execute them through our working on behalf of the national interests.

The third point to which I have drawn attention is the increased demand from neutral countries. To some extent, but not to the whole extent, that is due to the closing down of the German supply. In Germany and abroad, but not much in England, we had a great competitor. I think that on the whole outside the British colonies they had a larger trade in cables than English manufacturers; and, therefore, the closing down of the German trade has increased the demand on English manufacturers. The demand, however, has been very difficult to meet in consequence of the uncertainty of obtaining licences for export from the Government, and although we are able to locate our consignees, so that we know that our cables will not find their way into an enemy country, there are no doubt other reasons which necessitate the stoppage of exports to neutral countries. We endeavour not to commence the manufacture of cables until we have reasonable grounds to suppose that we shall be able to despatch them, and we believe that the Government gives us all the aid it wisely can, so that we shall not unduly multiply our liabilities on orders which we cannot ship. I wish the shareholders to understand that the large increase in our profit is not due to a larger rate of profit made on Government work than is obtainable on ordinary commercial work. The increase in the profit—£161,000 in the past year compared with £119,000 in 1914—is due particularly to two causes which I will explain as briefly as possible. First, there is the strong financial position we are in. When the war started, the Company's position and credit were at a very high standard, and we used them—and we continue to use them—to buy as freely as desirable those materials which were essential to meet the demand for our products which we expected would be upon us. Copper, rubber and lead were the principal essentials, and our large forward purchases of these materials, which have risen so much in value, has brought us considerable profits as they have been made into cables, which are sold on the price of raw materials at the time the cables are ordered. There is, of course, another side to the picture. When raw materials fall in value, we are bound to be carrying a stock which involves us in a loss when sold in the form of cable. The second cause of the increased profit is increased turnover. We have added considerably to our plant in order to enable us to meet the demands which are made upon us in common with the war. Some of this plant will be useless after the war, some may be in use, but all of it has had to be put down at the enhanced war cost. In this connection the shareholders will be interested to learn that owing to the uncertainty of our getting deliveries of small sizes of copper wire which we did not ourselves make, and which is required for urgent war cables, we acquired for a cash payment a small factory at Brighouse in Yorkshire. That has enabled us to satisfy the demands of the Ministry of Munitions, and it will be satisfactory to you to learn that at the end of the year under review our deliveries to the orders of the Ministry were four days in arrear. The new motor tyre factory is more than paying its way, and has borne its share, in proportion to the capital employed, in the dividends we are paying. I think you would like me to say a few words as to our trade after the war. Of course, we do not know what the demand for our products will be, but there are one or two things in connection with after-war conditions we do know. We know that the capacity for making insulated wires and cables in this country has enormously increased owing to the war demand. As we have put down new plant we may be assured that other cable makers have done likewise, and there will be a severe struggle for the business to be had, which will probably mean cutting of prices. We hope that that may be avoided for the good of the industry generally, but with more machinery in the country than can be employed, it looks as though we may have a difficult time in front of us. We are not afraid, however, that Henley's will be unable to meet the position, for we possess three first essentials of success—money, skill and good organisation; and as we have successfully weatherd storms in the past, we may look forward to the future with equanimity. I have pleasure in seconding the motion.

The resolution was carried unanimously.

The declaration of the proposed dividend and bonus on the ordinary shares was sanctioned; the retiring Directors, the Earl of Galloway and Mr. Robert James Hatton and the retiring auditors (Messrs. Ball, Baker, Cornish & Co.) were re-elected.

A resolution authorising the Directors to create a staff pension fund was carried unanimously, and a vote of thanks to members of the staff and workmen who had joined His Majesty's Forces was also passed.

The proceedings terminated with a vote of thanks to the Directors and staff.

British Insulated & Helsby Cables (Ltd.)

The twentieth ordinary general meeting was held at Liverpool on Monday, Mr. JAMES TAYLOR, J.P., presiding in the absence (through indisposition) of Dr. E. K. Muspratt, Chairman of the Company.

The CHAIRMAN, in his speech, stated that the profit for the year amounted to £295,131, compared with £277,428 for the previous year, an increase of £17,703, and he was sure the shareholders would agree that the results were satisfactory considering that the profits were more than the Company had made in any previous year. Those good results had come about from the fact that during the year the Company had done a very much larger volume of trade than ever before, many of the departments having been worked continuously day and night. They became a "Controlled Establishment" as from August 18, 1915. During the whole of the year an increasing business had been done with the British Government on the ordinary lines of the Company's manufactures, and he was pleased to say that, generally speaking, they had been fully able to meet all Government requirements in spite of the extreme pressure on

machines, and the fact that they had been very seriously handicapped in the matter of experienced staff and workpeople. During the year several new lines of manufacture had been undertaken at the request of the Government. Those were of such a nature that they hoped to be able to continue them with success when normal conditions again prevailed. They had followed the policy of giving an absolute preference to Government orders of all kinds, and were devoting themselves to the prompt fulfilment of these contracts. They had next met the demands of home and colonial trade to the best of their ability, and had lastly endeavoured to obtain foreign business in the open markets with considerable success. At the last annual meeting he had referred to the large number of men (viz., 625) who had left the Company's service and joined the Military or Naval Forces of the Crown. During the year under consideration that number had been increased. After examination of each case on its merits the Directors had continued to make a fit and proper allowance to the dependents of both officers and men during their absence. He was pleased to say that the staff and workpeople of the Company continued to make voluntary weekly contributions to War Funds, and had raised to date the sum of £2,181.

Turning to the profit and loss account, the Chairman said, adding the balance brought forward from 1914, there was available the sum of £414,511, out of which there had been paid the sum of £5,915, Directors' and trustees' fees, &c., and after placing £25,000 to depreciation on buildings, plant, machinery, &c., £10,000 to special depreciation on plant and machinery, which was necessarily due to the large amount of overtime worked during the year, £70,000 to reserve account, £8,500 to special reserve account, £5,000 to debenture stock redemption account, and after paying debenture interest, preference dividend and interim dividend on ordinary shares amounting to £87,500, there remained £222,596 available for distribution. The Directors recommended a further dividend of 10s. per share, making, with the interim dividend already paid, a distribution on the ordinary shares of 15 per cent., together with a bonus of 2½ per cent., making a grand total of 17½ per cent., leaving £146,096 to carry forward, an increase of £40,717. From the balance carried forward, a deduction would have to be made both for the excess profits duty and also under the Munitions of War Act since the date they became a "Controlled Establishment." The amounts payable under these headings had not yet been ascertained. In regard to capital expenditure the balance-sheet showed that after debiting the amounts expended during the year at the Prescot and Helsby factories, the figure now stood at £651,175, compared with £643,898 last year. The addition was ordinary capital expenditure on the growing business, but it included the cost of erecting a new dining hall at Prescot for the workers, necessary on account of the largely increased number of employees, both male and female, also required to have warm food provided for them at mid-day. Stocks and work in progress had increased by as much as £202,000, largely owing to the increased cost of copper and lead, and other raw materials, which had risen in price to an unprecedented extent. With regard to investments, which stood at £531,602 compared with £531,423 last year, the shareholders would be interested to learn that after a careful valuation of the investments the Directors were of opinion that, notwithstanding the general depreciation in the value of securities, they still exhibited figures in excess of that appearing in the balance-sheet. He concluded by moving the adoption of the report and accounts, which was seconded by Mr. HAREWOOD BANNER.

Mr. H. C. WOODWARD, whilst congratulating the Directors upon the satisfactory result of the year's working, was of opinion that more of the profits might have been distributed among the shareholders in the way of dividend, for, in point of fact, whereas the total amount involved by payment of dividend was £117,500, the Directors had carried forward from the previous year £119,000, so that they were in the happy position of having paid the dividend out of the "carry forward," and had left the whole of this year's profits intact.

The CHAIRMAN said he was old enough to remember some 14 years ago the Company had no reserve fund, and a very heavy goodwill account. It was the conservative policy of the Directors that had brought about the present position, and the shareholders were deriving the benefit of that policy. Nevertheless, in the future if profits still continued the Board would consider the possibility of a larger dividend.

The motion was then put and carried unanimously, and it was also resolved to pay the further dividend and bonus recommended on the ordinary shares.

Messrs. J. Carton Sibly and Sir Harwood Banner, the retiring Directors, were re-elected, and Messrs. Chalmers, Wade & Co. were re-appointed auditors.

The CHAIRMAN, in proposing a vote of thanks to the manager and staff, spoke very highly of their services. Their difficulties had been increased by the fact that some of the most highly-qualified workers had been lost for a time through joining the Army. Without the devoted services of all the officials and workpeople the Directors could not have brought the year's work to so satisfactory a conclusion.

The resolution was carried with applause, and a vote of thanks to the Directors and to the Chairman for presiding concluded the proceedings.

AERO & GENERAL FINANCE CORPORATION, LTD.—The report for 1915 states that, after providing for depreciation and debenture stock interest, &c., and paying dividend paid during year and excess profits tax, the profit (including £8,078 brought in) is £24,184. The directors recommend a final dividend of 10 per cent. on the ordinary shares, leaving £20,484 to be carried forward.

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AUTOMATIC TELEPHONE MFG. CO. (LTD.)—Mr. Jos. Taylor, J.P., who presided over the annual meeting on Monday, said the profit for 1915 was £41,867, an increase over last year of £3,620. With £5,256 brought forward the available total was £47,124, and the directors recommended that (after payment of directors' fees, £2,450, placing £6,000 to depreciation, writing off £3,500 from underwriters' commission account and £2,000 off preliminary expenses and payment of preference dividend, amounting to £12,000) a dividend of 4 per cent. for the year, less tax, be paid on the ordinary shares, which will absorb £14,400, leaving £6,774 to be carried forward, an increase of about £1,500. It was almost unnecessary to state that during the year 1915 the automatic section of the company as well as the general business had suffered considerably from the conditions arising out of the war. As a matter of fact about 150 of the company's men, many of whom had been specially trained in the business, had joined the Forces. Therefore, the directors considered that the increase in the profits was satisfactory, inasmuch as the business had not been conducted on normal lines. The shareholders would be gratified to know that the company's staff, workpeople and equipment, dealing as they did in normal times with the manufacture and installation of highly scientific apparatus, had proved very adaptable and useful in turning out other important material during the present critical time. They had, however, during the year succeeded in completing and bringing into service automatic telephone exchanges at Rosario (Argentina), Newport (Mon.), Accrington and Chepstow, as well as smaller but important exchanges. With regard to these smaller exchanges it might be interesting to note that in cases where a 24-hour day was being worked it frequently became desirable to install an automatic exchange as compared with eight hours a day conditions, because three operators instead of one were displaced. The company had in hand important automatic exchanges at Portsmouth, Paisley, Leeds and Blackburn. All of these were also in an advanced state, but for the reasons given the progress was slow. The Leeds exchange might be further delayed on account of a large extension, but it was hoped that the other three named would be completed and brought into use during the present year. All the automatic exchanges already in use in this country, as well as in Argentina and in India, were working quite satisfactorily. Since the end of the year the directors had invested £45,000 in Government securities. The report and accounts were then adopted and the retiring directors re-elected.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The directors in their report for 1915 record some further improvement in the business of the company. The net profit for the year amounts to £176,751. 19s. 2d., and with £8,121. 2s. 2d. brought forward the total is £184,873. 1s. 4d. After writing £25,000 off patents, goodwill, &c., and appropriating £35,241 for special depreciation of plant, machinery, &c., and £5,000 as additional reserve for employers' liability, and paying dividend of 7½ per cent. on preference shares (£75,000), £44,072. 1s. 4d. is carried forward. There have been charged against revenue the usual expenses for maintenance of works, plant, &c., and in addition there has been applied to depreciation of the same items an amount of £87,150. The company was declared a "controlled establishment" on Aug. 1st, 1915. In the last report reference was made to the acquisition of a controlling interest in the French Westinghouse Co., and the directors say that the business of that company shows signs of improvement.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—During 1915 the connections to the company's mains increased from 4,080 kw. to 4,254 kw. Including £1,621 brought forward, the year's profit is £12,159. 10s., and after payment of debenture interest and trustees' fees, &c. (£2,979), the balance is £9,172. An interim dividend at rate of 4 per cent. per annum was paid for the half-year in October, and the directors recommend payment of a further dividend for the second half-year at rate of 8 per cent. per annum, making a total dividend of 6 per cent. for the year, that £3,000 be placed to general reserve account, leaving £1,672 to be carried forward.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The revenue account for 1915 shows a credit balance of £26,476, which, with £5,626 brought forward, £354 balance of interest received, and £3,000 transferred from reserve fund account, makes a total of £35,456. 11s. After deducting £1,901 for interim dividend on the 7 per cent. cumulative preference shares, and £7,648 interim dividend at rate of 9 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the sum remaining, £25,704. 18s., be dealt with as follows: To amount written off cost of investments, £262. 8s. 2d.; amount written off shares in and advances to Brompton & Kensington Assessors, Ltd., £3,009; credit of depreciation account, £6,393. 12s. 2d.; payment of dividend on preference shares for half-year ended Dec. 31, £1,901. 4s. 6d.; payment of dividend on ordinary shares for half-year ended Dec. 31 at rate of 11 per cent. per annum, making 13 per cent. for the year), £9,548. 1s. 6d.; directors' additional remuneration, £668. 1s., leaving £1,011. 10s. 8d. to be carried forward. At the end of the year the equivalent of 327,292 (35-watt 8 c.p.) lamps was connected, an increase of 17,964 lamps over 1914; the number of consumers was 6,512, against 6,330; gross receipts were £30,074, against £26,099; and net receipts £26,395, against £30,271.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—The gross profit for 1915 was £31,157, and after providing for debenture interest the balance, with £8,270 brought forward, is £19,248. A dividend of 2 per cent. on the preference shares is proposed, transferring to depreciation and renewals account £2,000, in reduction of expenses of issue of debentures £1,000 and carrying forward £8,574.

CLYDE VALLEY ELECTRICAL POWER CO.—At the half-yearly meeting last week the chairman (Mr. F. C. Goodenough), who moved the adoption of the report and accounts, said the increased profit was entirely due to

additional demands for power, and in view of the costs in all branches of the company's business having more than correspondingly increased the results were considered most satisfactory.

EVERED & CO. (LTD.)—The report for 1915 states that, after meeting debenture and other interest (£2,171), income tax and reserve for war taxes (£9,168) and war bonus (net exceeding) (£2,000), the profit is £22,056 It is proposed to pay a dividend of 7½ per cent. for the year, to write £3,000 off plant, to place £6,000 to reserve, and to carry forward £2,175.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—Up to Dec. 31, 1915, the equivalent of 153,451 8-c.p. lamps was being supplied, an increase of the equivalent of 7,508 8-c.p. lamps over those connected at the end of 1914. The agreement with Cheriton Council for the supply of current in their district has been completed, and the necessary order has been obtained from the Board of Trade. Including receipts from hired installations, the profit for the three undertakings amounts to £16,759. 12s. 4d. With £1,437. 19s. brought forward, and interest and installation profits, and after allowing for interest on debenture stock and preference dividend the balance is £11,602. An interim dividend at rate of 6 per cent. per annum has been paid on the ordinary shares, and the Directors have carried £5,000 to depreciation fund, and £500 to reserve fund, and they recommend payment of a dividend at rate of 8 per cent. per annum (less tax) on the ordinary shares for the half-year (making 7 per cent. for the year), leaving £2,602 to carry forward.

GATESHEAD & DISTRICT TRAMWAYS CO.—Mr. H. S. Day, who presided at the meeting last week, said the past year's results were eminently satisfactory. The receipts were £72,901, increase of £6,531 as compared with 1914, whilst the expenses, including provision of £3,000 for renewals and mortgage interest, amounted to £37,452, increase of £1,078. Owing to lack of labour and difficulty in obtaining materials, certain repair work was in arrears, and the directors considered that the special reserve of £10,000 was necessary to provide for these repairs, and also to cover any claims for excess profits tax.

LLANELLY & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—At the recent meeting the chairman (Mr. A. R. Holland) said the past year had been an extremely difficult one. The price of fuel and other materials had been greatly increased, and whilst the turnover had shown an increase that was more than offset by the increase in expenses. Under all circumstances, he considered that the shareholders were to be congratulated on the result of the year's trading, although the net profit shown was less than in former years. In the ordinary course the shareholders would have been asked to sanction an increase in the capital of the company to provide for past expenditures and for future development, but under the circumstances, and in view of existing restrictions in the way of raising new capital, the directors had decided to postpone the question. The rates for lighting and power were increased in the latter part of 1915 in order to meet the increased expenditure, but further increases might have to be made in the near future. The results so far for the corresponding period of 1915 showed an increase in both tramway and power sections, and he was glad to say the outlook for the future was satisfactory. A fair amount of new power business had been secured and further additions were under consideration. Formal resolutions providing for dividends at rate of 6 per cent. per annum on the cumulative preference shares, and of 2 per cent. per annum on the ordinary shares were passed, £673 being carried forward.

NEWCSTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—Mr. J. H. Armstrong, who presided at the meeting last week, stated that the connections to the company's system at the end of 1915 amounted to 258,390 H.P., an increase of 26,965 H.P. The profits were £294,418, compared with £178,300 in 1914 and £141,140 in 1913. They had written off as reserve for depreciation £25,000 (against £20,000 in 1914, and £15,000 in 1913), and the transfer to general reserve was £28,000 (against £17,000). Profits had been adversely affected during the year by the reduction in lighting hours and in the supply to the tramways to the extent of 2,000,000 units. Other factors had been the increase in the price of coal, material and labour, but there had been compensating benefits from general consumers. They had spent £93,965 upon upkeep, against £74,571 in 1914, the reason being that they had taken out two motors and two turbines, each of 3,000 H.P., and replaced them by two new and more modern ones of 6,000 H.P. each. The dividend was ½ per cent. increase on the previous year. In the past the interim dividend had been paid about four months after the final dividend, but in future it would be paid six months after the final dividend. In the year £110,078 had been expended on capital account, in accordance with the programme of development laid down in 1914. On the laying of new mains £18,825 had been expended, but only four new mains had been laid against 20 in 1914. He referred to the fusion scheme under which the company took over the whole of the share capital of the Durham Electric Supply Co., and said the area previously covered by the latter was now practically served by the Newcastle Company. The Durham Company had made £27,645 profit last year, against £23,946 in 1914, when 4 per cent. was paid on the preference shares at their original value; while this year 3 per cent. was paid on the whole of the capital and £6,000 was set aside for depreciation. The Houghton Company, which was part of the interest they acquired in the Durham Collieries, had paid a dividend of 10 per cent. and had carried £1,000 to reserve.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—At the annual meeting last week the chairman (Mr. F. E. Gripper) stated that during the past year the equivalent of 692 33-watt lamps had been added, making the total connections equal to 31,436 lamps. The profit (with £151 brought forward) amounted to £2,121. After deducting debenture and other interest the balance was £1,400, and the directors recommend payment of a dividend of 2 per cent., that £650 be carried to reserve for renewal of plant, and that the balance (£219) be carried forward. He stated that the sales of current had produced £353 less than in 1914, while working expenses were practically the same. Their old coal contracts carried them up to practically the end of the year, but they had to the coming year to look forward to a largely increased coal bill. They had increased the price of current last October by 10 per cent.

PARAGUAY CENTRAL RAILWAY CO.—The report for the year ended June 30, 1915, states that the receiver had written that since the close of the financial year the improved earnings had enabled him to arrange for substantial remittances from Asuncion to London. Those funds will be required in the near future to meet certain expenditure, and to protect the company's interest in the tramway company, including the improvement and extension of the tramway undertaking in which the company is so largely interested. The Asuncion Tramway Light & Power Company's earnings had been seriously handicapped by the high rate of exchange and lack of capital for the development of the business; consequently it had not yet been possible to formulate a scheme which would enable the receiver of that company to be discharged.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—The chairman (Mr. G. Alderson-Smith) stated at the recent meeting that the receipts for 1915 were £7,500, against £11,000 in 1914, and meter rental was also down £200. All their charges had been carefully looked into and all of them were down. The bombardment drove or frightened away 200 of their customers. They shut up their houses, and the company's servants could not get to read their meters, but after a great deal of trouble that was effected. 13 of their men had joined the Army, and he was sorry to say that three of them had been killed. Mr. A. A. Campbell Swinton, who seconded the motion for the adoption of the report, thought the company was to be congratulated that they had not made a loss on the year's working, with £4,000 falling off in the revenue.

SLOUGH & DACHET ELECTRIC SUPPLY CO. (LTD.)—At the end of 1915 the equivalent of 30,120 33-watt lamps was connected, an increase of 1,263 new lamps during the year. The annual revenue was £9,625, against £8,956, and the units sold were 1,070,927 against 831,803. The lighting load decreased, but there was an increased power supply. Fuel oil for the Diesel engines increased from £3 to over £6 a ton. A dividend of 4 per cent. has been declared, £1,250 has been placed to reserve, &c., and £219 carried forward.

WINDSOR ELECTRIC INSTALLATION CO. (LTD.)—The accounts for 1915 show a profit, including £468 brought in, of £6,515. After transferring £2,000 to depreciation, renewal and reserve, and paying debenture interest, &c., and the 5 per cent. preference dividend, the directors recommend a dividend of 4 per cent. per annum, carrying forward £779. The year's capital expenditure was £1,027. The total connections are equivalent to 60,389 33-watt lamps, an increase of 3,736 30-watt lamps.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

CHARNLEY MFG. CO. (LTD.) (143,343).—Reg. March 21, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in electric and gas and oil lamps, and all apparatus used in connection with the distribution, supply, accumulation and employment of electricity, oil, gas or water, electricians, electrical, mechanical and civil engineers, &c., and to adopt an agreement with the Textile Illuminating & Engineering Co. Private company. First directors are L. Hermes and J. Birch.

MARSHALL & PLUMTREE (LTD.) (143,369).—Reg. March 23, capital £2,000 in £1 shares, to carry on the business of an electric light company and that of electricians, engineers, &c., and to adopt an agreement with E. Marshall and J. S. Plumtree. Private company. First directors are E. Marshall and J. S. Plumtree. Reg office: 20, High Holborn, W.C.

NEW ERA SIGNS (U.S.A.) (1916) (LTD.) (142,233))—Reg. March 8, capital £200 in 1s. shares, to acquire and develop the patent rights in the U.S.A. of an invention for improvements in or relating to flashlight advertising devices, to carry on the business of manufacturers of and dealers in advertising apparatus for displaying electric and other advertisements, dynamos, lamps, cables, insulating materials, &c., and to adopt an agreement with E. C. Leachman and the Magna Charta Publishing Co. Private company. First directors are T. C. Elliot-Lawson, F. Hope-Jones, E. C. Leachman and C. H. R. Profumo. Reg. office: Albion House, 59-61, New Oxford-street, W.C.

MORTGAGES AND CHARGES.

BAUGHAN & CO. (LTD.)—Particulars of £4,000 debentures, created March 7, 1916, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, including uncalled capital. No trustees.

ELECTRIC FURNACES & SMELTERS (LTD.)—Memorandum of satisfaction on various dates from May 31, 1913, to Nov. 30, 1915, of debenture (no dates given) securing £9,200, has been filed.

C. W. HACKING & CO. (LTD.)—Particulars of £600 debentures, created Feb. 18, 1916, have been filed, whole amount being now issued. Property charged: Company's property, present and future. No trustees.

RUSSELL BROS. & CO. (WOLVERHAMPTON) (LTD.)—Particulars of £1,000 debentures, created Feb. 29, 1916, have been filed, whole amount being now issued. Property charged: Company's undertaking and property, including uncalled and unpaid capital. No trustees.

CITY NOTES.

MEMORANDA (March 29).—Bank rate 5 per cent. (since Aug. 8, 1914). Consols 57 ⅛. Consols Pay Day, April 5. Stocks and Shares Ticket Days, April 12 and 27. Pay Days, April 13 and 28. Price of silver, 27 ⅛d.

ALTRINCHAM ELECTRIC SUPPLY (LTD.)—A dividend of 7s. 6d. per share has been declared on the 1s. deferred shares and £2,625 carried forward. For 1914 10s. per share was paid and £2,000 was carried forward.

BRITISH COLUMBIA TELEPHONE CO.—The profit for 1915 (including $4,457 brought forward) was $403,882, and a dividend of 8 per cent. has been declared on the ordinary shares, carrying forward $5,504.

SIMPLEX CONDUITS (LTD.)—The accounts for 1915 show a disposable balance of £22,127, and the directors recommend a dividend of 10 per cent. and a bonus of 5 per cent. Last year a similar dividend was paid but no bonus was declared.

VICKERS (LIMITED).—The directors announce that, under existing circumstances, the accounts for 1915 must necessarily be delayed, but the final dividend on the preferred stock and preference shares was paid on the 30th inst.

METAL PRICES.

Messrs. J. B. Garnham & Sons, 132, Upper Thames-street, London, E.C., quote under date, March 28, the following as the present basis prices of

New Metals.	per lb.
[illegible]	17d.
Solid Drawn Copper Tubes	18½d.
[illegible]	18½d.
Brazed Brass Tubes	19d.
[illegible]	16½d.
[illegible]	18d.
[illegible]	16½d.
[illegible]	16½d.

	per ton.
Copper Sheets	£148 0 0
[illegible]	£0 0 0

	per ton.
English Lead	£36 10 0
Antimony	Nominal.

Old Metals.	per ton.
[illegible]	£101 0 0
Clean Brass Scrap	£65 10 0
Brazier Copper Scrap	£90 0 0
Old Lead	£30 0 0
Old Zinc	£60 0 0
Hollow Pewter	£125 0 0
Black Pewter	£80 0 0
Gun Metal	£85 0 0

Mr. A [illegible], Bath-street, London-road, Southwark, London, S.E., quotes under date March [illegible] the following approximate prices of Scrap Metals:

	per ton.
[illegible] Cuttings	£112 0 0
[illegible]	£0 0 0
[illegible]	£0 0 0
[illegible]	£0 0 0
[illegible]	£80 0 0

	per ton.
Old Lead	£30 0 0
Tea Lead	£28 0 0
Old Zinc	£68 0 0
Hollow Pewter	£120 0 0
Shaped Black Pewter	£85 0 0

[illegible] Prices for Bar [illegible]; Commercial Tinman's Solder, £115; Blowpipe Solder, £120.

ELECTRICAL COMPANIES' SHARE LIST.

What were known as "official quotations" are not now issued, but we give below the latest prices at which actual transactions took place on or before Tuesday, March 28. The greatest care is taken in compiling these figures, but the difficulty of verification is now much increased.

Shrs.	Last Dividend	Name.	Price, Tues., March 28.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply.		£ s. d.	
10	7%	Bournemouth & Poole E.L. Ord.	9[illegible]	7 11 10	Mar, Sept
10	4½%	Do. 4½% Cum. Pref.	9[illegible]	4 15 [illegible]	Feb, Aug
10	6%	Do. 6% Cum. Pref.	10[illegible]	[illegible] 4	Feb, Aug
5	10%	Brompton & Kensington Ord.	7[illegible]	7 1 7	Mar, Sept
[illegible]	[illegible]	Do. Pref.	7	0 0	Mar, Aug
St.	4%	Central Elec. Supp. C. Deb. St.	[illegible]	0 0	..
St.	4%	Charing Cross West End & City Debs.	[illegible]	5 0 11	Jan, July
5	2/3	Do. 4½% Pref.	[illegible]	7 2 7	..
[illegible]	[illegible]	Do. Ord.	[illegible]	7 1	Aug, Feb
[illegible]	4½%	Do. City Pref.	[illegible]	[illegible] 9	Jun, Dec
[illegible]	[illegible]	Chelsea Elec. Supp. Co. Ord.	4[illegible]	4 [illegible]	[illegible]
St.	4%	Do. Deb.	[illegible]	5 [illegible]	Jan, July
[illegible]	[illegible]	City of London Elec. Lt. Ord.	[illegible]	7 10 [illegible]	Feb, Aug
10	6%	Do. 6% Pref.	10	6 0 0	Mar, July
St.	4%	Do. 4% Deb. St.	9[illegible]	5 2 [illegible]	Jan, Dec
[illegible]	4½%	Do. 4½% Debs.	[illegible]	5 12 [illegible]	Jan, Dec
[illegible]	[illegible]	County of London Ord.	[illegible]	[illegible] 11 [illegible]	Mar, Sept
[illegible]	6%	Do. 6% Pref.	[illegible]	[illegible] 15 [illegible]	Feb, Aug
[illegible]	[illegible]	Do. 1st Deb.	[illegible]	[illegible] 4 [illegible]	Jan, July
[illegible]	4½%	Do. 2nd Deb.	[illegible]	4 12 [illegible]	My, Nov
[illegible]	[illegible]	[illegible] Elec. Supply 4½% Debs.	[illegible]	[illegible] 0 0	July
[illegible]	[illegible]	[illegible] & Kensington Bridge Ord.	[illegible]	7 0 0	Feb, Aug
St.	4%	Do. Deb. St.	[illegible]	[illegible] 1 [illegible]	Jan, July
[illegible]	[illegible]	London Electric 6% Pref.	4[illegible]	7 5 [illegible]	[illegible]
[illegible]	[illegible]	Do. Ord.	[illegible]	[illegible] 17 [illegible]	Mar, Aug
[illegible]	[illegible]	Metropolitan Elec. Supply Deb. St.	91	[illegible] 11 [illegible]	[illegible]
[illegible]	[illegible]	Notting Hill Elec. Lt. Ord.	[illegible]	5 1 [illegible]	[illegible]
St.	[illegible]	Notting Hill & Ealing E.L. 4½% Deb. St.	9[illegible]	6 0 0	Mar, Sept
[illegible]	[illegible]	Notting Hill Electric Lt. & Power 6% Pref.	9[illegible]	5 [illegible] [illegible]	Mar, Sept
[illegible]	[illegible]	Pearl Electric Supply Co. Ord.	1	[illegible] 0 0	April
[illegible]	[illegible]	South London Elec. Ord.	[illegible]	6 10 [illegible]	May

† Ex dividend or interest.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Shrs.	Dividend	Name.	Price, Tues., March 28.	Rate per cent. Yielded.	Dividend Due.
		Electricity Supply—*cont.*		£ s. d.	
5	8%	St. James' & Pall Mall Ord.	5[illegible]	6 17 8	Feb, Aug
5	7%	Do. do. Pref.	5[illegible]	6 0 3	Feb, Aug
St.	3½%	Do. do. Debs.	74	4 14 8	Jan, Dec
St.	4½%	Urban Elec. Supp. 4½% Db. St.	83	5 8 5	Apl, Oct
1	8%	Waste Heat & Gas Elec. Gen. Stations.	1[illegible]†	7 2 3	Mar, Aug
5	7%	Westminster E.S. Corp. Ord.	5½	6 7 3	Mar, Sept
5	4½%	Do. 4½% Cum. Pref.	4	5 12 6	Jan, July
		Electric Railways & Tramways.			
St.	5%	British Elec. Traction 5% Debs.	80½	6 4 3	Apl, Oct
St.	6%	Do. 6% Cum. Pref.	71[illegible]†	8 8 5	Feb, Aug
St.	4%	Central London Guar. Assented Ord.	67[illegible]	5 11 0	..
St.	4%	Do. do. Assented Def. Ord.	67[illegible]	5 18 0	..
St.	4½%	Do. 4½% Pref.	99[illegible]	4 10 3	Jan, July
St.	4%	Do. 4% Deb. St.	93[illegible]	4 5 9	Jan, July
St.	4%	City & S. London Deb.	72	5 13 11	May, Nov
St.	5%	Do. Pref. 1896	62½†	8 0 0	Feb, Aug
10	1½%	London Electric Ry. Ord.	1[illegible]	6 11 2	Jan, July
St.	4%	Do. 4% Pref.	64½†	6 3 7	Mar, Sept.
St.	4%	Do. 4% Debs.	85	4 14 4	Jan, July
St.	1%	Metropolitan Ry. Con. Ord.	23½	4 5 1	Feb, Aug
St.	3½%	Do. 3½% Pref.	77½	4 10 4	Feb, Aug
St.	3½%	Do. 3½% Convertible Pref.	74[illegible]	4 13 9	Feb, Aug
St.	3½%	Do. 3½% A Debs.	82[illegible]	4 4 6	Jan, July
St.	3½%	Do. 3½% Debs.	83[illegible]	4 4 1	Jan, July
St.	..	Metropolitan Dist. Ry. Ord.	16[illegible]	..	Feb, Aug
St.	4%	Do. 4% Prior Lien	92	4 7 0	May, Nov
St.	4½%	Do. 4½% First Pref.	70½†	6 7 8	Feb, Aug
St.	6%	Do. 6% Perp. Debs.	108½	5 10 7	Jan, July
St.	4%	Do. 4% Debs.	71½	5 12 1	Jan, July
St.	4%	Do. 4% Debs. (1903-5)	72	5 11 1	Jan, July
St.	4%	Do. 4% Guar. Stock	68½†	5 17 3	Mar, Sept
		Electric Manufacturing, &c.			
1	14%	Babcock & Wilcox Ord.	2[illegible]	5 1 10	Apl, Oct
1	6%	Do. 6% Pref.	1[illegible]	4 9 4	Apl, Oct
1	5%	Brit. Aluminium Ord.	1[illegible]	4 6 6	Mar
100	5%	Do. Prior Lien Debs.	90	5 11 1	Jan, July
1	6%	Do. 6% Pref.	[illegible]	6 12 5	Jan, July
5	15%	Brit. Insulated & Helsby Ord.	11	6 16 4	Aug, Feb
5	3/0	Do. 6% Cum. Pref.	5[illegible]	5 15 8	Jan, July
1	6%	British L.M.Ericssion Mfg. Cm.6% Pref.	[illegible]†	6 15 2	Mar, Sep
St.	4½%	British Thomson-Houston Db.	91	4 18 11	Feb, Aug
2	7½%	Brit. Westinghouse Pref.	2[illegible]	7 7 8	April
100	6%	Do. 6% Prior Lien Debs.	102[illegible]	5 17 4	Apl, Oct
St.	4%	Do. 4% Mort. Deb. St.	64[illegible]	6 4 0	Jan, July
5	15%	Callender's Cable, &c., Co. Ord.	11[illegible]	6 14 9	Jan, July
5	2/6	Do. 5% Pref.	4[illegible]	5 17 8	Feb, Aug
St.	4½%	Do. 4½% Debs.	98	4 11 10	Jun, Dec
1	6%	Dick, Kerr & Co. 6% Pref.	[illegible]	1 17 2	Sept
5	..	Edison & Swan U.Elec.Lt.A. £3 pd.	[illegible]	..	Feb, Aug
St.	4%	Do. 4% Deb.	59	5 4 3	Jun, Dec
1	6%	Elec. Construction Ord.	[illegible]	8 0 0	May
1	7%	Do. 7% Cum. Pref.	1	7 0 0	Jan, July
St.	4%	Do. 4% Debs.	72	5 11 1	Jan, July
[illegible]	10%	General Electric Ord.	10[illegible]	9 6 1	July
10	6%	Do. 6% Pref.	9[illegible]	6 2 2	Jun, Dec
5	20%	W. T. Henley's Telegh. Wks. Co. Ord.	14[illegible]	6 16 9	Feb, Aug
5	2/3	Do. 4½% Cum. Pref.	4[illegible]	4 14 9	..
St.	4½%	Do. 4½% Db.	87[illegible]	5 2 9	Jun, Dec
10	10%	India Rubber, G. P. &c., Ord.	9[illegible]	10 13 4	Feb, Aug
10	5%	Do. Pref.	7[illegible]	6 16 9	Apl, Oct
100	4%	Do. 4% Debs.	99[illegible]†	4 0 7	Apl, Oct
12	20%	Telegh. Con. & Main. Co.	34†	7 1 2	Mar, July
100	4%	Do. 4% Debs.	93	4 6 0	Jan, July
1	7½%	Vickers Ord.	1[illegible]	4 5 9	May, Aug
1	6d.	Do. 5% Pref.	[illegible]	5 10 4	May, Aug
St.	4%	Do. 1st Debs.	79	5 1 3	Jun, Dec
[illegible]	4½%	Do. 4½% 2nd Debs.	99½	4 10 5	Jan, Dec
St.	4%	Willans & Robinson B. Cum. Pref.	41	9 15 2	..
St.	4%	Do. 1st Mt. Deb. St.	50½	7 18 5	..
		Telegraphs.			
St.	30/0	Anglo American 6% Pref. Ord.	98	6 2 0	Fb,My,Aug,N
St.	1½%	Do. Def. Ord.	21½	6 17 2	Fb,My,Aug,N
St.	4%	Commercial Cable 4% Debs.	70	5 14 3	Ja,Ap,Jly,O
10	5%	Cuba Submarine Ord.	7[illegible]	6 1 8	May, Nov
10	10%	Do. 10% Pref.	12	8 6 [illegible]	..
5	5/0	Direct Spanish 10% Pref.	7[illegible]	6 13 4	..
10	4%	Direct United States	[illegible]	6 1 9	Ja,Ap,Jly,O
St.	7%	Eastern Tel. Co. Ord.	125	5 9 5	Ja,My,Jly,O
St.	17/6	Do. 3½% Pref.	63	5 9 8	Ja,My,Jly,O
St.	4%	Do. 4% Debs.	77	5 3 11	May, Nov
St.	4%	Eastern Extension Tel. Co., 4% Debs.	77	5 3 11	Feb, Aug
10	7%	Do. Ord.	12[illegible]	5 9 3	Ja, Ap, Jly,O
10	22%	Gt. Northern Tel. Co. with Coup. No. 9	34[illegible]	6 8 6	Ja, My, Jly
25	13%	India-European	4[illegible]	6 10 4	May, Nov
1	1[illegible]	Marconi's Wireless Tel. Co.	2[illegible]	4 14 1	April
1	7%	Do. 7% Pref.	1[illegible]	3 15 11	July
10	1%	West India & Panama Ord.	1[illegible]	8 18 10	May, Nov
10	6%	Do. 1st Pref.	7[illegible]	7 12 11	May, Nov
10	7%	Western Telegh. Co.	13	5 7 8	Mr, Jly,O,Dec
St.	4%	Do. 4% Deb. St.	77	5 3 11	Jun, Dec
..	4½%	Western Union 50 yr. Bds.	99[illegible]	4 10 3	May, Nov.
		Telephones.			
1	7½	Monte Video Telephone Ord.	[illegible]	6 12 5	Nov.
1	10%	Oriental Telephone Ord.	1[illegible]	5 14 3	Apl, Oct
St	4%	Do. Deb. St.	79	5 1 3	Jan, July
St.	4½%	Telephn. Co. of Egypt Db. St.	83	5 8 5	Jan, July
[illegible]	8%	United River Plate Ord.	5[illegible]	6 17 7	Apl, Oct
5	[illegible]	Do. 5% Cum. Pref.	4[illegible]	5 10 4	Jan, July
St.	4½%	Do. Deb. Stk.	84½	5 6 2	Jan, July
		Financial and Investment.			
10	6%	Globe Telegh. & Trust.	10[illegible]	5 15 0	Sp,De,Mr,Jn
10	6%	Do. 6% Pf.	10	6 0 0	Sp,De,Mr,Jn
100	5%	Mackay Companies' Common	80[illegible]	6 4 7	Ja,Ap[illegible],O
..	4%	Do. $100 Pref.	6[illegible]	5 14 9	Ja,Ap,Jly,O
100	6%	Submarine Cable Trust Certs.	124	4 16 9	Apl, Oct
		Colonial and Foreign Electric Supply, & c.			
5	3/0	Adelaide Elec. Supply 6% Pref.	4[illegible]	6 15 3	Mar, Sept
St.	5%	Do. 5% Debs.	95[illegible]	5 4 9	Jun, Dec
10	[illegible]	Bombay E. S. & T. 6% Pref.	10[illegible]	5 16 4	..
St.	4½%	Do. 4½% Debs.	87[illegible]	5 2 10	Jan, July
5	[illegible]	Calcutta E. S. Corp. Ord.	6[illegible]	7 5 5	May, Nov
5	[illegible]	Do. [illegible]% Pref.	4[illegible]	5 12 8	Mar, Sept

* And 13⅓% bonus. † Ex dividend or interest.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Mr. J. P. Kemp drives a 2-ton Edison commercial chassis to Birmingham, 140 miles, in 10 hours' running time. (Route via Luton and Rugby, to get "charged.")

* * * *



ONE HORSE POWER (AND QUITE PLENTY).
[From *Glover's Calendar.*

* * * *

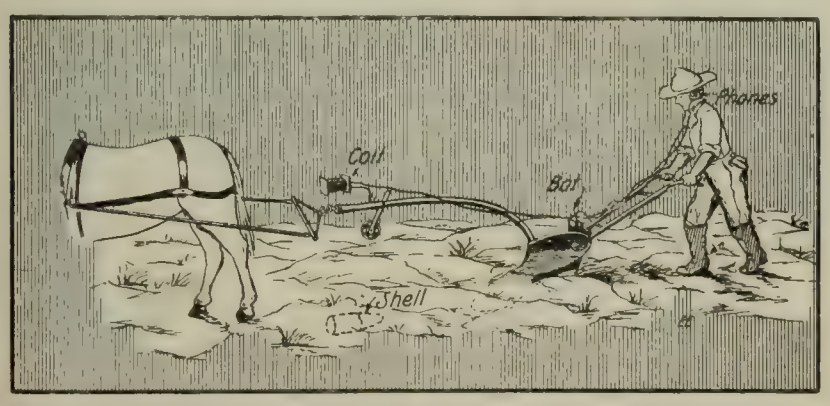
A correspondent has called our attention to the following advertisement in the For Sale column in a recent issue of the "Iron and Coal Trades Review" :—

VERY FINE 90 B.H.P. MOTOR, A.C. 3-phase,
500 volts, 590 revs., *never worked.*

The italics are ours. Evidently the motor is "very fine," but, judging by the italicised words, it must have been cut too fine.

* * * *

Our old friend the exploring coil is, judging by the illustration, to be put to a novel use. It is to be hoped that the



ploughman hears the telephone click before the ploughshare hits the nose of the buried shell!

* * * *

The answer to the correspondent who asks if the individuals, societies and organisations figuring in our unofficial Electro-Harmonic programme actually appear at the concerts is in the negative. (Unfortunately, KVA.)

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), October 12, 1878.]

At the half-yearly meeting of the Surrey Consumers' Gas Company, held on the 4th inst. . . . Mr. Storr said he did not believe a word in the electric light; but the way to meet it was to cheapen the price of gas, and thus "take the bull by the horns." If they did this they might, he said, laugh at the electric light. That it would never come into our households he was quite certain, for one could not cook by it or light up rooms. As long as coal could be got, gas could be made and he had no doubt would supersede electric light.

MECHANICAL TELEPHONE.—An improved mechanical telephone has been patented by Messrs. Schuyler S. Parsons, Francis R. Shaw and George N. Daniels, of Chatham, Centre, Ohio. This invention consists of a diaphragm of cloth or other textile fabric, mounted in an open wooden case. The transmitting wire branches out in a number of smaller wires joined to the main wire, and attached to the diaphragm. The main wire is hung to insulators made of sheepskin, placed in a frame with a central opening, the frame and sheepskin being slitted, and the latter re-inforced at the slit.

ELECTRO-HARMONIC SOCIETY.

1ST CONCERT, 30TH SEASON, 1915-1916.

Unofficial Programme.

OPENING PIECE ..."Soldiers of the King" ... ... —
ELECTRICAL ENGINEERS AT THE FRONT.

MICROMETER MEDLEY "Shell Out" ... ... —
Mr. A. H. SEABROOK.
(Chorus of London Munitions Committee.)

INSTITUTION SOLO PATHETIQUE "Sleep On" ... —
President C. P. SPARKS.

"C.T.S." MELANGE "Brookings Bust-ling Belles Bathing Backtyre Blisters" —
(The Audience may assist.)

DIRGE ... "Always Merry and Bright" ... —
Mr. C. H. WORDINGHAM.

SHRAPNEL REVUE ... "Kill that Fly" ... ... —
ANTI-AIRCRAFT CORPS.

SINTERED DUET "'E can't take a roise out of 'Oi"... —
POPE AND OSRAM.
(Chorus of Expert Witnesses.)

FREE TRADE CHOIR "The Yankee Shuffle" ... ... —
AMERICAN IMPORTERS.

NON-TREATING CHORUS "Drink to me only with thine eyes" —
ELECTRICAL SALESMEN.

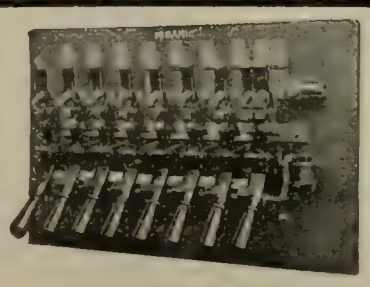
GAITER DUET "I didn't want to do it" ... ... —
ANY LADY CONDUCTOR.
ANY TRAMWAY MANAGER.

GOD SAVE THE KING.

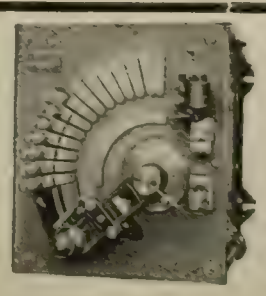
THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. G. W. Spencer Harries (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparks (W. Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).

No. 10G. — Foolproof Starter for large motors, a succession of circuit breaker type switches that can only be closed in the correct order. They are all magnetically held in the running position, but are released by overloads or voltage failure.



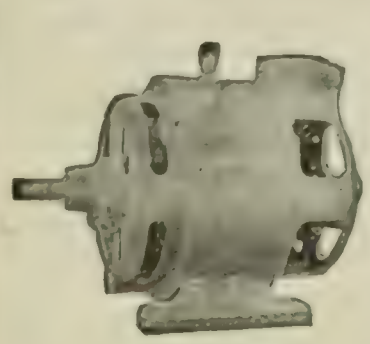
'IGRANIC'
DIRECT CURRENT STARTERS.
IGRANIC ELECTRIC CO., LTD.,
147, Queen Victoria St., London.



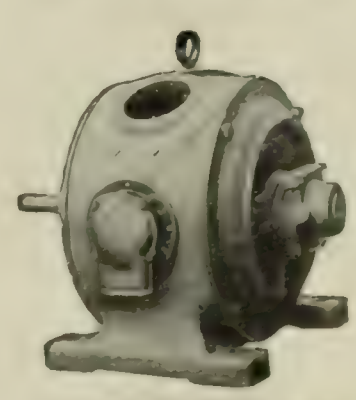
No. 10A.—Heavy Duty Motor Starting Switch for arduous service. Large renewable contacts, ample auxiliary carbon contacts, every part more robust, both mechanically and electrically, than ordinary service requires. No-volt release always, overload release when desired.

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"REVO" ELECTRIC FIRES.

Yet another of the already fairly large number of electric fires has now been added to by a range of fires known under the above



The "Elite Revo" Fire.

trade name. The fire is built up of a cast or sheet metal frame, to which the requisite number of element bars are suitably attached. The element is of the solid fireclay bar type of special shape: it is grooved with a ridge in the centre, this latter being grooved to receive the spiral element and retain it in position opposite the notched outer edges of the bar into which the element is also dropped. A rod passes into the ridge or thickened portion of the bar, and the ends of the wire are secured so as to furnish terminals and also supports in the frame of the fire. We understand that a spring device is fitted which takes up contraction and expansion in the element. The concave shape of the fire bar tends to act as a reflector for the heat given off by the element, so that no metal reflector is needed,

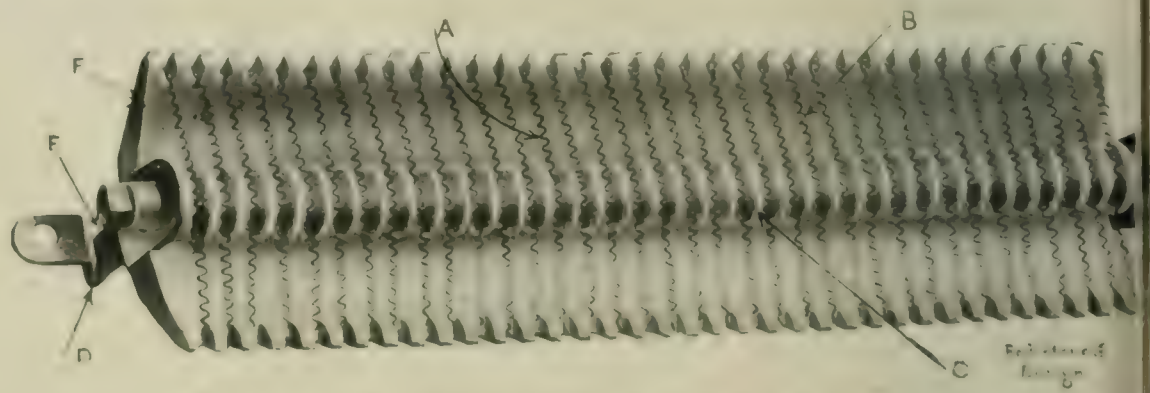


The "Popular" Revo Fire.

practically the whole length of the heating element being at the front of the supporting firebar.

This fire is being made by the Cable Accessories Co., Tipton, and from a newly-published list we understand that the elements are guaranteed three years. The "Revo" fires are also offered in a number of designs, which range from the inexpensive to the medium priced fires.

It cannot be said that any of the prices are on the high side. As is usual, various classes of finish are offered, though it is now understood that the customer does not mind paying a little more for



Detailed View of "Revo" Fire Bar.

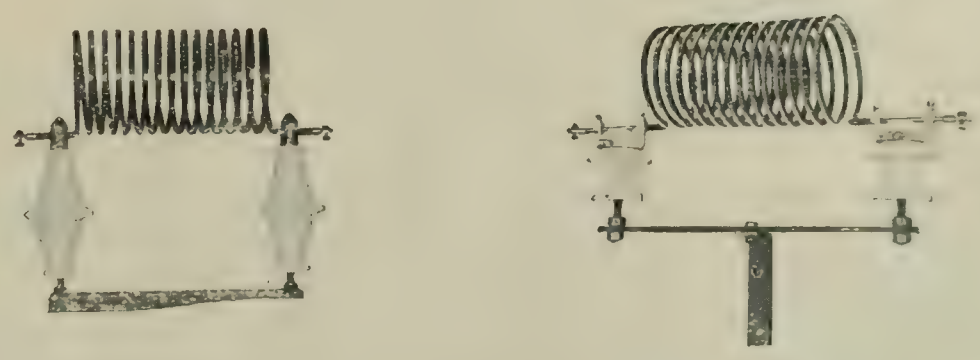
embellishments. The standard ratings are 2 kw., 2½ kw. and 3 kw., with two-heat control. The "Popular" fire measures 16¼ in. wide by 18½ in. high by 5½ in. deep and weighs 16 lb.

PORTABLE D.C. TESTING SET.

The Crompton testing set described in leaflet No. 526 has been designed to make wide ranges of current and voltage measurements in a convenient and accurate manner. The set is mounted in a light and strong oak case, which permits convenient and ready handling. It comprises a moving coil instrument which can be used either as a voltmeter in conjunction with series resistances contained in the instrument, or as an amperemeter in conjunction with a set of shunts. A selector switch is used for coupling the instrument as an amperemeter or as a voltmeter, as required. The voltage range is altered

The Electric & General Works, Ltd

15, Victoria Street, London, S. W.



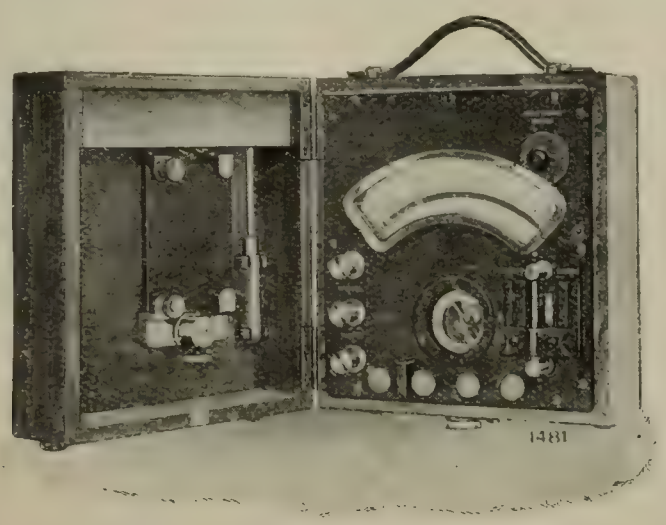
Iron Choke Coils for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC LONDON."**

by means of a switch, actuated by pulling out a small knob, which is so arranged that on closing the case this switch is automatically set to the highest range. This device protects the instrument against the risk of applying a high voltage to a low voltage range.

The shunts are constructed of manganin, and the makers claim that thermo-electric troubles arising from differences in temperature



Crompton Portable Instrument, Open.

at the shunt ends are practically eliminated. The instrument is magnetically shielded, and is adjusted to a definite resistance and degree of sensibility, and without its shunts or resistances forms a milliamperemeter reading up to 15 milliamperes, and a millivoltmeter reading up to 75 millivolts. The shunts are also adjusted as standard resistances, and can be replaced, or shunts of other capacities supplied, without the necessity of returning the instrument to the makers' works. The scale of the indicator is marked 0-15 and is divided into 150 parts.

The shunts are marked with their maximum currents, which respectively produce full deflection upon the instrument. The voltmeter range switch indicates for each position the voltage which produces full deflection, and the actual reading in amperes or volts is obtained by multiplying the indicator reading by a simple factor. Any slight change of zero which may take place can be corrected by a simple adjustment outside the case. Additional shunts with convenient terminals can be supplied, and they can be fitted in portable oak cases to match the set.

The electrical data below make it possible for tests to be taken on high and low resistances. High resistances can be compared with the known resistance of any of the volt ranges by observing the reduction of deflection when they are put in series with the instrument used as a voltmeter.

Resistance of the 3 volt range	.....	200	ohms
30 ,,	.....	2,000	,,
150 ,,	.....	10,000	,,
300 ,,	.....	20,000	,,
600 ,,	.....	40,000	,,
150 ampere shunt		0·0005	ohm

Resistance of the 300 ampere shunt		0·00025	ohm
500	,, ...	0·000125	,,
900	,, ...	0·00008333	,,
1,200	,, ...	0·0000625	,,
1,500	,, ...	0·00005	,,
2,000	,, ...	0·0000375	,,
2,250	,, ...	0·0000333	,,

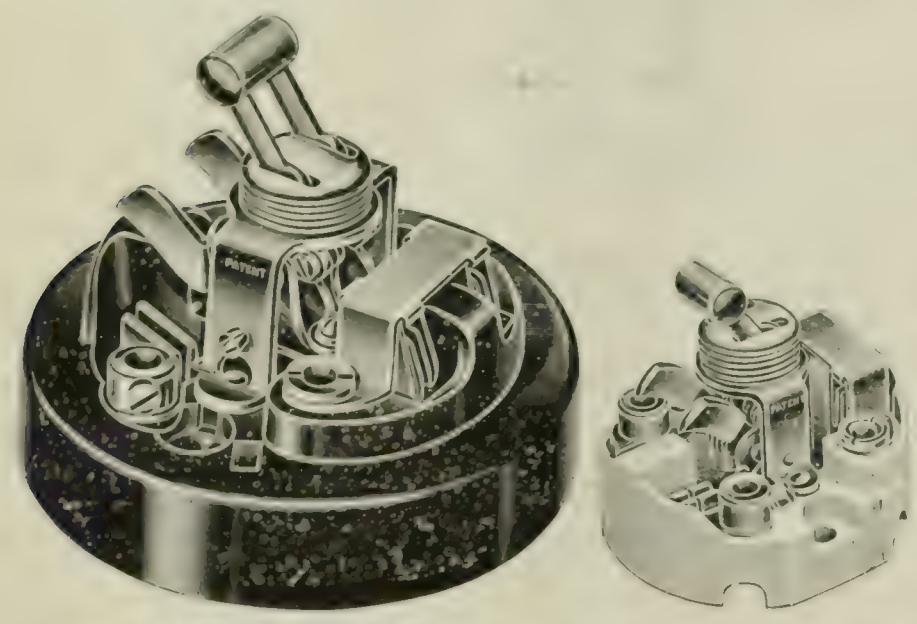
Low resistances can be compared with the amperemeter shunts by passing a current through the unknown resistance and a shunt in series, and comparing the drop in volts. Prices and further details can be obtained from the leaflet referred to. A copy will be sent on application to Crompton & Co., Chelmsford.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37. NOBLE STREET. LONDON. E.C.

SINGLE-WAY TUMBLER SWITCHES WITH QUADRUPLE BREAK.

The standard "Pivot" single-way tumbler switch made by Messrs. A. P. Lundberg & Sons, of 477-489, Liverpool-road, London, N., has an independent quick-break action, and the advantages of this construction will, we feel sure, be obvious. For tumbler-switch circuits where there is liability of somewhat excessive spark-wear due to high voltage or heavy current or to both, or to the inductance of heating apparatus, small motors, &c., the new Lundberg "Quadbreak" switch illustrated in Figs. 1 and 2 is likely to meet a distinct demand. At first sight this switch appears to be identical with the single-tumbler D.P. switch noticed a few weeks ago in our columns, but there are essential differences in construction.



FIGS. 1 AND 2.—SURFACE AND FLUSH PATTERNS OF QUADRUPLE BREAK SWITCHES.

The "Quadbreak" switch—as its name implies—has four breaks in its circuit; and it is clearly twice as effective as the ordinary double-break switch. Its normal limit of voltage is 250. Its effectiveness has, we understand, been amply proved by tests, and it will easily deal with more than 50 per cent. increase over its rated current capacity if the circuit be not highly inductive. If the nominal current be reduced, the switch may be used on circuits at proportionately increased voltages up to 400.

Fig. 1 shows the 10-ampere size of surface-pattern "Quadbreak" switch, there being also a 5-ampere size. Fig. 2 shows the flush pattern, which is made for 5 amperes only. Both figures are two-thirds the actual size, and the flush or small base pattern is for use in the surface or flush conduit boxes used in the various modern systems of wiring.

It need hardly be said that the construction of these switches shows that careful attention to details which we have always emphasised as being characteristic of Messrs. Lundberg's accessories. The service work which is nowadays put on tumbler switches is often very heavy, and the switches just described are, we gather, especially adapted to cope with it. They should consequently meet with general approval and use.

PARDONED MURDERER AND ELECTRICAL DEVELOPMENT.

The following interesting article has been sent in to us by the Electric Vehicle Association of America:—

"Last week was one of many bewildering surprises for George Cram, 86 years old, who has recently been pardoned by Governor Whitman, of New York, and released from Sing Sing prison for good conduct after 21 years of imprisonment. It was a new world that Cram found when he landed in New York City. Twenty-one years had wrought a considerable change, probably the greatest one being the tremendous advance made in electricity, and its many appliances. The Society for Electrical Development, which is developing many unique plans for Electrical Prosperity Week, November 29 to December 4, thought it would be rather interesting to reveal to this man for the first time some of the wonders of electricity. With the assistance of the Electric Vehicle Association of America, Cram was taken on a little tour of inspection accompanied by the Goddess Electra (otherwise Miss Doris Easton), who carried him off in her electric vehicle to the Grand Central Terminal where she showed him the wonders of the electric locomotive, electric trucks and the hundreds of electric baggage carriers used in the Terminal. An electrically-prepared luncheon at the McAlpin Hotel was a revelation in modern methods of cooking. Of all the interesting devices which he saw, Cram seems to have been most interested in the electric vehicle. He was evidently mystified by the ease with which it glided smoothly in and out of the conjested traffic along Fifth Avenue. He marvelled at its instant response to the driver's touch, and at the small amount of effort required to control it. As the old man remarked 'the world do move,' and if he were in a position to own an automobile, it certainly would be an electric."



The steamer "Eastland" as she appeared in June, 1914. On July 24, 1915, she turned over on her side in the Chicago River when crowded with holiday passengers, employees of the Western Electric Co., Hawthorne Works, Chicago. (See p. 31.)

POPE
Elasta
British Made Wire
Lamps

What Lamps are You Selling?

HUNDREDS OF ENTERPRISING CONTRACTORS ARE MAKING FINE PROFITS AND BUILDING A GOOD BUSINESS BY CENTRING ON

ELASTA

BRITISH MADE WIRE LAMPS.

Isn't it time you made some enquiries?

THE LAMP WITH A LIVING IN IT

Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps. Hythe Road, Willesden, N.W.

CARRON ELECTRIC FIRES HAVE CAUGHT THE MARKET.

By Appointment.

Electrical Contractors and Engineers find them a profitable line to handle because no arguments are needed to affect a sale—the public are so familiar with their merits. The tasteful designs—the ruddy "fire-like" glow—the reliable elements—the skilful construction and the refined workmanship and finish all go to account for the popularity of Carron Electric Fires.

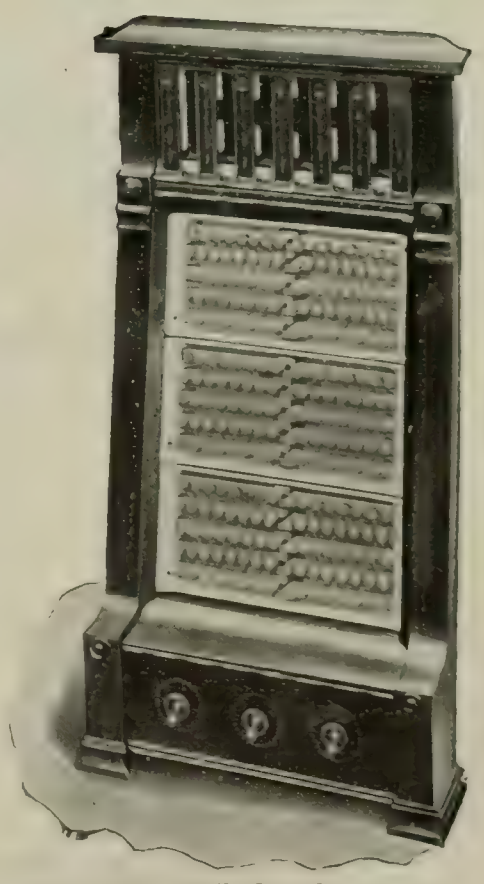
No. 226 Fire is strong, portable, and well designed and fitted with the latest Carron heating elements and switches. A guard and earthing terminal are provided. Size 15½ × 25½"—Loading 3,000 or 3,500 Watts. No. 228 Fire, strongly constructed and arranged for three heating elements, three heat control, and having a trivet or fall-down shelf at top.

Made of fine cast-iron and supplied in a variety of finishes. Whether in armour bright or electro-plate finishes, such as brass, copper, or cymric (a new Carron finish resembling armour bright, but rust proof), this fire is a distinct addition to the furnishing of a room. Size 15¼ × 27½"—Loading 3,000 or 3,500 Watts. Complete with Guard.



No. 226 FIRE (Regd. Design).

CARRON ELECTRIC FIRES



No. 228 FIRE (Regd. Design).

Write for the Company's Illustrated Catalogue, which contains full particulars and will be sent free on request.

CARRON COMPANY
INCORPORATED BY ROYAL CHARTER

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Showrooms: London (City)—15, Upper Thames Street, E.C.; (West End)—50, Berners Street, Oxford Street, W.; Liverpool—20-30, Redcross Street; Manchester—24, Brazennose Street; Glasgow—125, Buchanan Street; Edinburgh—114, George Street; Bristol—6, Victoria Street; Newcastle-on-Tyne—13, Prudhoe Street; Birmingham—218, 220, 222, Corporation Street; Dublin—44, Grafton Street.

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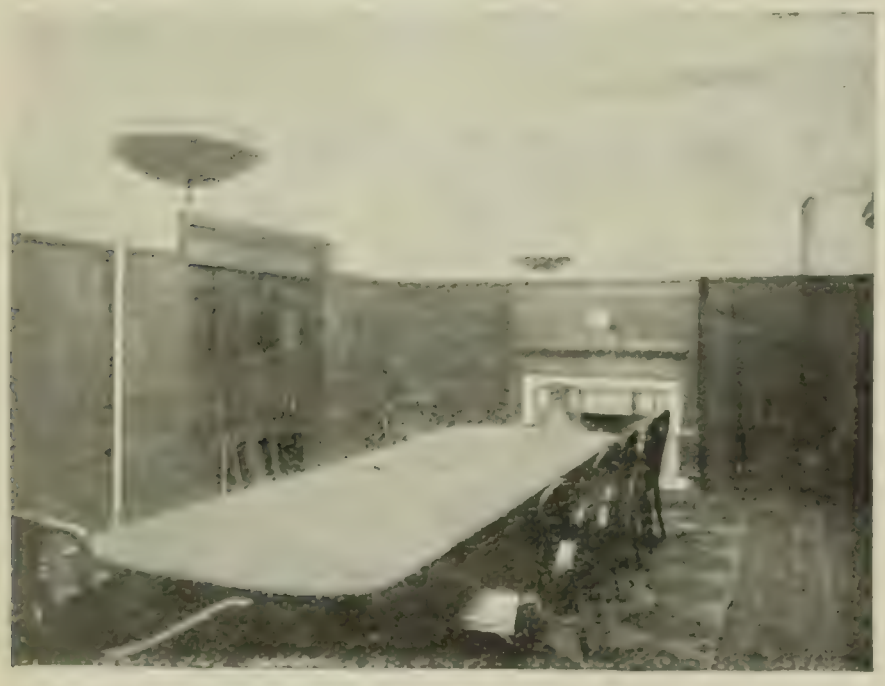
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LIGHTING EFFICIENCY IN THE OFFICE.

As a result of extensive investigations, an authoritative medical association has arrived at the definite conclusion that electric lighting on the "indirect" principle is better than any other system of artificial lighting and almost as good as the best daylight illumination in respect of permitting continuous working with minimum loss of eye-efficiency. Good daylight illumination and indirect artificial lighting alike permit the eye to work for hours at a stretch without any important loss of efficiency. This is the case over a wide range of illumination, whereas, with all other lighting systems fatigue is more or less rapid at all intensities of lighting.

Though it is virtually impossible to convey photographically an accurate impression of the full merits of a lighting scheme, the accompanying illustrations are chosen as typical of the results obtained by the British Thomson-Houston Co.'s "Eye-Rest" indirect lighting system in West African House, Kingsway. The whole of the building, including the ground-floor Recruiting Office, is lighted throughout on the indirect principle by Mazda lamps in some 120 "Eye-rest" fittings. Part of the ground floor is occupied by Martin's Bank, and here the illumination provided is obviously up to a high standard of quality and uniformity. So also are the requirements of efficient working and efficient supervision met by the lighting provided in the general offices of Messrs. Millers (Ltd.). In the bank oxidised silver metal fittings are used.

The wiring in West African House was already installed before the details of the illuminating scheme had been determined, and it was unfortunately arranged that all the lights in each room were turned on and off by a single switch. To overcome the inflexibility thus imposed upon the lighting system, an interesting innovation has been made by providing a three-way pull chain switch in each lighting bowl where required. The pull chain, which constitutes a



Board Room.

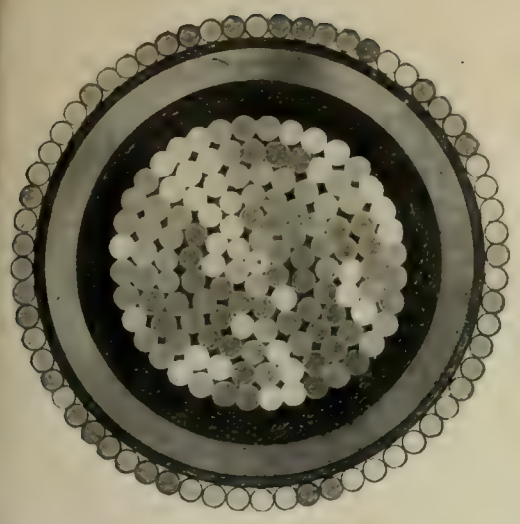


Secretary's Office.





View of the General Office Lighting.
The chains suspended from the fittings are used to actuate the three-way switches.



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perfectly unobtrusive addition to the fitting, permits flexible lighting from each bowl or permits all the lamps therein to be extinguished, as may be desired.

In the secretary's office and agent's office a single "Eye-rest" fitting in each case with Mazda lamps and X-ray reflectors is used. In harmony with the furnishing of the board room are two handsome "Eye rest" fittings. Both lighting units being always required when the room is occupied after dark, two separate pull chain control switches are provided in this instance. We are informed that all the illustrations are reproduced from untouched photographs taken by the unaided light of the lamps installed. They give a good, though not entirely adequate, representation of the admirable diffusion and quality of lighting obtained all over the working plane.

A NEW INSULATOR CLIP.

The "Stirrup" clip illustrated herewith provides a simple and efficient means of attaching overhead conductors to insulators.

The clip is rapidly fixed without the necessity for specially skilled labour; in fact, it requires no special tools, but merely a screw driver or pocket wrench. It may, therefore, be readily detached and used again.

In clips of this nature it is necessary that the means of attachment be of the same metal as the conductor, in order to obviate electrolytic or corrosive action. Up to the time of the introduction of the "Stirrup" clip, clamps were usually made of cast metal. This method has two obvious objections: The large amount of metal makes the cost excessive; rigid castings prevent the passing on of vibrations in the line set up by wind, and so induce crystallisation of the conductor at the point of fixing. In the clip shown, however, adequate strength is obtained by using strip metal having a considerably higher tensile strength than cast metal. In consequence less metal is required, thus the cost is brought within commercial limits, and the clip has a degree of flexibility sufficient to obviate crystallisation of the conductor. We understand that this is proved by the results of inspection of clips which have been long in use in exposed positions, especially where the atmospheric conditions are deleterious. We also gather that in no case has corrosion of the clip or crystallisation of the conductor been discovered.

The clips are used in this country on the transmission lines of the Scottish Central Electric Power Co., Edmundson's Electricity Corpn. (Ltd.), the Lancashire Electric Power Co., the Lancashire & Yorkshire Railway Co., and also on many transmission lines abroad.

They are made by Bullers Limited, Tipton, Staffs, who inform us that their pressing tools have been improved and standardised, and



THE "STIRRUP" INSULATOR CLIP.

that "Stirrup" clips can, therefore, be made to suit all insulators and all sizes of conductors without additional tools. The latter fact enables the company to give quick deliveries. A pamphlet, giving prices and particulars, can be obtained from the company on request.

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THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The disappearance of the "What'llers" and the "Mine-sers."

* * * *

The lamp shown in the illustration has its pip firmly embedded in the top of an oak table. Around it are lying the pieces of the shattered opal shade, which formerly distributed the light of the lamp over the "working plane." Only the



shade and the "working plane" seem to have suffered, for when the lamp was put on circuit it lighted up. It was, and still is, an Osram.

* * * *



OLD LADY: "COME ALONG, FIDO, YOU'LL BE GETTING IN THOSE GENTLEMEN'S WAY." [From *Glover's Calendar.*

We hear from one of our advertisers in the metal trade that the labour scarcity has compelled him to employ boys. He says that four boys are equal to one man, and he is prepared to effect an exchange on this basis.

There is a boom in electric fires just now. The number of makers is being rapidly increased. Very soon the gas fire makers will get restless and will start competing by building their own fires, electric ones, of course. Mr. Goodenough will see to that!

* * * *

In the front showroom window of a firm of gas-cooker manufacturers in London is a specimen cooker with the oven door open; on the hook inside is a sirloin of beef, "done to a turn." On closer examination, coupled with the fact that the joint is always there, it proves to be a wooden dummy. Small wonder at the poster in the window, immediately in front of this display, "Take up the Sword of Justice."

* * * *

At the First Electro-Harmonic Concert, on Friday last (*see* p. 16), Mr. W. J. Tennant, who was in the chair, said, amongst other things, that the programmes had been shortened owing to the difficulties of getting home in these times. The remark was received with a titter by the old and regular members who failed to distinguish between the difficulties of getting home in former times and "in these times."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), October 19, 1878.]

SHOREDITCH.—Shoreditch being sweetness and light, the Vestry are going to illuminate the ratepayers with electricity, and say, as Macbeth did, "Out, brief gas!" St. Leonards, Shoreditch, means to cry, "After me, whoever likes can be first."—*Metropolitan.*

AMERICA *v.* ENGLAND.—One of the great characteristics of the Americans is the eagerness they show to adopt the hundreds of minor inventions calculated to save daily labour, and add to the comfort of the house. In visiting the Paris Exhibition we were amazed to see the numberless ingenious devices for household purposes. It seems, again, that they employ electricity in a hundred different ways unknown here. The matron has a motor to run her sewing machine, the grocer to turn his coffee mill, the dentist to aid in his work, and so on. We are informed that an attempt is being made to introduce one of these simple and inexpensive motors into England, and trust the event may be successful.

FOOTBALL BY ELECTRIC LIGHT.—The intense interest aroused by the application of the electric light to novel uses was strikingly apparent on Monday night in Sheffield, when nearly 30,000 people gathered at Bramwell-lane Grounds to witness a football match played under that light. The match, which was played by two teams belonging to the Sheffield Football Association, commenced at 7:30. The electric light was thrown from four lamps 30 ft. from the ground, and the rays, which were of great brilliancy, lighted nearly the whole of the ground, the players being seen almost as clearly as at noonday. The brilliancy of the light, however, dazzled the players, and sometimes caused strange blunders. The illuminating power was equal to 8,000 standard candles.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).	Mr. W. G. Pickvance (Wrexham).
Mr. H. F. Street (Southampton).	Mr. H. Gray (Accrington).
Mr. W. H. Cooke (Luton).	Mr. S. E. Fedden (Sheffield).
Mr. T. Roles (Bradford).	Mr. J. W. Sparks (W. Hartlepool).
Mr. A. S. Blackman (Sunderland).	Mr. J. W. Beauchamp (West Ham).
Mr. C. S. Davidson (Barnes).	Mr. A. H. Shaw (Ilford).
Mr. A. H. Seabrook (St. Marylebone).	Mr. C. Furness (Blackpool).
Mr. G. W. Spencer Hawes (Reading).	Mr. C. M. Shaw (Worcester).
Mr. J. W. Hame (York).	Mr. H. A. Nevill (Wakefield)
Mr. S. T. Allen (Wolverhampton).	Mr. Frank Ayton (Ipswich).
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	Mr. S. E. Britton (Chester).

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SIEMENS

ELECTRIC MOTORS

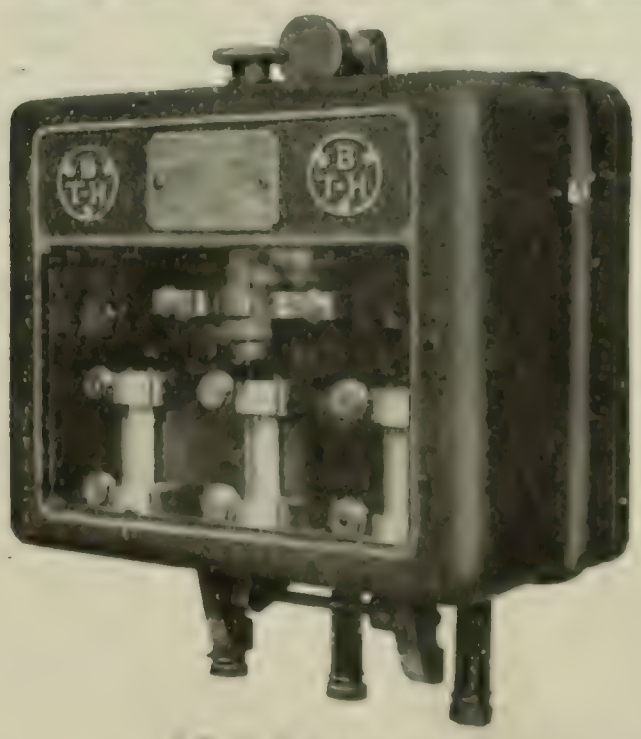


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GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

A.C. AND D.C. OVERLOAD RELAYS.

We gather from pri e list No. 4,401—B that the British Thomson-Houston Co.'s overload relays are of simple design, compact, sensitive, and require but little power for operation. They are self-contained and arranged for mounting directly on switchboard



B.T. H. RELAY CLOSED.

panels from 1¼ in. to 2 in. thick. The covers are also arranged so that easy access can be obtained to all parts of the relay. All the parts are of neat appearance and are of substantial construction.

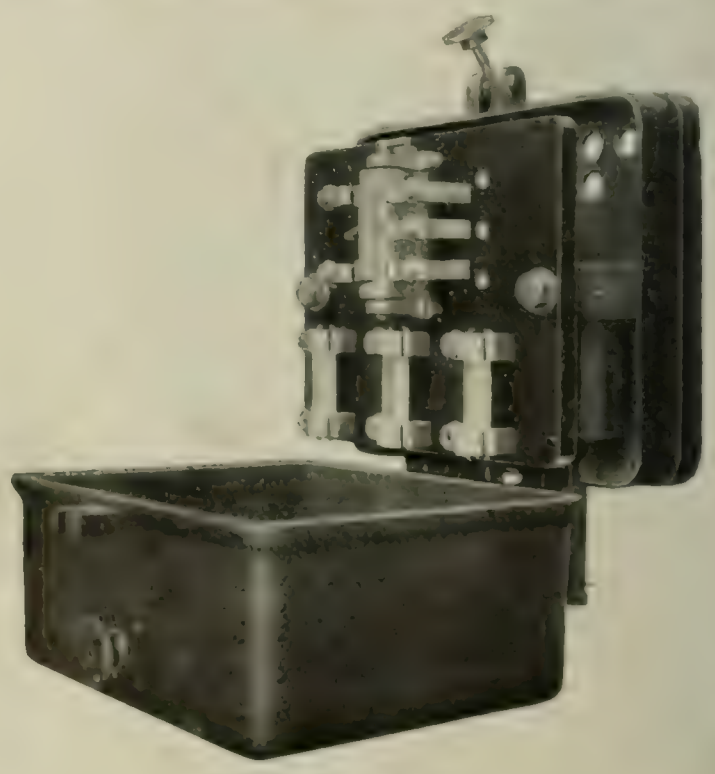
The type S, form H, relay operates on excess current and may be employed for overload or leakage protection. The coils are furnished with external terminals for back connection, and the contacts for controlling tripping circuits together with their terminals are totally enclosed, thus avoiding the danger of the trip coil being excited by accidental short circuit of the relay terminals. The contacts are of a somewhat novel type, giving positive action free from chatter and independent of the force exerted on the plungers. They are self cleaning and will handle heavy currents without burning.

The relay has an iron casing, the body of which is designed to form the magnetic circuit for the solenoids and the support for the base carrying the contacts and time limit fuses. A dust-proof metal cover is hinged to this casing and is fitted with a glazed opening. Two sets of fixed spring contacts are mounted on an enamelled slate base, on which is also mounted a spring-actuated drum carrying the moving contact. The drum is held in the "off" position by a catch which is released by the plungers when they are pulled up in the solenoids on a predetermined current being exceeded. When the catch is released the drum is turned into the "on" position by the positive action of the spring.

The two sets of fixed contacts are arranged so as to be bridged by the moving contact in the "on" and "off" positions, and the relay may thus be used for breaking circuit, making circuit, or for both purposes. An additional contact can also be provided, so that two independent circuits may be closed. The latter design has five fixed contacts, and the former four fixed contacts. The position of the moving contact gives a clear indication when the relay has operated, thus showing what has been the cause of tripping the oil switch. The moving contact is reset by hand by means of a knob on the outside of the case. The current settings can be adjusted by means of milled nuts at the bottoms of the tubes carrying the plungers. The tubes are clearly graduated and the adjustment is self-locking. All exposed current-carrying parts are finished in polished copper and hot lacquered. The frames and covers are finished dull black with polished copper facings, giving the relay a neat and attractive appearance.

The windings are designed for connecting in the secondary circuits of instrument transformers on alternating-current circuits. The standard relay for overload protection is fitted with coils wound to carry 5 amperes continuously and to operate over a range of 4 to 15 amperes. The standard coils for leakage trip are wound to carry 1 ampere continuously and calibrated to operate over a range of 0·5 to 3 amperes. Other windings can be furnished if required. Special care has been taken in the design of these relays so as to minimise the volt-ampere load imposed on the current transformers, thus permitting the use of relays and instruments on the same current transformers. The maximum volt-amperes taken by the standard over-load coil is 10 volt-amperes at 5-ampere load. The standard coil for leakage trip takes 13 volt-amperes at 1-ampere load.

The action of the relays is delayed by the provision of time limit fuses connected in shunt to the trip coils. These fuses give an inverse time characteristic adapted to a wide range of service conditions. The current and time settings are adjusted by the selection of suitable fuses. The settings obtainable are clearly shown by the



B.T.-H. RELAY OPEN.

curves published in the price list. For example, if a 6-ampere fuse be used on a circuit such that 4 amperes corresponds to the full load current, the curves show that the oil switch will be tripped in 7½ seconds on twice full load current—*i.e.*, 8 amperes. With a current equal to four times full-load, the relay will operate in 1½ seconds, whilst on 10 times full-load the action will be practically instantaneous. The price list in question can be obtained from the B.T. H., Rugby.

OSRAM-ROBERTSON RED CROSS VAN.

The illustration herewith shows the ambulance van presented to the St. John's Ambulance Association by the Osram-Robertson Lamp Works (Ltd.) This van is designed to carry eight patients,

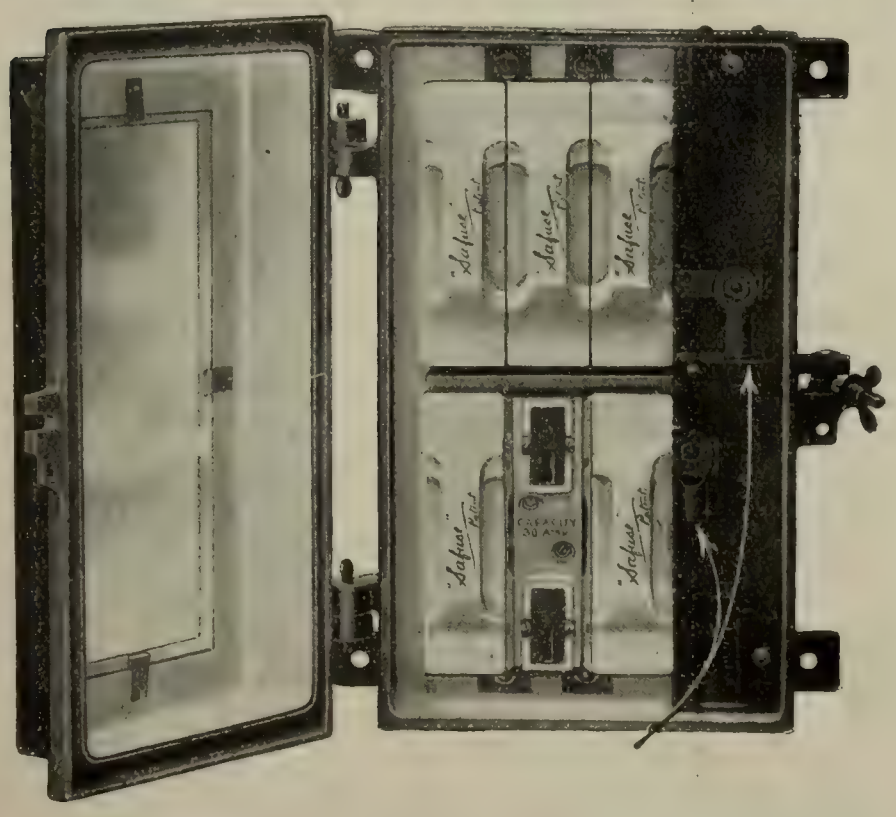


Osram-Robertson Red Cross Van.

the driver and an attendant, and the design of every detail of the equipment conforms to the latest and best practice. The van was photographed outside the Osram-Robertson Lamp Works at Hammersmith, but it is now doing valuable work on active service.

THE "SAFUSE" SYSTEM.

A system of safety fuses was brought out some time ago to comply with the Home Office rules for the use of electricity in non-textile factories for E.M.F.'s up to 500 volts by Donovan & Co. With this system all live parts are protected when the fuse bridge is in position, and equally so if all the fuse bridges are removed. Engineers in charge of power plants realise that the most likely time for an accident to happen at a fuseboard is when a fuse must be replaced, and therefore it is important that live parts should be protected when the bridge is out more than at any other time.



Safuse Board, showing Detail of End Cable Connections.

The blades attached to the "Safuse" bridge pass through narrow slots into the base, so that it is impossible for the hand or finger to touch any live part. In all sizes the fuse wire passes through a stout asbestos tube, and this tube can be easily and quickly replaced should it be burnt owing to repeated blowing of the fuse. The makers draw attention to the ease with which fuse wire can be renewed. Instead of the operator having to lift up a number of washers to pass the wire



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round the screws, in the "Safuse" the wires are gently pulled round and, owing to the bevel on the washers, the wire almost finds its own way round, and all that is needed is to tighten the screw.

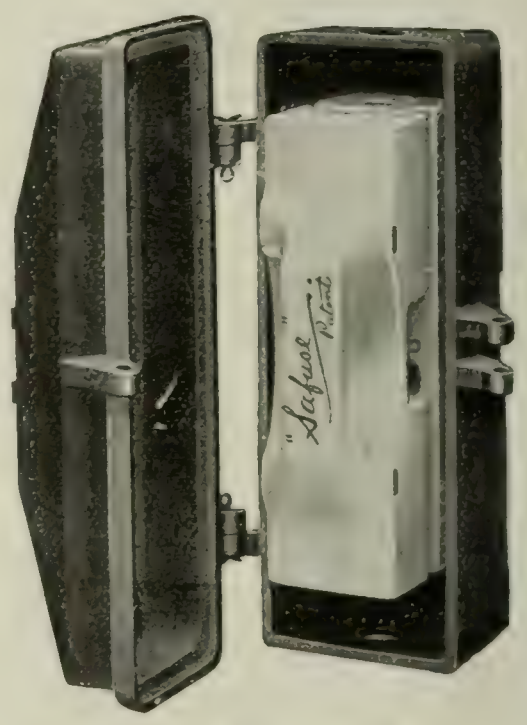
The contact surface area between the bridge finger and the base clip is large, the current density varying between 25 and 50 amperes



Back View of Safuse Fuse

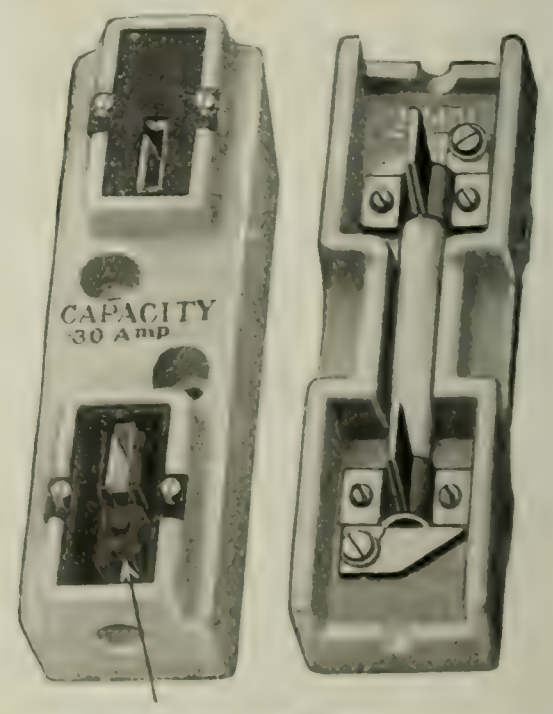
per square inch, and special stress is laid on the method of ensuring a good connection between the base clip and the terminal block. The clip is bolted under a nut and screwed up tightly before it is placed in the china base. Unnecessary heavy pressure between the two, and a separate nut is used for bolting the pin to the base, thus nut only exerting sufficient pressure to hold the fitting in position. The larger sizes are fitted with cable sockets which can be tightened up in a few seconds, as they are fitted into standard reamered holes.

The fuse units are made up in three types: "2xBB" for use on switchboards where the pins are required to go through the board for connection at the back; type "BBC" for use in fuseboards for connection at one end to a 'bus-bar, and the other end to a circuit cable; type "2xC" for positions where a circuit cable is run into each end. The main lugs and 'bus-bars are covered with a shield, because it is necessary that provision should be made to take off the



S.P. Safuse in Iron Box.

main lugs from the front for testing purposes, without disturbing the interior of the fuseboards. This cannot be done in power boards if the main lug is at the back of the fuses. It should be noted that there is a large amount of space at the back of the boards, allowing clearance for circuit wires to pass behind. This is especially noticeable in the illustration showing a 6-way 100 ampere D.P. board, where not only is ample room provided, but owing to the fact that large cable is used the lower pole is made to project further from the wall than the upper pole, thus allowing the wires to pass straight from the conduit to the fuse ways without a bend. To any engineer



Detail of Safuse.

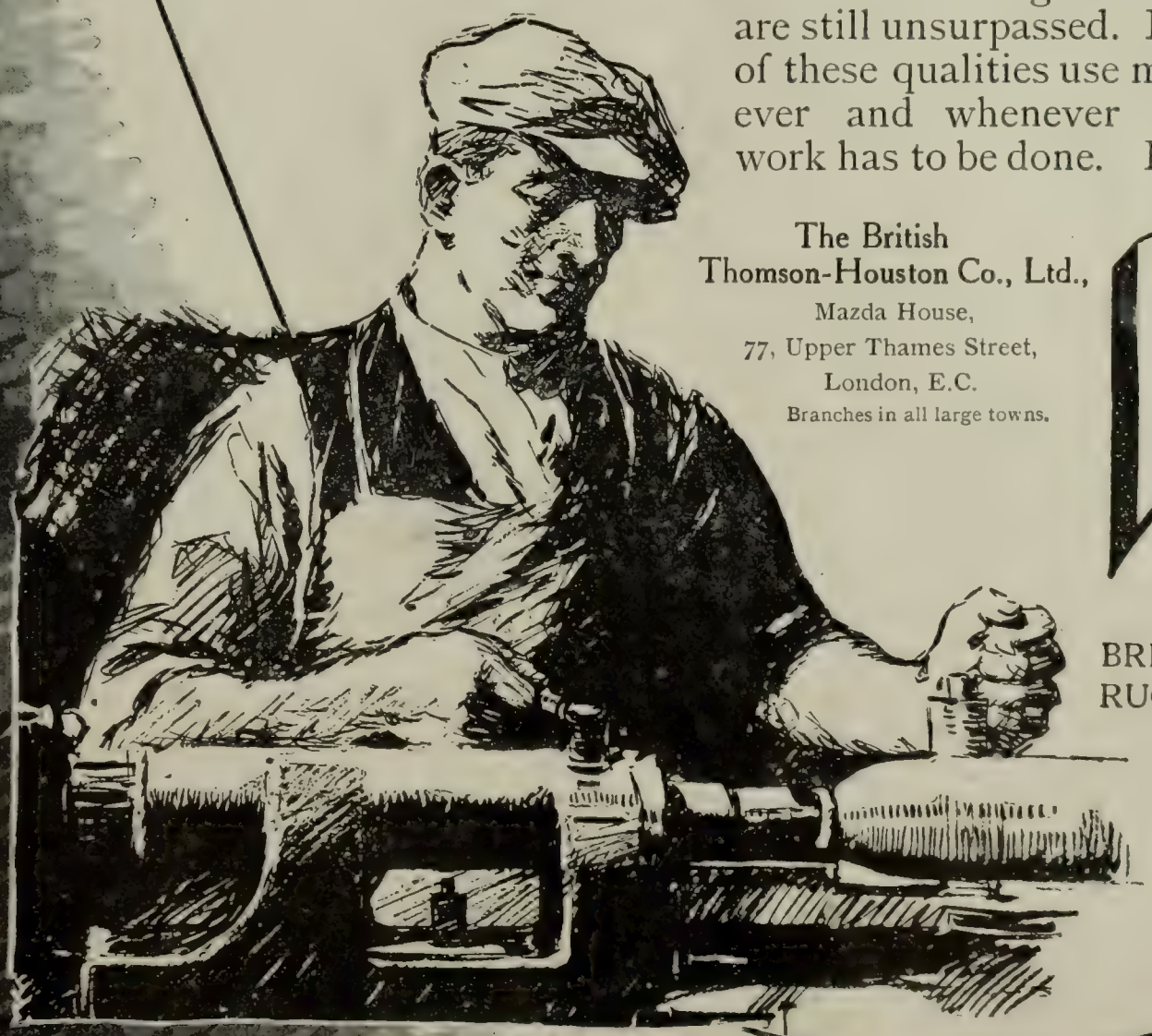
who is responsible for the continuous running of plant, these fuses should give a feeling of security; and they should appeal to the buyer who is more anxious to install a fuse which shall be safe and reliable than to save a small sum which after all can only be a small percentage of the total cost of an installation. "Safuses" are made in the following sizes:—

Maximum current	15	30	60	100	200
" volts	250	500	500	500	500

A neat bulletin describing these fuses has been issued by the makers, Donovan & Co., Cornwall-street, Birmingham.

War Work

Good lighting was never more important than in these stirring "24-working-hours-a-day" times. All over the country huge factories are engaged, without ceasing, on war work—there is no night for them—thanks to artificial light. I'm Mazda, and I am turning night into day in hundreds of factories—shedding my light that many thousands of workers may perform their urgent work expeditiously and well. The vibration of the heavy machinery perturbs me not—the drawn wire filament which I possess, and which I invented, makes me strong. My wonderful economy and outstanding brilliancy are still unsurpassed. Because of these qualities use me where-ever and whenever important work has to be done. I'm Mazda.



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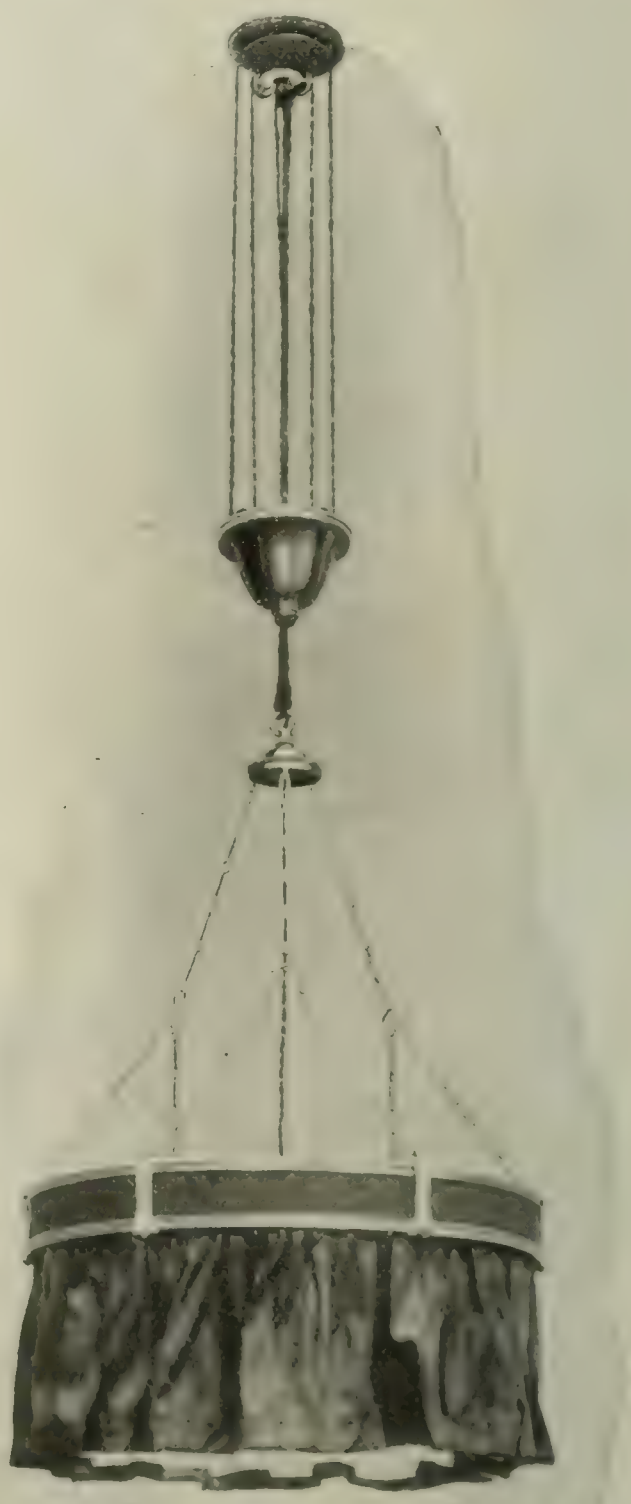
"EDISWAN" FITTINGS CATALOGUE.

The installation and contracting section of the industry will, we feel sure, welcome the new bound copy of the Edison & Swan Co.'s artistic fittings catalogue. This comprises catalogue section VI. of the company's main list. It is a publication of nearly 200 pages, printed on art paper, and containing illustrations and prices of a wide range of fittings. The designs include pendants for billiards



Artistic Wall Bracket.

rooms and bedrooms, brackets in the Adam, Georgian and Louis XV. styles, convertible bracket standards and ceiling fittings. There is a considerable choice of electroliers in Sheraton, Flemish, Georgian and Adam styles. Fancy brackets, newel pillars, piano and reading lamps, balustrade standards, and hall and vestibule lanterns: the latter are offered either plain or in the Queen Anne or Louis XVI. styles. The illuminating engineer will be interested in the designs of indirect and semi-indirect fittings, and also in the many tasteful designs of shades. We cannot do full justice to this admirable production in the space of a short notice, but we feel sure that those of



Ediswan Adjustable Pendant.

our readers who are interested in raising the standard of the design of electric light fittings will make themselves acquainted with Ediswan ideas on the subject. The vogue of the high candle-power and half watt lamps should lend exceptional interest to the semi-indirect

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Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

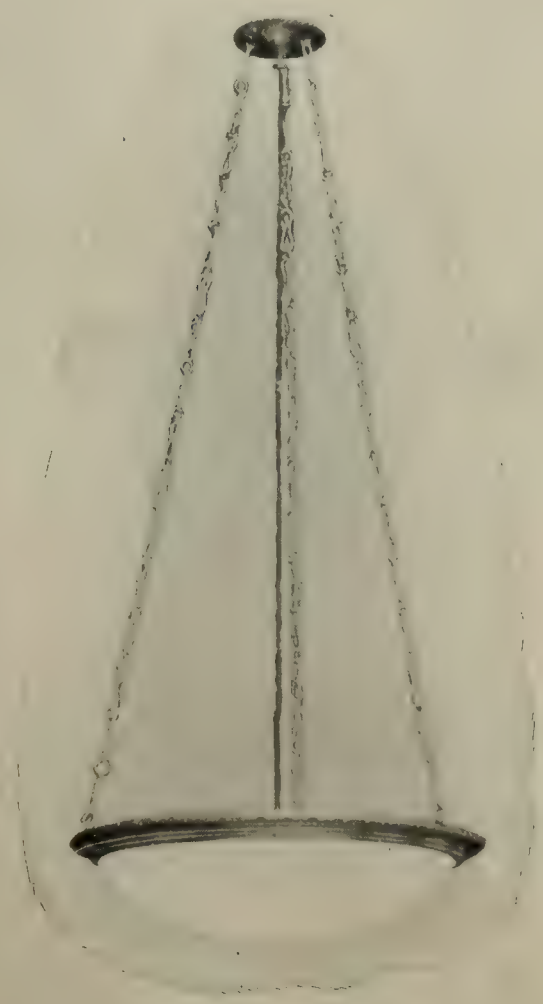
AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

fittings, of which there are many artistic and beautiful designs put forward in the list. Although there is a considerable number of fairly high-priced bowl fittings, there is, we are glad to notice, a wide and useful selection of inexpensive designs which cannot fail to appeal to light users with moderate purses.

We are asked to state that this interesting list is now available for distribution, and when we state that the company has decided to keep a larger assortment of stock designs, and that the present list contains nearly 500 illustrations, we feel sure that not only will the list itself be in brisk demand, but there will be a steady call for Ediswan fittings of all classes.



PENDANT BOWL FITTING.

NEW HOLOPHANE HANDBOOK.

We have just received a new illustrated handbook comprising a series of reproductions of photographs of actual lighting installations, made with the Holophane system of illumination. The book is divided into sections according to the class of building dealt with.



MILLINERY SHOW-ROOM WITH HOLOPHANE LIGHTING.

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

For instance, there are separate sections relating to churches, public buildings, railways, private houses, banks and offices, industrial lighting, &c. The object of the book is to prove by photographs that Holophane lighting is capable of meeting the illumination requirements of any class of building or style of architecture. Although Holophane glassware is often chosen on account of its scientific design and because of the economies it introduces, the appearance of the units is also a matter of some importance. In the lighting of fine interiors it is necessary to select fittings and glassware which harmonise with the general scheme of decoration and have a dignified and impressive appearance. Its qualities in this respect have led to Holophane glassware being widely used in many important public buildings and interiors of architectural distinction. We are quite sure that the handbook is one which architects and electrical contractors would find most useful for reference as well as being highly instructive.

THE FIRST ELECTRO-HARMONIC CONCERT.

The gathering at the above concert was, if anything, a little below the first night last year.

Mr. W. J. Tennant (who was in the chair) expressed regret that the hon. treasurer, Sir John Snell, who was to have taken the chair, at the last moment found himself unable to do so, his official responsibilities having recently been much increased. The musical director, Mr. Gatehouse, had written that he was recovering from a slight attack of bronchitis, but said that the programme had purposely been made a little shorter than usual on account of the difficulty of getting home these times. One had to grope ones way owing to the increased darkness of the streets, and there are also the difficulties of reduced train facilities and other means of locomotion to contend with. Members may therefore be glad of the opportunity of leaving somewhat earlier than has been the case in previous years. Mr. Tennant said that the number of members on the roll at the end of last season was 632 as compared with 664 at the end of the previous season. Since the end of last season 2 have died, 21 have resigned outright and 36 memberships are in abeyance till the end of the war, either on account of absence on active service or because of bad times. He thought this was somewhat serious, as the result is that the active membership is reduced to 573, and furthermore, only 13 new members have been put up for election so far this season, as compared with 55 last year. Last, but not least, current subscriptions are not coming in as well as they might, and certainly not as well as usual. In these unprecedented times, he thought that a special effort should be made to keep things going, and to carry on as usual. "Is it to be said when the war is over," he said, "that we had not the nerve or the cash to keep the Electro-Harmonic Society going in spite of the 'Bosches'?" There were wise and unwise economies, but this was essentially a time when a sane and reasonable amount of recreation should be taken, especially when it does not run into much expense. The concerts at the Electro-Harmonic Society are half the price of, and far superior to, those usually provided for this class of entertainment; and there is a camaraderie existing amongst members that is not to be found amongst ordinary audiences. He suggested that all should put their shoulders to the wheel, and determine to keep the flag of the Electro-Harmonic flying bravely until the better times arrived. In conclusion Mr. Tennant said: "Remember the 'Ladies' Nights,' and bring the ladies on those occasions just the same as usual. The ladies are doing a great deal for us in these days, and we should show our gratitude to them in every possible way."

GLASGOW'S NEW SHOWROOM.

The opening of the new Corporation showrooms in Glasgow last week, upon which we commented, is a matter of considerable local electrical interest. A noteworthy fact is the arrangement entered into with the Glasgow electrical contractors, whereby they and their customers are afforded all possible facilities for inspecting the stock of appliances kept in the central showroom. Any electrical contractor who requests the Corporation to sell from stock in the central showroom any fittings, accessories, lamps or apparatus is entitled to receive out of the purchase price one-half of the discount which he would have received from the makers, had the contractor sold such apparatus to his customer direct. All fittings, accessories, lamps and apparatus sold from the showroom are at the usual retail selling prices current in the trade.

All wiring work resulting from inquiries at the showroom is done directly by a contractor, and no undue preference is shown to any one or more electrical contractors. The hiring of apparatus is not undertaken from the showroom, but the showroom management is free to lend apparatus for a short period to possible customers under exceptional circumstances, and make a charge, if they think fit, for the loan of such apparatus. All charges made to consumers by the showroom management are separately stated on the relative demand notes sent to consumers, and all sums paid to and obtained by the Corporation as a result of business done in the showroom are separately shown in the annual accounts of the Corporation electricity department, which accounts are audited by an independent auditor.

LEWIS'S SCIENTIFIC CIRCULATING LIBRARY.

ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

New Works and New Editions can be had from the Library immediately on Publication. Telephone: MUSEUM 1072.

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H. K. LEWIS & Co. Ltd.,

136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C.

Printed and Published by [illegible] TUCKER, at the Editorial, Publishing and Publishers' Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, OCTOBER 15, 1915.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—Mr. F. H. Whysall, borough electrical engineer, Greenock (who was in Newcastle on business), is prevented by the officials from going over any of the local electricity works.

* * * *

The sketch taken from an advertisement of the National Brake Co., N.Y., is interesting by comparison with the present operations in the Dardanelles. The letterpress reads as follows :—

"When Xerxes wanted Greece he wanted to conquer it in a hurry. To him the natural thing was to overwhelm the enemy by brute force. So he crossed the Hellespont with about two million men.



Greece, with a smaller force of men but with greater intelligence, defeated Xerxes. Brains usually make brute force unnecessary."

In view of Mr. Ashmead Bartlett's latest description of our monitors at the Dardanelles, history is going to repeat itself.

* * * *

About this time last year, Mr. W. H. L. Watson, of Edison Accumulators, made the interesting statement that he had been examining the matter of towns refuse and had come to the conclusion there was *something in it*. The photograph of an Edison dust van proves that he was not altogether wrong in his beliefs.



AN EDISON TIPLING WAGON, FULLY LOADED.

A complete Revolution in Electric Table Lamps : The new Mazda advertising novelty.

* * * *

Speaking of the battery-driven truck at Paddington Station the London "Evening News" says (our italics) :—

"It is easily driven and makes *light* of eight or ten churns of milk."

Lamp makers will be interested in this remarkable discovery. Are we to assume that filaments of galalith are made from the churns of milk ?

* * * *

The recent raids by the Hun Gang of Dark Nighters has quite naturally imposed a severe strain upon the filaments of the many tungsten lamps in use, and out of use (by order of the police) in the "East Coast region." Reports have already reached us, after passage through the Censor's office, that both Osram and Mazda lamps have stood the concussion and subsequent shocks and that, like the "home fires," they are "still burning brightly."

* * * *

Those who have one eye on the new recruiting proposals and the other on some summer clime where there are neither wars nor rumours of wars, will be interested in the following Breakfast Menu on the s.s. "Kashima Maru" on the Nippon Yusen Kaisha line :

Fruit.
Oatmeal.
Fried Fish.
Miroton of Mutton.
Rump Steak, Onion Sauce.
Parsley Omelet.
Meat Curry and Rice.
Potato Boiled Lyonnaise.

Hot Cake with Syrup. Hot Rolls.
Jam, Marmalade, Tea and Coffee.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), October 26, 1878.]

ELECTRIC LIGHT.—Some of the talent at work on the electric light might, perhaps, with advantage to itself and to the community, be devoted to trying the effect of platinised or iridiumised asbestos or pipeclay in the circuit. By this means it seems to us that a simple and economical light for household purposes might be obtained. A good deal remains to be done with iridium, its alloys and compounds. alumina and the silicates.

WHITECHAPEL AND THE ELECTRIC LIGHT.—On the subject of the electric light exhibition on the premises of Messrs. Wells & Co., of Shoreditch, the Committee of Works reported that they had discussed the matter with the surveyor, Mr. Iron. The surveyor intimated his desire to have leave of absence for four or five days to visit Paris. He explained that it was his intention and desire, while there, to procure information as to the electric light in use in the Paris Exhibition, and it was resolved that the required leave of absence be granted, and that the surveyor be requested to obtain such information with regard to the use of the light as opportunities may afford. On this recommendation being submitted to the full Board it was adopted amid general laughter.—*Metropolitan.*

THE "POINT FIVES."

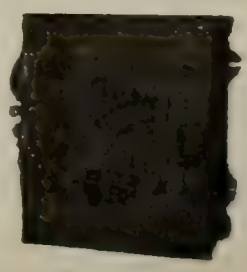
Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. G. W. Spencer Hawes (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparks (W. Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



No. 631.—Convertible Plate type Field Rheostats for controlling the field of motors and generators. Designed for fine regulation and built for a wide range of capacity and resistance, adapted for either front or back of board mounting. Described by our Pamphlet No. 631.

'IGRANIC'
ELECTRIC CONTROL GEAR.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

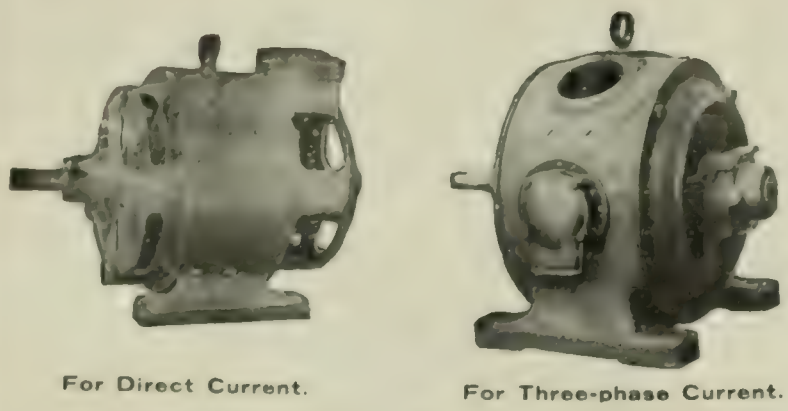
No. 27.—Patent Inching Starter widely used in factories and workshops. Thoroughly foolproof, robust in design and construction, thoroughly reliable in operation. Circuit always made and broken by magnetically operated circuit breaker, permitting inching & the most frequent starting & stopping.



SIEMENS

STANDARD

ELECTRIC MOTORS



For Direct Current. For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
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BRISTOL—30, Bridge Street.
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GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood
SHEFFIELD—22, High St. [Bldgs.
SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

"SUN" ACCESSORIES.

The trade will shortly be in receipt of the Sun Electrical Co.'s new catalogue of electric light accessories, this being Part I., Section X., of the company's main catalogue. The list describes, prices and illustrates lampholders of all classes, switch-holders, ceiling roses, close cut-outs, wall sockets and plugs, plug adapters, watertight plugs and couplings, tumbler switches of all classes, double-pole switch and cut-out boxes, candle and counterweight fittings, electric unpickable locks, and a variety of wiring sundries.

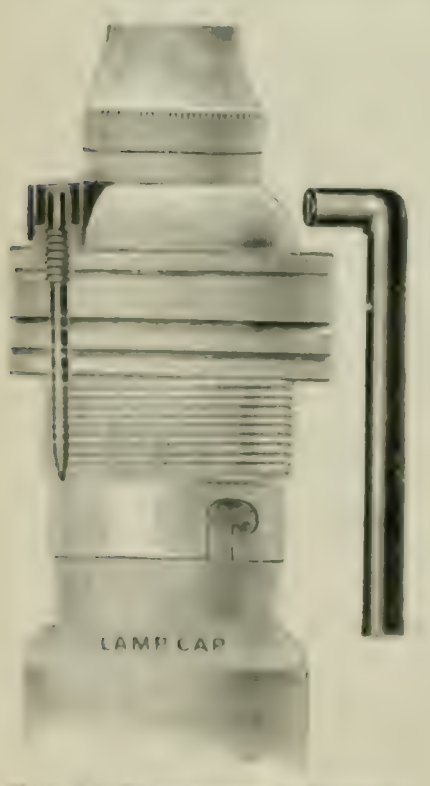


FIG. 1.—LAMPHOLDER BODIES WITH KEY.



FIG. 2.—HANDSHIELD PLUG AND SOCKET.

We illustrate in Fig. 1 an interesting pattern of locking lampholder. The illustration explains the method employed for preventing the removal of the lamp from the holder without the use of the special locking key. A long pin, threaded at one end, where it enters the lamp body, projects right through the inside of the holder to a point at which it bears upon the back of the lamp cap. When this is screwed home the lamp cannot be pushed upwards to disengage it from the bayonet slot. Fig. 2 shows a wall socket with handshield plug. This is designed for use with radiators, fires and other heavy current-carrying apparatus. The flexible cord enters at the side, and can be neatly finished off at the point of entry. The provision of a substantial wooden knob prevents the withdrawal of the plug by means of the flexible cord. We also illustrate in Fig. 3 a neat pattern of charging board for small accumulators. It is fitted with adjustable resistance, and is designed for charging ignition cells from the regulating cells of the accumulators installed in country-house plants. By this method the smaller cells are charged economically, and at the same time the regulating cells can be kept in good condition. The set illustrated is suitable for currents up to 10 amperes.

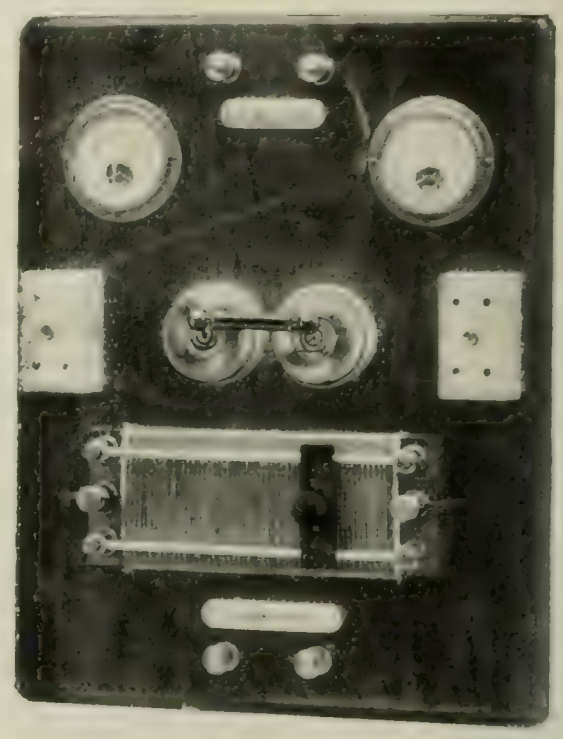


FIG. 3.—SMALL BATTERY CHARGING BOARD.

There are many other interesting accessories referred to in the catalogue, but for these we recommend our readers to obtain a copy for themselves.

ADVANTAGES OF THE ELECTRIC MOTOR DRIVE.

Electricity is the most convenient form in which to transmit and apply energy, and the electric motor is a means for transforming electrical to mechanical energy, and produces motion and torque at various speeds and in different directions. The advantages of the electric drive of machinery in general are :—

An increased production for a given equipment, and an improved product.

A decreased power consumption and higher efficiency.

This is due to :—

Centralised power supply.

Simplicity of power transmission and distribution.

Machinery may be conveniently located with reference to production rather than to the power transmitting system.

Changes can easily be made.

Reduced friction losses and, thus, increased efficiency.

Cleanliness and better light, due to absence of a large number of belts.

Less danger of accidents.

Better reliability of operation.

Wide choice of motors as to size, mechanical design and operating characteristics.

Perfect control, including readiness of starting and stopping and making close speed adjustments.

Remote and automatic control.

The operations may be closely studied by means of recording devices, and tests can readily be made.

Economy in time.

Ability to operate any portion of a factory at any time with a power consumption approximately proportional to the work done.

The Electric & General Works, Ltd

15, Victoria Street, London, S.W.



Horn-type Lightning Arresters for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC LONDON."**

MONOMETER FURNACES.

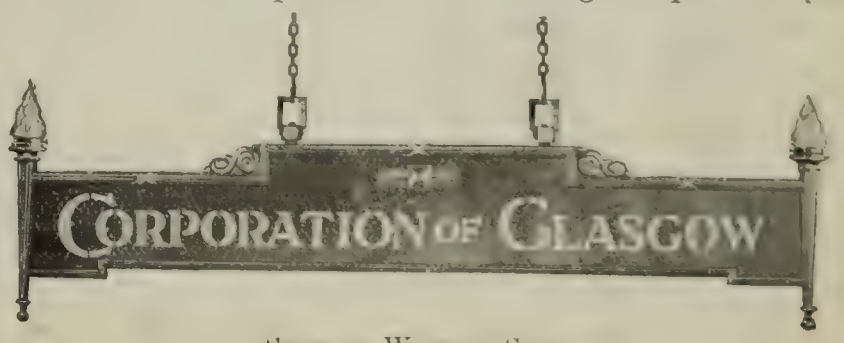
The value of the Monometer furnace for melting white metals for lining bearings, and for heating moulds preparatory to lining, is being recognised by motor car companies, tramway companies and corporations. We understand that orders have been received for this type of furnace from the Daimler Motor Co., the Lanchester Motor Co., Sheffield Corporation Tramways and the India Rubber, Gutta Percha & Telegraph Works Co. Manufacturers of cables find such a saving in residue by the Monometer furnace that a number of them are, we understand, equipping their entire works. Messrs. Johnson & Phillips have installed one of these furnaces, together with the Monometer patented low-consumption burners for lead pressure.

The unique Monometer system of melting aluminium without crucibles and without oxidation is also finding favour. Castings served from this furnace have shown on laboratory tests that their tensile strength, breaking point and elongation tests cannot be approached by castings produced by the old method. Furnaces specially constructed for melting scrap lead, tin and for recovering tin and solder from disused tin cans are also, we understand, filling a want hitherto not met, judging by the orders which the Monometer Mfg. Co. have received for this class of furnace. The company also inform us that they have received orders from leading firms for hardening furnaces, and for non-corrodible ladles for aluminium, whilst another special line which has caught on is the new tinman's stove with automatic cut-off, which is claimed to be a real gas saver.

Manufacturers interested in these furnaces and ladles, &c., should make their requirements known to the Monometer Mfg. Co., Whitehouse-street, Aston, Birmingham, who will be pleased to furnish full nformation and particulars on request.

ADVERTISING WINDOW SIGNS.

The illustration shows a window sign designed and made by Simplex Conduits (Ltd.) for the new showroom of the Glasgow Corporation electricity department, the opening of which in Glasgow we commented upon last week. During the present trying



Simplex Window Sign.

times for shopkeepers, when the lighting restrictions in large towns are strictly enforced, it is useful to remember that windows lighted in this way are well illuminated, without flooding the street with light, or half blinding the passer-by. It has required a European war to bring home the merits of correct window lighting, but now it has been done there should be good business in such signs.

CHINA COVER SWITCHES.

Samples have been sent to us of the standard pattern of Tucker tumbler switch fitted with a china in place of a brass cover. The importance of conserving the supply of brass at the present time is

H. WEIDMANN, Ltd., RAPPERSWIL, SWITZERLAND



MAKERS OF PRESSPAN AND INSULATING MATERIAL.

PRESSBOARD (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.

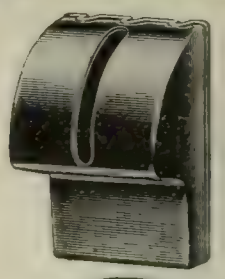
AMIANITE (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.

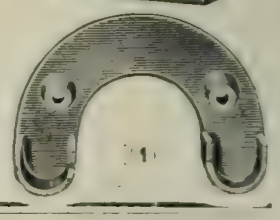
BAKELITE & CORNITE (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.

ASBESTOS-CEMENT in Plates, Arc Shields for Controllers, &c.



Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk and Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.

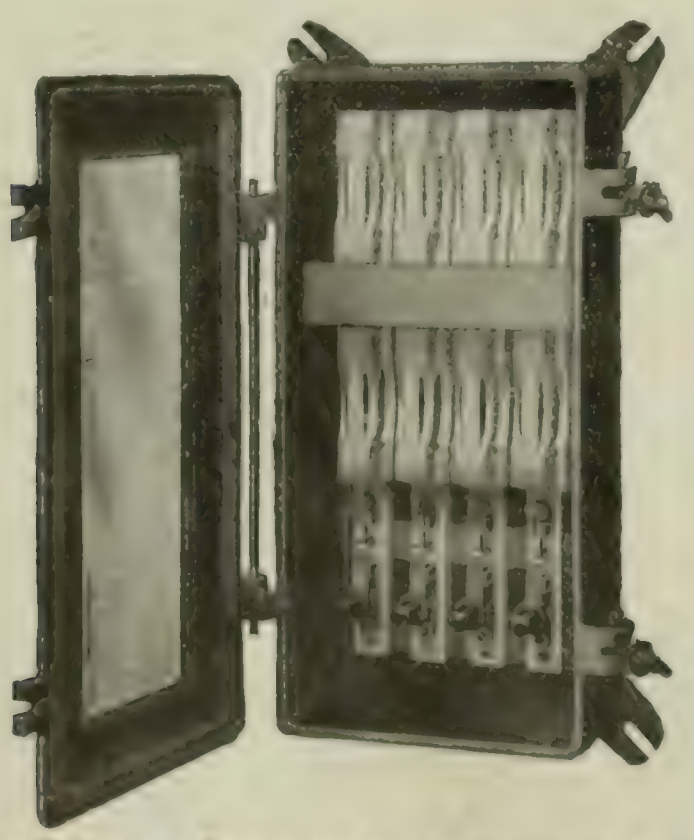




generally recognised and although the tumbler switch per se is a diminutive electrical accessory, the net weight of metal used in its covers will be considerable. The china cover is in itself no new thing for tumbler switches, but the makers of the Tucker switch have introduced an element of novelty in a variety of colours and stains which can be applied to the covers. The samples sent to us, for instance, will match mahogany or oak furniture or wall decorations. Other schemes of colour are available for harmonising with interior furnishings, and particulars of these will be supplied on application to J. H. Tucker & Co., Birmingham.

IRONCLAD SWITCHGEAR.

Interesting details are being published by Johnson & Phillips in a new catalogue and price list which deals with ironclad switchgear. The "Charlton" bridge fuse, illustrated herewith, is included amongst the apparatus dealt with, and it is designed for pressures up to 600 volts, and capacities ranging from 30 to 500 amperes. This fuse

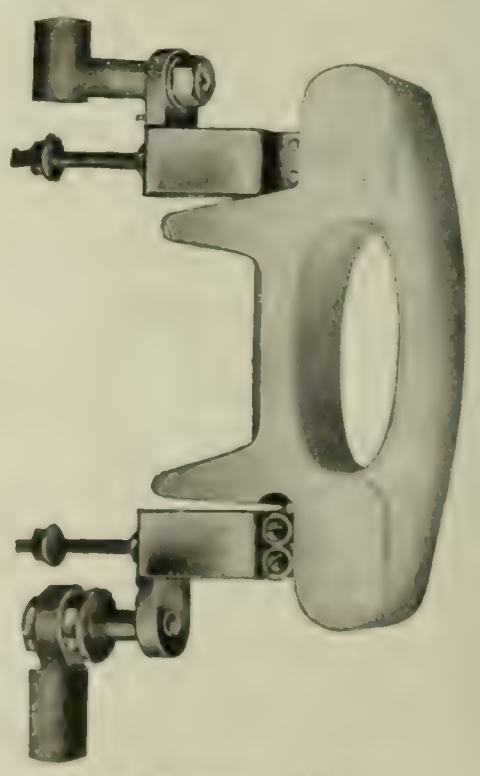


"Juno" Ironclad Switch and Fuse Distribution Board.

meets the requirements of the Home Office, and has been designed to comply with them in every detail. It will be seen from the illustration that the contacts are completely shielded from the grip fuse, and the operator is thus afforded complete protection. The fuse wire itself is carried in an asbestos tube which effectually chokes any arc which may tend to form. For currents up to 60 amperes the fuse bridge is designed with a finger grip, the porcelain being recessed for this purpose. Above this capacity a handgrip is provided, as shown in the illustration. If the customer wishes to use this type of fuse on his own bases a porcelain end shield is supplied.

Amongst the items dealt with in the list is the "Juno" ironclad fuseboard, designed to comply with the Home Office regulations. The "Juno" fuse is of special design, the contacts on the fuse bridge being of the U-type, and the bridge being so shaped as to entirely enclose all current carrying parts when the carrier is in position. The entire construction has the appearance of a solid block of porcelain. Ample room is left behind the fixed contacts for wiring purposes. These fuses are made up from 2 to 10 ways, and capacities 10-15, 20-30 and 50 amperes per way. An illustration is shown of a double-pole "Juno" switch and fuseboard, there being knife contact switches of the single-pole pattern mounted at the bottom of the case.

Fuseboards are also offered in which the "Charlton" fuse is assembled, double or triple pole for 2 to 10 ways. The "Charlton" ironclad switch made for double or triple pole, and the "Victoria" ironclad switch, are also described and priced in the list. The concluding pages are occupied with details of motor-starting panels for direct-current service, for motors ranging in capacities from 1 to 50 H.P. These are made up of a tubular iron framework, with cross-members of iron strip; the starter is mounted at the bottom of the panel, immediately above it in separate iron boxes are the double-pole fuses, and at the top of the panel is a double-pole switch with ironclad instrument surmounting it. The panels are supplied complete with cable sockets and interconnections, the switch, fuse and starter being so placed that these connections make practically a straight run. The panels are supplied either for wall fixing or for



The "Charlton" Fuse.

placing on the floor. The switch and fuses are totally enclosed, and the starter is fitted with a water-tight cover or cover with glass inspection window. A copy of the list is obtainable from Johnson & Phillips, Charlton, London, S.E.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

POPE
Elasta
British Made Wire
Lamps

Selling More Lamps than Ever!

That is what we are doing—that is what Elasta Agents are doing too.

The **ELASTA** Lamp.
Brilliant–Strong–Economical

Yields a better margin of profit—pleases the customer and incidentally helps in building up your business.

THE LAMP WITH A LIVING IN IT

Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps. Hythe Road, Willesden, N.W.

Making three grow where there were but two before



TRANSMISSION LOSS IS PRACTICALLY NEGLIGIBLE.

Western-Electric

REPEATING COILS
FOR
PHANTOM CIRCUITS
WHICH WILL INCREASE

your available telephone circuits without increasing your outside wire plant.

They will mean a greater efficiency in existing plant with practically no increase in maintenance expense.

You accomplish that which seems impossible. "YOU GET SOMETHING FROM NOTHING"—you make three blades of grass grow where there were but two before.

THE PHANTOM CIRCUIT

makes it possible to transmit three telephone messages at the same time over two ordinary metallic circuits merely by adding repeating coils.

EFFICIENCY

The No. 4006A. Repeating Coil is designed to give the highest possible efficiency for ringing and talking. With one No. 4006A. Repeating Coil connected at each end of a phantomed circuit, satisfactory signalling is assured over any circuit which can be used for satisfactory speech transmission.

WORKS: N. WOOLWICH.

Western-Electric Company, Limited.

INGRAM'S
Indiarubber Gloves & Gauntlets
FOR ELECTRICAL PURPOSES.

NON-CONDUCTING

BEST QUALITY INDIARUBBER.



Made in ALL SIZES and ORDINARY STOUT SUBSTANCES to suit varying Voltages.

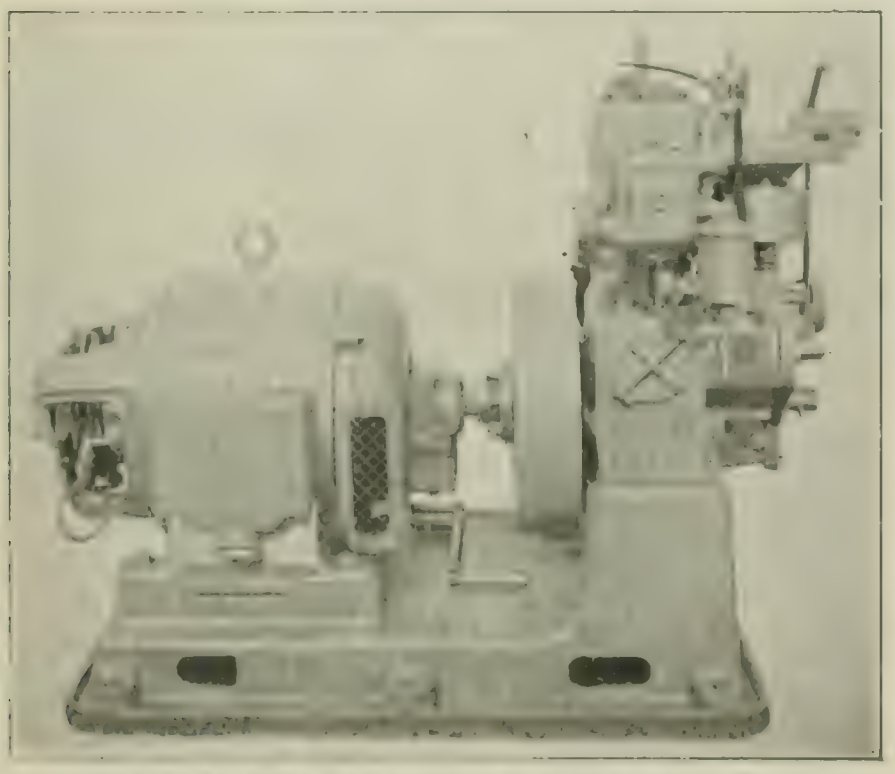
PRICES ON APPLICATION.

Manufacturers—
J. G. INGRAM & SON, Hackney Wick, LONDON, N.E.

One, Two & Three Phase
MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

PARAFFIN LIGHTING SET.

One of the changes that has been taking place of recent years is the use of small direct-coupled sets for house lighting, &c., instead of the horizontal engine and belt-driven dynamo. There are many advantages in a self-contained plant, and indeed, for such work as yacht lighting, it is the only plant possible. Amongst the firms who have had con-



Side View of Peatties Dynamo Plant.

siderable experience in the production of an engine fit for continuous full power duty is the Parsons Motor Co., Ltd., Town Quay Works, Southampton, so well known in connection with paraffin machinery for marine propulsion. It is a 3½ kw. plant by this company which we illustrate. The engine is coupled to a Mather & Platt dynamo, and the normal speed is 900 revs. per min. The working parts of the engine are the same in size as the marine engines, which, we understand, are built to pass the requirements of all authorities. This particular plant is one of three for country house lighting, but the company has, we are informed, built larger plants, up to 90 B.H.P. for various military camps about the country; in some cases there being half a dozen large engines in one generating station.

Referring again to the illustration, attention might be drawn to the neat design of bedplate with drain channel all round, keeping any oil, &c., from foundations. The engine in running is closely governed by means of the company's enclosed high-speed governor, gear driven as shown. The engine is fitted with its own water circulating pump, and is simple and flexible to handle. A point which may be mentioned is that the coupling between the engine and dynamo is not solid bolted, but is driven through six pins and collars, which allows the armature spindle to float endwise.

FISH FRYERS.

An electric fish fryer is a necessity in all establishments where much deep frying of fish is carried on. The Jackson No. 220 is made in stout polished copper, heavily tinned inside, close rivetted, and is fitted with draw-off tap and draining rack. It can be fitted with sheet metal hood, in which case a flue outlet is provided. Nos. 500/2 are heavily constructed in cast-iron, oval in shape. They can be fitted in pairs into a steel frame with hood, draining rack, &c. Both types of fryer are of strong construction and are designed to meet the severest calls that can be made upon them. Their loading is such as to bring the fat to its right cooking temperature, from cold, in 15 minutes, and the elements are arranged for three-heat control—full half and quarter. The dimensions of four patterns are given below:

Cat. No.	Approximate overall. Height. Ins.	Width. Ins.	Projection. Ins.	Weight. lbs.	Weight. kgs.	Loading. Watts.
220	11	13¾	12¼	17½	8·0	2,500
500	6½	14	11	29½	13·4	1,200
501	8	16	12	36	16·4	1,700
502	9¼	19	13	51½	23·4	2,400

The Jackson double fish fryers are made in two types, Nos. D500/2 being oval in shape and D503/5 being square. The latter, besides being different in shape, are also heavier in construction than Nos. D500/2, and are specially adapted for large restaurants where a great amount of fish is served. Both types consist of two heavy cast-iron pans fitting into $\frac{3}{16}$ in. (5mm.) wrought-steel plates, and being complete with draining rack and sheet metal hood with flue outlet. Each pan is separately heated so that they can be used independently or together. The elements are arranged for three-heat control—full, half and quarter, and the full heat will bring the fat to right cooking temperature, from cold, in 15 minutes. The table gives the principal dimensions:—

Cat. No.	Approx. size of each pan. Internal. Ins.	Approximate overall. Height. Ins.	Width. Ins.	Projection. Ins.	Weight. lbs.	Weight. kgs.	Loading. Kw.
D500	13 × 10	40	42	18½	103	47	2·4
D501	15 × 11		42	18½	113	51	3·4
D502	18 × 12		42	18½	139	63	4·8
D503	15 × 15		42	18½	184	84	8·0
D504	22 × 22		55	26	382	174	13·0
D505	30 × 18		70	24	442	201	16·0

Prices can be obtained from the Jackson Electric Stove Co., Blandford-street, London, W.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 95 97, NOBLE STREET, LONDON, E.C.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

Printed and Published by GEORGE TUCKER, at the Electrician Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London, England, October 22, 1915.

THE ROUND TABLE.

By "KVA."

The latest in resistance materials BELLINIUM.

* * * *

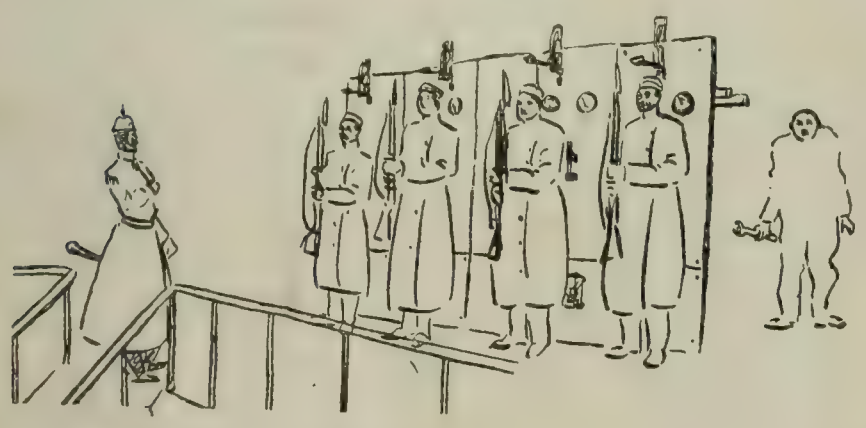
It is not often the "Electrical World" has consecutive editorial notes expressing contrary views on the same subject. Thus in one note :—

There is need for the development of the water powers. Of that there can be no doubt. As sane and reasonable men why cannot the advocates of State and federal control meet with engineers and bankers and determine on just what basis development of the existing water-power sites is possible ? Some solution must be forthcoming.

Thus in the note immediately following :

Assume a water power, for example, capable of delivering several thousand horse-power. The immediate market for the sale of energy may be so small, however, that for a number of years the plant will actually be required to produce only a fraction of its total possible output. It is at this point that the cost of money pokes its head into the line of items in total cost. A water-power plant cannot be developed piecemeal. It is necessary to invest at the start practically the full sum of money in right-of-way, dams and approaches, foundations, and so on. The few horse-power generated at the start, therefore, must carry the load of interest charges for a very large proportion of the final cost of the installation. It is thus easily seen that it may actually be cheaper per unit output to put in a much smaller steam plant with its relatively much lower investment charges than to develop the water-power project.

* * * *



THE GERMANS TAKE POSSESSION OF THE POWER HOUSE.



THE SWITCHMAN SAVES THE SITUATION AND INCIDENTALLY DEMONSTRATES THE ADVANTAGES OF THE FIXED HANDLE CIRCUIT BREAKER.

The adjoining illustration is not taken from an early edition of the "Forty Thieves." It is, however, of some interest in a pantomimic sense. A hot plate will be awarded to the reader



whose reply, accurately describing it, is first opened. The supply voltage should be stated with the reply, which should be marked "KVA. Hot-plate." Post-cards disqualify.

* * * *

Another Arrol-Johnson advertisement reads : –

It has been freely stated of late that British motor engineering will fall behind during the war. Which is the kind of theory that is born over a typewriter and dies over a bench-test. Aero engine construction and war experience are actually putting the British motor engineer many technical points ahead of his rivals.

Many other theories born over a whisky and soda have died in the w.p.b. * * * *

An ultra-electrical enthusiast who hates petrol motor cars and all their works (being the victim of many breakdowns) suggests that the Chancellor of the Exchequer should tax them for using the atmosphere for purposes of carburation. He would have every air inlet pipe fitted with a meter to register the consumption ! Who would get the order for the meters ?

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), October 26, 1878.]

EDISON'S ELECTRIC LIGHT.—The New York "Herald" of Oct. 12th, says :—

The alarm among the English gas companies, and the panic in their stock on account of Edison's latest invention in electric lights, are not without good cause. America's great inventor has in truth solved the problem which for years had puzzled the ablest electricians of the age. He has successfully divided the electric light, and has made it, for illuminating purposes, as far superior to gas as gas is to the tallow candle of the past. His marvellous invention gives a mild, soft, yet brilliant light, pleasing to the eye, clear, steady and without blemish, and at a cost less than one-third that required for gas. Already a company has been formed, composed of a number of wealthy capitalists, and Mr. Edison's lawyers are engaged in completing the final arrangements for the legal transfer. When word is cabled Mr. Edison that the European patents have been granted he will throw his invention open to the public gaze ; but until then he declines to make known its details, his recent controversy with Prof. Hughes over the alleged stealing of the microphone having made him cautious.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
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Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield)
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).

All enquiries concerning
PLATINUM
should be sent to
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Golsilplat, Ox., London." 4746 Gerrard.

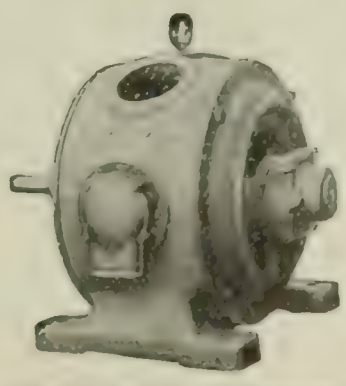
SLATE
INIGO JONES & CO.,
Tudor Slate Works.
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

SIEMENS

STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St. | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

ELECTRIC LABORATORY FURNACES.

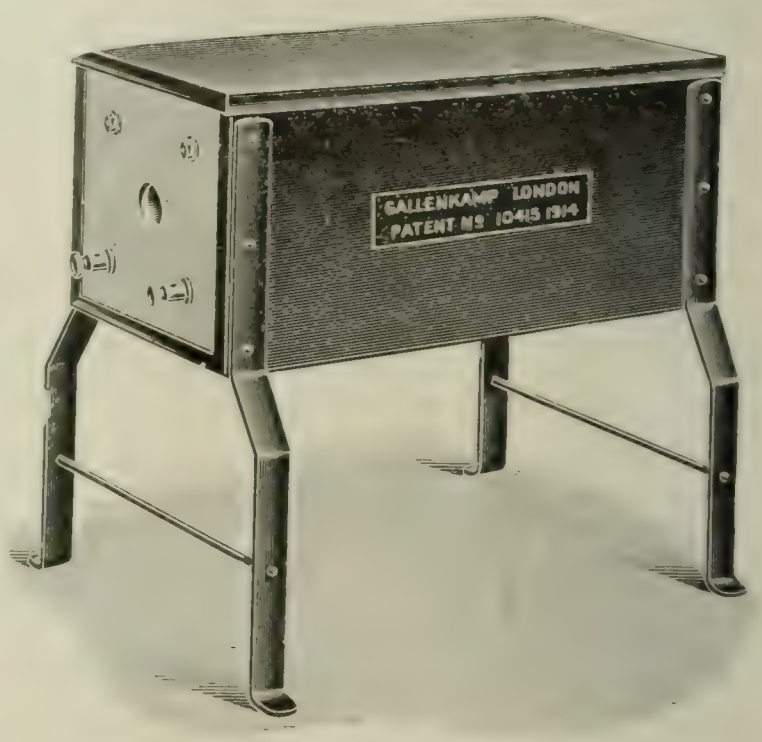
An interesting pamphlet just issued describes furnaces for the laboratory, built on a new and patented principle. Some electric furnaces made for laboratory purposes have been wound with platinum, and of a design costly to manufacture and repair. Although the advantages of electric furnaces has been generally recognised, the prohibitive cost has prevented their extended use in the laboratory. The furnaces under notice have been designed with a view to reducing the cost to within reasonable limits. For temperatures up to 1,000°C. constant, a winding of special high resistance alloy is used, which for short periods can be taken up to 1,100°C. safely. Platinum is only used when higher temperatures are required up to 1,300°C. In these cases the amount of platinum used has been reduced to a minimum, the efficient lagging rendering only a small current consumption necessary. The types of furnaces described in the pamphlet are (1) tube furnaces, vertical and horizontal; (2) multiple tube furnaces, for carbon in steel determination; (3) explosion tube furnaces; (4) muffle furnaces, (5) crucible furnaces.



HEATING ELEMENT OF TUBE FURNACE.

The heating chamber is made of pure fused silica, which is one of the most refractory of materials, melting between 1,700°C. and 1,800°C. The coefficient of expansion of silica is extremely small, and it is therefore possible to subject the heating chamber to rapid changes of temperature without danger of breakage. Silica is superior to porcelain and similar materials as an electrical insulator. For temperatures above 1,200°C. alundum is recommended, with melting point at 2,050°C., and a very high thermal conductivity. For temperatures up to 1,000°C. a winding of special high resistance alloy is used. This alloy has, we understand, been specially developed for use in electrical resistance furnaces, having a small temperature coefficient (+0·00009 per 1°F.) and being strongly resistant to oxidation. If this winding should be destroyed accidentally the cost of renewal is trifling. For short periods this winding may be safely taken up to 1,100°C. For higher temperatures up to 1,300°C., platinum strip or wire is used. The winding is arranged to give a uniform temperature throughout the heating chamber.

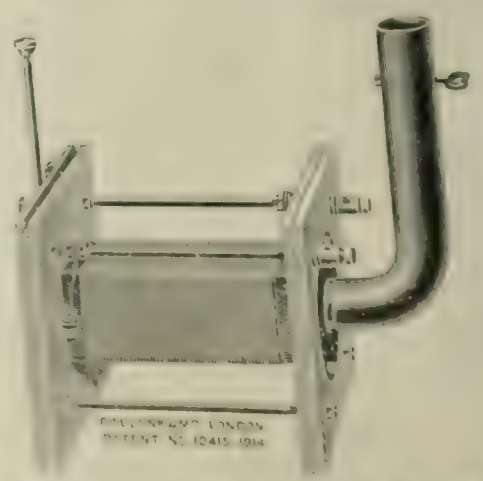
The winding is protected with a special cement, which keeps the coils stationary. The space between the lagging and the winding is packed with finely powdered quartz. This arrangement prevents



TUBE FURNACE.

oxidation and corrosion of the winding, and also gives increased efficiency to the unit. The lagging is in the form of slabs, and is composed of light magnesium carbonate, mixed with asbestos fibre; it makes an effective heat insulator. The small amount of energy consumed by these furnaces is largely due to the efficient lagging. The frame consists of end walls of refractory material, held apart by four steel tie-rods, two of which have terminals attached at one end, and serve as conductors to the winding. The "live ends" of these two rods are covered by insulated nuts. The end walls are recessed to take the ends of the heating chamber, and hold same firmly, preventing side play. The casing is of sheet iron, with wrought iron legs attached, and is provided with a detachable cover, in the flange of which are slots adapted to receive screws to attach cover to casing.

The heating chamber, tube, muffle or crucible, is wound with the heating coil, the ends of which are secured by bands. The chamber is then fixed in the frame and connection made from the coil to the two bottom tie rods. The bottom slab of lagging is placed in the casing, and the frame lowered into same; the sides are lined with lagging slabs, the space between filled with powdered quartz, the top lagging placed in position and the sheet iron cover screwed on.

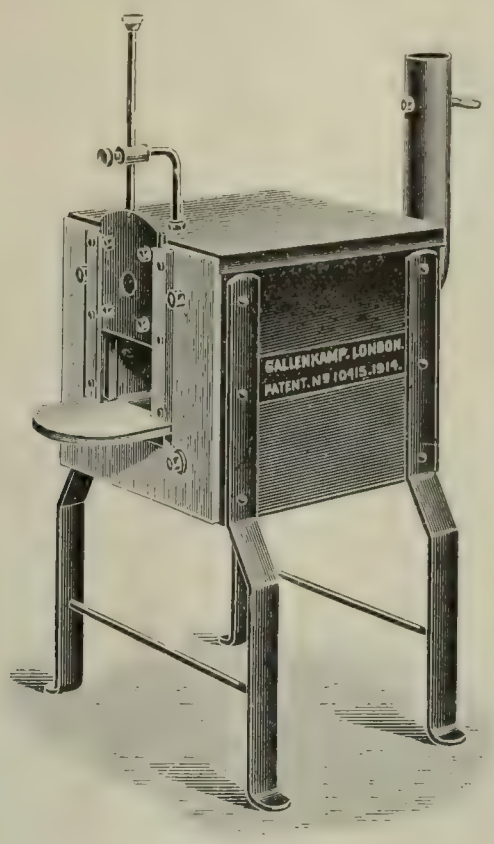


HEATING ELEMENT OF MUFFLE FURNACE.

In the tube furnaces access to the interior of the tube can be made at both ends through orifices in the end walls. In the crucible furnaces the bottom is of course closed and the top is furnished with a

fireclay cover. The muffle furnaces are closed at one end by a sliding door, which can be adjusted to give any size opening, the other end is furnished with a chimney carrying a baffle plate. The draught through the furnace can be finely regulated.

We gather that these furnaces operate on direct and alternating current, and may be wound for any voltage up to 250 volts to give any maximum temperature within the limits stated. The heat insulation is most effective, and the heating chamber acquires its



Muffle Furnace.

maximum temperature with small power input, heating slowly and cooling slowly. For many classes of work this is a valuable feature. By means of a regulating rheostat the temperature may be controlled and maintained steady with great exactness, provided the voltage of the supply does not fluctuate.

The pamphlet referred to may be obtained from Messrs. A. Gallenkamp & Co., Sun-street, Finsbury-square, London, E.C.

"BELLING" NEW SEASON FIRES.

The pioneer work done by Mr. Belling in the development of the bar type of electric fire is, we feel sure, greatly appreciated by central station engineers, electrical contractors and electrical traders throughout the country. The Belling fire may almost be said to be



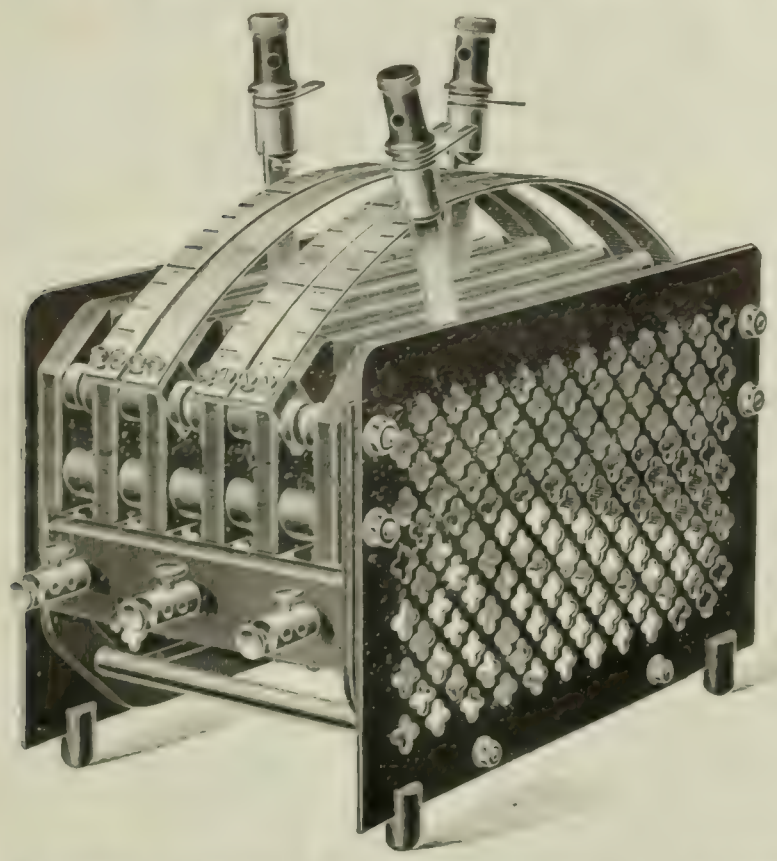
Fig. 1.—"Renown" Belling 3-kw. Fire.

to the electric heating business what the metal filament lamp is to the electric lighting business. For the coming winter and spring season Messrs. Belling & Co. are assisting the work of those who are making it their business to increase the popularity of the electric fire in general and of the Belling fire in particular. They have prepared



RHEOSTATS

NEW LIST IN THE PRESS.

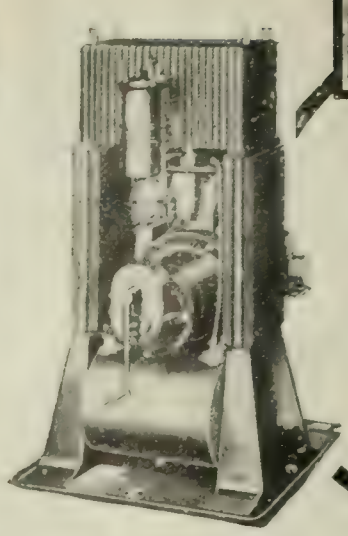


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(DEPARTMENT 4).

DENZIL WORKS, NEASDEN, LONDON, N.W.

Contractors to the Admiralty, War Office, India Office, Canada Office, Postmaster-General, &c.



THE UNI-LECTRIC Lighting Plant

The new one-unit lighting, cooking and power machine

NO BATTERIES. NO SWITCHBOARD.

Standard 110 volts direct current output 500 to 750 watts.

Electric Current Always ready for Every Purpose.

A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.

Pour in oil, petrol, and water once a week, or as needed—that is all the attention required.

The perfect plant for country house, farm, garage, yacht, etc. Built for continuous service.

WRITE TO-DAY FOR COMPLETE DESCRIPTION

WALTER D. FAIR & CO.

43 LEICESTER SQUARE

LONDON W.C.

a quantity of attractive literature, ranging from double crown posters to pamphlets for enclosure with correspondence. The poster referred to hits off rather a happy idea, and one which we have not previously seen embodied in an electric fire advertisement. It shows an officer bending down to a Renown pattern of Belling fire and taking a light from it for his cigar with a piece of twisted paper. Quite a number of people still believe that it is not possible to take a light from a modern electric arc. They have probably attempted it with disappointing results with a four-lamp radiator. The poster is attractively coloured, and the catchline is "Hot as Fire," this idea being adequately conveyed by the colouring adopted.

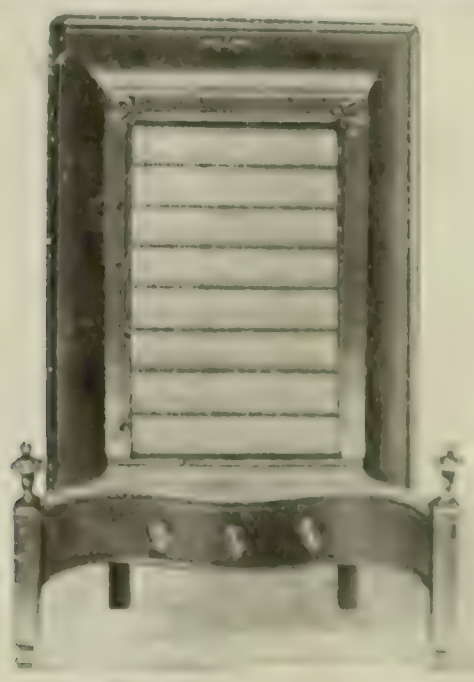


Fig. 2.—"Concave Dog" Type.

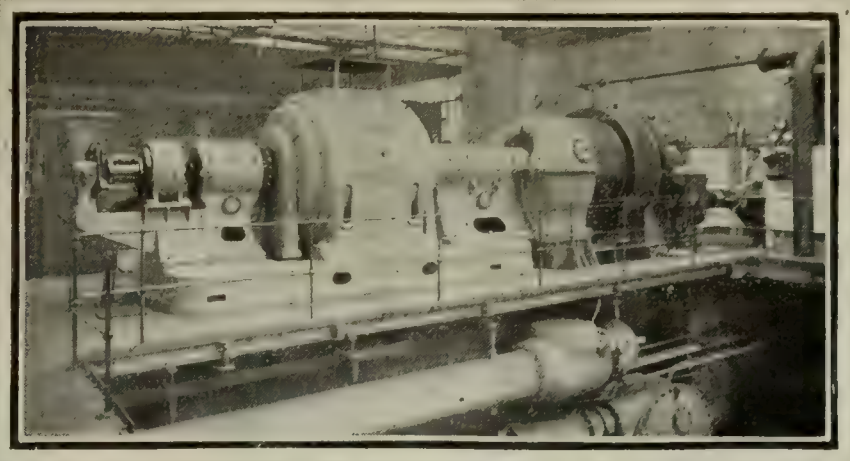
We gather from the attractively printed and illustrated list which accompanies this trade matter that a number of new Belling lines are being introduced this season. The standard lines which have been so popular in the past are retained, and will, we feel sure, continue to be used in increasing quantities. We may comment upon one interesting point—namely, that the company has now standardised a 500-watt fire bar for use in all its fires. This pattern of bar was tentatively introduced into the 3 kw. fires in 1913, and the

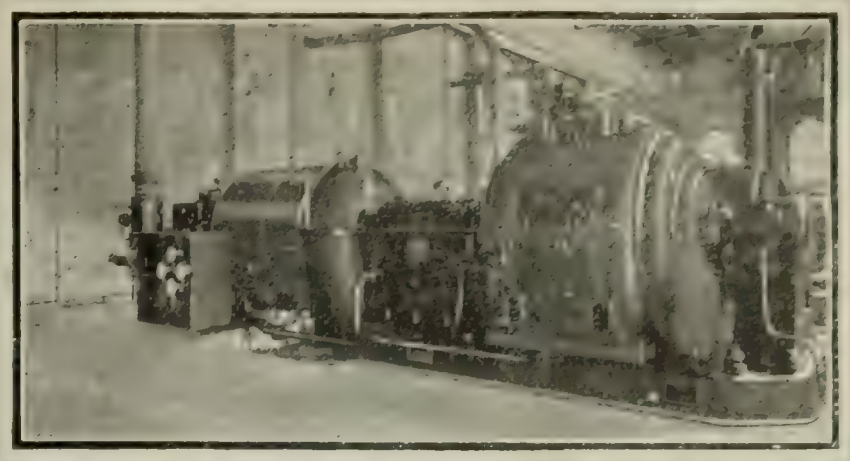


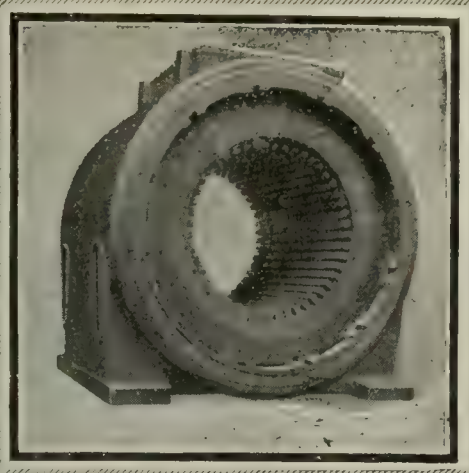
Fig. 3.—Fireplace Type Belling Fire.

experience gained during that season, and also during 1914, has encouraged the company to take the step referred to. They call attention to the fact that when a number of this size fire bars are placed close together they form an almost unbroken surface of glowing red heat, and strongly resemble a coal fire when it is burning under its best conditions. It is also emphasised that the efficiency of the fire does not in any way depend upon the use of a polished metal reflector. The construction of the bar is such that the heat from the Bellinium element is thrown directly forward from the bar itself.

We illustrate a number of the new designs of fires which are put forward in the present season's list. The Renown fire, illustrated in Fig. 1, is made up in a close-grain iron frame, and the elements, six in number, are mounted horizontally at the front of this frame in a casing which curves slightly upwards. At the extreme limit of the curve is a fender, which serves the double purpose of a kerb and protection for an amber-coloured lamp, which throws its rays forward up the ladder of bars. This lamp is entirely concealed from view, and the effect produced upon the bars, together with the glowing elements themselves, is both striking and comforting. The loading of this fire is 3 kw. all on, and the fire measures 25 in. high by 18 in. wide by 8 in. projection, the weight being approximately 28 lb. It can be supplied with either square or round top. It is designed for use with separately mounted switches, and is, therefore, fitted with four terminals, one common and one to each two bars. If desired, the switches can be embodied in the frame, but at a slight extra cost. Fig. 2 shows a concave dog pattern fire, which is another new model. This is an eight-bar type, the bars being fitted in a curved frame, and there is no lamp illumination. Five degrees of heat are obtained from three switches mounted in the extended portion of the frame at the front of the fire. Two switches control three bars each and one two bars. The maximum loading is therefore 4 kw. This







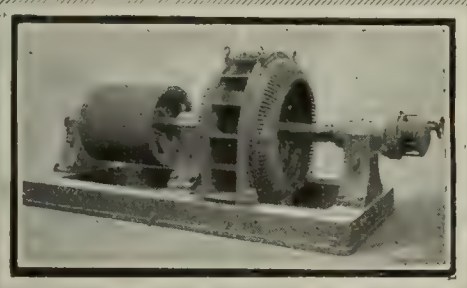
VICKERS Limited

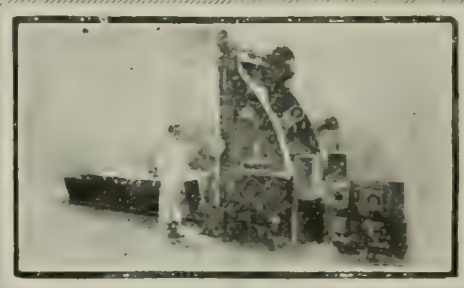




RIVER DON WORKS, SHEFFIELD

ELECTRICAL EQUIPMENT
of every description





A Good EARTH

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PARAGON EARTH CONE



is replacing the old time earth piate, because it is much easier and cheaper to instal. It makes a more reliable and permanent earth.

The cone is made of perforated copper and filled with small charcoal. It attracts and retains moisture, and consequently provides a certain earth.

The Cone is made in various sizes for Lighting, Power, Tramways, Telephones, Telegraphs, Lightning Conductors, &c.

SCHOLEY & CO., Ltd.,

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EDISWAN EVERYTHING ELECTRICAL

THE ALL-BRITISH
HOUSE FOR ACCESSORIES

ROYAL
EDISWAN
DRAWN WIRE LAMPS

CATALOGUES ON REQUEST
FROM THE
EDISON & SWAN
U·E·L CO., LTD.,
PONDERS END
MIDDX.

FULLY LICENSED UNDER BRITISH PATENTS Nos 21513/06 - 27712/07 AND OTHERS

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BOILERS
GRILLERS
COOKERS

Over 300 Corporation and Electric Supply Authorities have bought our goods for the last 3 years.

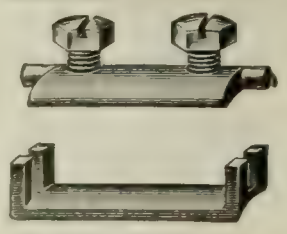
We endeavour to turn out strong practical articles for everyday use.

May we send you our Catalogues?

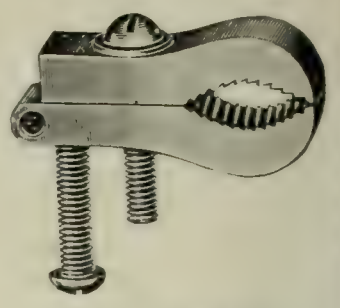
BELLING & CO., Derby Road, Edmonton, LONDON, N.

E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

TRADE MARK.



582 N.—Earth Clip.



505 L.—Earth Clip.

Every description of Finger Tips, Connecting Pieces and Segments, made for Tramway Electrical work.

Sole Agent for the Electrical Trade:—

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fire measures 26 in. high by 17¼ in. wide by 10½ in. projection, the width over the dogs being 18½ in. The approximate weight is 38 lbs. Fig. 3 shows the fireplace type of fire, which is designed for fitting as a permanent feature into existing fireplaces. The outer surround is of an ornamental character, and is constructed of the finest grain cast iron; the small inner frame around the heat bars is of polished copper. This fire is designed for control by three switches, each of which turns on two bars, there being six bars in all; the switches require to be separately mounted. The total loading of this fire is 3 kw. Quite the most interesting of the fires listed is that known as the Vertibar pattern, illustrated in Fig. 4. It will be seen that there are seven standard Belling type bars placed vertically in a row at the front of a frame, which resembles either a gas stove or an ordinary modern type of coal fire. At the back of the bars is a solid block of



Fig. 4.—"Vertibar" Belling Fire.

asbestos, which prevents loss of heat at the back of the fire, and after the bars have been in circuit some time its stores up heat, which is thrown forward usefully into the room. This is designed for 3 kw. loading, and measures 28 in. high by 17 in. wide by 7 in. projection, the approximate weight being 36 lb. This fire is the best imitation gas stove which we have hitherto seen, and we feel sure that it will cause no little fluttering in the dovecotes of the gas fire manufacturers.

Needless to say, the Belling fire literature is available for the use of those enterprising central station engineers and contractors, also electrical dealers and traders, who are in a position to push this class of electrical material.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

ELECTRIC LIGHT FITTINGS ACCESSORIES.

The average wireman during the course of his daily work frequently requires some small accessory which, though insignificant in itself, is most necessary in order to complete some fitting in a neat and artistic manner. A number of these accessories are of quite an ordinary standard kind. Others are a little more unusual, and are only needed on infrequent occasions. It is most useful to have handy a list of these items, and contractors will doubtless welcome Leaflet No. A 3,114 issued by the Edison & Swan Co., with which details and



Fig. 1.

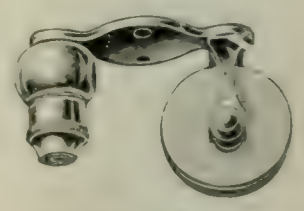


Fig. 2.

prices are given of a considerable variety of cord grips, ball fittings, nozzles, couplings, ceiling loops and hooks, ceiling plates, shade carriers and glass holders and cord ornaments.

Fig. 1 illustrates a somewhat unusual but at the same time a useful fitting for use with counterweights. It comprises a pair of china wheels mounted on an annular brass base with projections which carry the supporting pillars for the wheels. The latter are 1½ in. diameter. Fig. 2 shows a single wheel fitting for use with a cord grip, such an accessory being useful for supporting extension flexibles, of which a number may be taken out on one ceiling rose.



Fig. 3



Fig. 4.



Fig. 5.

Fig. 3 shows a useful form of insulated screw eye, a rather longer specimen of the familiar pattern which is used so frequently for supporting flexibles in shop windows, &c. The pattern illustrated is a little more ornamental than the small type, and measures 4½ in. long from the flange to the hook: the screw is 1½ in. long. Figs. 4 and 5 are examples of knuckle and swing joints for use on fittings employed in show cases. These joints confer flexibility on brackets and other fittings, making them adjustable to any desired angle for lighting purposes. The catalogue referred to can be obtained from the Edison & Swan Co.

FERRY **FERROZOID**

CONSTANTAN **CHRONIC**

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British-Made Resistance Materials

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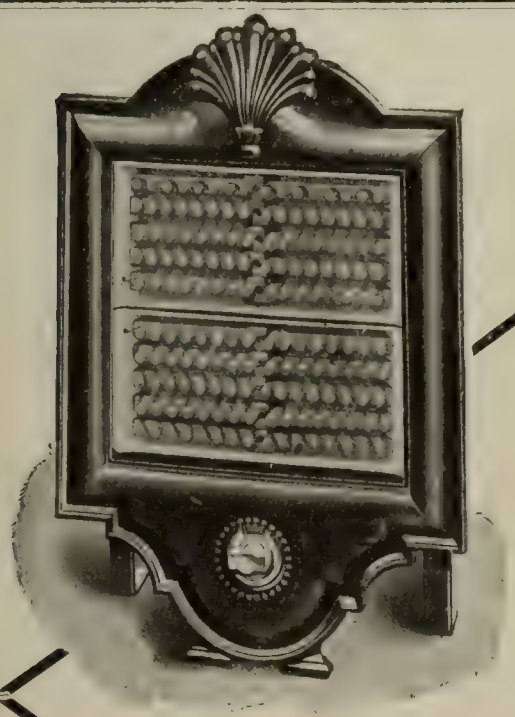
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No. 240. Reg. Design.

By Appointment.

Build up your Sales——

By handling fires of merit and repute, viz.,

CARRON **Electric Fires.**

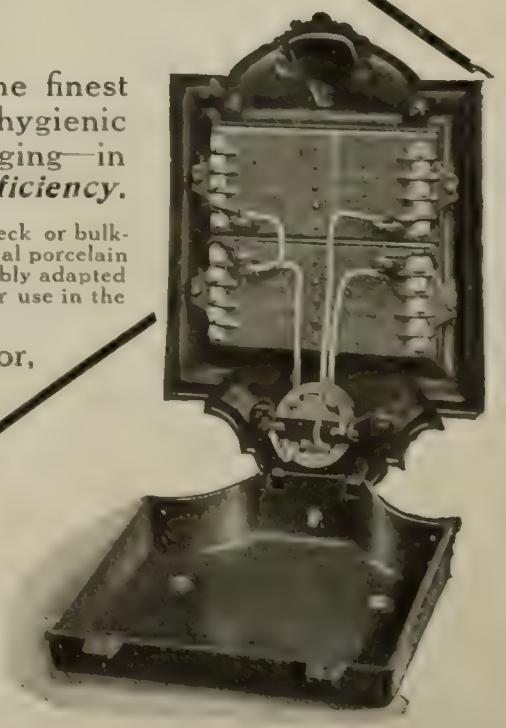
A TOUCH OF THE SWITCH DOES IT

The designs are unique—they are made from the finest material—are simple in construction—portable—hygienic—perfect air circulation round coils and no sagging—in short, ***they are the embodiment of electrical and mechanical efficiency.***

Fire illustrated is specially designed for ship's use, and is equally adaptable for fixing to the deck or bulkhead, and takes up very little space. The light cast-iron back has a protective coat of special porcelain enamel, the front being porcelain enamelled in colours, to suit requirements. Admirably adapted to withstand water, and easily cleaned with a damp cloth. Equally suitable for use in the home, office or institution. Loading 2,000 to 2,500 watts.

Get a copy of the Company's new catalogue—free—or, better still, order sample fires and prove to your *own* satisfaction that ***these fires will compare favourably with anything on the market***

CARRON COMPANY
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WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

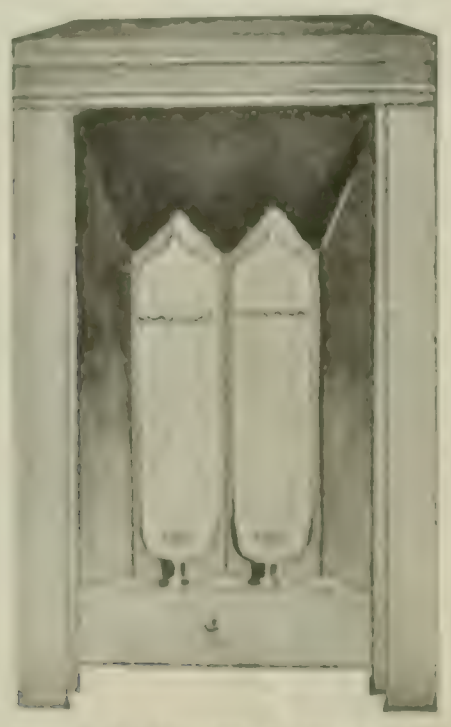
Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines)

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A.B.C. & Western Union.

EDISWAN RADIATOR LAMPS.

Although the electric bar fire with open element is now enjoying a considerable vogue there are still in every thousands of lamp radiators in service. By reason of this fact Leaflet No. 13117, just issued by the Edison & Swan Co., should be in the hands of all electrical contractors. It deals with Ediswan radiator lamps and calls attention



Ediswan Radiator Lamp of the

to the strength of the filaments used in them. We understand that they are all specially prepared and are tested as to their heating qualities before leaving the works. The flanged cap of the lamps is secured by means of two set screws, so as to ensure rigidity. The lamps are made throughout at the Pendlebury Ediswan works of the company.

Deliveries from Stock.

QUICK BREAK KNIFE SWITCHES.

Totally Enclosed STARTERS.

A. REYROLLE & Co., LTD. HEBBURN-ON-TYNE.

OSRAM PAINTING BOOKS.

The General Electric Co. (Ltd.), 67, Queen Victoria-street, London, E.C., has adopted a novel form of advertisement in a series of children's painting books. Each of the three books has, on the left-hand pages, a coloured drawing; and on the corresponding right-hand pages the same drawing in outline. The pictures illustrate rhymes which, in simple fashion, sing the praises of lamps. The first of the series deals with the lights of 1830, 1890 and 1915—the candle, the gas light and the Osram lamp respectively. The second tells the story of how an Eskimo girl discovered what she mistook for the sun; and the third relates how the lesser light which rules the night has been forgotten by children who live where Osram lamps are used. The drawings have a quaintness which will appeal to the children who are set the pleasant task of colouring them, the idea being that both they and their parents will receive a happy impression of the Osram lamp. On the back page of the cover various "Hints to the Young Artist" are given, followed by "Advice to Parents," bearing on the question of eye-strain and the importance of providing a good light for their children to work by. These painting books are being distributed among electric light consumers and have, we understand, already proved most popular.

WASHING PAPER MONEY.

According to the "Daily Telegraph," Miss Thomas has been in charge of a laundry for paper money in the United States for the last three years. She was previously engaged in the Bureau of Engraving and Printing, but when the so-called laundry was started she was put in charge, and she holds the distinction of having handled 75,000,000 dollar bills in one day. American bankers do not agree that paper money which has been washed is of use, some will not accept any other, while there are those who object to it altogether. It is stated that the expert counters who handle the notes can detect counterfeits while the bills are under cleansing process more easily than in any other way. The machines, which are worked by electricity, are in charge of girls known as washers and ironers. One girl feeds soiled money to the washer, and another catches it as it leaves the ironer. All notes are ironed as soon as they are washed. Some bankers declare that those which have been cleansed on wet blankets, passed over rollers of soapy suds and sterilised, then ironed on heated rollers, sifted and scrutinised are more readily counted even than new issues. They do not stick together and they are softer to handle.

Miss Thomas is responsible for the washing of 35,000 bills every day, and she counts that as a good day's washing. Not all money is redeemed by the laundry process. Ten per cent., however, of the notes issued in the United States pass through the Treasury at Washington, and the girl who tests them to see whether they are fit for further circulation stacks them into different piles. It takes 60 expert counters to deal with them afterwards and check them, some being cast aside as useless, others being classified as fit for further operation as current coin of the realm. Miss Thomas has been telling a Press representative that her experts recognise a counterfeit by the mere touch. They pass it on at once to the Secret Service detectives, who never fail to trace it to its source. Small bills in constant circulation are redeemed by washing, but nothing higher in value than a $20 note ever goes through the laundry, while bills of high value are never redeemed at all.

FERRANTI LTD

Central House, Kingsway, London, W.C.

SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.

Write for Binder "N."

Printed and Published by [illegible] TUCKER at the Electrical Publishing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London. Friday, October 29, 1915.

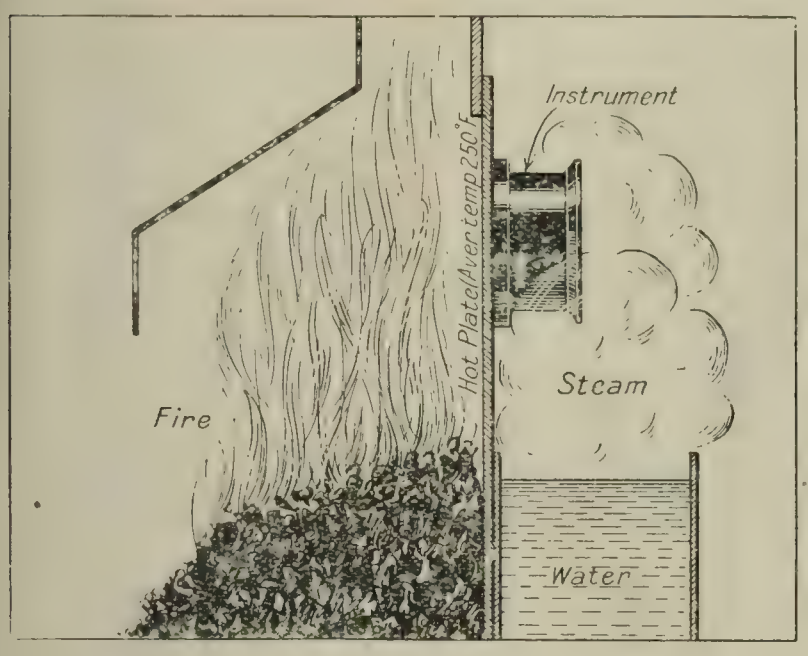
THE ROUND TABLE.

By "KVA.'

EVENT OF THE WEEK.—Two Glasgow tramcars collide, and the "conductress" (vide press) on one of them faints.

* * * *

A somewhat novel, as well as drastic method of testing electrical indicating instruments is that illustrated in the adjoining sketch. It might be described as the "betwixt" test, bearing in mind the ancient tag, "betwixt the devil and the deep sea."



From a business point of view it would also be rather impressive for the salesman to say to the customer, "These instruments have all been betwixt." The sketch was sent in to us by Ferranti (Ltd.), who recently tested one of their new instruments in this fashion.

* * * *

Quite a flutter has occurred in the dovecotes at the new Statutory Regulations regarding what is termed "Abuse on the Telephone." On another page of this issue I read what makes my hair fairly stand on end. What is Abuse ? and who shall decide ? "What in the captain is a choleric word, in the common soldier is rank blasphemy." I hope that all telephone users will be served alike, and also that Miss Tantrums is not necessarily to have the last word. In the throes of a desperately bad telephone situation, after several wrong numbers and other wearying troubles, I have seen the face of my mildest friend turn Cooper-Hewitt with rage, and exasperation take possession of him. He is but human. And what is to become of our dear old friend, Capn. Cuttle if he is to be arrested, tried and sentenced by Miss Arabella Tantrums. The regulation is as sound as a bell, but its application may mean persecution in the hands of a vixen. On the whole, I much like the suggestion that a Glossary or Index Expurgatorius should be issued as to the terms, words and phrases which may (or may not !) be used on the telephone. And how I should like a hand in its preparation ! There is certainly great promise in this particular Regulation, and the Old 'Un should feel grateful. Will any perplexed reader of the Round Table submit to me a list of the words upon which he is in doubt as to their suitability for use, under "real red heat" conditions, on the telephone ?

The Generators have decided to go on load at the Trocadero on Friday, December 3rd (6:15 for 6:30 p.m.). This is about the time of maximum peak, but as it is the only occasion on which the machines will be running this season all Generators (d.c., a.c., unipolar and otherwise) are expected to be up to phase and voltage for switching in at the time named. Hon. scribe A. P. O'Brien at 11, Victoria-street, London, S.W., should be notified without delay.

* * * *

At last the Ediswan Miniature Rifle Club has to acknowledge defeat at the hands of the British Electric Transformer Co. The teams of eight each were allowed two sighters and 10 shots on a five-bull target, the six best scores to count. The shooting resulted in 554 points to the B.E.T. and 541 to "Ediswan," the averages being 92·3 and 90·2 respectively. Messrs. Harvey (99) and Whish (95) were the top scorers for the winners, and Messrs. Golding and Winterflood (each 94) for the losers. The



Ediswan team were afterwards the guests of the B.E.T., at whose range the shoot was brought off. The Ediswan team may now say they have been fairly B.E.T.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), November 2, 1878.]

MR. EDISON AND THE ELECTRIC LIGHT.—The fierce denunciations of the gas companies at the latest discovery of Mr. Edison have produced no effect on the serenity of the Menlo Park laboratory. When Edison was told that eminent scientists and prominent gas company officials pronounced his alleged discovery concerning the electric light a sham, and offered to prove by figures and facts that division of the electric light to any practical extent was impossible, he smiled imperturbably and gave orders that a new 80 H.P. engine be at once placed in operation, and that more workmen be added to the number already engaged in manufacturing the apparatus.

THE "POINT FIVES."

Mr. J. Horace Bowden (Poplar).
Mr. H. F. Street (Southampton).
Mr. W. H. Cooke (Luton).
Mr. T. Roles (Bradford).
Mr. A. S. Blackman (Sunderland).
Mr. C. S. Davidson (Barnes).
Mr. A. H. Seabrook (St. Marylebone).
Mr. G. W. Spencer Hawes (Reading).
Mr. J. W. Hame (York).
Mr. S. T. Allen (Wolverhampton).
Mr. F. W. Purse (Carlisle).
Mr. W. G. Pickvance (Wrexham).
Mr. H. Gray (Accrington).
Mr. S. E. Fedden (Sheffield).
Mr. J. W. Sparks (W.Hartlepool).
Mr. J. W. Beauchamp (West Ham).
Mr. A. H. Shaw (Ilford).
Mr. C. Furness (Blackpool).
Mr. C. M. Shaw (Worcester).
Mr. H. A. Nevill (Wakefield).
Mr. Frank Ayton (Ipswich).
Mr. C. N. Hefford (Leeds).
Mr. S. E. Britton (Chester).



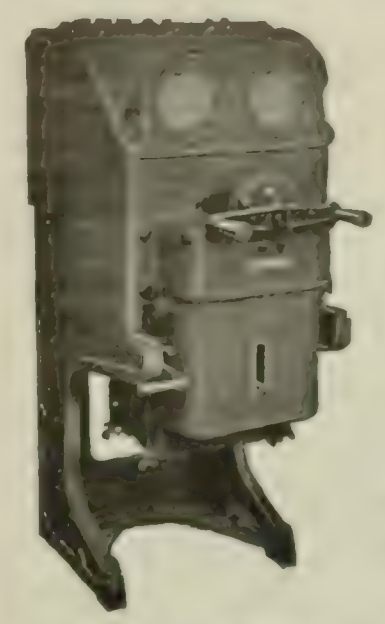
No. 29-1.—Self-acting Direct Current Motor Starting Switch for voltages and capacities up to 15 H.P., 500 volts. May be controlled by Pushbutton or Tumbler Switch, and is very suitable for the remote or automatic control of Motors, Driving Pumps, Compressors, Elevators, and the like.

IGRANIC
SELF-ACTING STARTERS.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

No. 30-1.—Self-acting Direct Current Motor Starter, having self-contained Magnetically operated Main Switch, suitable for Motors up to 20 H.P., 500 volts. This is a well tried and thoroughly standardised Automatic Starter. There are literally thousands of them in daily use.



SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
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Illustration shows our Standard Cast-iron Mining Pillar suitable for pressures up to 3,300 volts.

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BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
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SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

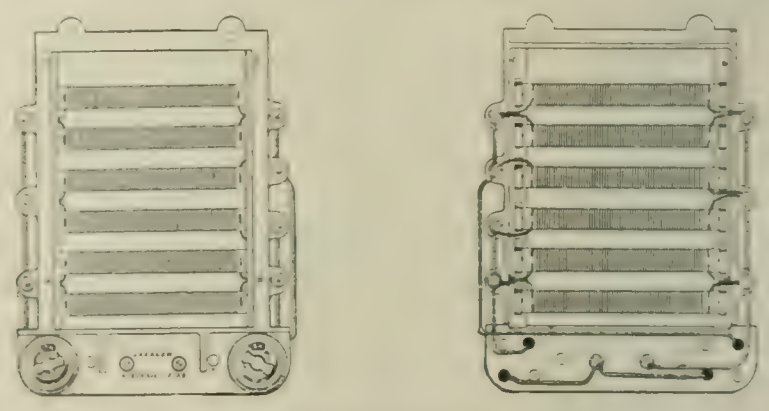
"JACKSON" FIRES.

Considerable interest attaches to the details, which are now being circulated in the trade, of the construction of Jackson electric fires. These fires have been on the market for some time, and are now being offered with a number of new constructional features which



Jackson 2 kw. Fire.

have been adopted as the result of several seasons' experience. The bars employed in these fires are comparatively narrow in width, and they are concave in front and convex at the back. Wound over them is the heating element of nickel-chrome strip, the turns of the strip at the front of the bar being out of contact with it. A sheet of mica is placed along the back of the bar, it is stated with the idea of preventing any movement of the strip due to expansion. The strip element is worked at a temperature of 1,500° F. (815° C.). The makers state that water may be spilt over the elements without fear of damaging them or cracking the bars. The bars themselves are provided with slotted ends, and are pushed into metal clips fixed to a cast-iron frame. The clips allow for any lateral expansion. The ends of the element strip are brought out from the bar through turn-back holes, and the exposed portions are covered with asbestos, the ends themselves being held down under substantial terminals, which, as will be seen, are placed on lugs cast on the side of the frame. The frame itself is a unit piece which carries the element bars, their terminals, the three-heat controlling switches, and the incoming terminals. A feature of the construction is the employment of pure nickel wire, asbestos covered, for effecting the connection between the element terminals and the controlling switches. The unit bar member can be mounted in any desired design of supporting frame, and the price of the fire is mainly regulated by the



Detail of Back and Front of Jackson Fire Unit.

class of finish and the amount of ornamentation of this frame. The standard finishes range from a popular priced fire to the more expensive article. The standard patterns are made up in cast-iron frames.

The standard rating adopted for each firebar is 500 watts, and standard spacing centres have also been adopted for the unit frame, whether the fire is of 2 kw., 3 kw. or 4 kw. loading. The construction of the frame is of interest in that there is no free passage of air through the frame itself, that is to say there are neither inlets at the bottom nor outlets at the top of the frame. There is only the rectangular opening at the front through which the radiant heat from the elements is projected into the room, in the first place from the front of the bars by reason of the concave shape of each bar, and also by the action of a reflector which is placed immediately behind the glowing bars. The makers claim that with this construction the air circulation, represented by a moving column of heated air, passes across the front of the firebars but does not move over them. The air within the frame of the fire becomes heated and it fills the frame, which then



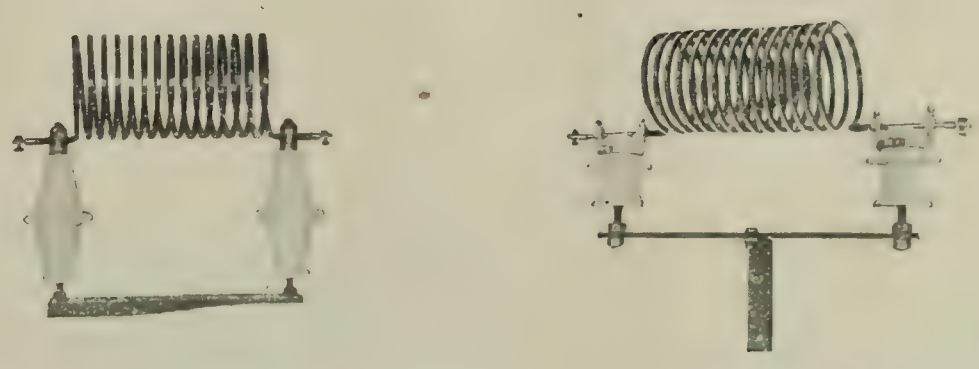
Jackson 3 kw. Fire.

becomes a species of hot-air chamber. It is claimed that this feature effectually prevents burning of the air by the firebars and the free passage through them, not only of air but also of the many fine particles of dust which are always suspended in the atmosphere, and especially in those of a room containing carpets, hangings, &c. The Jackson is claimed by the makers to be a "non-throat" fire.

With each fire 2 yds. of 130/40 flexible cord is supplied. Double this size of flexible is used with the 3½ 4 kw. fires. The heating

The Electric & General Works, Ltd

15, Victoria Street, London, S.W.



Iron Choke Coils for Indoor and Outdoor Mounting.

Electrical Apparatus up to 80,000 Volts & 4,000 Amps.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC LONDON."**

lements are guaranteed against defects in workmanship, materials r design for a period of 2 years from the date upon which the re aves the works. It is the opinion of the makers that this period a long enough time in which to demonstrate that the apparatus is ound or otherwise. It is their experience that defects show them-lves during the first season's use of the fire. A pocket catalogue, ist issued, and which is quite attractively prepared and worded as to be understandable of the multitude, is now available It ves particulars and prices of five sizes of fires, the smallest of hich measures 18½ in. high by 12⅝ in. wide by 4½ in. projection nd weighs 24 lb., and the largest 27 in. high by 17 in. wide by 11 in. ojection, and weighs 57 lb. A copy of the list may be obtained the Jackson Electric Stove Co., Blandford-street, London, W.

AUTOMATIC MACHINE TOOL CONTROL.

Those who have had experience of the relative output of machine ols driven from shafts and individually by electric motors, know at the latter system is best, because it is more flexible, and because gives a much greater output. If, in addition, they have studied rious methods of control, they recognise that the maximum output d the greatest flexibility of operation are realised only when motor-iven machine tools are equipped with automatic control.

When the workman can start and stop the machine without leaving normal position; when the foreman can set the control at the oper speed for a job and leave the workman free to start and stop, t unable to change the speed; when injury to the motor, by too pid starting, is made impossible by automatic removal of the start-g resistance; when maximum starting torque is secured and the ne occupied in acceleration is reduced to a minimum by auto-atically strengthening the motor fields during starting (if they have previously been weakened); when, by means of an automatic dynamic brake, a tool that would otherwise run for several seconds after the power is cut off, is brought to rest practically at once (the motor acting as a generator and stopping the tool), conditions have been established which all make for increased output and lower cost of production.

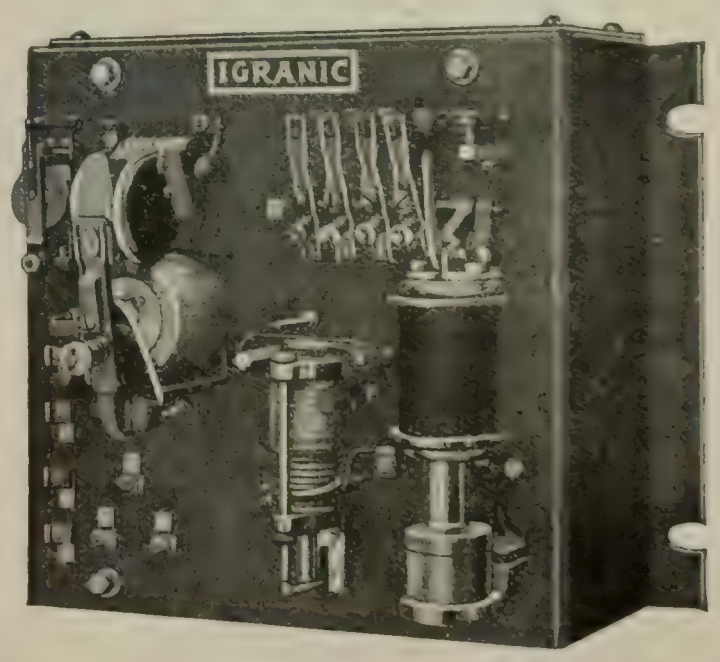
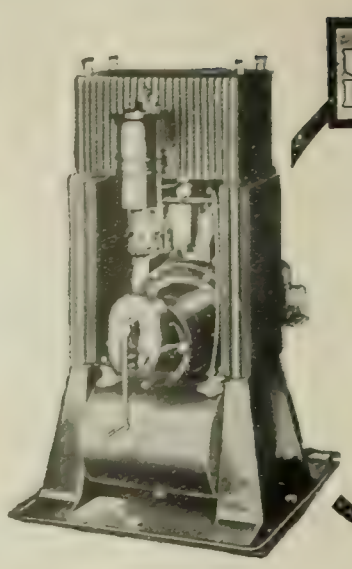


FIG. 1.—CONTROL GEAR FOR SMALL MOTORS.

Prominent among the tools for which the type constant speed of controller is suitable are shears, punch presses, bending rolls, and similar machines fitted with massive high-speed flywheels, and which run always at the same speed. It might be supposed that the

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GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
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THE UNI-LECTRIC Lighting Plant
The new one-unit lighting, cooking and power machine.
NO BATTERIES. NO SWITCHBOARD.
Standard 110 volts - direct current output 500 to 750 watts.
Electric Current Always ready for Every Purpose.
A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboard, and costly storage batteries requiring constant expense and care.
Pour in oil, petrol, and water once a week, or as needed—that is all the attention required.
The perfect plant for country house, farm, garage, yacht, etc. Built for continuous service.
WRITE TO-DAY FOR COMPLETE DESCRIPTION
WALTER D. FAIR & CO.
43 LEICESTER SQUARE
LONDON W.C.

starting of such machines requires no special skill, but owing to their great inertia considerable damage may be done both to the motor and to the starting gear by excessively heavy starting currents unless the starting resistance is cut out slowly and gradually. This demands from the operator an amount of care and patience that cannot reasonably be expected from the heavy-handed class of workmen who usually have charge of such machines. With automatic control no such patient skill is required. The switch that the workman has to operate is of the simplest character, and its use is equally simple.

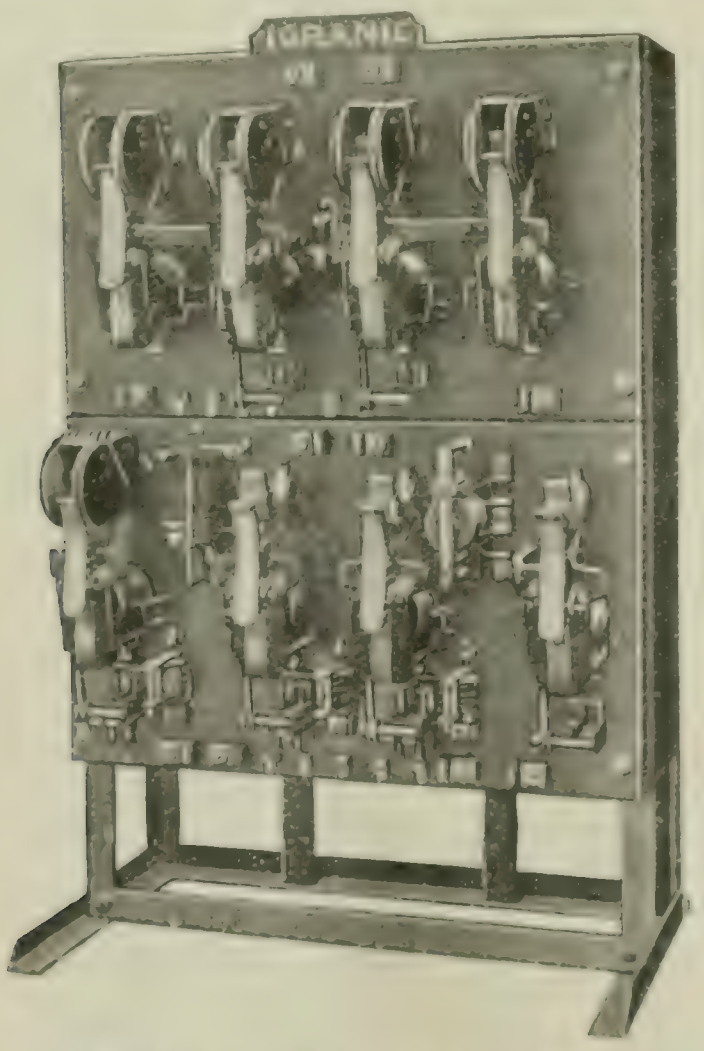


Fig. 2.—Control Gear for Lathe Motors.

Variable speed type of controllers can be sub-divided into two classes, viz: (*a*) The speed setting class, for use with machines whose speed is not usually varied during the progress of a job, but which have to run at different speeds for different jobs, and (*b*) the speed regulating class, for use with machines whose speed requires to be varied (perhaps frequently) while a job is in progress.

Speed setting controllers are invaluable for such tools as duplex, radial drills, and machines having similar characteristics. The motor switch in this class is not distinguishable from the constant-speed type. The self-acting panel which it controls includes, in addition to the starting switch, a field regulator by which the speed of the motor is controlled. This field regulator is turned by hand, at the commencement of a job, to the speed most suitable for the work. When the speed has thus been predetermined the workman may stop and re-start the motor as often as the work demands, but each time that it is started it will automatically return to the predetermined speed. This automatic return to a predetermined speed after a stop is a useful feature. The operator does not have to guess which stop his regulator was previously upon, since there has been no need to disturb this for stopping or re-starting.

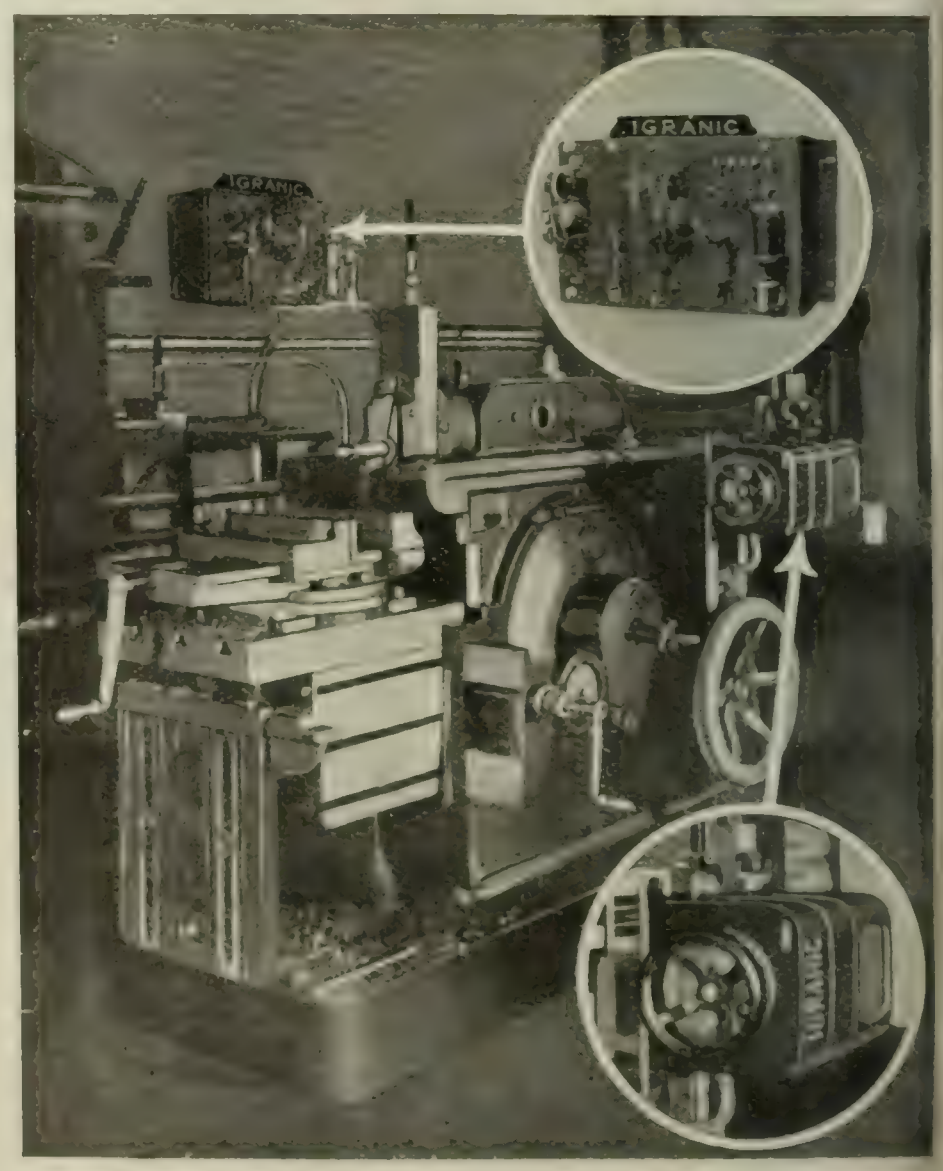
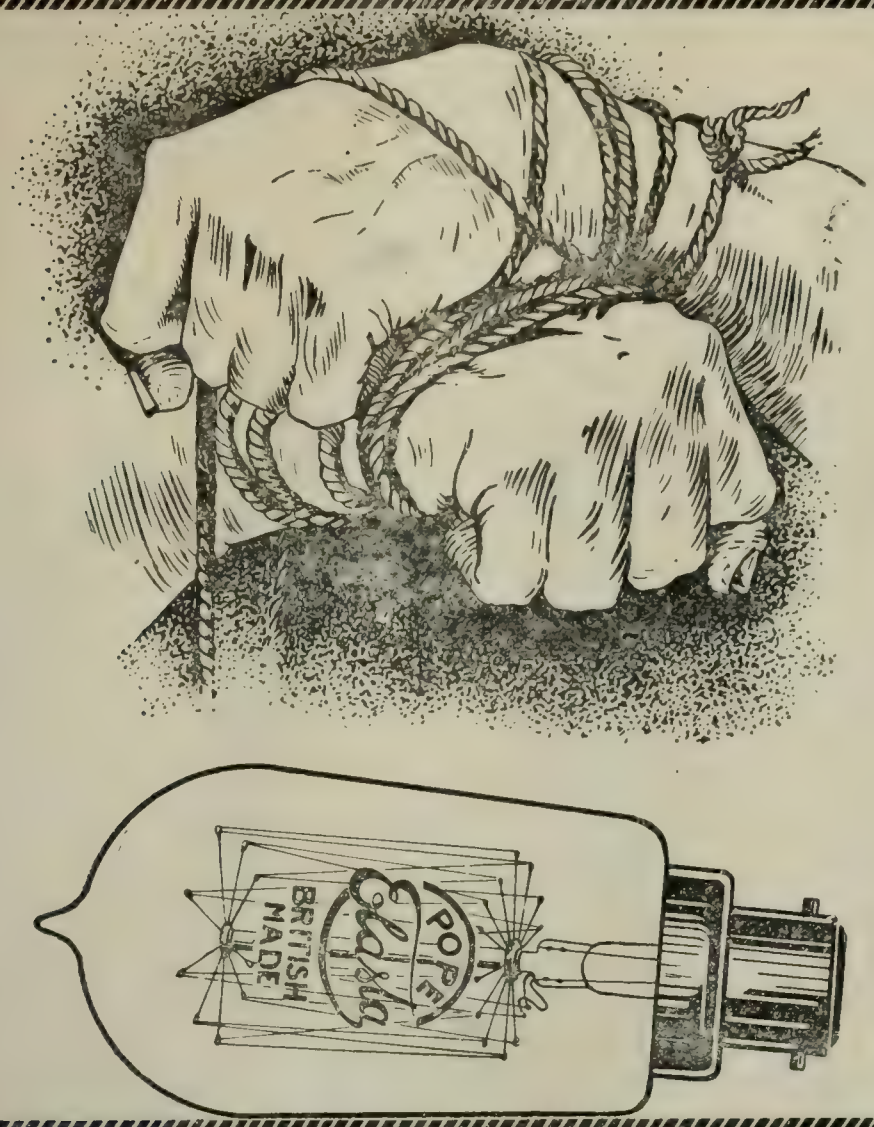


Fig. 3.—Application of the System to a Machine Tool.

While the starting resistances are being short-circuited the field of the motor is always at full strength and after all the starting resistance has been cut out the acceleration is automatically continued by the gradual insertion of the predetermined amount of field regulating resistance. This gradual and safe introduction of the field regulating resistance is controlled by a patent "gradual change" relay which is so designed as always to prevent the field resistance being inserted so quickly as to cause the motor current ever to exceed a safe value. This prevents the setting up of injurious stresses and obviating excessive currents. It limits the starting current to a predetermined value, and will also limit the running current to this same value, by automatically slowing down the motor, whenever circumstances require, just enough to keep the motor load at this limit.



Why be tied
to any make of Lamp
Give a trial to the Famous
ELASTA LAMPS

The Lamps with a living in it!

Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps. Hythe Road, Willesden, N.W.

When constant speed or speed setting controllers are to be applied to machines that have to be reversed, an additional button is added to the control station, or for small motors a drum type master switch. In the latter type the hand wheel is turned clockwise to start in the forward direction and anti-clockwise to start in the reverse direction, the central position being the "off" position. Speed regulating control is applicable to motor-driven lathes and similar machines. It enables the operator, without leaving his working position, to start, stop and reverse the motor, as well as

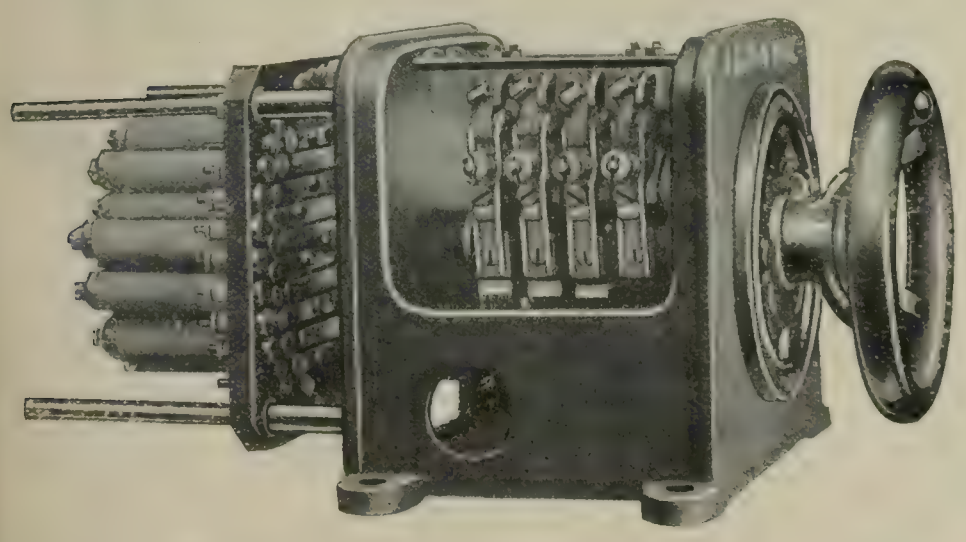


Fig. 4—Detail of Master Controller.

control its speed. It is fool-proof, and demands neither electrical knowledge nor special skill on the part of the operator. The reason for this is that the main portion of the control gear (which is as Fig. 1 for small motors and Fig. 2 for larger motors) is automatic in action, never requires to be touched by the operator, and can consequently be fixed either in a pillar standing on the floor or to any convenient wall or column, not necessarily near to the tool at all (Fig. 3).

The only piece that needs to be attached to the machine is the M.C. master switch, illustrated by Fig. 4. This is small in size and can either be fitted with a hand wheel for direct operation (as shown in the illustration) or with an extended shaft, or geared through a splined shaft to a rotary operating handle movable with the apron of the lathe. The switch has two principal parts: one a drum type switch, with pilot contacts for actuating the controller proper, giving the workman control of starting, stopping, braking and reversing, and the other a field rheostat giving him control of the speed by means of shunt field regulation. The field regulating resistance is a part of the master switch, and is controlled directly by the master handle. The resistance is enclosed and protected by a ventilating case, which allows the master switch to be mounted in any relative position.

Further details of the method of operation of this system of control are given in Pamphlet No. 625 (issued by the Igranic Electric Co., Queen Victoria-street, E.C.), from which the foregoing information and illustrations are taken.

HALF-WATT LAMP FITTINGS.

The new high candle-power incandescent lamps, known as half-watt lamps, demand new types of fittings. It is convenient that the nature of the lamp enables the fitting to be made more attractive in appearance than was possible with the arc lamp, which it is now steadily replacing for certain classes of lighting. This applies equally to the inexpensive enamelled iron type for outside use as to the more elaborate designs for domestic, shop or public building lighting. In the designs shown herewith, while due consideration has been given to appearance, considerable care has also been given to mechanical suitability. In those for outside



Half-Watt Lantern Fitting.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire: also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37, NOBLE STREET, LONDON, E.C.

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

use the enamelling is of good quality and finish, the ventilation is ample, and the lanterns are weatherproof. The special glass used in the more elaborate designs is, we are informed, the result of considerable experiment, and is designed to secure the maximum of



Chain Pendant Half-Watt Fitting.

light with the minimum of glare. Simplex Conduits, Ltd., who are the makers of these fittings, are always pleased to submit designs for special purposes and positions, and have a considerable number of standard types of fittings suitable for use with the new lamps.

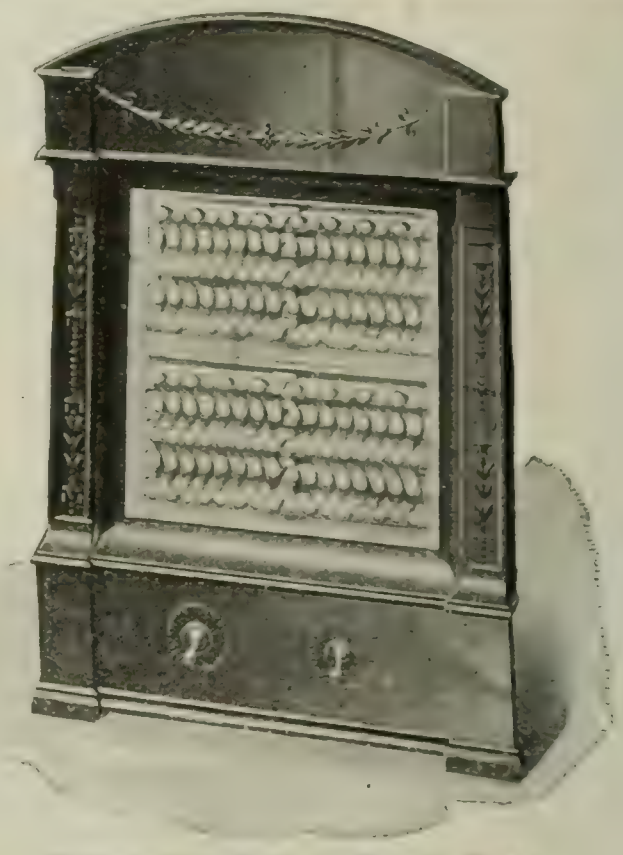
MAZDA "POSTER" STAMPS.

In furtherance of its season's campaign on behalf of the Mazda lamp, the British Thomson-Houston Co. (Ltd.) has just issued a set of six gummed and perforated poster stamps for use on general correspondance. The "stamps," which measure about 3½ in. by 1¾ in., are well printed in colour, and make a vigorous appeal, whether taken individually or as a set. Though each set consists of "Six assorted—all different," to use the phraseology of the philatelist, there is, we gather, no limit to the number of sets supplied gratis to any bona fide applicant, and no factor or contractor can afford to neglect the advertising medium thus placed at his disposal.

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

CARRON FIRES.

A particularly attractive booklet is being sent out to the trade by Carron Co., giving prices, illustrations and particulars of their lamp



Ornamental Pattern Carron Fire.

radiators, convectors and bar fires. We commented upon the design of the latter which the company introduced for last season, this particular pattern having the curved and grooved fire-clay bar

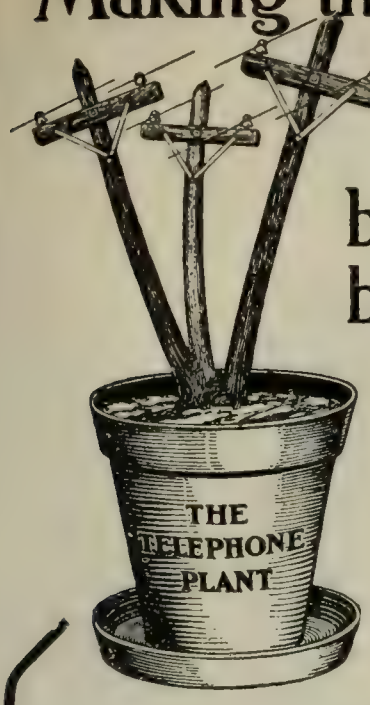


Popular Carron Fire.

in the recesses of which a spirally wound element is laid. This fire is still listed, and can be obtained in ratings from 2 kw. to 3 kw. A new type of fire is also listed in which the element, also a nichrome

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

Making three grow where there were but two before



TRANSMISSION LOSS IS PRACTICALLY NEGLIGIBLE.

Western-Electric

REPEATING COILS
FOR
PHANTOM CIRCUITS
WHICH WILL INCREASE

your available telephone circuits without increasing your outside wire plant.

They will mean a greater efficiency in existing plant with practically no increase in maintenance expense.

You accomplish that which seems impossible. "YOU GET SOMETHING FROM NOTHING"—you make three blades of grass grow where there were but two before.

THE PHANTOM CIRCUIT

makes it possible to transmit three telephone messages at the same time over two ordinary metallic circuits merely by adding repeating coils.

EFFICIENCY

The No. 4006A. Repeating Coil is designed to give the highest possible efficiency for ringing and talking. With one No. 4006A. Repeating Coil connected at each end of a phantomed circuit, satisfactory signalling is assured over any circuit which can be used for satisfactory speech transmission.

WORKS: N. WOOLWICH.

Western-Electric Company Limited.

WE CAN DELIVER FROM STOCK.

3 POLE 15 AMP. IRONCLAD, COMBINED FUSES, SWITCHES AND INTERLOCKED WALL PLUGS.

QUICK BREAK KNIFE SWITCHES (All Sizes).

TOTALLY ENCLOSED MOTOR STARTERS

½ H.P. to 2½ H.P. 120 Volts to 500 Volts.
11 H.P. to 30 H.P. 250 Volts and 500 Volts.
25 H.P. 110 Volts.

ALSO VARIOUS SIZES OF

Porcelain Handle Self-Aligning Fuses, Oil Break Switches, etc.

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J. P. DEVINE CO., BUFFALO.

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Vacuum Drying and Impregnating Plant.

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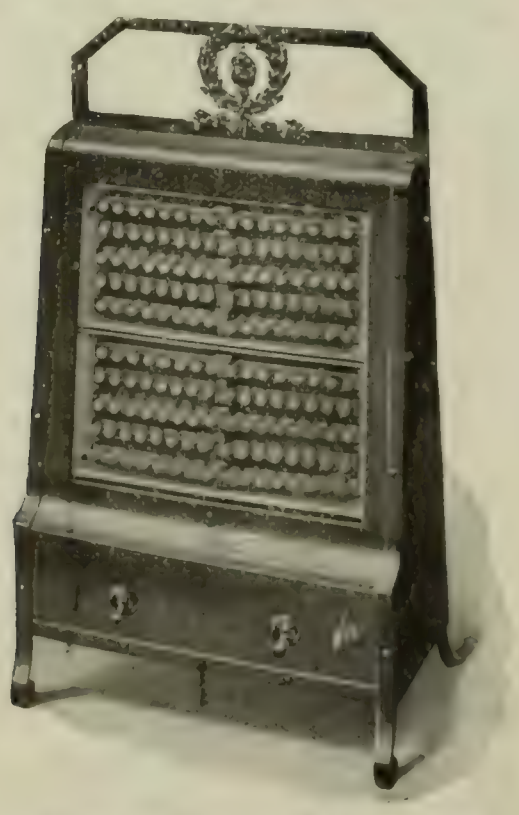
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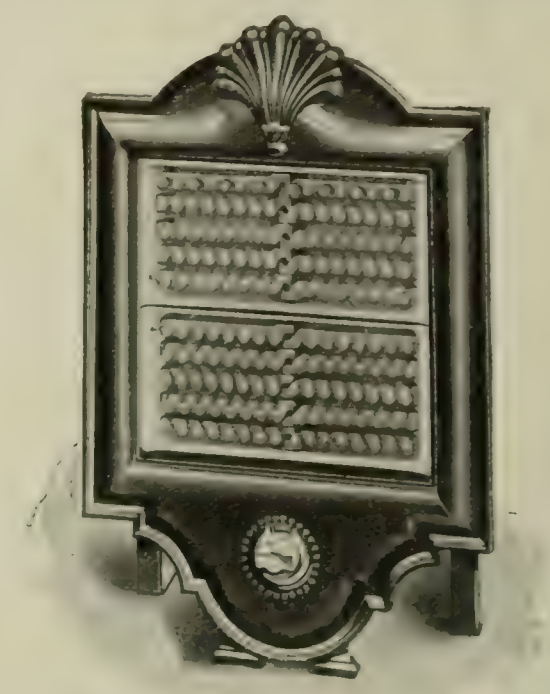
Telegrams and Cables : "CINERARY, LONDON."

Telephone : LONDON WALL 3151.

spiral, is held in position against the fireclay block by a number of fireclay pins. These pins are so fixed that they are superposed and staggered, so that the element when laid in position is zigzagged from one pin to the other. The complete element which has a rating of 1,000 watts, is made up in an iron casting with slotted fixing plugs at each side. The illustrations explain this construction. The ends of the heating element are brought out through bushed holes in the casting to terminals which are supported by and insulated from plugs cast on the back of the frame. In making a complete fire from one to three of these unit elements are employed, and the surrounding framework, which can either be cast iron or sheet metal, is made as ornamental as the user desires. The fires are pleasing in appearance when turned on, the whole of the element and its fireclay supports emitting a bright glow. Four distinct patterns of these fires are offered for commercial and domestic use, and a ship fire suitable for attachment to the deck or bulkhead is also listed. In this fire, illustrated herewith, the connections are neatly taken from the elements to the fourpoint switch in the base of the frame.



PORTABLE PATTERN CARRON FIRE.



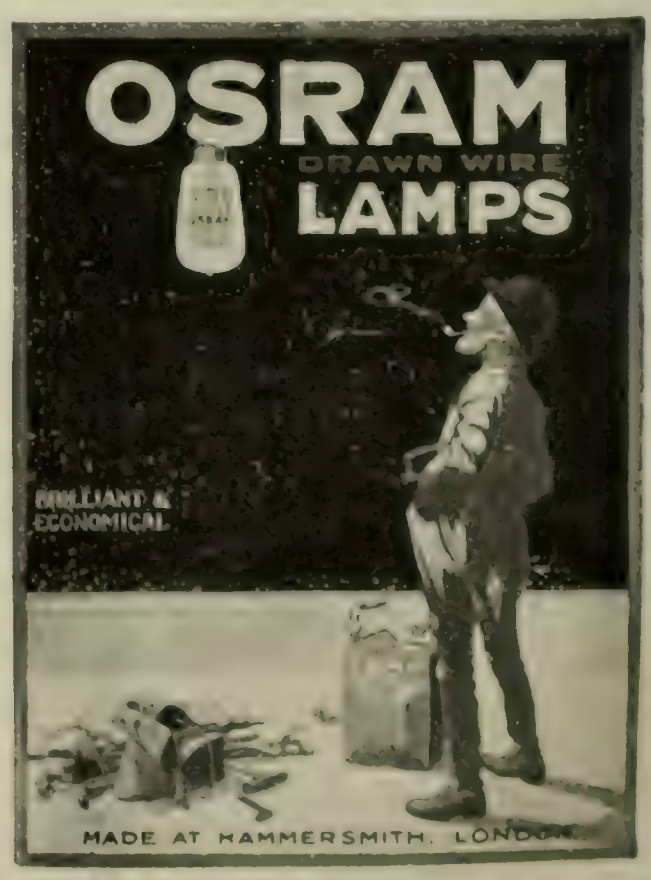
SHIP PATTERN CARRON FIRE.

Immediately behind the switch are two substantial terminals for the incoming wires. The price of the fires range from a popular figure to more expensive ornamental types.

On the cover of the catalogue appears an illustration of a lady's hand touching the knob of a tumbler switch, the slogan being "A touch of the switch does it." This little motto is being widely used in the company's electrical trade literature, and it has, we understand, proved very popular.

NEW OSRAM POSTER.

The latest design for advertising Osram drawn-wire lamps will be admitted to be exceedingly effective. We reproduce here this design in black and white, though it does not do justice to the original, which is strikingly coloured. The background is a rich blue, and the foreground stone colour, making an attractive setting. The attitude of the gas-fitter—a kind of "well, I'm busted" look—adds considerably to the effect of the design. We are informed that posters and show-cards, lithographed in 10 colours, will shortly be available, and in a few days' time a small folder and a quarto size four-page list of Osram drawn-wire lamps will be ready for distribution. In these two latter cases the design is printed in four colours on the outside front page.



Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, NOVEMBER 5, 1915.

THE ROUND TABLE.

By "KVA."

Our contemporary, the "Ironmonger," keeps a tame poet on its staff. In a column of verse in a recent issue the following Limerick appeared :—

Have you heard of the cunning manœuvre
Of Johnson, a plumber's improœuvre ?
He pushed Mrs. J.
Down a drain pipe one day,
And it took twenty men to remœuvre !

* * * *

We hear that the wife of a stoker at a certain electricity works who is serving at the front, and who has x children, remarked recently, when drawing her allowance from the Electricity Department, that she hoped the war would last a "good long time" !

* * * *

A Canterbury correspondent sends us the following :—

"SAME OLD TALE."

Scene : Any and every power station.
Time : 8:15 a.m. Saturday morning.
Relief Shift Man : Hullo, sorry I'm late, old man. Got a cigarette ? Any jobs going ?
Relieved Shift Man : Help yourself, old chap ; one at Falkirk and one at Dewsbury.
Relief Shift Man : Nothin' doin' !

* * * *

At the time of the formation of the Point Fives Association, immediately after the Harrogate Convention in 1912, we registered a vow that we would publish the names of the members until they reached a total of 24. The membership has stood at 23 for a long time past, and there seems no immediate hope of bringing the number up to our figure. We therefore propose to declare the vow off, and from now onwards the names of this cheery band of electricity supply enthusiasts will disappear from our columns. We shall, of course, as in the past, continue to record the good work which they are still doing, and we will award a hotplate to the station engineer who brings the membership roll up to the figure which we thought in a rash moment it would reach shortly after the inception of the movement.

* * * *

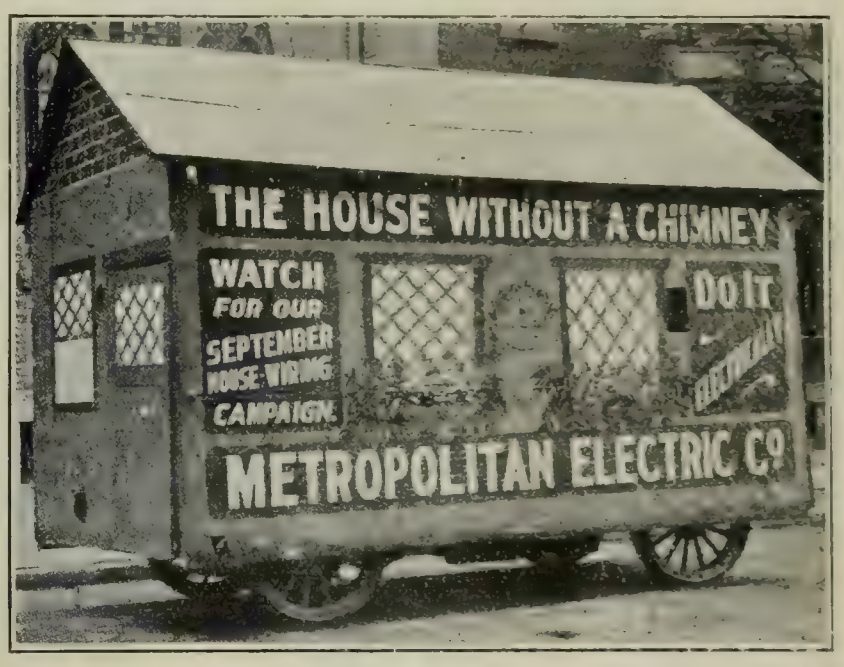
The new Mazda advertising novelty, the revolving lamp shade, is a most effective advertisement. Last week I noticed one in a contractor's window, which was certainly exceeding the speed limit; it was making N^{th} revs. per min. Peeping under the shade, my suspicions were confirmed ; the contractor had put in a carbon filament lamp. Here is an idea for increasing the utility of this advertisement, for which I will make the B.T.-H. Co. no extra charge. If they supply the contractor with two shades and request him to put a carbon lamp under one and a Mazda lamp under the other, the would-be consumer will then get an idea of the difference in the speed at which his meter will go round. A printed card calling attention to this difference would considerably enhance the value of what is, I think, the best lamp advertising novelty put out this season so far.

The Philadelphia Electric Co., which has installed the latest in turbo-generators, a 35,000 kw. machine, also uses 20-60 H.P. steam turbines for the blowers on the stokers in the same station. The small turbine, therefore, still has its uses if only for raising the wind.

* * * *

Apropos of the above, a correspondent informs us that he has been experimenting with the small steam turbine in conjunction with what he terms a "heat steam transformer." He also claims to have "operated experimentally on rotary engines and steam turbines just as long as Parsons, only knowing what had been previously done by 'Hero' and many others," etc. Not content with this claim to priority, he goes on to say that he has made steam without fire under a boiler, and asks us, with him, to "just fancy a steamship or generating station without a funnel or chimney shaft or stokers—only engineers !"

Our correspondent is evidently a reader of the "Round Table," for he concludes in a P.S. by saying : "As our waggish friend KVA. would say—He who shall prove the mysterie what eyes as yet unborn will see."



ONE WAY OF USING THE ELECTRIC BATTERY VEHICLE AS AN ADVERTISEMENT.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), November 9, 1878.]

TAKE NOTICE !

[A humble voice from America.]

I'm the greatest genius going, and the talents I possess
"Are enough to stock the world"—please see the New York Press ;
And I give you now fair warning that I claim in every land
What could, would, should, or might come, of all I take in hand.

I may mention, for example, with my *newest* Telephone,
You'll hear to-morrow's rumours—so let Telephones alone ;
And the Phonograph I'm *making* will take part in a debate ;
I'm *going* to do a lot of things—so you are all too late.

They've contrived Electric Lighting, without consulting me,
On your side the Atlantic ; this is downright piracy ;
But I've taken out a patent that will cover all that's known.
And—when I've *thought it over*—I shall count it all my own.

And, lastly, as a clincher, I've determined in my wrath
To patent Electricity, and Magnetism, both ;
If this is not effectual to answer my intent,
I guess I'll take a patent for my sole right To INVENT.

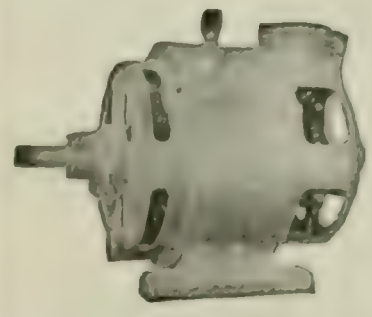
Nov. 5th, 1878. F. UNNEY, Contributor.

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ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

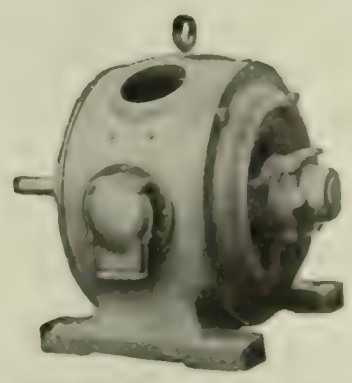
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For Direct Current.



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ALL OUTPUTS, SPEEDS AND VOLTAGES.

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Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."
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Cast
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Sizes made. Amps.	Sizes made. Amps.
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Immediate Delivery. Prices on Application.

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TELEPHONE: *Holborn* 6323.

TUMBLER SWITCH CONTROLS FOR AUTOMOBILES.

BY W. P. M.

There are many ways of arranging switches on automobile switchboards for any given type of car and electrical equipment: and as these ways vary further with the style of car and kind of equipment, it is quite impossible to deal with such matters in a small space. The following notes regarding isolated controls may be of interest nevertheless, and may furnish ideas for use in designing car boards.

The inside lights of a car can be controlled by a two-way circuit with one switch inside and one by the driver. The driver can turn on the lights when the car is about to be occupied, or he can turn them out if they have been left on by the late occupants. If there are one or more electric heaters on the car, they ought to be controlled by pilot switches and the pilot lamp fitted in a conspicuous place. If a two-way circuit is used with the pilot lamp, independent control is given to the driver. Spring on switches let into the door jambs provide for automatic step or footboard lighting.

The uses of the "all or part and off" switch are of interest. If the tail light be on the "part" contact and the head light (or other lights) on the "all" contact, this will ensure the tail lamp being lit when the other lights are on, and also permits of the tail lamp being on by itself. Another use is with the two side lights; the off-side lamp being on the "part" contact, and the nearside lamp on the "all" contact. It is then possible to turn off the nearside lamp when standing, but it cannot be put on by itself. Yet another use is to put the side lights on the "part" contact, and the head light (or lights) on the "all" contact.

A series-parallel-and-off switch will provide for the dimming of the two side or head lamps, when passing through towns or when standing still. The dimming will save current, but the lamps will still give an appreciable light. There is a special control of this type for dealing with three lamps. Two intermediate switches coupled together may be connected to form a changeover switch when two batteries are carried.

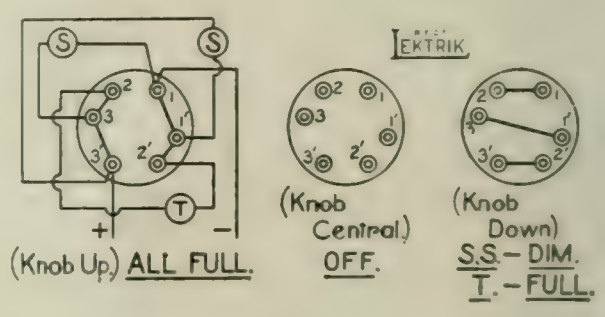


FIG. 3.

Lamp signals to the driver can also be arranged for. Two small lamps on the dashboard and a "Twinob" switch inside the car. Right-hand lamp=*Turn to the right.* Left-hand lamp=*Turn to the left.* Both lamps on when running=*Stop.* Both lamps on when standing=*Start.*

In Fig. 1, the single tumbler D.P. switch puts the current on or off. When the current is on, the special switch on the left puts the two lamps (say, the head or side lights) either in series or parallel, or lights one only, viz., the off-side lamp.

The switch in Fig. 2 is a modification of the original pattern of "Twinob," and allows either the head lights or side lights, or both to be put on. In each of these three cases the tail lamp is also lighted. The dotted circle indicates an additional small lamp by the driver, this (if used) being in series with the tail lamp, and serving to indicate that the latter is doing its work.

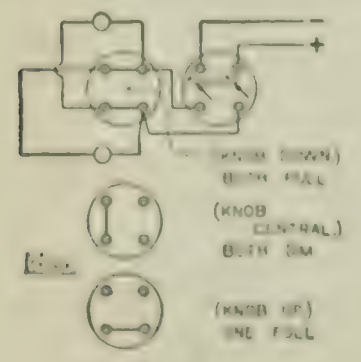


FIG. 1.

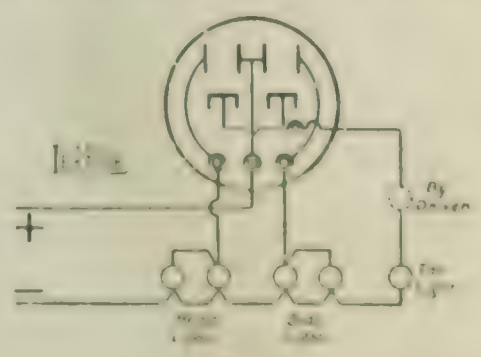


FIG. 2.

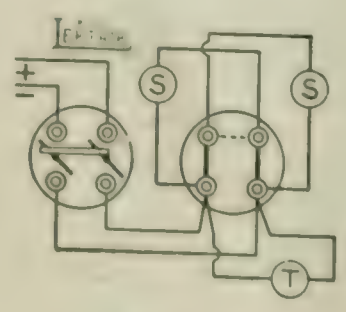


FIG. 4.

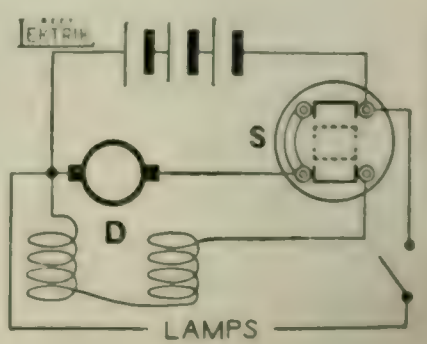


FIG. 5.

In Fig. 3 SS are the side lights, and T the tail light. The switch is a modified "Marvel intermediate," and gives the following control: *Knob up*—All lights in parallel and bright. *Knob central*—Off. *Knob down*—Side lights in series and dim; tail light bright. Obviously, a pilot lamp could be connected in series with the tail light as in the previous control (Fig. 2). When the total current exceeds 2½ amperes, a single tumbler D.P. (or a single-way) switch and a

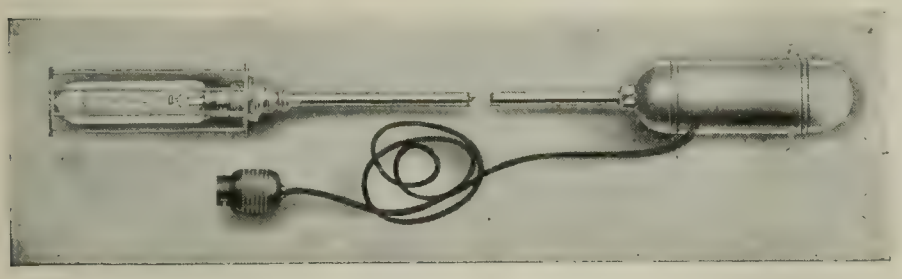
series-parallel switch should be connected to give the same control; as shown in Fig. 4.

The switch S (Fig. 5) is a modified two-way, and might be termed "simultaneous two-way-off," as it has an off position and connects both ways when on. Its use prevents the dynamo being connected to the lights without the battery.

The foregoing diagrams illustrate some "controls" recently brought out by Messrs. A. P. Lundberg & Sons, 477-489, Liverpool-road, London, N., and their special tumbler switches are also referred to elsewhere in this article.

INSPECTION LAMP FOR SHELLS.

A feature of modern shell construction is the minute care with which every part is inspected at each stage of its construction. One of the most important and certainly one of the most awkward of the inspection operations is that of examining carefully the interior of the shell, and to facilitate this operation the B.T.-H. Co. have brought out the very serviceable hand lamp shown in the accompanying illustration. A stout brass wire guard with top and bottom plates forms a "squirrel cage" accommodating a tubular lamp of size not exceeding $4\frac{7}{8}$ in. by $1\frac{1}{2}$ in. diameter. This guard (which can be removed if required) is carried in the usual manner by a bayonet lampholder, which is mounted on a brass carrier rod. At the outer end of the latter is a boxwood handle, incorporated with which is a soundly constructed push-bar switch. The lamp is supplied as illustrated, ready wired with 12 ft. of 35/40 workshop flex to a cocus adapter

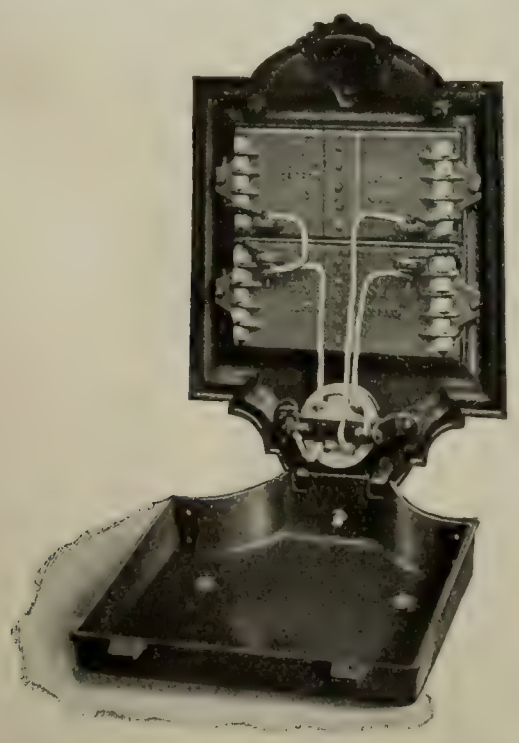


Inspection Lamp for Shells.

for connecting to existing electric light installation. In every respect this useful accessory is built to withstand hard workshop service, and its use should save a great deal of time besides leading to increased and better output. This inspection torch can be supplied in any length required. An important point is that where an ordinary electric light supply is not available, the new inspection lamp, equipped with one of the many types of Mazda miniature bulbs, can be worked from a low voltage accumulator or even dry cells. It can, therefore, be effectively used in every munitions workshop.

CARRON FIRE ELEMENTS.

In our last issue we described the pattern of Carron fire which has been introduced for the coming winter season. The fires are of



Back View of Carron Fire showing Interconnections.

interest on account of the novel form of element which is used in them.

With regard to the construction of the elements, we are informed



The "SIMPLEX"

Galvanized Watertight Lampholder.

Ordinary brass lampholders are unsuitable for outside wiring: they are subjected to the vigorous attacks of impurities in the atmosphere and quickly corrode.

The "SIMPLEX" Watertight Lampholder is strongly made of galvanized steel; easily wired and assembled; even when installed in the most exposed places it will last a life-time.

Particularly suitable for use in Station Yards, Cellars, Lavatories, Mills, Factories and other situations where the conditions are severe.

Large Stocks held at all our Branches.

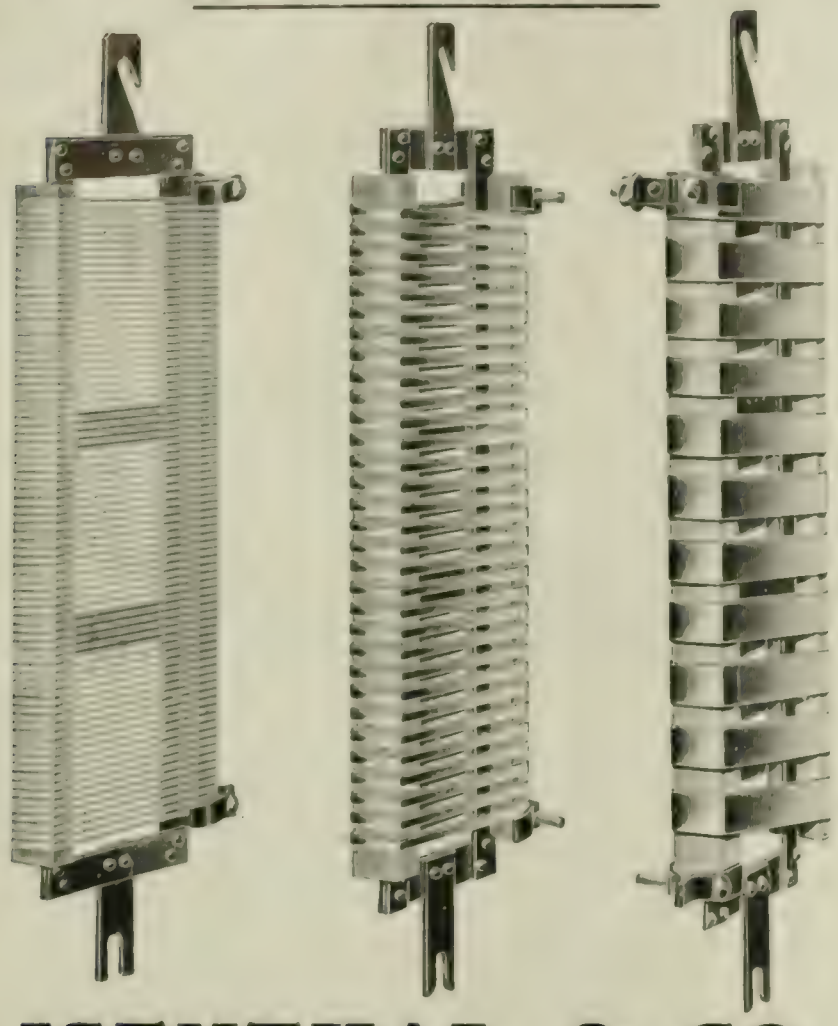
Simplex Conduits Ltd.

Garrison Lane, Birmingham

London—
113-117, Charing Cross Rd., W.C.
Manchester—
16, Corporation Street.
Glasgow—
72a, Waterloo Street.
Bristol—
11, Denmark Street.
Newcastle—
61-65, High Bridge.
Leeds—
6, White Horse Street.
Liverpool—
96, Whitechapel.
Swansea—
14, Heathfield Street.
Cardiff—
4, Westgate Street.
Aberdeen—
1, Crimon Place.

RHEOSTATS

NEW LIST IN THE PRESS.



ISENTHAL & CO.

(DEPARTMENT 4).

DENZIL WORKS, NEASDEN, LONDON, N.W.

Contractors to the Admiralty, War Office, India Office, Crown Agents, Colonial Governments, &c.

by the company that these consist of small cast-iron dishes or frames porcelain enamelled white inside. On these dishes are mounted five pairs of special fireproof formers, which are fixed in the centre by means of screws, and the ends project through slots at the end of the castings, thus being entirely free to move—or, in other words, to allow of expansion and contraction of the frame without fear of fracturing the formers. Each former is supplied with a series of over-hanging flanges or buttons, and the resistance coil is laced



Front View of Carron Fire, showing Construction of Element

around these in such a manner that the expansion of the coils is taken up equally, avoiding sagging. We understand that it is impossible for the coils to fall off owing to this unique construction, and that the coils are in no way damaged by being pinned or fixed in position with wires. The air has a free access all round the coils, and they therefore attain a maximum radiant heat within a few

INGRAM'S

Indiarubber Gloves & Gauntlets

FOR ELECTRICAL PURPOSES.

NON-CONDUCTING

BEST QUALITY INDIARUBBER.



Made in ALL SIZES and ORDINARY STOUT SUBSTANCES to suit varying Voltages.

PRICES ON APPLICATION.

Manufacturers—

J. G. INGRAM & SON, Hackney Wick, LONDON, N.E.

moments of being switched on. Owing to the white porcelain enamelled interior of the element frame, a rich red glow of heat is obtained without the use of a reflector or other metallic backing, which, in addition, would require repolishing.

As the standard rating of the elements is 1,000/1,100 watts, a large gauge wire can be used in the coil, a fact which should make for great mechanical strength and consequently long life in the heating elements.

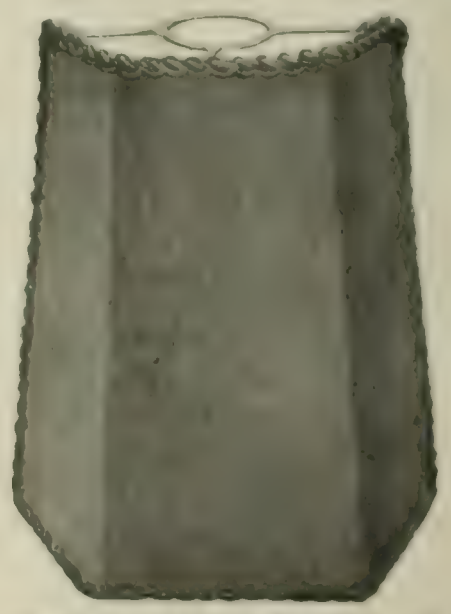
The coils are guaranteed by the makers for three years, but they claim that there is no reason why the elements should not last many years longer if they are not abused or roughly treated.

As these elements are fitted close together in the fires, it will be clear that no dust or free matter can collect in the base of the frame amongst the connections and switches.

It would doubtless be of interest to state that water can be thrown on to the "Carron" fires without in any way damaging them, and the makers have had a No. 226 on circuit in their test room which for the last five months has been daily subjected to a swilling of water whilst on circuit; it is, we hear, still giving every satisfaction.

"EDISWAN" ANTI-ZEP. SHADES.

When the regulations for reduced lighting were first put into force the majority of tradespeople and commercial houses complied with them by using shades of an extremely temporary character. Many



Anti Zep. Screen Pattern Shade.

of these were very dangerous and must have occasioned a number of fires. Since the regulations have been made even more drastic than before, and since it is also apparent that they are likely to

SLATE

INIGO JONES & CO.,

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GROESLON, R.S.O., NORTH WALES.

Slates Drilled & Shaped to Specification.

Manufacturers of every description of

SLATE WORK for ELECTRICAL ENGINEERS.

Slate Masons, Turners and Enamellers.

FERRY

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WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

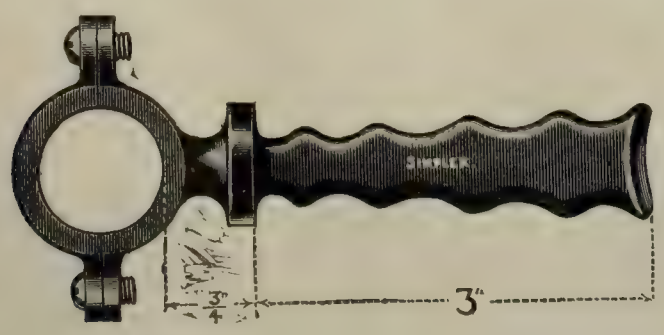
LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

remain current for some time, it is important that the shading of the lamps should be of a permanent nature, and should confer complete immunity from fire risks. The Edison & Swan Co. are, therefore, offering a line of anti-zep. shades which, while complying with the regulations, do not disfigure but rather add to the artistic appearance of the lighting unit both by day and by night. The prices of the shades are also quite reasonable. We gather from leaflet No. SS 3,121 that three shapes of shade are offered. Two of these are of the screen pattern—that is, they only partially enclose the lamp, one being rectangular and the other shell shaped, and the third is a conical shade 8 in. across the widest part. The prices range from 2s. 4d. to 2s. 9d. each. The shades comprise covered wire frames, and are filled in with green sateen trimmed gimp to match. The fact that so many areas, both inland and on the coast, come under the restricted lighting regulations should ensure a brisk demand for these shades.

CONDUIT SPACING SUPPORT.

Particulars are being circulated by Simplex Conduits of a useful accessory for conduit wiring which is designed to hold the tubing clear of the wall to which it is fixed. In certain situations where



damp and free moisture run down the walls it is desirable in all good installation work to keep the conduit clear of these wet surfaces. The device illustrated herewith is designed for securing on the surface of brick, stone and cement walls. The bolts should be grouted into the wall and the hole filled with Keene's or similar cement up to the shoulder. When fixed in this manner the conduit will be spaced clear of the wall a full $\frac{3}{4}$ in. They are made in seven sizes from $\frac{5}{8}$ in. diameter conduit to 2 in. diameter. The supports are supplied with galvanised finish at an extra charge on the enamelled prices. Where the supports are used for vertical conduits carrying heavy cables collars should be provided to prevent the conduit slipping through the support.

A NEW DESK PAD.

Siemens Brothers Dynamo Works, Upper Thames-street, E.C., are issuing a neat and convenient form of desk pad. If comprises an art metal base on which is placed a block of scribbling leaves, which are punched with holes to secure them to the base. They are, however, held firmly in place by a spring clip at the upper end of the scribbling block. This advertising novelty, issued on behalf of the now famous Wotan lamp, will, we are sure, be a hard-worked desk companion of the installation and contracting trade during the coming season. There should be no need to worry about stationery for making rough notes, for the company kindly offer to supply refills. To quote the old-time theatrical gag, "Come early to avoid the crush."

"MAGNET" ELECTRIC FIRES.

A pattern of electric fire which possesses a number of distinctive features is that marketed by the General Electric Co., under the above trade name. It was introduced last season, and we understand is in considerable demand now that the cold mornings and evenings are with us once again. The fire is fitted with a novel form of heating unit or panel which is built up in standard sizes, each loaded to 500 watts. The spiralled nickel-chromium element is laid in deep grooves in a curved fireclay block which is of standard size for each complete 500 unit. Each block is secured to horizontal

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

supporting members in the frame of the fire, there being a minimum contact surface between the block and the frame in order to avoid an undue heating up of the frame by conduction currents. The use of a curved element in a curved frame also presents the entire surface for effective use in the desired directions, *i.e.*, outwards and upwards.

A feature of the fire which should appeal to users is the employment of solid copper rod for the interconnections between the elements, the control switches and the terminals for the incoming flexible leads. The makers claim that this construction eliminates the risk of loose connections or contact between the internal conductors and the frame of the fire.

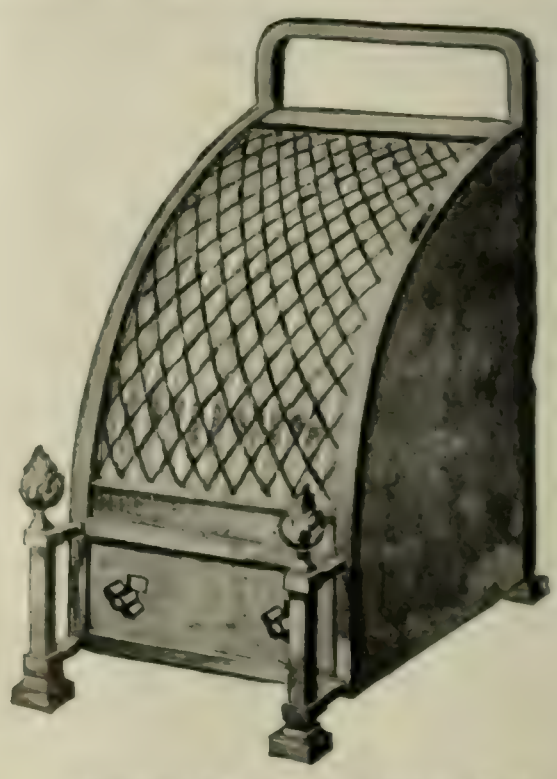


2 KW. MAGNET FIRE SHOWING USE OF TRIVET OVER HEATING ELEMENTS.

The complete fire, as the illustrations herewith show, is of neat and artistic appearance, and it is being offered in sizes from 1,500 to 3,000-watt rating. A popular priced fire is listed, and the more expensive designs containing the standard panel type of heating element are, of course, fitted in highly ornamental polished brass or copper frames. The fires are all conveniently portable, the carrying handle being clear of the hot air currents, and therefore always cool enough to hold. The 2 kw. size of fire is 15¾ in. high by 12½ in. wide by 6½ in. projection.



2 KW. MAGNET PANEL TYPE FIRE.



"ROCHDALE" DESIGN MAGNET FIRE.

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ELECTRICAL, MECHANICAL & GENERAL ENGINEERING TEXT BOOKS & TECHNICAL WORKS.

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H. K. LEWIS & Co. Ltd., 136, GOWER STREET, and 24, GOWER PLACE, LONDON, W.C

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, NOVEMBER 12, 1915.

THE ROUND TABLE.

By "KVA."

The latest in electric fires—The "Veriott."

* * * *

Yet another anti-Zep shade has reached me, this time from Dick, Kerr & Co. When not in use dimming the brilliance of Britannia lamps it makes a good sugar or sand scoop.

* * * *

If every officer returning from the Front receives a warm welcome from his wife and from an electric fire at the same time he is a lucky fellow. The C.L.E.S. Co. think he ought to, and are not afraid to say so. (*See* p. 60.)

* * * *

Mr. F. W. Purse, City Electrical Engineer, Carlisle, and an ardent "Point Five," has sent me the following letter :—

"My Dear KVA.—You appear to have been over-rash in your rashness this week in discontinuing the list of "Point Fives." You commenced this immediately after the Harrogate Convention, and very appropriately enough the Harrogate Corporation have come into line as "Point Fives," which makes a list of 24, thus Harrogate started and Harrogate completes. It is the introduction of it at Harrogate at the present time which is specially noteworthy, coming as it does after many attacks on the "Point Fives" system, particularly the rateable value, and now we have an ex-president fully taking it up."

* * * *

THAT PEAK LOAD PROBLEM.

We've hustled for power contracts and landed a lot as well,
We've hunted the country over for fancy outfits to sell,
We've peddled electric irons, we've boosted electric pots,
And gathered up fans and sold 'em in regular carload lots,
We've hinted and preached and threatened and advertised year on year
And talked to the folks like Uncles and written 'em plain and clear,
But in spite of our ceaseless efforts, our labours almost sublime,
Full half of our power units are idle most of the time.

And that's the fault of peak load
(It never is a weak load)
Which jumps upon the backs of us at certain times of day
A bold and not a meek load,
A make-you-swear-a-streak load,
Oh, if it weren't for peak load our labour would be play.

The sun goes down in the western sky and the stars come into sight,
And the homes of the busy city are drawing on us for light,
The theatres glow in glory, the signs and the street lights glare,
And here at the central station we've worry enough to spare,
For the straining boilers trouble, the labouring engines throb,
And we start up the whole equipment to handle the heavy job,
It's trouble enough on week days to manage the problem well,
And then when Saturday Night comes round—say SATURDAY night is Hell !

And so we cuss the peak load,
The big load, the freak load,
Which jumps upon the backs of us at certain times of day,
A strong and not a weak load,
A make-you-swear-a-streak load,
Oh, if it weren't for peak load our labour would be play.

If only the load were steady each hour of the twenty-four,
We wouldn't be fretting and fuming and figuring any more
On boosting the "off hour" business by every kind of scheme ;
But the peak load still is with us and life is no idle dream.
For all of the new inventions we've brought to the public's view,
Electric curling irons and vacuum cleaners, too,
For all our advertising, our urging in prose and rhyme,
Full half of our power units are idle most of the time.

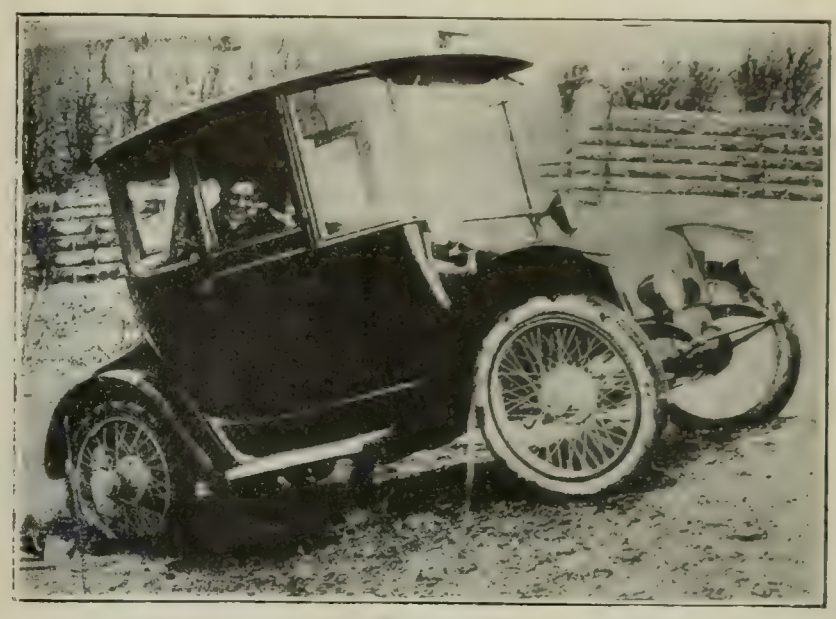
And that's the fault of peak load
(It never is a weak load)
Which jumps upon the backs of us at certain times of day,
A not at all unique load
Yet, in a way, a freak load,
Oh, if it weren't for peak load our labour would be play.

Berton Bradley, in "Power."

According to an announcement in a contemporary, the Engineering Institutions Volunteer Training Corps has "sections for shooing parade at the miniature ranges." Surely these must be the farriers !

* * * *

I am authorised to state, in answer to a correspondent, that the horse (sic) power developed by the new Mazda revolving lamp shade is being measured by the National Physical Laboratory. The results will be available for publication after the war.



A Detroit Electric Coupe climbing a "Pimple."

While on the subject of advertising novelties, I must mention the telephone pad which the Park Royal Engineering Works are sending out to the deserving in the industry. Personally I have given up recording telephone messages, but our overworked accountant has clipped the pad to his 'phone and is now supremely happy. Unlike many of its pad-ecessors this pattern can be attached to the telephone, and is at the correct angle for writing on without acrobatic or other mathematical expressions. * * * *

A correspondent has kindly called my attention to the following verse from the "Song of the City Clerk," reproduced in the first number of "The Two Asuwere," the magazine of the 2nd Battalion 1st Surrey Rifles. Evidently the clerk is now with the Forces, and no longer travels by L.C.C. :—

Aubrey Llewellyn Coventry Fell,
Your day is done, your race is run.
You'll take no fares from me.
Your yellow cars may jamb
From the City to East Ham,
I no longer care a ——
I am free !

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), November 16, 1878.]

Dynamo-Electric Machines.—The cry is, still they come ! It would be a great mistake to suppose that we have seen the last of the really important improvements to be made in this direction. The whole question in relation to these machines is at the present moment being very carefully considered by several practical electricians, who have also a due knowledge of electrical theory.

Novelty in Telegraph Wire.—The National Tube Works, at McKeesport, have succeeded in making a novelty in insulated telegraph wire which bids fair to ensure the doing away with the unsightly telegraph poles in the streets of our cities. It consists in rolling an iron tube around a glass tube which insulates one or more copper wires. The new wire is to be used in underground lines in Philadelphia. It is claimed for it that it is better insulated than the ordinary telegraph wire suspended in air, and that, therefore, less battery power will be needed than with the present system. [We greatly question the value of this novelty.]



No. 39.—Direct Current combined Motor Starter and Field Regulator, with No-Volt Release and predetermination of speed. Fitted also with Overload Release when desired.

'IGRANIC'

A.C. STARTING SWITCHES.

IGRANIC ELECTRIC CO., LTD.,
147, Queen Victoria Street, London.

No. 32.—Improved 3-Phase Rotor Starter for Slip Ring Motors ; starts the motor with resistance in all three phases of the rotar circuit. All parts interchangeable, automatic protection against overloads and voltage failure.



SIEMENS

ELECTRIC MOTORS



Part of small Motor Shop, Stafford Works.

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Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."
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BRISTOL—30, Bridge Street. | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street. | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
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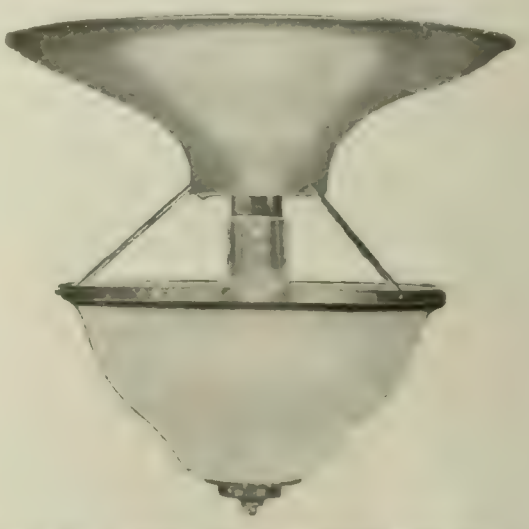
LIGHT AND MUNITION WORK.

Nine out of every ten British factories are now engaged in the production of "munitions of war" in one form or another. Labour is being encouraged to put forth its utmost efforts; shops are being re-organised to hasten the progress of orders; new plant is being installed to cope with the exhaustless demands of our armies. Overtime is being worked everywhere, and all over the country there are factories in full swing night and day. These manufacturers often overlook an item which might make a difference of as much as 10 per cent. in the output, and that is good lighting.

Artificial light can be made practically as good as daylight, and it may even be made better than daylight where a factory is badly provided with windows. Some time ago the Home Office appointed a Departmental Committee to study this question of factory lighting, and in an interim report the committee notes that witnesses in general admitted the effect of improved lighting in increasing both the quantity and the quality of the output. In one case the output was from 12 to 20 per cent. less during the hours of artificial lighting, and this showed that the lighting was wastefully bad. In another case the installation of an improved system of lighting increased the output by 11·4 per cent. Good lighting, of course, reduces the risk of accident, and the committee found that the probable accident rate per hour was about 40 per cent. higher for artificial than for natural lighting.

The more closely artificial lighting gets to good daylight, the fewer the troubles and delays due to accident. The Accidents Offices' Association, which includes most of the insurance companies interested in workmen's compensation, states that "the effect of deficient or bad lighting upon a risk is distinctly prejudicial in varying degrees from the accident point of view."

Good factory lighting in the present circumstances may be said to have become a national necessity. Here are the conditions of good lighting laid down by the committee: (1) Adequacy. (2) A reasonable degree of constancy and uniformity of illumination over the necessary area of work. (3) The placing or shading of lamps so that the light from them does not fall directly on the eyes of an operator when engaged on his work, or when looking horizontally across the workroom. (4) The placing of lights so as to avoid the casting of shadows on the work.



G.E.C. ATMOS SEMI-INDIRECT FITTING.

These conditions appear simple enough. But in practice it is not easy even to decide what is "adequate" in the way of lighting. Every class of factory and every class of work has its own standard of adequacy, and it is a complex matter to select the size of lamps and the design of reflectors, and to arrange the positions of the lights so as to give adequate uniform illumination, without glare or troublesome shadows.

We may remind our readers that the General Electric Co. (Ltd.) has developed the manufacture of the electric lamps and fittings required for the most efficient lighting. The main industrial uses of the Osram lamp are in the local lighting of tools, and in the illumination of offices, corridors, stores, testing laboratories and other auxiliary sections of a factory. Larger sizes of these lamps are also used in the general illumination of bays and workshops. For these higher candle-powers, however, economy is enhanced by the use of the Osram-Atmos lamp, which is of the half-watt type. These last-named lamps are available only in the larger sizes, from 200 to



G.E.C. ATMOS REFLECTOR FITTING.



G.E.C. ATMOS SEMI INDIRECT FITTING.



G.E.C. ATMOS WORKS LANTERN.



Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps, Hythe Road, Willesden, N.W.

300 c.p. upwards. They are a highly efficient source of general illumination, and it is stated that they maintain their candle-power throughout a long life, and, in fact, give the brilliancy of the arc lamp with all the advantages of ordinary incandescent lamps and the added one of much greater economy. All these lamps are, of course, capable of withstanding vibration and other shocks incidental to factory use.

For use with these lamps the General Electric Co. has produced an extensive range of reflectors and fittings specially designed for factory purposes. The variety of these reflectors and fittings is most extensive, and to assist prospective users in their correct employment the illuminating engineering department of the company is at disposal. After a study of the special conditions in the factory, the department specifies the degree of illumination which is necessary to obtain the highest efficiency in each part of the factory, and, at the same time, indicates how that degree may, with certainty, be attained.

A new leaflet has just been issued dealing with a number of G.E.C. industrial lighting units suitable for use in different positions in factories and workshops, special attention having been given to ensure that the present lighting regulations are complied with. Among the designs to which attention is particularly directed is one known as the G.E.C. munition shop pendant, a G.E.C. shell inspection handlamp, as well as some new and useful reflectors, both direct and semi-indirect, for Osram-Atmos Lamps. From this leaflet the adjoining illustrations have been taken, and copies of it may be obtained at the head offices of the company, 67, Queen Victoria-street, London, E.C., or branches in the chief provincial centres.

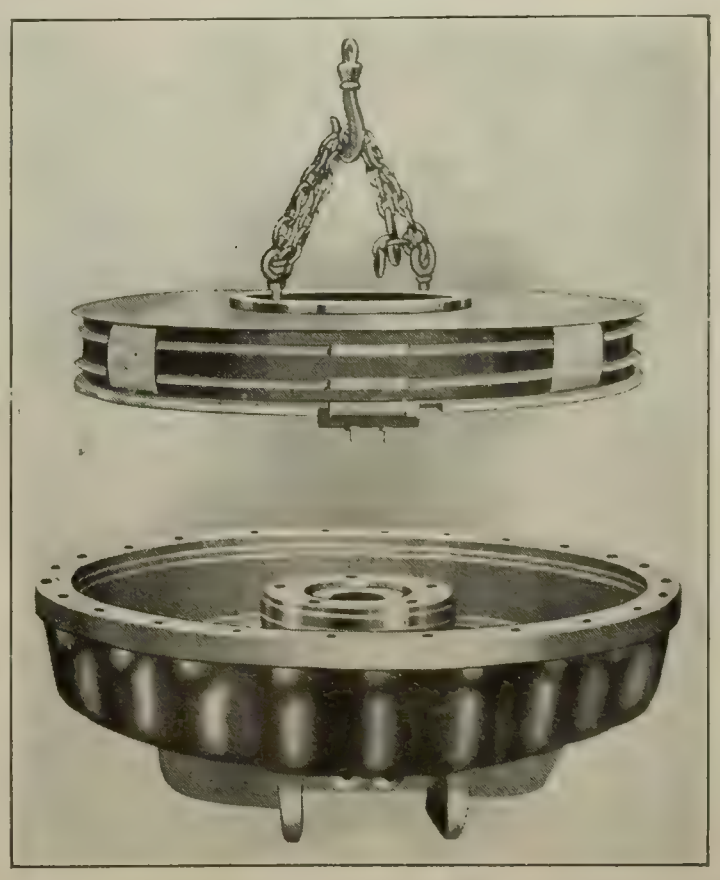
LIFTING MAGNETS.

As a labour-saving device the lifting magnet ranks next to the crane in the iron and steel industry. In handling such materials as pig iron or heavy scrap, one magnet can, and has, displaced as many as 50 men, indeed some kinds of scrap can only be dealt with at all by this means, without having to break it up into small pieces.

As an illustration, we quote from the letter of a user of an Igranic magnet, and more unfavourable conditions for a magnet it would be difficult to imagine. The magnet was 36 in. diameter, and used for handling chips, rail ends and chippings.

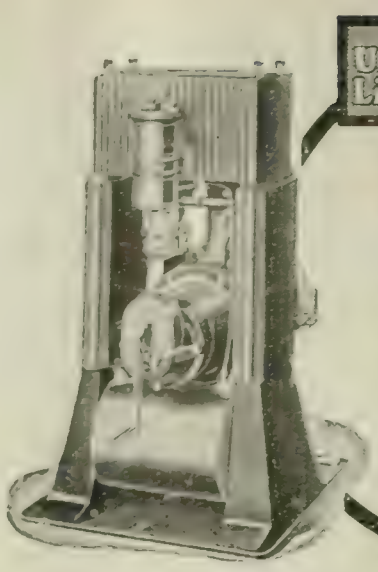
We use the magnet only 20 hours per month. It used to take 10 men 10 hours to load a truck of chippings at a cost of £4, whereas, with magnet, including power, depreciation, men, &c., it costs us 8s. per truck, and we load it in two hours' time.

In other words this 36 in. magnet working only 240 hours per annum, accomplishes a saving of £3. 12s. per truck, and the number of trucks loaded per year is 120. The total saving, therefore, is



DETAIL OF IGRANIC LIFTING MAGNET SHOWING COIL RAISED.

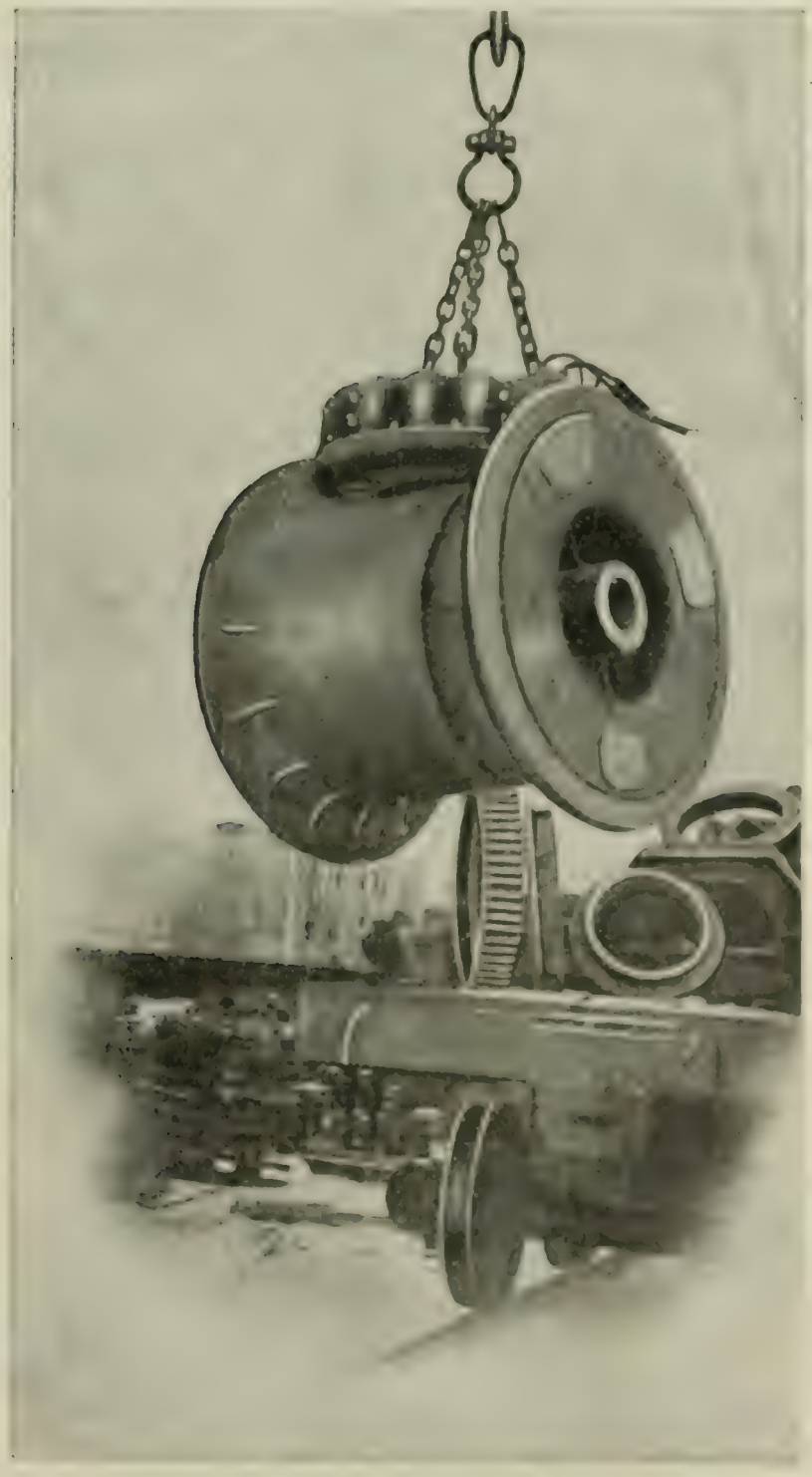
Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
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UNI-LECTRIC Lighting Plant
NO BATTERIES. NO SWITCHBOARD.
Standard 110 volts—direct current.
Output 500 to 750 watts.
A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.
WRITE TO-DAY FOR COMPLETE DESCRIPTION
WALTER D. FAIR & CO.
43 LEICESTER SQUARE
LONDON, W.C

£432 per annum. The cost of the magnet is about one-third of this amount.

Other instances of somewhat similar economies are constantly appearing, and the evidence seems perfectly convincing of the economy effected by the use of a properly designed and constructed lifting magnet for handling magnetic material. It is a significant fact that the general proportions and arrangement of lifting magnets have changed but little since they were first introduced. The structural details, however, have changed radically, and this emphasises the fact that the difficulty in magnet design has not been to proportion the magnetic and electric circuits (important as this is), but in the development of a machine which will remain operative under the severe usage to which it is ordinarily subjected.



Ironic Magnet lifting Steel Billets.



Ironic Magnet showing lugs for lifting pins cast with the casing.

It is not an exaggeration to say that no electrical machine in the steel or any other industry is called upon to meet the service conditions of the lifting magnet.

When handling pig iron the magnet is dropped on to the pile, often at the full lowering speed of the crane, 500 times a day; it is out of

Making three grow where there were but two before



TRANSMISSION LOSS IS PRACTICALLY NEGLIGIBLE.

Western-Electric

REPEATING COILS
FOR
PHANTOM CIRCUITS
WHICH WILL INCREASE

your available telephone circuits without increasing your outside wire plant.

They will mean a greater efficiency in existing plant with practically no increase in maintenance expense.

You accomplish that which seems impossible. "YOU GET SOMETHING FROM NOTHING"—you make three blades of grass grow where there were but two before.

THE PHANTOM CIRCUIT

makes it possible to transmit three telephone messages at the same time over two ordinary metallic circuits merely by adding repeating coils.

EFFICIENCY

The No. 4006A. Repeating Coil is designed to give the highest possible efficiency for ringing and talking. With one No. 4006A. Repeating Coil connected at each end of a phantomed circuit, satisfactory signalling is assured over any circuit which can be used for satisfactory speech transmission.

WORKS: N. WOOLWICH.

Western-Electric Company, Limited.

doors day and night; it is used in rain and snow; it may at times be entirely submerged; and is used by men more interested in big tonnage than in the care of the magnet. The Igranic Electric Co., Ltd., claim that their Igranic magnet was designed and constructed with all these conditions in view, and that their magnets are daily performing such work, and furthermore they state that they have yet to hear of even an hour's delay in operation due to the failure of one of their magnets.

They claim that repeat orders from large steel works in this country and abroad, where their magnets are working side by side with other magnets, indicate that the operating engineers agree as to the reliability and dependability of the Igranic lifting magnet. The structural details which contribute to these excellent performances are :—

1. Coil positively anchored to magnet frame to prevent relative movement.
2. Coil and surrounding space thoroughly impregnated under a combined heat-vacuum—and later—pressure system rendering the coil waterproof and eliminating pockets of dead air.
3. Fireproof materials throughout.
4. Coil shield of manganese steel.
5. Three-point suspension by lugs cast integral with frame.
6. Pole shoes centred on turned shoulders to prevent the swinging side blows from breaking the through bolts.
7. The use of through bolts for securing shoes.

There are other points, but the foregoing are of vital importance. In dealing with 1 it should be remarked that the Igranic magnet is wound on a steel spool, so that all spool material is active, forming part of the magnetic circuit. The coil shield used on these magnets (which, with the pole shoes, forms the under surface of the magnet) is of special ribbed manganese steel, and the use of this material is noteworthy. Coil shields are often made of brass or phosphor bronze, but with the usage to which the magnet is subjected, this becomes easily dented, and the coil is permanently injured. Also these shields under constant blows, become riveted into the case so that removal becomes very difficult. Manganese steel is the one material which withstands this service, and being non-magnetic, this material is used for the coil shields of the "Igranic" magnet. It should be noted that not all mixtures of manganese steel are non-magnetic, but that used in Igranic magnets is.

With regard to suspension lugs, it has been conclusively proved in practice, that eye-bolts are inadequate, as they may soon break off. In the 52 in. "Igranic" magnet heavy lugs are cast integral with the casing, and a pin is used for the chain. If by any chance a pin wears unduly or breaks, it is a simple matter to knock out the old pin, and fit a new one, whereas a broken eyebolt involves drilling out and retapping.

As illustrating the extreme robustness of "Igranic" magnets, we are informed of the following well-authenticated cases of "Igranic" magnet abuse: A magnet was installed in a works, a part of which became flooded. The magnet was under water for 10 days. At the end of that time the water subsided, and the engineers connected the magnet up again and successfully went to work with it, as though nothing had happened. Its efficiency was unimpaired. In another works is installed a 43 in. "Igranic" magnet designed for 125 volts, and which for over a year has been operating successfully on 220 volts. The magnet, of course, heats up considerably, but is simply allowed to cool off, and then starts work again. In another instance a 43 in. "Igranic" magnet was directly in a fire, which gutted the whole of the adjacent buildings. The magnet must have been subjected to intense heat. It was salvaged after the fire, and put into service with no attention except the renewal of some bolts holding the cover plate in place.

The Igranic Electric Company are, naturallly, enthusiastic in recommending their lifting magnet for hard service, and perhaps engineers will think this confidence is justified.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37, NOBLE STREET, LONDON, E.C.

A TEMPORARY TRAVELLING CABLE WAY.

A radial travelling electrically-operated cableway of 1,790 ft. span, erected last year, according to the "Engineering News," is now in operation at the Goldfield Consolidated Mines Co., Goldfield, Nev., for the transportation of railings from a large dump to the mill for re-treatment. The tailings have been dumped at the present location since 1909 and cover 75 acres. The radial travelling tower of the cable way is 125 ft. high, and the head tower is 160 ft. high. The tail tower travels through an arc of 109 deg. 40 ft. about the head or pivot tower. Owing to the uneven nature of the ground over which the rail tower travels, it has been found necessary to build a steel trestle in some places to carry the trackway. In the remaining portion the tracks are laid on the ground. The cableway operates a four-line 3 yd. Andresen-Evans bucket, weighing 9,800 lb. The cable way is operated 16 hours per day in two shifts and delivers 1,000 tons to the mill, which runs continuously to handle this amount. The grab bucket digs the deposit, conveys and dumps it into a receiving hopper in front of the pivot tower, at a considerable elevation above the tower base. This hopper is mounted to move radially with the cableway travel. From this first receiving hopper a trough on a radial line delivers to the final receiving hopper.

AN ATTRACTIVE FIRE POSTER.

The County of London Electric Supply Co. have sent us an advance proof of their latest poster, designed to boom business in electric fires. The reproduction herewith gives a fair impression of the original photograph, which conveys an excellent idea of the warmth of the Belling fire, and also the warmth of the welcome which the returned soldier is receiving from his sweetheart. The design is not only patriotic, but is rather nearer to life than many of the attempts we have recently seen in this direction. The posing, too, is both artistic and natural, two facts which further commend the illustration as a useful piece of electrical publicity material.

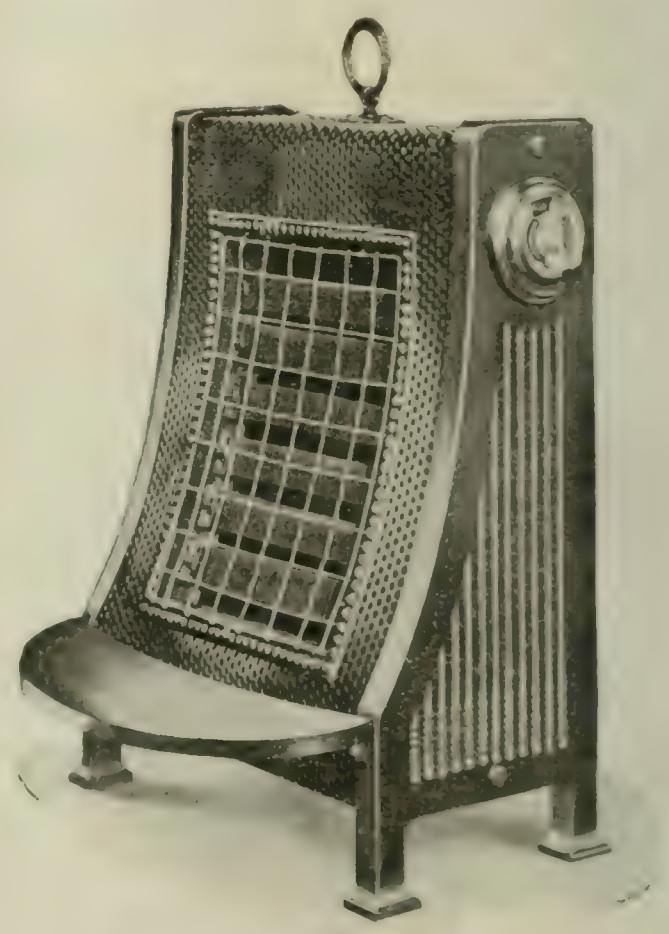


A Warm Welcome at a Warm Fire.

THE "VERIOTT" ELECTRIC FIRE.

Many of our readers will recall the fact that Messrs. Crompton & Co. have been in the market with electric fires for some time past. Interest, therefore, attaches to an entirely new and distinctive design of fire which they are now putting on the market. The adjoining illustration shows a half side view of this fire, and it will serve to explain the general lines of the construction. The fire is made in one design only, and the standard finish is nickel-plated centre in repoussé pattern Louis-Sieze style, ornamental panelled cast-iron ends and perforated steel body, stoved black enamel. At the front of the fire is a nickel-plated detachable trivet shelf. It will be noticed that there is a 3-heat 4-point control switch recessed within the frame of the fire, and also a ring handle is furnished for carrying purposes.

The elements are mounted in six horizontal rows in a recessed metal



Half Side View of "Veriott" Fire.

reflecting chamber, which is entirely shut off from the frame of the fire; it is only open at the front. The elements themselves are of the mica former pattern, and are wound with thin nickel chromium ribbon. The surface of the reflector is streaked with vertical lines, which, when the elements are glowing, give the appearance of a completely red fire panel. A hinged metal guard is fitted at the front of the heating panel. The fire measures 18 in. high by 14 in. wide by 12 in. projection, the latter including the trivet. The weight complete is 18 lb.

It is offered in five different loadings, 1 kw., 1½ kw., 2 kw., 2½ kw. and 3 kw. We were given an opportunity of inspecting a specimen fire at Messrs. Crompton's London offices, and were much impressed by its neat appearance and the warm glowing effect produced when it is turned on. The fire has appropriately been given the trade name of the "Veriott."

FERRANTI LTD
Central House, Kingsway, London, W.C.
SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London, Friday, November 19, 1915.

THE ROUND TABLE.

By "KVA."

A Winter's Tale: The Pope-Osram Appeal case.

* * * *

Many pawnbrokers are now making munitions. More golden bullets for the enemy!

* * * *

Bon Mot of the Week.—Mr. C. P. Sparks, in his presidential address: "I believe that the commercial engineer is just as much a recognised member of our profession as a pure scientist." At last the head of the Institution speaks out for the commercial man!

* * * *

Contemporary Sayings.—"In spite of our national disregard of deductive methods, we have, nevertheless, managed to build up a great Empire and a great trade, and our success has long been a puzzle both to friendly and hostile critics."—"Engineering."

* * * *

The "Western Electric News" says: Here are some of the standard time-honoured requisitions which green employés in our shops and stockrooms are sent after:—

Left-handed monkey wrench.
Buckets of watts.
Brass magnet.
Half round square.

I can only recall the marine engineer's gag of sending the raw youth for a bucket of "propeller pitch."

* * * *

In proposing a vote of thanks to the new President of the Inst. E.E. on Thursday evening last, Mr. C. H. Wordingham was briefly reminiscent. He recalled the occasion when the President was with Dr. Ferranti in Charterhouse-square, and when he (Mr. Wordingham) applied for a "job." Meeting a friend afterwards he said, "I've just called on Ferranti and seen Sparks!" Appropriately so (as Mr. Wordingham himself remarked), for those were the 10,000-volt Deptford days.

* * * *

The Rural Council of Newton Abbott have authorised the Dartmoor Electrical Supply Co. to erect electric light standards in Union-street and near Edgehill.

Or, to adapt the Scriptural saying, "Where the Zepp turneth not and the fire is not quenched."

* * * *

Notwithstanding all other means of producing heat, light and power introduced by modern science, the position of coal—the magnet of commerce—as the great basis of the world's industries remains practically unshaken, and there are no indications that the day of its supersession is at hand.

Thus sayeth the Great Central Railway Co. in its new booklet "The Magnet of Commerce"—a complete symposium of the winning, transport and utilisation of English black diamonds. Now all ye professors of wind, water and oil power, will ye take up the challenge?

Colwyn Bay Council is opposing the use of double-deck tramcars for two reasons: (1) The local hills would render them dangerous, and (2) "such cars would be out of keeping with the character of the district." The Council must be thinking of the lady conductors, who will ultimately have to come.

* * * *

In his reminder to The Generators of the function of that social society on December 3rd, the hon. scribe says: "As this is the *only dinner of the season*, the Boosters trust that there will be a good attendance." I am glad to see The Generators setting this noble example in war economy, and would commend it to the notice of all other societies.

* * * *

The Mazda revolving lamp shade, to which I have referred in the last two issues, is illustrated herewith. I think that to those scientifically minded persons who regard it as a possible source of power the B.T.-H. might supply a shade fitted with a pulley or perhaps a simple back gearing on ball bearings. By the side of the illustration I have also included a picture



THE ACTIVE AND PASSIVE IN MAZDA LAMP SHADES.

of one of the Mazda lamp shades used on the Joint Great Western and Metropolitan Railway. I understand that the new regulations do not prohibit the passing of the light, which under peace conditions would be available for reading the news, through filters which give it a business meaning!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), November 23, 1878.]

SUN ELECTRIC LIGHT COMPANY.—We understand that this Company has applied its system of electric lighting to the machine shop at the works of Messrs. Grant & Co., Turnmill-street.

POPULAR SCIENCE IN GERMANY. A Telegraphic Museum was inaugurated at Berlin on the 1st inst. The collection is intended for the instruction of the people, and includes over 200 objects connected with telegraphy, and some historic instruments. Submarine and military telegraphy are specially well represented.

NEW ELECTRIC MOTOR.—M. Trouvé has laid before the *Société de Physique* a new electric motor, composed of a series of articulated parallelograms, similar to those of the "lazy tongs." Each lateral articulation is provided with an electro-magnet, these magnets being caused to attract or repel each other through a very small distance; whence the name of *constant force motor* given by the inventor to the apparatus. The *stroke* is proportionate to the number of parallelograms used, and may be indefinitely augmented.

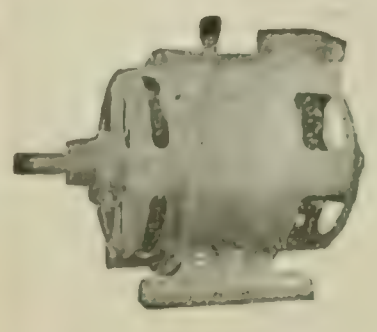
All enquiries concerning
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should be sent to
J. BLUNDELL & SONS,
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"Golsilplat, Ox., London." 4746 Gerrard.

FERRANTI LTD
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ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

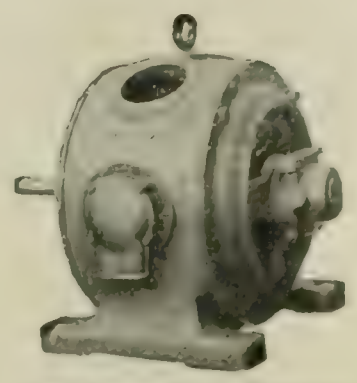
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STANDARD

ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

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ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.

HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.

Telephone: GERRARD 860. Telegrams: "SIEMBRALOS, VIC, LONDON."

Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.

Telephone: CITY 5350. Telegrams: "SIEMOTOR, CENT., LONDON."

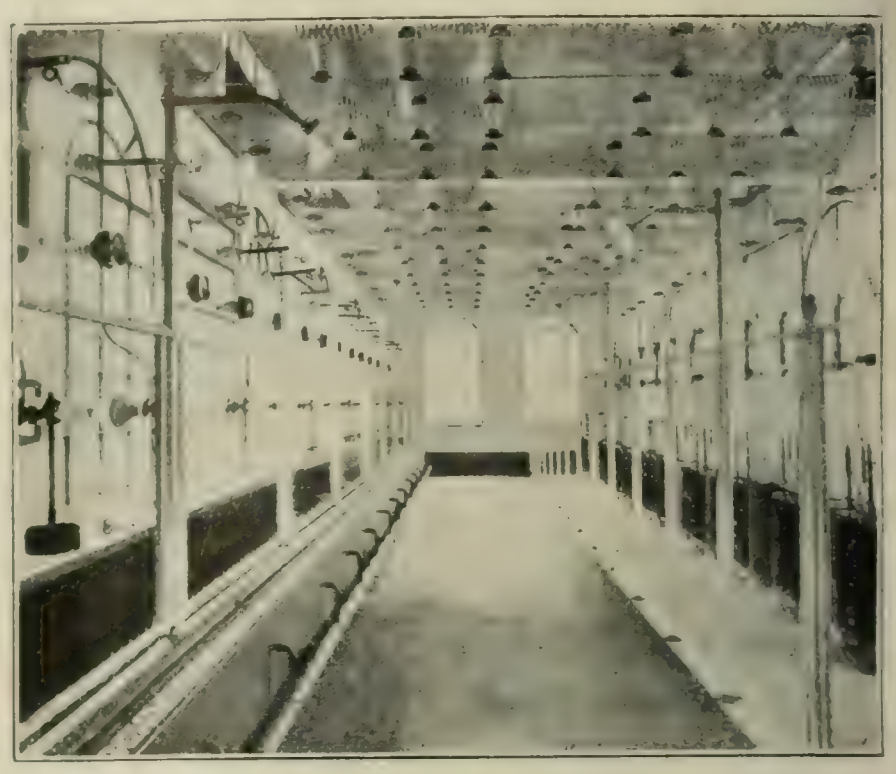
HOME BRANCH ADDRESSES:

BIRMINGHAM—Central Ho., New St.
BRISTOL—30, Bridge Street.
CARDIFF—89, St. Mary Street.
GLASGOW—66, Waterloo Street.
MANCHESTER—196, Deansgate.
NEWCASTLE—64-68, Collingwood Bldgs.
SHEFFIELD—22, High St.
SOUTHAMPTON—46, High Street.

Branches in Principal Towns Abroad.

SURGE PROTECTION.

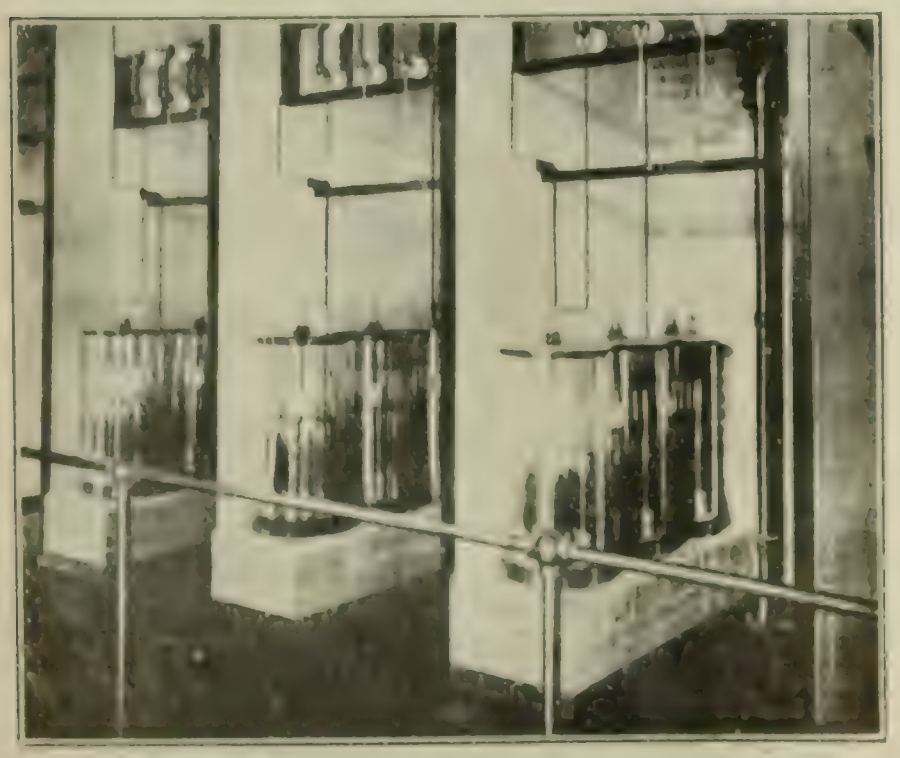
Surge protection in this country has received a scanty amount of attention compared with that given to it in America and on the Continent. The violence of storms abroad, as well as the long overhead transmission lines, are to some extent accountable for this, but with the growth in size of systems in this country it has become increasingly evident that our distribution engineers need apparatus which will afford adequate protection, not particularly against lightning, which does not present many dangers in this country, but against those surges which originate in underground cables and which, if unchecked, may damage the insulation of the generating and transforming plant. Much of the apparatus now in use for affording such protection fails to accomplish its purpose, and the reason for this failure, together with other matters concomitant to the whole subject of surge protection, is reviewed in a bulletin which the General Electric Co. have issued, entitled "The Condenser System of Protection against Surges." While this bulletin has the primary object of bringing to notice the condenser system of surge protection,



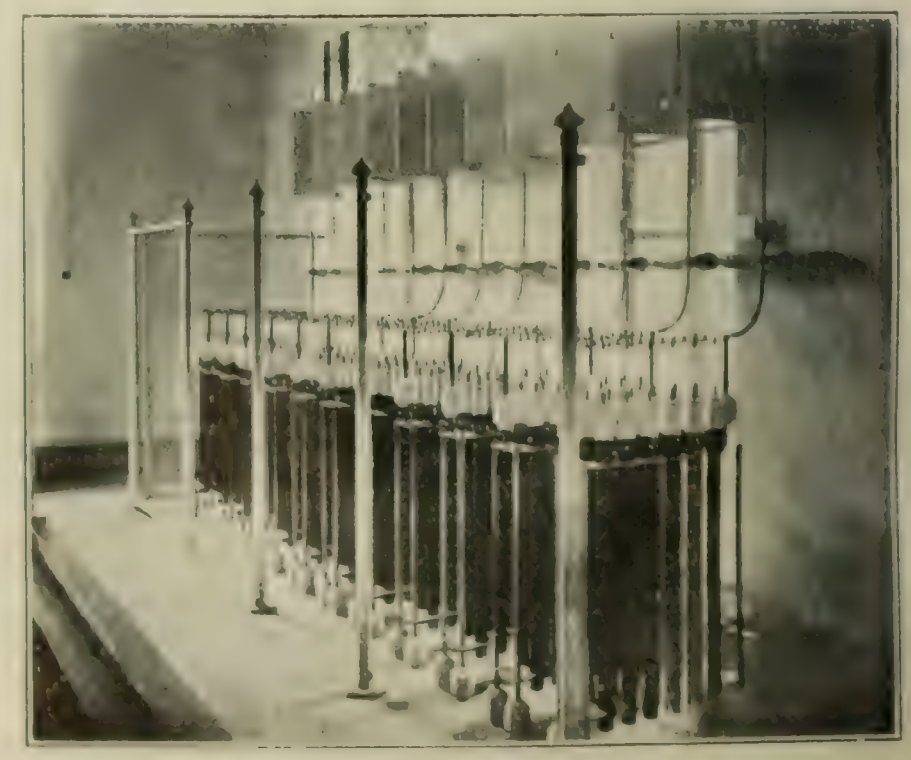
A LARGE CONDENSER INSTALLATION.

it reviews the causes of voltage surges and the means of protection to be adopted against them, matters which have received little attention in English technical literature.

The bulletin opens with a discussion of the origin of voltage surges, through resonance, switches, arcs and sparks, and lightning effects. It proceeds to show that a surge protection device has to cope not only with high voltages, but with high frequencies, and that such combinations as high-frequency surges of comparatively low voltage, or, on the other hand, high voltage surges of low frequency may be experienced. Protection has therefore to be given to a distribution system which shall be thoroughly effective against these and all other forms of surges. It is pointed out that the steepness of wave front is an important factor in surge protection, electrical apparatus having to be protected against the steep wave fronts, which in the past have been the cause of breakdowns in the interiors of transformers, for which breakdowns the transformer maker has been held culpable.



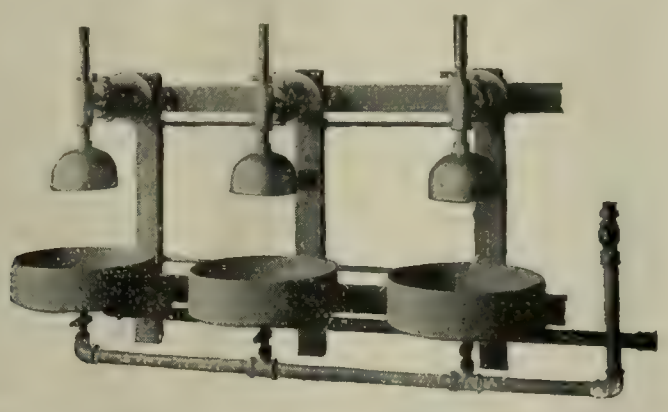
AN INSTALLATION OF GILES VALVES IN A POWER HOUSE.



BATTERY OF MOSCICKI CONDENSERS PROTECTING SYSTEM COMPRISING 500 MILES OF OVERHEAD 32,000-VOLT LINES AND 200 SUB-STATIONS.

Special prominence is given in the discussion to the question of air-gap arresters. It is demonstrated that the introduction of a gap in the arrester gives that arrester such characteristics that it cannot be expected to protect the system against all forms of surges. Emphasis is laid upon the fact that each kind of surge must be separately considered, and that apparatus must be installed in a suitable combination to protect the system against any probable combination of circumstances.

A defect inherent with all arresters embodying a spark-gap—in addition to the well-known unreliability of setting—liability to resonance, is set out. This defect arose from the fact that, due to the dielectric time lag in the arrester, that is to say, the period which elapses between the wave attaining the maximum continually applied voltage discharge point and the actual voltage at which the arrester sparks over during a surge, a dangerous surge may pass right by that



Water Jet Resistance for relieving Static Charges.

arrester without being discharged. This renders air-gap arresters unreliable as apparatus for surge protection. Nevertheless, a suitable air-gap arrester such as the Giles valve or a multi-gap arrester may be used for various purposes as pointed out in the bulletin, to protect against high voltages, providing that protection against high frequencies and steep wave fronts is also embodied.

In considering the principles of the horn arrester the difficulties are outlined of choosing the value of the necessary series resistance. It must have very low value in order to prevent it doing this excessively, but inserting a low resistance in series with a spark-gap is known to be a source of resonance dangers, and there appears to be no middle way out of the dilemma. The aluminium arrester being a horn gap with a special kind of resistance, the bulletin gives reasons to show that it includes many of the defects of the simple horn arrester and is not by any means a complete solution of the problem. Moreover, the aluminium arrester, as is well known, requires charging daily, an operation which probably does not endear it to supply



Moscicki Condensers, Electrolytic Condenser and Giles Valve.

engineers. Cases are quoted as having occurred in this country where the insulation of generating machinery has actually been broken down during the charging of aluminium arresters, which despite their charging resistance had set up very high surges. The multi-gap arrester, in various forms, including the Giles valve, is discussed and a conclusion is arrived at, that in one form or another it is a useful piece of apparatus.

Turning now to the condenser, the point is made that the condenser is the only piece of apparatus for surge protection which is connected directly to the line. Embodying no air-gap, the condenser can, therefore, give protection against high frequency of low voltage, and, moreover, it can modify wave fronts. It effects the discharge of a surge without any shock to the system. Unlike the air-gap arrester, it does not introduce resonance troubles; it acts quickly, having no dielectric spark lag, and does not require any charging or daily attention. Just as no other form of arrester will protect against all classes of surge, the condensers weak point is the high voltage surge of low frequency.

The condenser must have some auxiliary apparatus to protect the



The "SIMPLEX"

Galvanized Watertight Lampholder.

Ordinary brass lampholders are unsuitable for outside wiring: they are subjected to the vigorous attacks of impurities in the atmosphere and quickly corrode.

The "SIMPLEX" Watertight Lampholder is strongly made of galvanized steel; easily wired and assembled; even when installed in the most exposed places it will last a life-time.

Particularly suitable for use in Station Yards, Cellars, Lavatories, Mills, Factories and other situations where the conditions are severe.

Large Stocks held at all our Branches.

Simplex Conduits Ltd.

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Newcastle—
61-65, High Bridge.
Leeds—
6, White Horse Street.
Liverpool—
96, Whitechapel.
Swansea—
14, Heathfield Street.
Cardiff—
4, Westgate Street.
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NEW LIST IN THE PRESS.

REGULATING RESISTANCES



ISENTHAL & CO.,

(Department 4),

Denzil Works,

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Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster-General, &c.

line against such surges and for this purpose the Giles valve is discussed, which is a form of multi gap arrester differing mainly from the multi-gap arrester in that each of the series gaps is connected to earth through a condenser, as compared with an ordinary multi-gap arrester where, when a surge has passed one gap, is has still to bridge the remainder of the series ere it can reach earth.

The bulletin gives diagrams of connections showing the best way of protecting distribution systems, and in general deals thoroughly with the question. Copies of it may be obtained from the head office of the General Electric Co., Queen Victoria street, London, E.C.

DISTANCE THERMOMETERS.

The thermometers described in a new leaflet, issued by the Cambridge Scientific Instrument Co., are suitable for the measurement of all temperatures from 300 F. to 1,000 F. (or the equivalent Centigrade ranges). They may be read at selected positions any desired distance from the source of heat. In cold stores, power plants, heating and ventilating systems, breweries, preserve factories, chemical works, explosive factories, steamships, &c., it is usually a great advantage to read from a single instrument the temperatures in various parts of the building or plant. The convenience of a centralised scheme of this kind is at once apparent where a number of temperature readings require to be observed at different and often inaccessible positions. Regardless of the distance between the thermometer and the instrument the accuracy of the readings can be confidently relied on, whilst on account of the thermometers being constructed entirely of metal and also strongly armoured, breakages are rare and the maintenance charges practically nil. Consequently, increased control and resultant efficiency are obtained.

The principle upon which these thermometers are based is quite simple. It depends on the fact that the electrical resistance of a platinum wire changes with its temperature according to a well-known law. The resistance of the thermometer wire is compared with known resistances, which are arranged to form a Wheatstone bridge in the indicator case. Any alteration in the resistance of the platinum coil causes a deflection of the galvanometer needle over a scale directly calibrated in temperature. A two or four-volt accumulator works the system according to the range required, and as the energy consumed is small, the accumulators only need re-charging at long intervals.

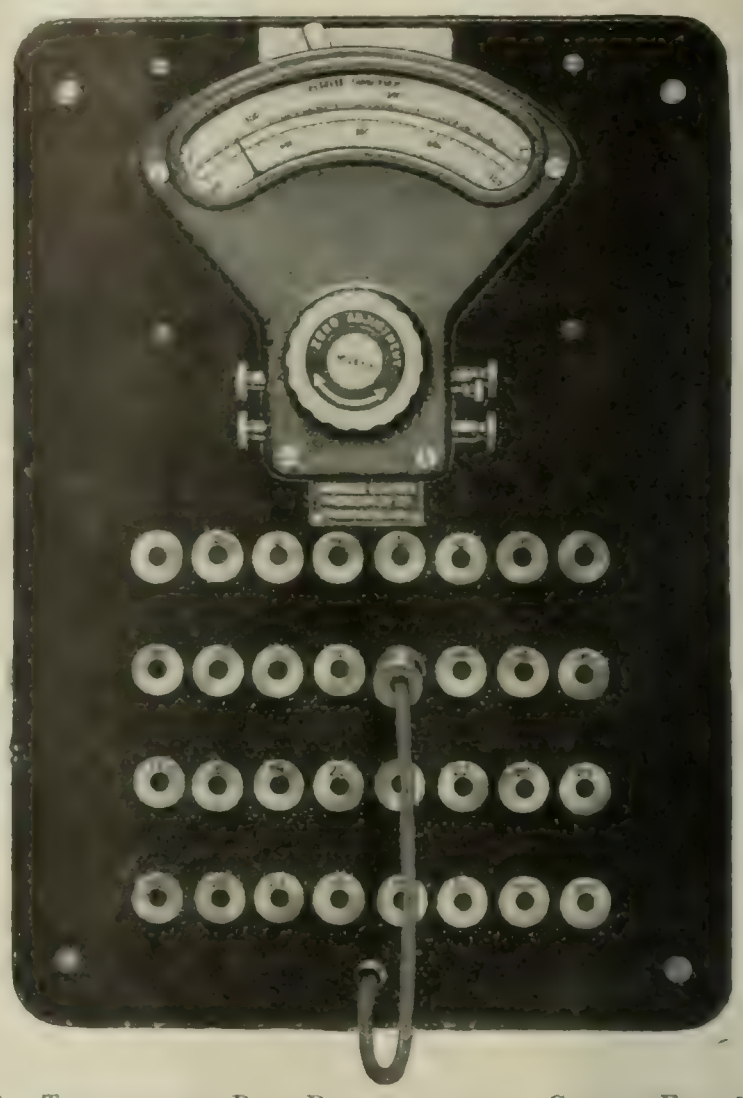


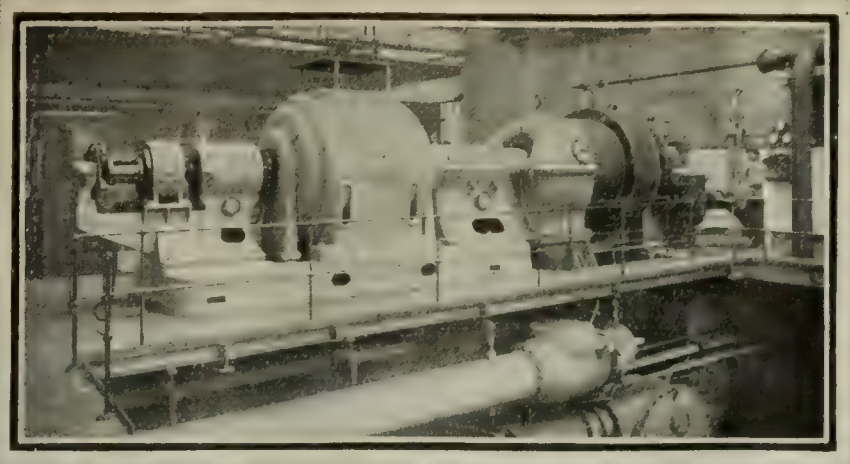
FIG. 1.—THERMOMETER PLUG BOARD AS USED AT CARDIFF ELECTRICITY WORKS FOR REGISTERING TURBINE TEMPERATURES.

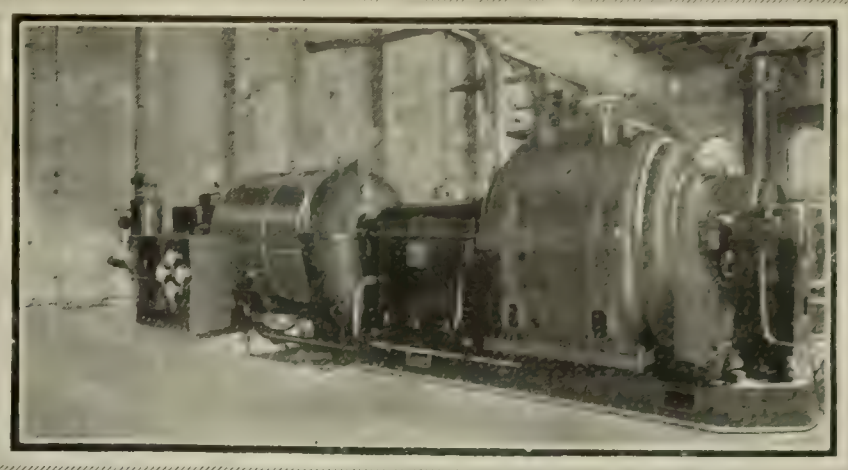
Sector-shaped indicators of high sensitivity are employed mounted on a switchboard, as shown in Fig. 1. They are double-pivoted instruments with dust-proof metal cases. The scales are 7 in. long and are unusually clear and open. To ensure open readings over a wide range of temperatures an additional scale can be added, the change from one scale to another being effected by means of a small



FIGS. 2 AND 3.—TYPES OF RESISTANCE COUPLES.

switch fitted on the top of the indicator. These instruments are calibrated in either Fahrenheit or Centigrade degrees, and the scale may be made to commence and terminate at any temperatures within the ranges already mentioned. A two volt accumulator is generally used, but where the temperature difference between starting and finishing is less than 180 F. [100 C.] a four-volt cell is necessary.





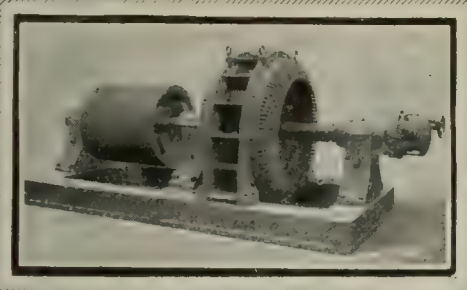
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The standard practice is to mount the indicator on a panel of black enamelled slate fitted with the requisite number of plug switches. The wiring is so arranged that when the plug is inserted in any one switch the indicator is connected to that particular thermometer. These switchboards can be supplied with any even number of switches and are always provided with an "off" or disconnected position. As the voltage of the battery may vary slightly, an additional switch is provided marked "test," and when the plug is inserted it connects the indicator with a resistance of such a value as to deflect the pointer to the red line at the end of the scale if the voltage is correct. Any discrepancy may be instantly corrected by turning the small milled screw indicated by an arrow in Fig. 1. In this way a ready means of assuring at all times the accuracy of the readings is provided, and it becomes possible to use the accumulator for a long period.

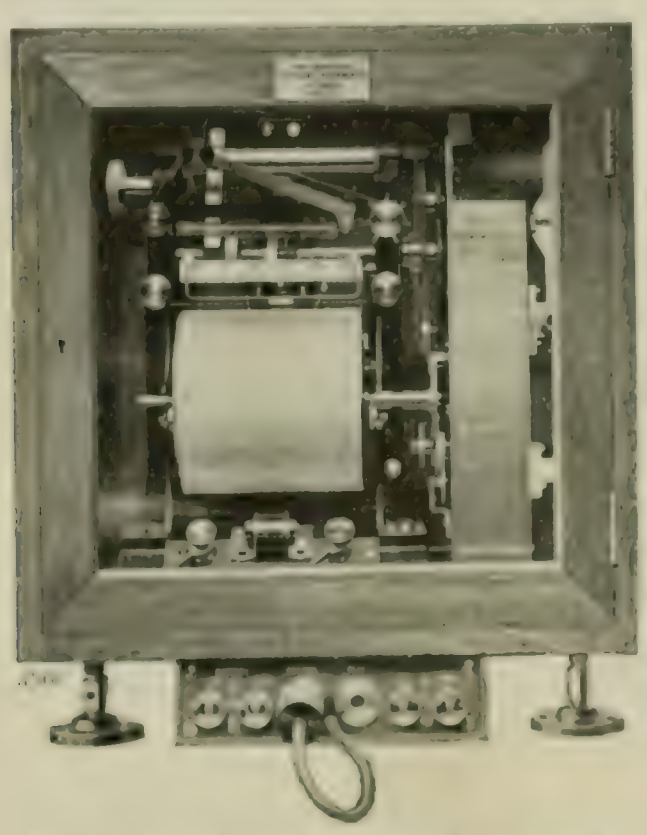


Fig. 4.—Front View of Testing Recorder.

The resistance thermometers consist of coils of platinum wire wound spirally on porcelain spools and protected according to the conditions under which they will be used. Although mounted in various ways to suit different requirements the thermometers are all interchangeable. They are strongly made and, we understand, are not subject to breakage. The platinum "bulbs," as they are called, are generally 50 mm. long and 11/16in. (in diameter, but vary for special purposes. It is important that the whole of the bulb be subjected to the temperature it is desired to measure. Fig. 2 shows a thermometer mounted in copper or steel tubes designed for use in open tanks. For flue gas measurements a thermometer as Fig. 3 with adjustable flange is employed. Special sheaths can be fitted if required; for example, on sulphuric acid plants silica protecting tubes are generally supplied. For continuous records a thread recorder (Fig. 4) is supplied, and these have become widely known for satisfactory service under works conditions. The pointer in these instruments is depressed every minute on an inked thread, thus giving a record of the temperature at the moment in the form of a dot. These dots following in quick succession merge into a continuous line. The charts have rectangular co-ordinates and are 13 in. long by 4 in. wide. The drum makes one revolution in 25 hours, and by a simple change speed gear, once in two hours five minutes. An inspection scale is provided from which the temperature at any moment can be read off. No pen is used and the thread only requires a little ink every month. An accumulator of two or four volts is used and, as with indicators, provision is made for checking the accuracy of the readings. To obtain two differently coloured records at once on the same chart, a two-colour mechanism is provided; for three records a triple selector switch or commutator; and for four records a double recorder fitted with the two-colour mechanism. Specimen charts of any of the above combinations will be supplied on request. In addition they can supply a multiple recorder for making any number of records up to 16 on the same chart.

Ordinary insulated lead-covered copper wire of about No. 16 S.W.G. is generally advised. One separate lead is connected to each distance thermometer, and a common return wire is brought back to the switchboard. The thermometers are usually calibrated for a 2 ohms wiring circuit, and a balancing resistance is supplied with each element for the adjustment of each circuit.

Copies of the Leaflet referred to can be obtained from the Cambridge Scientific Instrument Co., Cambridge.

MONOMETER TINNING FURNACE.

In the mechanical arts an inventive mind will sometimes bring into being a new or improved process or new means to attain an old end in a cheaper or more efficient manner, which will almost revolutionise an industry. In this category may be placed the floating of wires with molten metal. The method current in this trade is to draw the wire through an open pot containing the molten metal, the considerable loss through surface oxidation being accepted as inevitable. Many ingenious features characterise the system just introduced by the Monometer Mfg. Co. (Ltd.), Whitehouse-street, Aston, Birmingham, all of which are directed to decrease the cost and increase the efficiency of the process. One may say that the outstanding feature is an enormous saving in residue.

The special features comprise a complete enclosure of the melting pot, means for the prevention of oxidation of the molten metal, a self-acting heat controller for maintaining the metal at the correct fluidity, a system of heating by low-pressure gas which produces intense heat without fans, blowers or compressors and ensures perfectly uniform distribution of the flame and heat, special guilding devices for the wire which enable it to be rapidly threaded on to the guide rollers, and the elimination of fumes. The last feature was

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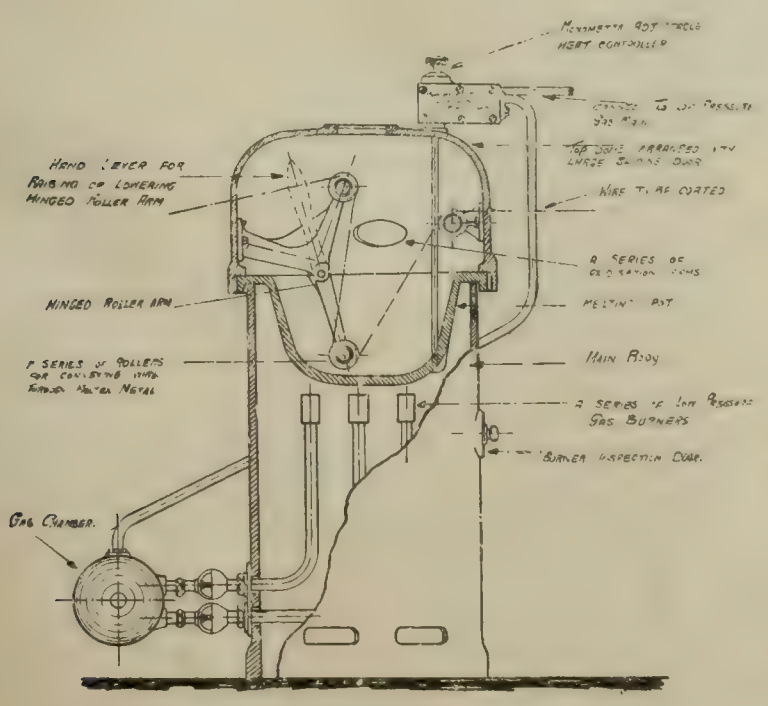
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LIONEL ROBINSON,
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TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

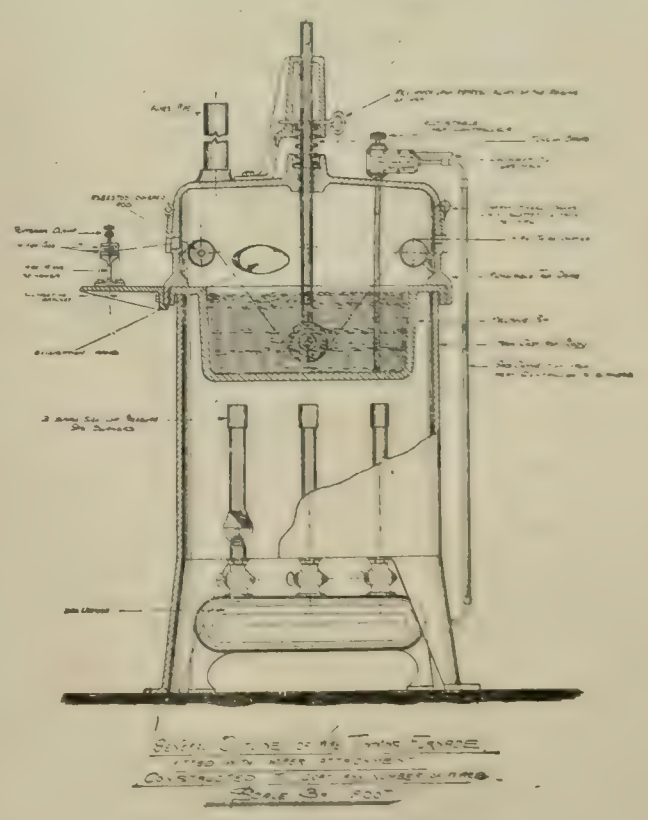
the motif for a recommendation by His Majesty's Chief Inspector of Factories.

Dealing individually with the technical features outlined above, the general description of the furnace will certainly appeal to the industry to which this process is of interest. The body of the furnace is strongly constructed by casting, and supports the melting pot, which is covered by an enclosing dome-shape casting forming virtually a sealed chamber for the melting operation. This chamber is supplied with inert gases from the bunsen burners under the



Monometer Tinning Furnace.

melting pot so as to produce an oxygen-free atmosphere, and the experience of many users of this system prove conclusively that the saving in residue effected amounts in many instances to not less than 4s. per ton of metal melted. Another factor in reducing the dross formed is the automatic temperature-controlling device which operates on the thermostatic principle, and is so constructed and arranged that immediately the metal has attained the required fluidity the gas supply to the burners is cut down and the temperature of the molten metal kept constant. In wire coating this is a most important point, as if the metal is too fluid or is not sufficiently viscous the coating on the wire or cable is imperfect and leads to a great amount of waste.



Monometer Tinning Furnace.

The patent gas burner system comprises any desired number of bunsen burners fitted to an equalising chamber which distributes

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uniformly the volume and pressure of gas supply to the individual burners, the latter themselves having a peculiar internal construction which produces an intense heat with a remarkably low consumption of gas. The gas supply is simply connected up to the ordinary town gas main, and there is no auxiliary mechanism to increase the cost of the apparatus.

Within the melting chamber and above the melting pot are arranged a series of guide rollers over which the wire is run, the lowest rollers being mounted on movable rods individually adjustable in order that the rollers may be moved to facilitate threading of the wire. A novel feature is the spring control of the rollers when in the active position, which substituting resilience for rigidity practically eliminates the possibility of wire breakages. As the wire leaves the molten metal it encounters a fixed wiper so located as to direct the drips back into the melting pot, the final wiping device being outside the melting pot and having the wiping blocks adjustable in relation to the pressure exerted on the wire. Any required number of wires can be coated simultaneously, the wire simply being wound on a drum and thus passed through the melting pot.

Generally speaking it may be stated that the complete furnace is strongly constructed with an ample reserve of metal, likely to meet any possible contingency that may arise, and the workmanship is such as is rarely found in furnace work. This is not surprising, as we understand the Monometer Mfg. Co. have a splendid equipment of machine tools for turning out the highest class of work.

AN ATTRACTIVE FIRE BOOKLET

Time, care and money expended on a trade publication are almost invariably a good investment. This is particularly true when the booklet or pamphlet, as the case may be, is intended for public consumption. We think that the new Ferranti fire booklet, of which a copy has just reached us, will prove no exception to this rule. It has been prepared with the idea of making the proposition for the electric fire, and especially the Ferranti fire, compelling and attractive. Each page bears a distinctive message on behalf of a distinctive type of Ferranti fire, and the message is told in drawing as well as type and illustration. The specimen page which we reproduce herewith conveys a good idea of the scheme adopted, but it omits the colouring and tints employed; these materially enhance the pleasing effect produced. If anything, the booklet errs rather on the side of the luxurious, and may give the impression that the electric fire is designed for the rich, and not even for the middle classes: in this respect it does not differ from its contemporaries. We do not regard this as in any way likely to influence detrimentally its value as a selling advocate for the Ferranti fire.

Contractors and central station men who have not had copies for distribution should certainly obtain them without delay. They will be most helpful to the electric fire movement.



HALF-SIZE REPRODUCTION OF ONE OF THE PAGES ON THE NEW FERRANTI FIRE BOOKLET. THE OTHER PAGES ARE EQUALLY ARTISTIC AND ATTRACTIVE.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, NOVEMBER 26, 1915.

THE ROUND TABLE.

By "KVA."

Bon Mot of the Week.—There are already several factories erected some years ago by foreign capitalists which have been allowed to cut themselves loose from such restrictions; but if there is to be a healthy patriotic spirit at work to put greater competitive power into the British electrical industry after the war, it should be clearly understood which firms stand wholly for British interest and which are merely a kind of "tied house."—"Times Engineering Supplement."

* * * *

Contemporary Sayings.—The rank and file of men in the engineering schools and colleges are lacking in what the city editors call a "nose for news." The reading and reflection that may follow the reading of news of the industry is a tonic for freshman and senior, whether he is going to school, at college, or in business. Possibly a reason for the student's lack of interest follows because mathematical and other engineering problems at school are tangible, the statement of the problem and the answer are in sight at the same time.—"Electrical World."

* * * *

America is now in the throes of its Electrical Prosperity Week. Gott strafe Deutschland!

* * * *

"Adapter" Prangnell is going to H.M.S. "Vernon," and I suppose will have to say "Sir" to Lieut. Haydn Harrison.

A Manchester correspondent tells me that in the days of his apprenticeship he was sent for a "female rollicking gauge" and "a black hot spanner."

* * * *

I hasten to state that the newspaper headline "Sparks in a Dublin Transformer" does not relate to the new President of the Inst E.E. I can vouch for his being in London on the evening of the recent breakdown.

* * * *

Another headline over a report of the derailment of a L.B.S.C.R. elevated electric train reads: "El. El. Service from London Bridge Disorganised." Quite what the stranded passengers might be expected to appreciate.

* * * *

The "Militär Sanitätswesen" describes

"Electrified pants" for soldiers in which extremely supple *but stiff* electrical warming wires are woven in with the stuff. The pants are put on like any other. If a part refuses to act, the rest of the dress is warmed and the warmth of course spreads.

Of course, the warmth would spread if the soldier connected his 100-volt pants across 200 volts.

* * * *

Gas consumers throughout the country are to have their patriotism strained even beyond the 10 per cent. increased price of that commodity. Says an evening paper:—

The War Office have notified local authorities, that owing to the demand for benzol and toluol for the manufacture of explosives, it has been found necessary to require gas undertakings throughout the Kingdom to extract these constituents from their gas, thereby in some cases affecting the illuminating power of the gas and its calorific power.



THE KIND OF "LOAD" THE CENTRAL STATION MAN MAY EXPECT WHEN HE HAS A FEW ELECTRIC VEHICLES RUNNING IN HIS AREA.

A girl employed at the Osram Lamp Works was recently injured by a quantity of coal falling on her. After her recovery she quite naturally claimed compensation, and appropriately she asked for *a lump sum!*

* * * *

"The Art of Finding your Way at Night Without a Compass" is the title of a forthcoming lecture by Lieut.-Col. W. A. Tilney before the Society of Arts. If the brave soldier will pay me a call any evening after 6:30 I may give him some useful hints for his lecture. Compasses are quite useless in Fleet-street just now.

* * * *

The electric warming pad has developed into the electric carpet, and the electric carpet is now about to develop into electrically warmed pants for soldiers—German soldiers. The War Office must go one better by winding the infantry as the secondaries of transformers and winding the trenches with the primaries thereof. Susie will then no longer need to knit socks, vests and other "undies" for our troops at the front!

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), November 30 1878.]

NATURAL POWER AND THE ELECTRIC LIGHT.—Sir Wm. Armstrong is using the fall from a lake near his residence, by means of a turbine, to actuate a dynamo-electric machine. The light, which is said to be a mile and a half from the point where the electricity is generated, is used to illuminate the picture gallery at Cragside. Such experiments as this will prove of the utmost service, as hitherto much has been said and little done to conduct the current over long distances. Sir W. Armstrong hopes, by means of an electrical engine at his house, to utilise to a still greater degree the source of power at his command.

LECTURE EXPERIMENT.—An old experiment of De la Rive's may be used (M. Trouvé shows) to demonstrate to a large audience the influence of *pressure of contacts* on the intensity of a current. You hold in your hand the extremities of the two wires of an electromagnet, and cause them to meet between its poles. In this position the sound of the rupture may be considerably varied, according as one wire is applied more or less strongly against the other. The sound, which is hardly perceptible when the two wires touch slightly, becomes like a pistol shot if they have been pressed strongly together

'IGRANIC'

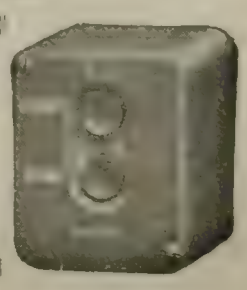
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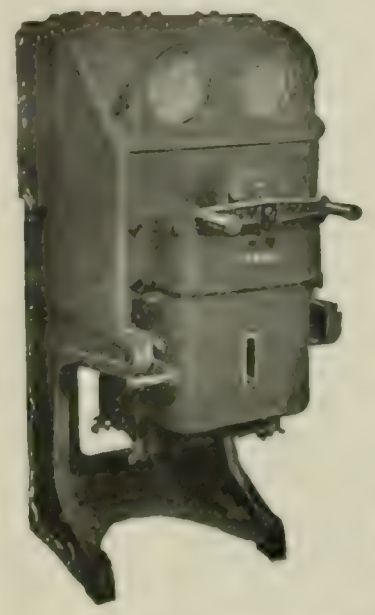


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The two simple Master Switches here shown are the control points for "IGRANIC" No. 57A Automatic Control Systems. They represent all that the workman has to operate to safely start and stop his tool or press (no matter what the size may be). Speed setting features are included too. Write for particulars.



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Made in ALL SIZES and ORDINARY STOUT SUBSTANCES to suit varying Voltages.

PRICES ON APPLICATION.

Manufacturers—
J. G. INGRAM & SON, Hackney Wick, LONDON, N.E.

SHOP LIGHTING.

The illuminating engineer may despair of the present standard of foot-candles for street lighting in areas which come under the new regulations, but he must admit that the war is accomplishing what years of his proselytising would have failed to do. Whether the tradesmen like it or not, they must light the goods in their windows and not the pavements outside; also they must not throw dust—*i.e.*, light—in the eyes of the prospective buying public. If "all the world's a stage, and men and women merely players," then all the shops are stages, and the goods must be treated like players, and be properly illuminated, without discomfort to the audience—the passer-by in the street.



A TYPICAL EXAMPLE OF HOLOPHANE SHOP LIGHTING, THE WINDOW BEING TREATED AS A THEATRE STAGE.

The war has already changed many ancient institutions, so ancient were they that any change in them was despaired of. It has certainly changed methods of shop lighting, and it is to be hoped permanently so. The early temporising with brown and tissue paper shades is giving way to more substantial screens and reflectors, and we may look for a still further step to the complete re-modelling of shop lighting in accordance with established principles and with a permanent effect in view. It would be a pity at the peace to allow tradesmen to revert to the types prevailing before the war, and it is to be hoped some check will be placed upon such tendency should it appear. The evidence is so overwhelming for the right as against the wrong method of shop lighting. To do wrong in this particular should be made a local crime, and give rise to a correcting protest from those who have been "converted."

The distribution of the Holophane Company's excellent little volume of pictures is doing a lot of good in this way. Those contractors and station men who have not used it as a canvassing document ought to do so without further delay. It was issued some weeks back, it is true, and we commented then on its publication, but we return to it because the subject needs to be hammered at while the iron of the lighting restrictions is still hot.

One of the principal merits of the booklet referred to is the reproduction of illustrations taken from untouched photographs. These pictures are views taken under actual lighting conditions, and they convey an accurate impression of the even character of the illumination afforded by the use of Holophane glassware. The originals of these are available from Holophane (Ltd.), Carteret-street, London, S.W.

"POPE" CARBON LAMPS.

An attractive leaflet from Pope's Electric Lamp Works reminds us that this company, despite its activities in the production of "Elasta" lamps, also makes carbon lamps. The brochure will be supplied in any desired quantities to contractors and supply houses. overprinted with name and address

The lamps are available as follows: The lamps are fitted with either B.C., E.S. or C.C. caps; B.C. fittings are always supplied unless otherwise stipulated.

90 to 130 volts: 5, 8, 16, 25, 32, 50 c.p. 190 to 260 volts: 5, 116, 25, 32, 50 c.p.

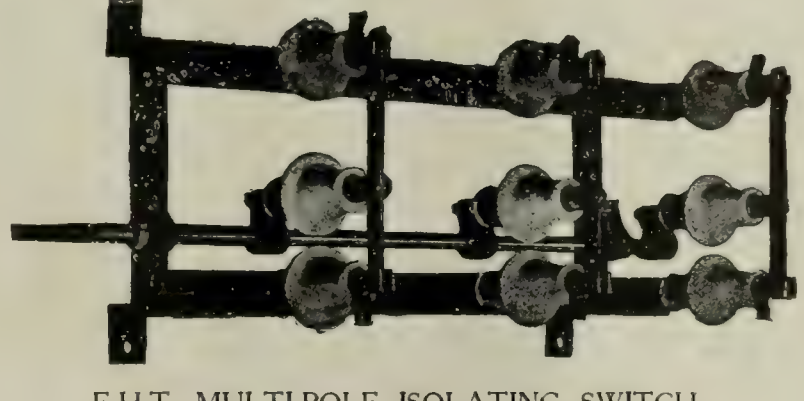
Radiator lamps are also made—96 to 260 volts, 250 and 500 watts.

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SIMPLEX INSPECTION LAMP FOR SHELLS

In inspection lamps for use in munition factories it is most important that the design should comply with Home Office regulations. The lamp herewith illustrated is made by Messrs. Simplex Conduits (Ltd.). Apart from its robust constructions, which makes it particularly suitable for the strenuous usage of a shell factory, it is provided with an "earth" wire, the lampholder is insulated from the body, and both holder and lamp cap are protected and cannot be touched by the operator so long as the guard is in position. The lamp shown, if used with an "earthing" plug, has the approval of the Home Office.



LIGHTING EFFICIENCY.

The accompanying illustration affords an excellent example of efficiency in office arrangement and equipment. The office depicted is the typists' room of the Chiswick Polish Co. (Ltd.). Though taken by artificial light, derived from a number of moulded compo "Eye-rest" fittings, the photograph shows the arrangements made for effective illumination. The side of the office in the background of the illustration is almost entirely of glass, the windows being carried up as high as possible to take full advantage of high-angle light. In the matter of artificial lighting efficient practice has been followed out. The large and properly situated window areas admit a flood of diffused natural illumination by day, and the B.T.-H. "Eye-rest" fittings ensure perfect illumination by night. In each of the bowls shown there are five Mazda lamps, each in an X-ray reflector, throwing a flood of light on to the white ceiling, whence there is reflected diffused illumination to the room below.



THE "CHERRY BLOSSOM POLISH" TYPISTS' "EYE REST" ROOM.

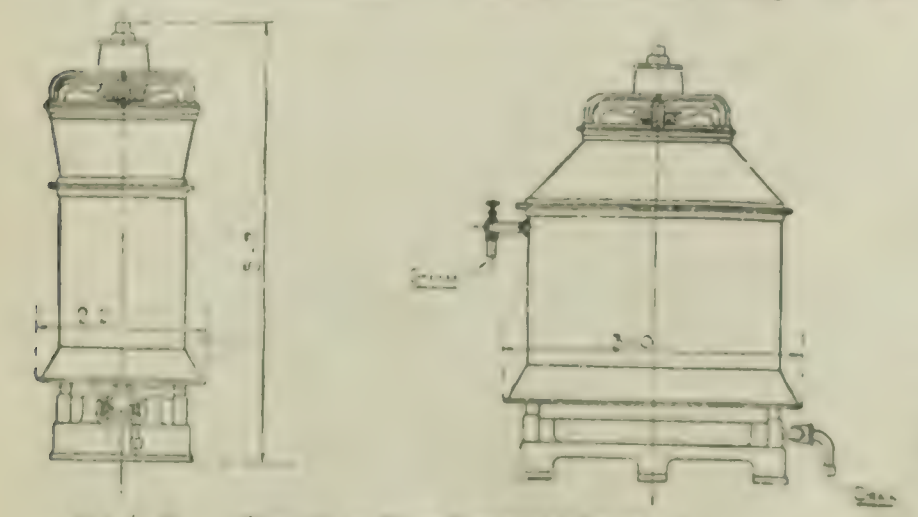


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The low-pressure steam heater unit comprises a battery of cast-iron gilled radiators, enclosed in a strong sheet-steel casing. At the



DETAIL OF LOW PRESSURE SYSTEM.

top of the latter is mounted an electric propeller fan. The fan blows the air downwards through the heater and distributes it near the floor level. The heater, which is carried on a substantial cast iron base, is fitted with steam connection and valve on one side and with drain pipe on the other. It is designed for use with steam at about 15 lb. per square inch, when it is capable of delivering 2,600 cubic ft. of air per minute raised through 60° F. The fan can be fitted to a continuous or alternating current motor, the current consumption being approximately 220 watts.

The high pressure heater comprises a battery of weldless steel tubes bent to U shape and expanded into the cast iron header. The propeller fan is placed on the top of a circular sheet steel casing which surrounds the tubes and header. The fan blows the air downwards through the battery, as in the low pressure unit. The high-pressure unit can either be placed on the floor, or, if desired, may be bolted to a column of a building. The fan of this heater can also be fitted with a continuous or alternating-current motor taking about 220 watts. It is designed for steam pressures up to 150 lb. per square inch, and has a capacity of 2,600 cubic ft. of air per minute raised through 60°F.

Prices and other details can be obtained on application to the General Electric Co. (Ltd.), Queen Victoria-street, London, E.C.

"THE MAGNET OF COMMERCE."

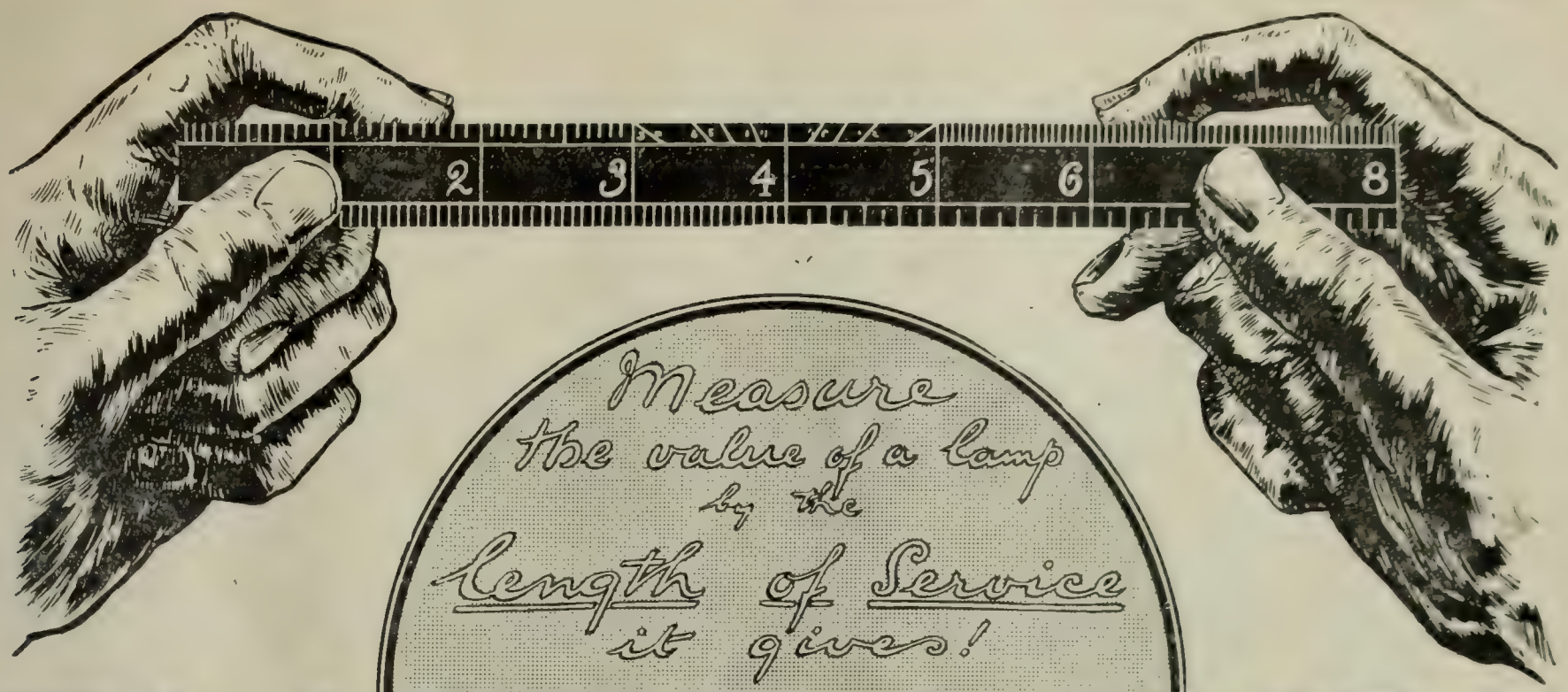
The above is the title given by the Great Central Railway to its publication which deals exclusively with the subject of coal getting and coal transport. Needless to say, the Great Central Railway system is in touch with the most important coalfields in this country, particularly those of Nottinghamshire and Derbyshire. A map of this important coal bearing area is included in the publication, and it shows the chief manufacturing towns and districts, the agricultural land and the moorland, the proved coalfield, and the concealed coalfield. The collieries through which the Great Central Railway passes are also shown, and the districts in which iron ore is found and iron works located are shown in red on the map, which makes a large folding sheet. Another interesting folding plate is a coloured birdseye view of the deep-water dock at Immingham. We have already described the electrical equipment of this industrial port in the columns of THE ELECTRICIAN.

In the space of a short review it is quite impossible for us even briefly to give an idea of the contents of this valuable industrial publication. Electrical engineers who are interested in the subject of the application of electric power to collieries and colliery railways, and also the electrical equipment of the industrial docks and harbours will find it a valuable work of reference. There is a considerable section dealing with the Midland coalfield, including a summary of the principal seams and a diagrammatic view of the coal output for the past 28 years. The Lancashire and North Wales coalfields are dealt with, and valuable statistics are included of the exports from this country in 1914, and the output value of coal in 1913. There are interesting sections on the making of coke, and the prices of sulphate of ammonia between the years 1905 and 1914. The magnitude of the business of coal traffic over the company's system is apparent from the sections which deal with the distribution of coal. The list of collieries served directly by the Great Central Railway fills many pages, and is of great interest to electrical engineers, together with the adjoining list of the collieries connected with the Lancashire & Yorkshire Railway in the Yorkshire district.

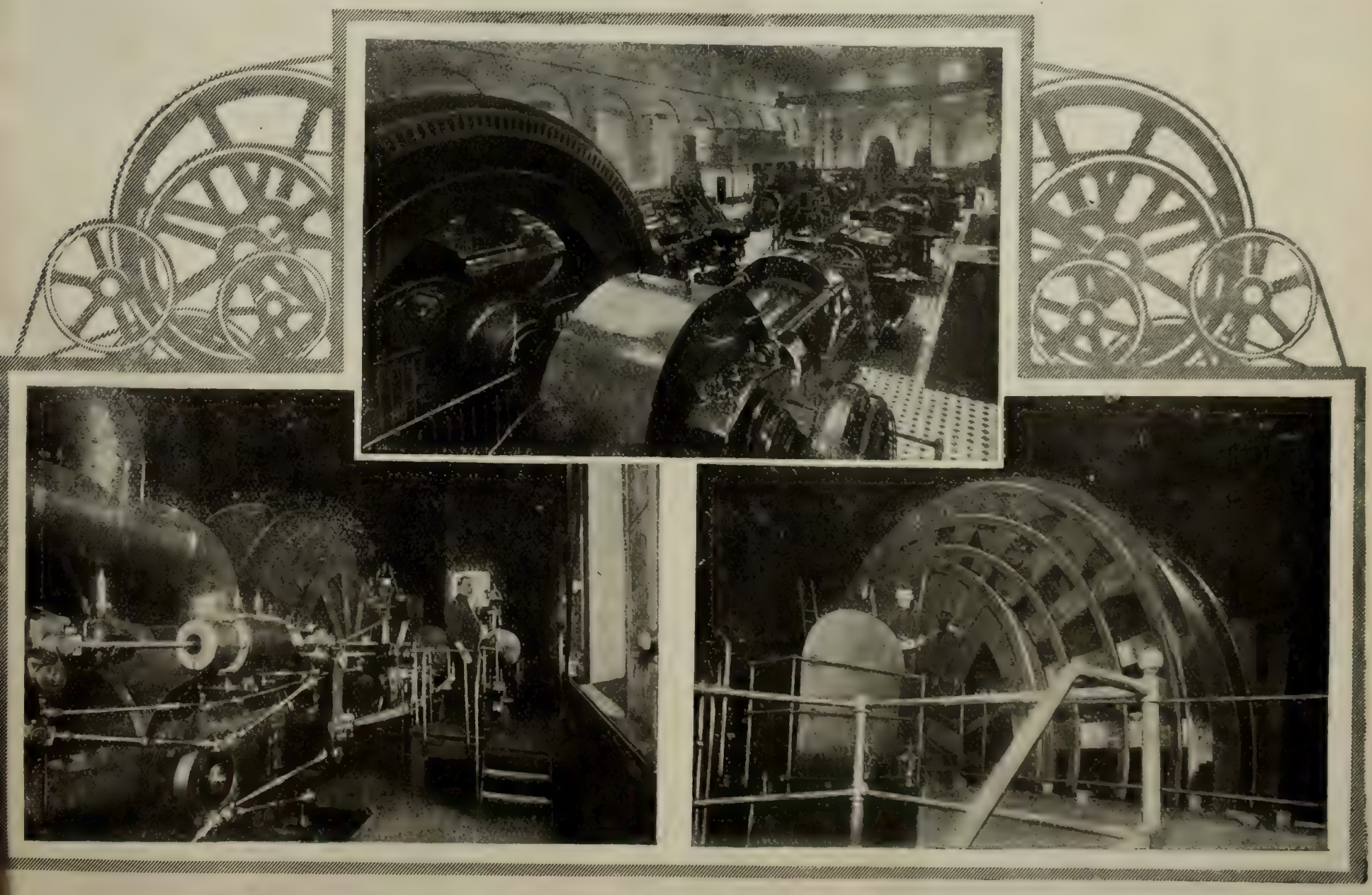
We suggest that the value of the book would be considerably enhanced if, in the next edition, a map or table were included showing those collieries in which electrical energy is used for power purposes to a large extent, and also the principal electricity undertakings which furnish electric power in bulk for colliery operation. This data should be conveniently available, and might appropriately be made to form a separate section of the book. This suggestion must not be regarded in the light of criticism, particularly as the publication referred to is supplied by the company free of charge to interested inquirers.

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SOME ELECTRICAL MINING PLANT IN THE MIDLAND COAL FIELDS. (*See* "The Magnet of Commerce" opposite.)

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PICTURE LIGHTING.

Some interesting details are being distributed to the electrical trade by the Edison & Swan Co. describing a picture lighting fitting which they have just introduced. The fitting is tubular in shape, and is designed to carry a tubular lamp with contacts at opposite ends. The tube surrounding the lamp is provided with a long opening, and on one edge of this are a number of serrations which have the effect



Ediswan Picture Lighting Fitting in Use.

of breaking up the light rays. The tubular fitting surrounding the lamp is adjustable, and it is provided with end plates and a movable hinged flap, which acts partly as a reflector and partly as a light screen. When the fitting is placed in position it can be adjusted so that the rays of the lamp completely illuminate the picture, but do not throw any rays on to the wall either at the sides or below the frame.

The fitting is also suitable for pulpit, desk or orchestra lighting, and attention is called to the fact that the choir stalls at Westminster Abbey are provided with these fittings. The stock length of fitting measures 18 in. over all, and takes a standard Tubolite lamp; but



Detail View of Ediswan Picture Lighting Fitting.

any length of fitting can be made to order. The standard finish is gilt lacquered brass. The adjoining illustrations will serve to explain the general design of the fitting and its application to picture lighting.

"E.A.C. NOTES."

The above is the title given to a handy pamphlet which the Electrical Apparatus Co., Vauxhall Works, London, S.W., have prepared. The "Notes" deal briefly with each of the company's principal products: House service meters, D.C. motor starters and regulators, D.C. motor-control panels, D.C. automatic motor-control gear, A.C. ironclad oil-immersed gear and A.C. motor-control gear on the



E.A.C. Ironclad Distribution Board.

E.A.C. drum-type system. We have previously referred in detail to the majority of these products, and may recall the chief features of the ironclad oil-immersed switchgear, which is designed for A.C. service in collieries, dockyards and industrial power installations generally. This gear is offered either as plain oil switches, as oil switch pillars, or as complete switchboards. The switches can also be combined with starting switches to form complete motor-control units. The capacity of the circuits controlled ranges up to 300 amperes and 3,500 volts. We illustrate an ironclad distribution board for five feeder circuits.

WESTINGHOUSE LANTERN SLIDES.

We are informed by the British Westinghouse Electric & Mfg. Co that they have available a number of lantern slides which they will be pleased to loan to authorised persons for use in lectures, schools, etc. We give below a list of the subjects with which these slides deal, and we understand that a complete catalogue of the slides is in preparation, and will shortly be available.

- Alternators.
- Colliery Plant.
- Control gear, including liquid controllers and drum controllers.
- Gas engines, vertical and horizontal.
- Instruments.
- Magnetic brakes.
- Motors applied to the driving of industrial machinery.
- Shop lighting and power.
- Lightning arresters.
- Traction motors and control.
- Turbines.
- Turbo-alternators.
- Condensing plant.
- Cinematograph plant.
- Field rheostats.
- Generators, D.C. and A.C. [Lamps.]
- D.C. and A.C. motors.
- Oil engines.
- Motor-generators.
- Switchgear.
- Starters.
- Transformers.
- Turbo-blowers.
- Brake solenoids.
- Condenser pumps.
- Diesel engines.
- Gas plant.
- Turbo-generators.
- Meters.
- Loom motors.
- Rotary converters.
- Circuit-breakers.
- Textile applications.
- Transmission.
- Haulage and winding machinery.
- Westinghouse works.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London. Friday, December 3, 1915.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The following P.S. has been sent out by the Secretary, Western Section Inst.E.E., in connection with a dinner to be held at Cardiff.

War Times.—Owing to present conditions, the Hotel Co. decline to prepare any meals without a guarantee that they will be paid for, even through not eaten. It is, therefore, imperative that I should know whether or not you intend to come to the dinner, which is 3s. 6d. per head. Dinner can only be prepared for those who reply, and must be paid for whether eaten or not. Therefore will you please advise me before Saturday, the 11th inst., if you will be present at the dinner.

* * * *

Greek: They have found iron wires at Athèns in excavating among the ruins, thus proving that we ancient Greeks understood wireless telegraphy.

Egyptian: Ah! but at Cairo they found nothing among the excavations.

Greek: Well, what does that prove?

Egyptian: Why, that we ancient Egyptians understood wireless telegraphy.

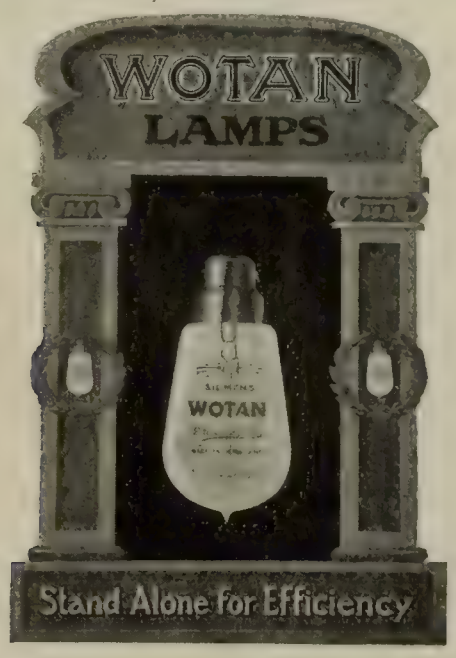
* * * *

Contemporary Sayings.—"The Electric Vehicle Committee is to be congratulated upon its enterprise in following up the *opening erected* by the position at Manchester."—"The Electrical Times." (My italics.)

"Perhaps the most surprising element constituting membership of the E.C.A., at least so far as the London section is concerned, is found to exist in the shape of utter isolation of its members, who are entirely dependent upon this journal for information of its (sic) activities. Were it not for the monthly arrival of the 'Electrical Contractor' and the payment of the annual subscription, the average member would be in ignorance of the existence of the E.C.A."—W. Ellerd-Styles, in the "Electrical Contractor."

* * * *

At the moment of going to press I have received an attractive "Wotan" lamp showcard novelty, which is illustrated here-



with. When in position the lamp "stands alone" against the velvet background. How is it done?

I am told that there is a run on bain maries in the London hostelries just now in order to supply "Hot Oxo ye ken," &c., during prohibited hours. Those electrical salesmen who are not bashful about entering a public-house, and their name is, I think, perhaps legion, should see that all those bain maries are "electrics." "A bain marie in the bar is worth two in the back stores."

* * * *

The local newspaper recently startled the citizens at Carlisle with the following poster:—

CARLISLE
ELECTRICITY STAFF
MARCH TO RECRUITING OFFICE
GREECE'S
EXPLANATION.

I have not read what explanation "Tino" gave to the Kaiser of this patriotic incident, but I can understand that Point-Five Purse (who headed the procession) gave a perfectly satisfactory answer for the conduct of his staff in thus answering Lord Derby's call.

* * * *

I note that among our satisfied "want" advertisers is a W./T. Commander, who writes that "the number of applications has greatly exceeded expectations. Please, therefore, cancel the third appearance of the advertisement, as the number of applications is becoming a nuisance." Thus are we deprived of the privilege of completing at least one Government contract!

* * * *

Among the exhibits at the Smithfield Cattle Show at the Agricultural Hall, London, this week is a full-sized model of a cow, which is used to show the merits of a milking machine. The demonstration is quite convincing and lifelike, particularly the filling of the "cow" with water through a funnel just aft its fifth rib!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), December 7, 1878.]

ELECTRICITY AND EARTHQUAKES.—Sturgeon, whose name is most unaccountably overlooked by those who are popularly deemed to have some knowledge of electrical subjects, wrote in 1836: "If, then, electro-momenta, capable of producing violent shocks and vivid sparks, can be produced by a few hundreds of feet of thin copper wire, what is it that might be expected from the electro-momenta of Nature, arising from currents of many miles in extent, kept in motion either by heat, saline, solutions or by other causes, amongst the metalline strata below the surface of the earth? A sudden disruption of the circuit would insure the blow, and an earthquake might be the result."

"TAKE NOTICE: A HUMBLE VOICE FROM AMERICA."—The signature appended to the verses bearing this title, printed in our issue of the 9th ult.,* has given rise to what in more senses than one is a funny mistake. The lines appear to have been understood and relished in many quarters, but the signature, which stamped them as a jest, has been taken by several intelligent editors in real earnest, Mr. F. Unney, contributor to THE ELECTRICIAN, being credited with the production! A Mr. L. E. Fant, of Boston, U.S., once pestered the proprietor of a New York Hotel for several days by wire demanding the trunk which, in spite of denials, he declared he had left behind him; and it was not until the whole batch of telegrams appeared in the newspapers that the hotel keeper awoke to the meaning of the elephantine hoax. This time it is the newspapers who are a trifle dull.

* The Round Table, November 12th, 1915.

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trical men throughout the country for many years as Spagnoletti, Limited. Last week we were afforded the opportunity of going over the new works which this company has built, equipped, and which they have been in occupation of now for some 12 months. The site of the factory is in Cumberland-avenue, Park Royal, and land to the extent of 1½ acres has been acquired. A considerable portion of this is now occupied by offices and engineering shops, and it is to this

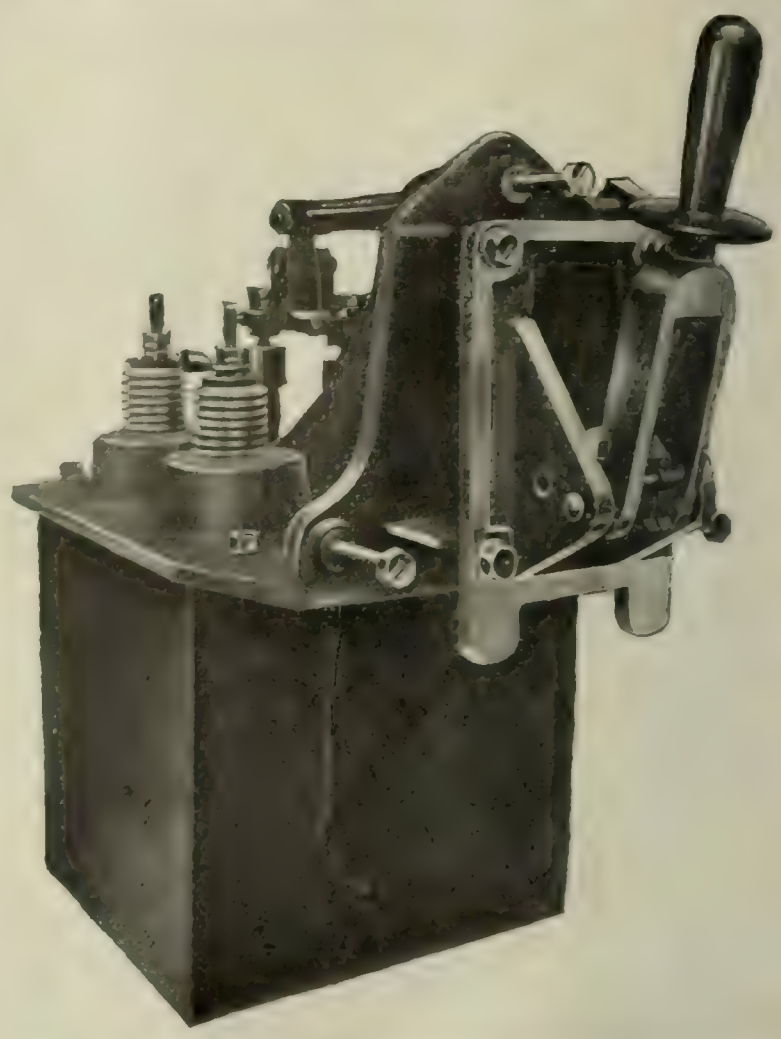


FIG. 2.—THREE-PHASE OIL SWITCH FOR MEDIUM PRESSURES.

PARK ROYAL ENGINEERING WORKS.

The identity of one firm with a distinctive line of engineering products is not always preserved. Their association with a range of specialties may continue for a period, until, perhaps, the centre of gravity around which these specialties moved has gradually shifted away and necessitated a change of outlook in the manufacturing sense. Some such argument may very well apply to the case of the Park Royal Engineering Works, to use the name of the organisation which has grown out of the firm of manufacturers known to elec-

centre that the activities of the former Spagnoletti Company have been transferred from Goldhawk-road, Shepherd's Bush.

We may recall the fact that much of the early work carried out by the company was connected with railway signal engineering. With the passage of time this class of business has been gradually supplemented by work in the production of high-tension and low-tension switchgear and those special classes of switchwork called for by the Government for Admiralty purposes. The company has had a progressive experience of the manufacture of switching apparatus for A.C. and D.C. service, and it is for the practical development of



FIG. 1.—SPECIAL SWITCH FITTING BAY.

this experience that the new works at Park Royal have been laid down.

The works themselves differ radically from the Goldhawk-road premises, in that they are laid out at ground level. This arrangement admits of the grouping of the various departments for the production of switch details in a manner which facilitates access to the raw material stores and its passage through the machine tools to the assembly benches. The design of the building can also be such as to provide efficient natural lighting at all times of the year. The saw-tooth roof and the north light are ideal in this respect, and the shops of the Park Royal Engineering Works have been laid out to take full advantage of both. Similarly, the pillar supports for the

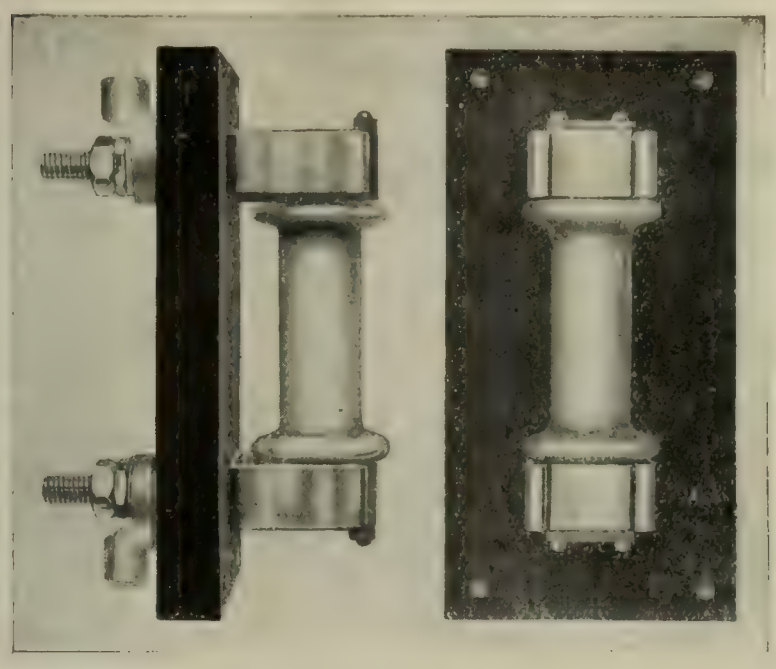


Fig. 3.—Views of Large Switch Fuse.

roof and the various girder members of the latter contribute to a convenient and effective arrangement of the shafting which serves the various groups of machine tools. These latter are driven in small sections from three-phase motors fixed at the ground floor level. The energy for the operation of the works and also for lighting purposes is obtained from the Willesden Urban District Council, and both three-phase and D.C. services have been run into the works. The south end is occupied by the office building, and giving out from a corridor at the back of this are entrances which lead directly into the works. The latter comprise a number of bays running east and west, with test room, meter department and buffing shops on the west side and cabinet shop and stores on the east. The transport of material

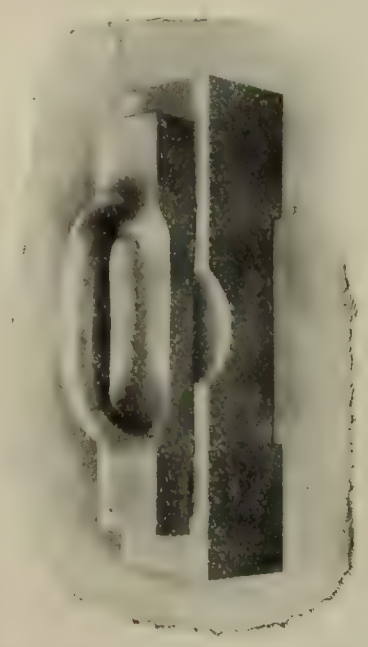


Fig. 4.—Home Office Pattern Switch Fuse.

of all classes is effected by means of a light tramway which encircles the shops and also feeds the bays. The south end of the shop is devoted to switchboard erection, ample space being available for the complete assembly of all classes of boards from the smallest to the largest which are put through the works.

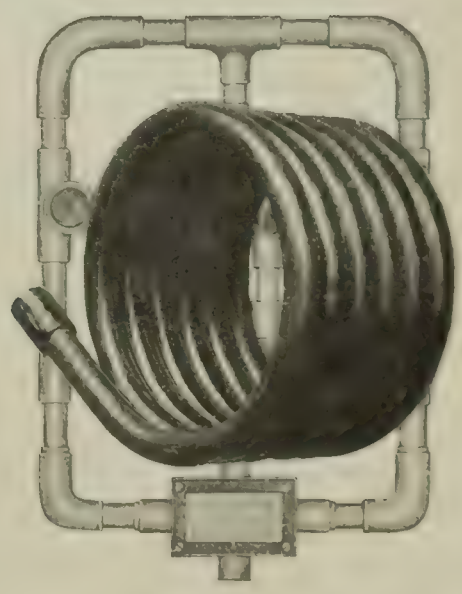
We need hardly say that the machine tool equipment is essentially modern, and includes large and small vertical drills, millers, heavy lathes, automatic lathes and turret lathes, and a variety of hand presses. The company obtains all its castings from outside founders,

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but naturally the greatest care is exercised in the supply of high quality castings which they produce from patterns made in the wood-working department.

We understand that the Park Royal Engineering Works have in recent years filed patents for improvements in foolproof switchgear for high-tension control. They have also protected a number of

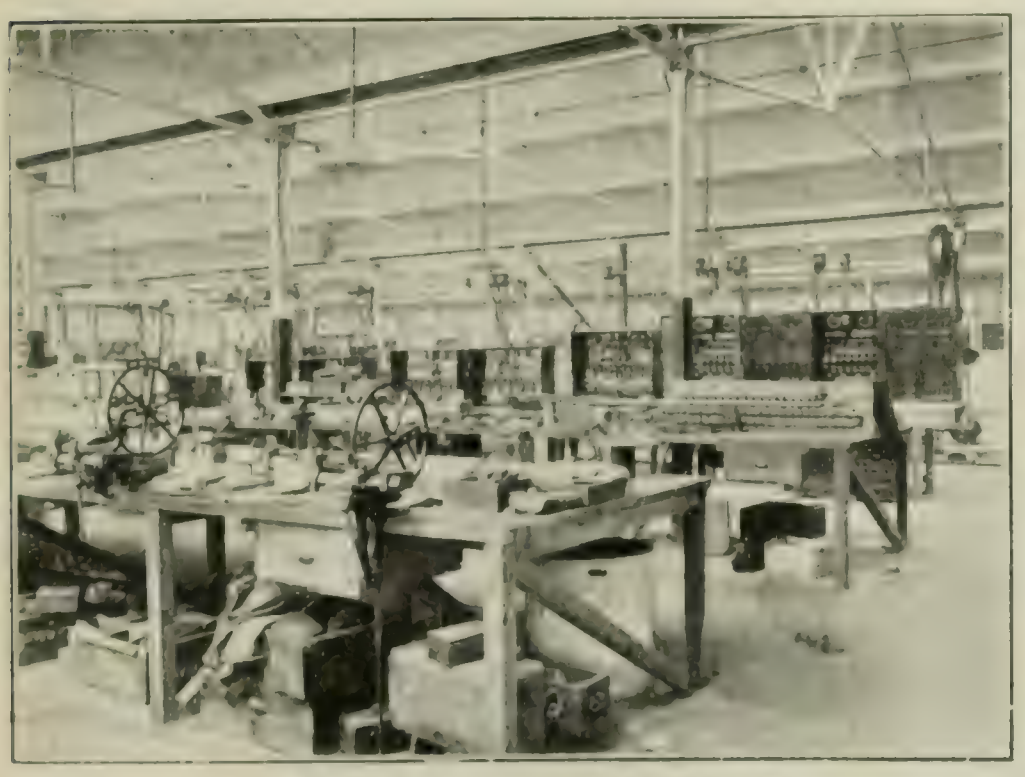


Fig. 5.—View of one of the Assembly Bays.

important principles relating to ironclad and general mining electrical gear. They have developed a line of circuit-breakers for D.C. service and oil switches for A.C. service, high tension and low tension, and they are in a position to supply these instruments for use under either normal or special conditions according to requirements. Fuses and fusegear, particularly those designed to comply with the Home Office Regulations, are another speciality of the factory. We noticed a considerable quantity of this material in various stages of construction in the shops at the time of our visit. In the instrument department the voltmeters and ammeters, which became famous with the name of Spagnoletti, are still made, and a special portion of the works has been set apart for this purpose. The metal cased instruments are indeed a speciality, particularly those rugged patterns which are intended for use in connection with mining and industrial ironclad switchgear. A considerable amount of care has been expended on the layout of the test room, in which there is a large switchboard with panels for the incoming mains of the Willesden Urban District Council and outgoing feeders for the motors in the works, and also for the purposes of the testing department. Alternating test pressures up to 50,000 volts can be obtained and are regularly used in connection with the manufacture of switchboards and switchgear. The testing equipment includes a battery which, in conjunction with other tests, is used for the calibration of instruments.

We reproduce in connection with this article a number of views which have recently been taken in the factory and which give a fair idea of its layout and general equipment. Fig. 7 is a composite photograph which shows two views in the main switchboard erecting department and also a view of the motor generators and switchboard testing and experimental department. Fig. 1 is a view looking from one end of the bay which is chiefly devoted to the production of special switchgear and fittings. Fig. 6 is an interesting view which shows the clear run of the tram road around the shops, and also a group of lathes and drills in the foreground. In Fig. 5 a number of the benches and the distribution gear of the assembly bay are shown. The other illustrations, Figs. 2, 3 and 4, show the details of



Pen Sketch View of Exterior, Park Royal Engineering Works.

typical switchgear products such as circuit-breakers, oil switches and porcelain handle fuses, which constitute a large proportion of the output of the works.

The facilities which the company has at disposal for the production of high-class switchgear, will doubtless be of interest to central station engineers and railway engineers who are in the market for sub-station equipment of all classes. We need hardly point out that there is a growing tendency to equip sub-

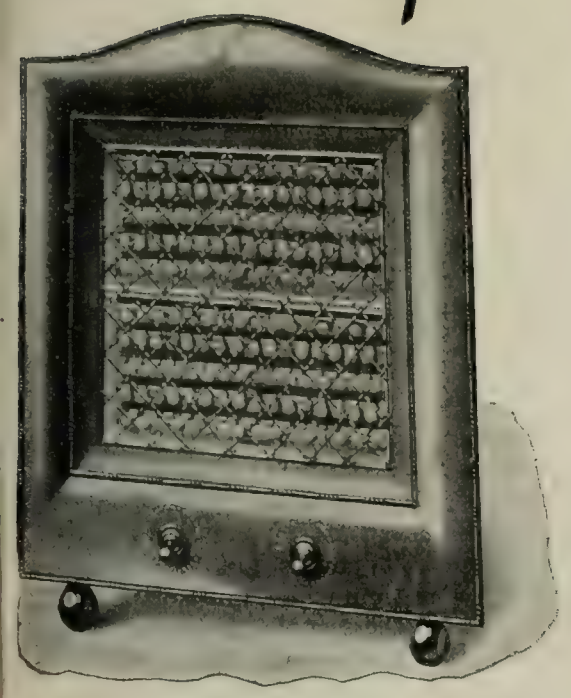


Fig. 6.—View looking down one of the Tram Roads.

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stations of quite considerable output in connection with railways, industrial power supply and the linking-up of the systems of contiguous municipal and company supply authorities. This trend in electricity supply is bound to occasion greater activity in switch production, and it is to be hoped that the claims of such British firms as the Park Royal Engineering Works upon the buyers of this class of material will not be overlooked.

In conclusion, we would thank the company for giving us the opportunity of visiting the factory, and for supplying us with most of the information and illustrations for the foregoing article.

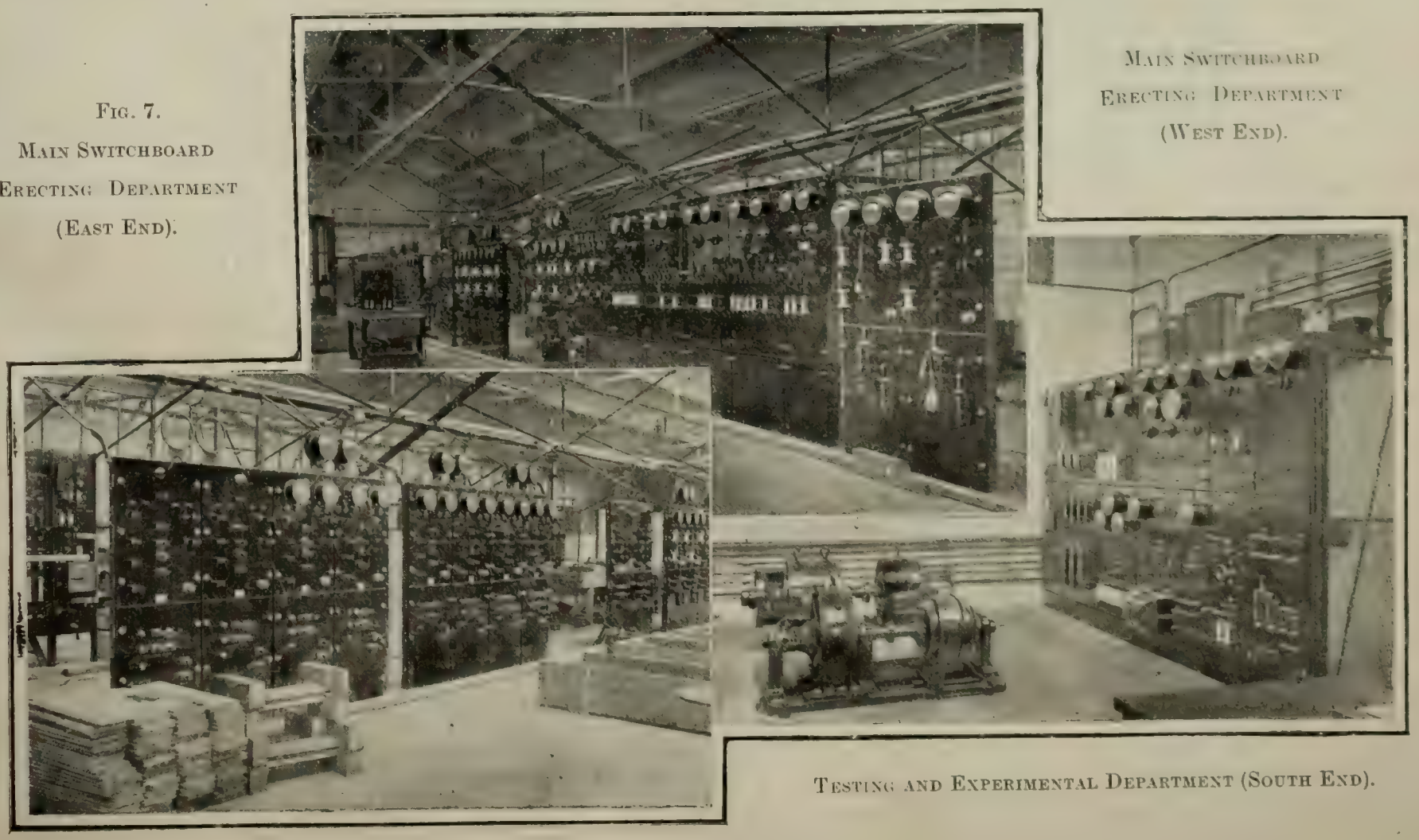


FIG. 7.
MAIN SWITCHBOARD ERECTING DEPARTMENT (EAST END).

MAIN SWITCHBOARD ERECTING DEPARTMENT (WEST END).

TESTING AND EXPERIMENTAL DEPARTMENT (SOUTH END).

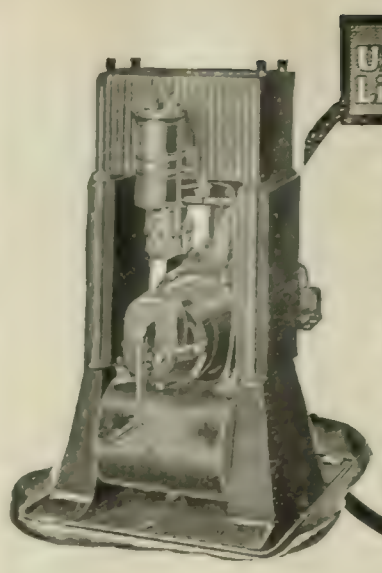
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Over 30,000 in use.

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A P.C. will bring our 40 page illustrated catalogue.

BELLING & CO., ELECTRIC HEATING SPECIALISTS.
DERBY ROAD, EDMONTON, LONDON, N.



THE UNI-LECTRIC Lighting Plant

NO BATTERIES. NO SWITCHBOARD.

Standard 110 volts—direct current.
Output 500 to 750 watts.

A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.

WRITE TO-DAY FOR COMPLETE DESCRIPTION

WALTER D. FAIR & CO.
43 LEICESTER SQUARE.
LONDON, W.C

THE "MIGAS" DETECTOR.

The "Migas" detector, of which brief particulars are now available, is an apparatus for detecting the presence of mine gas, fire damp, marsh gas, or inflammable gas, as the dangerous explosive constituent of mine air is variously called. It is a portable instrument, weighing about 13 lb., and has been specially constructed for use in coal mines.



"Migas" Detector in Carrying Case.

The detector, which is the invention of Messrs. Arnold Phelps and Louis J. Steele, does not merely indicate the presence of fire damp. By the automatic movement of an index hand over a graduated scale, it gives to within 0·03 per cent. a direct quantitative measurement of the percentage of fire damp present in the mine air which is being tested.

The actual range of the readings of the standard detector has been made such that it will indicate any amount of inflammable gas between 0·02 per cent. and 3 per cent. This range has been selected, in order that the readings may fully cover the measurements of all the different limiting percentages of inflammable gas which are prescribed in the Coal Mines Act of 1911. These limits are as follows :—

0·25	per cent.	of	inflammable	gas	Section 29, par. (3), page 21.
0·50	,,	,,	,,	,,	32. ,, (1A), ,, 23.
1·25	,,	,,	,,	,,	60. ,, (2), ,, 41.
2·50	,,	,,	,,	,,	67. ,, (2), ,, 45.

The readings of the "Migas" detector are, we understand, equal in accuracy to the results obtained by careful chemical analysis. The rapidity with which an estimation of the amount of inflammable gas can be made by means of this instrument is, of course, greater than can be attained by the latter method. The time which must elapse before the percentage of inflammable gas in the sample of air under test can be ascertained by chemical means is at least an hour from the time of taking the sample. This, however, is a particularly favourable case, for in most collieries, at the present time, there is no chemical laboratory and no trained observer. To add to this delay there is the added danger of the bottles containing the samples becoming broken or possibly opened, and also the chance of a determination being actually accidentally spoilt or rendered inaccurate during the chemical testing.

If the "Migas" detector is used in the pit at the same time as the sample of air is taken for chemical testing, it is found that at least three separate readings of the percentage of inflammable gas can be made on this instrument before one satisfactory sample of the mine air has even been collected for chemical analysis. The direct readings obtained will, it is stated, be found to agree with the results of the chemical tests made on the same mine air to within 0·03 per cent. Since the Coal Mines Act of 1911 has come into force, it has become most desirable that the colliery manager should constantly keep himself correctly informed as to the actual state of the ventilation, as represented by the percentage of inflammable gas present in the mine air. With the "Migas" detector a reading at any point can be made inside 15 seconds, and if 45 seconds are allowed for moving from point to point, it will be seen that as many as 60 separate tests can be made per hour, and a considerable distance can be traversed.

The cost of a single analysis is usually about 10s., and few mines working under the 1911 Act can have less than 60 determinations made in the course of the year, whilst if a chemical laboratory is set up at the colliery, the cost is, of course, considerably greater. The "Migas" detector, besides giving accurate and readily obtainable information concerning the amount of inflammable gas present in the mine air of any colliery, permits questions of ventilation to be systematically investigated, and it therefore should more than pay for its cost within a single year.

The "Migas" detector is at present made in two forms: (1) "The Standard 'Migas'." This instrument possesses a scale graduated to show from 0 to 3 per cent. of inflammable gas, and is designed for use in collieries using safety lamps. (2) "The Naked Light 'Migas.'"

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WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

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TO:—

MAKERS:

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George Street, Birmingham.

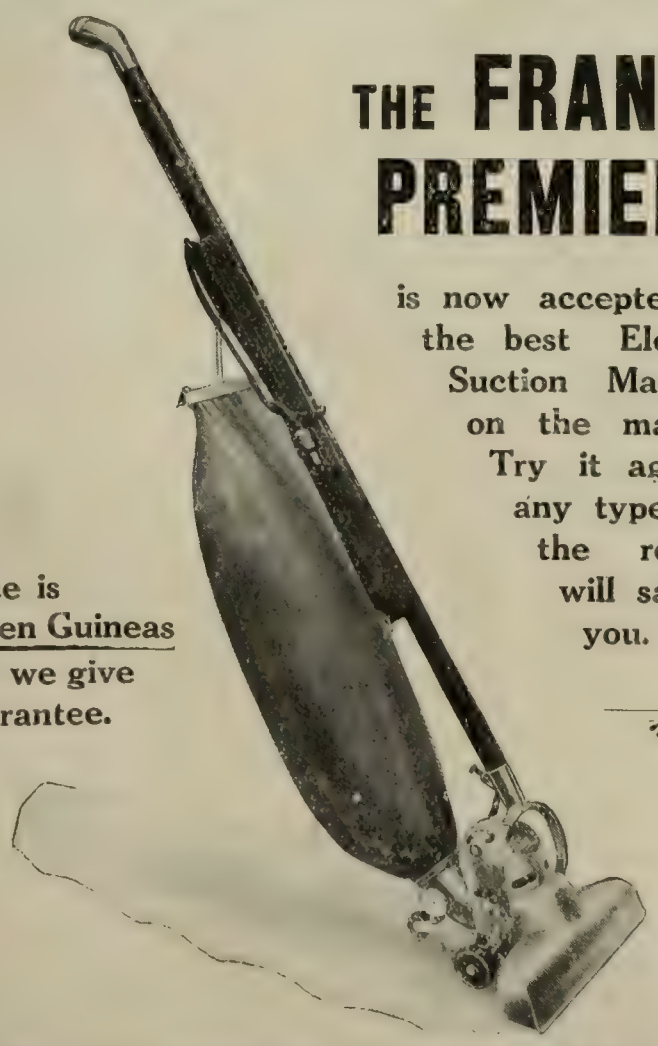
TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

AGENT:

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is now accepted as the best Electric Suction Machine on the market. Try it against any type and the results will satisfy you.

Price is Seven Guineas and we give guarantee.

ELECTRIC SUCTION CLEANER CO.

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EDISWAN EVERYTHING ELECTRICAL

THE ALL-BRITISH HOUSE FOR ACCESSORIES

ROYAL
EDISWAN
DRAWN WIRE LAMPS

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FULLY LICENSED UNDER BRITISH PATENTS Nos 21513/06 - 27712/03 AND OTHERS

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CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston. Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868. Codes 5th Edition A B C & Western Union.

This instrument is specially designed for high accuracy between the limits of 0 and 1 per cent. of inflammable gas, and reads up to a maximum of 1·5 per cent. It is intended specially for use in collieries in which naked lights are permitted.

Both these forms of the "Migas" detector are perfectly safe for use in the most fiery mines, and both are so constructed that a sample of gas from a crevice, or more or less inaccessible point, may, if desired, be brought to the detector by means of a flexible tube and hand pump. These detectors can also be supplied to measure the percentage of inflammable gases and vapours other than marsh gas (fire damp). In such cases, the scales of the instruments require special calibration.

Additional particulars and technical data can be obtained from The General Electric Co., 67, Queen Victoria street, London, E.C.

ZEPP PROOF MOTORS.

During the last raid on London and the Eastern Counties, we are informed that a bomb was dropped on a flour mill. The whole of the plant in the mill was electrically driven by Crompton motors, and was installed many years ago. The attached illustration represents a group of four motors which were installed on the second floor of the mill, and which were precipitated into the basement when the bomb wrecked the building, the latter subsequently catching fire. After the flames had been extinguished, the motors were taken from the debris with a view to making use of them if at all possible in another temporary mill. It is a remarkable fact that after re-filling the bearings with oil and replacing some of the brushes, the four motors were in satisfactory running order, in itself a splendid testimony to the rigidity of construction of the "Crompton" motors of the period to which these machines belong. The latest design of



E. SHOWELL & SONS, LTD.,
STIRCHLEY, BIRMINGHAM.

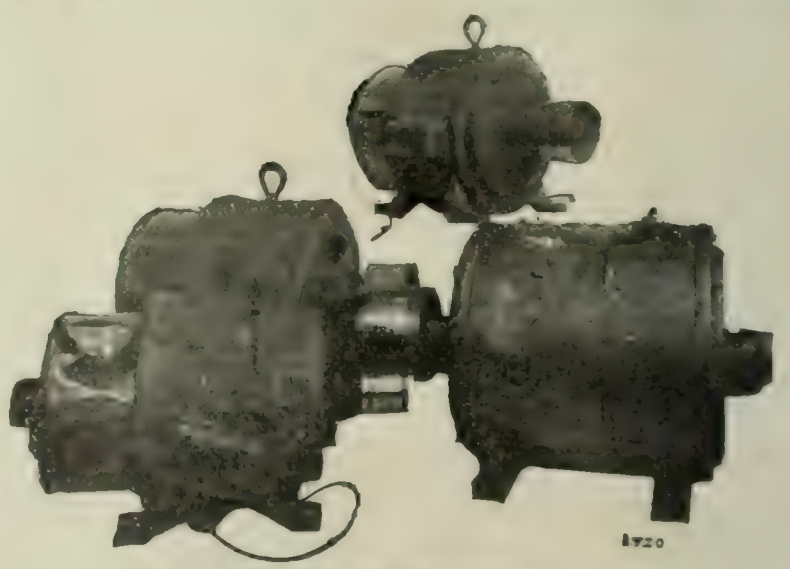
Cast Cable Sockets.

Suite No. E74.	Sizes made. Amps.
Type A.—Straight.	10, 25, 50, 100.
,, B.—Cranked.	150, 200, 300.
,, C.—Right angle.	400, 500, 600.

Immediate Delivery. Prices on Application.

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TELEPHONE: *Holborn* 6323.

motors by Crompton & Co. has, of course, superseded such old machines, and in the modern type attention is given to high efficiency,



A GROUP OF "SURVIVORS."

low temperature rise, and large overload capacity with sparkless commutation throughout the whole range of load.

NEW LISTS.

HALF-WATT LANTERNS, &C.—In section list No. 506 the Benjamin Electric (Ltd.) describes its new range of fittings for half-watt lamps of all sizes. The makers claim that the range of fittings is as complete as exhaustive experiment and research can make it. The contours of a number of standard reflectors have been re-designed to give efficient results with the new lamps. A feature of the list is the addenda, a separate sheet, giving tabular prices and particulars of all the company's products.

WILLANS-ODDIE PUMPS.—A complete illustrated description of an interesting steam pump is given in catalogue No. 953, just issued by Willans & Robinson. The Willans-Oddie is "the pump with the single-balanced steam valve." The description of the action of the pump is made clear by several good sectional lettered drawings.

DOWSING HEATERS.—A fully illustrated large catalogue and a smaller pocket price list and other useful trade literature is being distributed widely by the Dowsing Radiant Heat Co. A number of new designs of the company's hot-bar fires are included in the lists.

NILFISK SUCTION CLEANERS.—An illustrated pamphlet and price list of the Nilfisk suction cleaner is being distributed by Messrs. Gillespie & Beales. The pamphlet contains particulars of the standard Nilfisk cleaner and also of a new pattern, somewhat smaller than the standard, and offered at a lower price. The machines are identical in design and the new pattern weighs 30 lb.

SLATE

INIGO JONES & CO.,
Tudor Slate Works,
GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

FURNACES FOR MELTING

Tin, Lead, Zinc, Antimony, Aluminium, White Metals, Plastic Metals, etc.

WITHOUT OXIDATION.

MONOMETER MANUFACTURING CO., LTD.,
WHITEHOUSE STREET, ASTON, BIRMINGHAM.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 10, 1915.

THE ROUND TABLE.

By "KVA."

A correspondent who omits his name sends me a p.c. with post-mark Lougborough, bearing the following riddle: *Why was sol-enoid?* The answer is electrical. Can you guess it?

* * * *

A perplexed correspondent inquires whether the Mazda revolving lamp shade will run with a lamp with any other name. The answer is in the affirmative, but naturally it must be a T.L.A. lamp, otherwise the shade may run backwards!

* * * *

My only remaining impression of enlisting under Lord Derby's scheme last week was the atmosphere of the doctor's "booth." It was very far from being an inert gas; in fact, it seemed quite solid enough to lean upon. I found myself one of 20 men who were clothed in anything from zero to 100 per cent. overload.

* * * *

"Tabasco" Bastian has decided to run the rule over his friends this Christmas, perhaps in preference to chastening them with a rod-o-lite. I am one of the victims, but a willing one, as I expect many more will be. The 6 in. Bastian rule is guaranteed to last, because it has at one end a calendar for the years 1907 to 1927 *inclusive!*

* * * *

A motorist who became a Tommy at the outbreak of war tells a good story against himself. He was told off to fetch some milk from a farm, but returned with an empty vessel. Asked for an explanation, he said "I found a queue waiting at the cow, and when it came to my turn I could only get *one of the jets* working about 5 seconds, and then missed the pail altogether!"

* * * *

A correspondent sends me the following homily on the "soft answer that turneth away wrath":—

"What a sweetener to business a little politeness is. On writing for a somewhat overdue account the following reply came back: 'You will remember that you disappointed us very sadly with respect to delivery of the motors in question, and, as a consequence, we have not felt animated by an overwhelming desire to pay for them. As the matter is now, however, getting somewhat ancient, we will deal with it durin g the present month.'"

* * * *

Just my luck. I am not likely to be in Glasgow, perhaps, until the war is over, and I have received an invitation to take lunch at the expense of the electricity department. The "grub" is electrically cooked, of course, and presumably all the "extractives" are placed unreservedly at the disposal of the guests. Here is the menu:—

Potage Hollandaise.
Tranches de Saumon à la Mozarte.
Filets de Veau à la Marguerite.
Omelette en Surprise.
Biscuits de Fromage.

Why will they not make the menu out in pure Scotch? Or is it patriotism that French is used?

According to the "American Machinist," "the substitution of steel for copper in the manufacture of electric switches is one of the first apparent results of the increased cost of copper." Our contemporary has probably omitted the words "in Germany."

* * * *

ELECTRO-HARMONIC SOCIETY.

2ND CONCERT, 30TH SEASON, 1915-1916.

Unofficial Programme.

"Wesco" Kingsbury in the Chair.

OPENING CHORUS	"None but the Brave Deserves the Fare." — Conductresses Choral Society. (Conductor, Mr. A. "ELSIE" FELL.)	
MONS SOLO	"Angels Ever Bright and Fair." ... ... — Mr. A. G. WHYTE.	
PARAGON-BACHELET INTERLUDE	Demonstration of Levitated Pants ... — (for Soldiers). Mr. W. P. DURTNALL.	
PATRIOTIC DUET ...	"Unter den Linden." ... ... — Mr. A. P. MARRYAT and "ANTI-HUMBUG."	
NI CHROME-ETTE ...	"Keep the Home Fires Burning." ... — Messrs. BELLING & BASTIAN.	
REBATE CHORUS ...	"All We Like Sheep." ... ... — TUNGSTEN LAMP ASSOCIATION.	
"ELASTA" MARCH	"See the Sintering Hero Comes." ... — POPE'S ELECTRIC LAMP CO.	
AUDION SOLO ...	..."O Silly-Un." ... ... — Dr. LEE DE FOREST.	
CHLORINE COMEDY	"If the wind had only blown the other way." "GASSED" ELECTRICAL ENGINEERS AT THE FRONT.	
PEACE PIFFLETTE...	"Let me like a soldier fall" (I don't think) Mr. HENRY FORD, U.S.A.	
GOTT-STRAFEZZO	"The Watch on the Rhine" ... ... — THE MANCHESTER ENGINEERS' CLUB.	
LULLABY ...	"Oh, Hush thee, my Baby." ... ... — Mr. JOHN CHRISTIE.	
THE QUANDARIES...	"Where, tell us where?" ... ... — THE B.E.A.M.A. Solo Quandary, Mr. D. N. DUNLOP.	

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), December 14, 1878.]

EXTENSION OF THE ELECTRIC LIGHT.—Messrs. Shoolbred have lighted their extensive premises by means of the Jablochkoff light, and Mr. Whiteley, of Westbourne Grove, is about to make the necessary arrangements for lighting up his establishment.

NEWSPAPER SCIENCE.—Dr. Werner Siemens criticises recent popular newspaper essays on the conversion of mechanical power into electricity, and the re-conversion of the latter into mechanical power. He shows that, in common with others, he had pointed out the future importance of this principle for the production of light, the conveyance of motive power and other technical purposes. But all this passed unnoticed until it was re-discovered by an American.

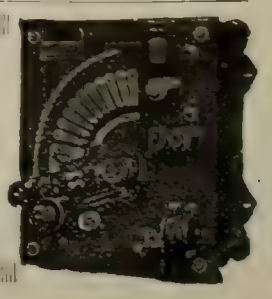
A PROMISING INVENTION (AMERICAN), IF TRUE.—A correspondent of the Boston "Journal of Commerce," writing from Philadelphia, tells of an invention, which has been kept secret pending the pro curement of patents, and which, with power derived from a spring like that of a clock, furnishes an electric light of great brilliancy. It is further reported that the whole apparatus occupies no more than an ordinary lamp, that it can be sold for six dollars per lamp, and that the light itself will cost only one-half cent per hour.



No. 32.—Three-Phase Rotor Starter for A.C. slip-ring motors. Automatic no-volt or no-volt and overload release is provided and semi or totally enclosing covers are supplied.
The starting resistance and current-carrying parts are liberally rated, and the general design embodies several new improvements.

'IGRANIC'
MOTOR CONTROL GEAR.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

No. 38.—Compound Starting and Speed Regulating Rheostat for shunt or compound wound D.C. Motors. This switch will start the motor and then regulate its speed by the insertion of field resistance. An infallible interlock secures full field during starting, and automatic no-volt and overload release is provided.

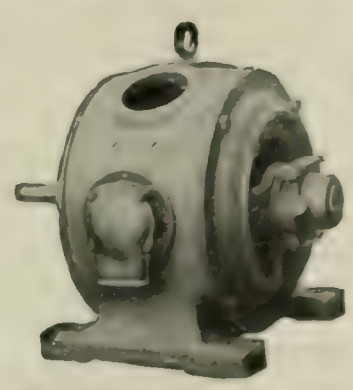


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STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

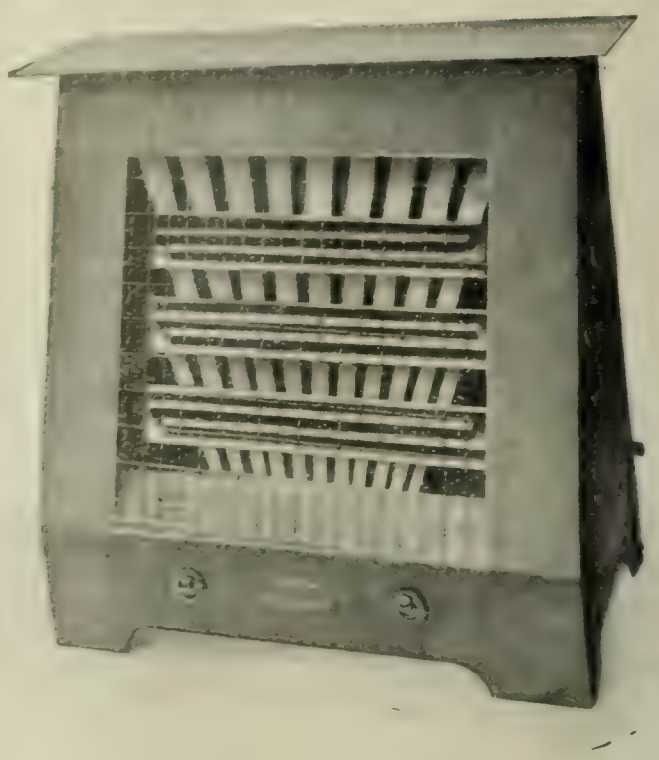
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GLASGOW—66, Waterloo Street. | SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

NEW DOWSING CATALOGUES.

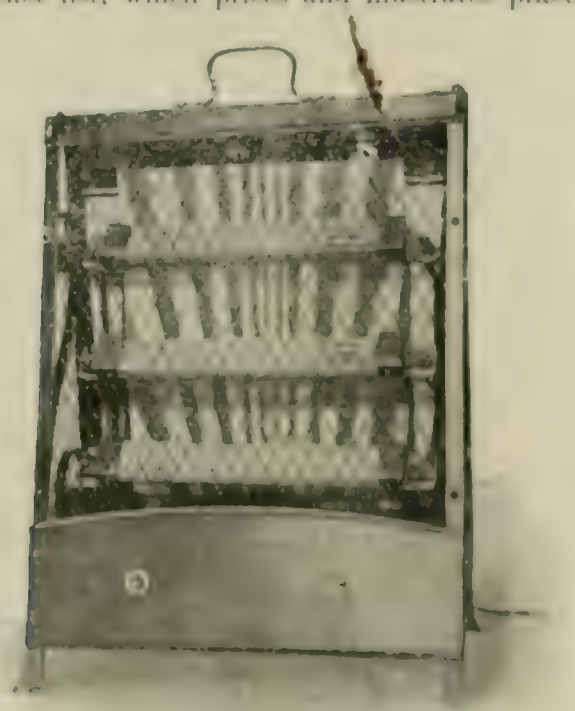
We have received from the Dowsing Radiant Heat Co. copies of two trade publications which they have recently issued to give publicity to their electric heating and cooking apparatus. One of these is a pocket list, which prices and illustrates practically the whole of the company's products. Presumably, this is intended for the use of electrical contractors, who will find it convenient and portable, and a useful book of reference. The second publication is much larger, and is printed on heavy art paper, and therefore is more suitable for distribution amongst the public as prospective users of electrical heating and cooking apparatus. The front cover bears an attractive design, which should serve the purpose desired of making the recipient of the publication anxious to examine its contents.

We understand that there is a considerable demand for the company's hot-bar radiators, of which three typical designs are illustrated herewith. This pattern of radiator was introduced several seasons ago, and has, we gather, proved very successful in service. A feature of the design is the employment of ruby illumination in conjunction with a reflector which produces a sunray or flame effect. This reflector is placed behind the horizontal fire bars which carry the heating elements. We may recall the fact that the latter are made up of horizontal grooved fireclay bars, the grooves containing the spirally-wound nickel-chromium heating element. A quartz protecting and diffusing plate can be placed in front of the hot bars if desired.



DOWSING HOT BAR FIRE.

In the same list is a new pattern of electric kettle, which is provided with an interchangeable heating element. The latter, which is made under the Eastman & Warne patent, consists of a light iron casting into which mica strip elements are fitted between gills forming part of the casting. These gills conduct the heat from the element to the bottom of the kettle. The underside of the casting is covered with an insulated backing and enclosed with a base plate, which carries the terminals for the element wires and the contact prongs for the connecting plug. It will be seen from the illustration that the kettle is recessed to take this pattern of element, and that it stands on three insulated feet. One pint of water can be



DOWSING HOT BAR FIRE.



DOWSING HOT BAR FIRE.

STRENGTH ECONOMY

When times are good and when times are bad—there's one line that always sells. It is

ELASTA LAMPS

BRITISH MADE

The lamp with a living in it.

Advt. of Pope's Electric Lamp Co., Ltd. Also makers of Carbon and Radiator Lamps. Hythe Road, Willesden, N.W.

boiled in 3½ minutes. This heating element is also supplied to urns and other liquid heaters. The kettle is offered in four sizes, three of 2 pints capacity and one of 3 pints, the former being loaded to 1,000 watts and the latter to 1,200 watts. The shape of the kettle is different in each case.

The cordless hot-point irons, made on the Belenus system, are also featured in the catalogue. These are designed for use in laundries and tailoring establishments, and we understand have proved successful in that they remove the chief objection to the electric iron—namely, the flexible connecting cord. Each iron is complete in itself, and the ends of the heating elements are brought out to a special two-piece contact plate mounted above the heel of the iron, immediately behind one end of the handle. Connection to the live circuit is made by placing the iron on a sloping stand and allowing it to run down by its own weight to a stop, at which point the iron contacts engage with spring clips attached to the back of the sloping board. We understand that the irons will not overheat and that the system has proved highly economical in running cost. The company publishes the following table taken from actual practice :—

Test made at	No. of irons.	Cost of gas.	Cost of electricity.	Final result.
		Per week.	Per week.	Irons installed.
London	5	7 8½	4 6½	120
Newcastle	3	4/1	3 0¾	46
Brighton	8	18/5	13/4	12

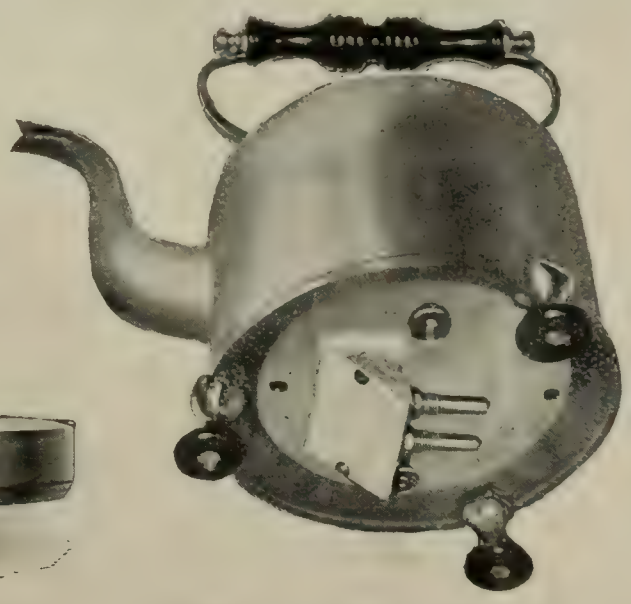
These irons are listed in 11 sizes, ranging in weight from 4 lb. to 22 lb. ; the energy consumption for the former is 275 watts and the latter 500 watts.

Interest attaches at the present time to the electric sterilisers which the company offers for the use of surgeons, dentists, &c. The illustration shows one of these useful accessories. It comprises a trough, nickel plated on copper, fitted with a perforated metal lifting tray. The heating element is a separate feature, and is constructed in cast iron with nickel-plated feet, the under side of the trough being recessed to take the heater. This is listed in three sizes, the smallest measuring 1½ in. high by 4 in. wide by 7½ in. deep, and consuming 500 watts ; and the largest measuring 3¾ in. high by 4 in. wide by 16 in. deep, and consuming 1,000 watts.

There are a number of other interesting electrical appliances, such as branding irons, sun baths and vibrators, referred to in the list



KETTLE ELEMENT.



NEW KETTLE WITH RENEWABLE HEATING ELEMENT.



ELECTRICAL STERILIZER FOR INSTRUMENTS.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

TRADE MARK
SEA-CLIFF



UNI-LECTRIC Lighting Plant

NO BATTERIES. NO SWITCHBOARD.
Standard 110 volts—direct current.
Output 500 to 750 watts.

A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.

WRITE TO-DAY FOR COMPLETE DESCRIPTION

WALTER D. FAIR & CO.
43 LEICESTER SQUARE.
LONDON. W.C.

but we would recommend interested readers to apply to the Dowsing Radiant Heat Co., at York-place, Baker-street, London, W., for further information.

Besides taking over Messrs. Eastman & Warne's business last year, the company states that they recently purchased the Phœnix Electric Heating Co.'s business *i.e.*, goodwill and useful stock. They have now also acquired the goodwill, patterns, secret process for manufacture of elements, drawings and stock of heating elements of the British Prometheus Co., of Birmingham and London, so that as soon as they have sufficiently increased their works they will be in a position to supply heating elements previously manufactured by these firms.

A NURSERY ELECTRIC COOKER.

Of recent years many admirable schemes have been developed for leading the young mind to think in certain channels which will lead to business in future. Such schemes are in the nature of an advertisement, and if they are carefully prepared will prove to be a profitable advertisement. Lamp makers can impress the trade name of their product on the child mind by means of painting books. The purveyors of a brand of margarine may distribute in every household where a family is known to live, cardboard models of animals, on each of which there is some reference to the product in question. Similarly, dealers in foodstuffs and comestibles of every description, not to mention patent medicines and packet foods, have adopted some simple form of advertising which provides the youngsters with a little genuine amusement and keeps them quiet for a period.

Electrical engineers who are keen on the sale of electricity for domestic purposes can now make use of a toy electric range wherewith to acquaint the junior members of the family with the cleanliness, convenience and, above all, the safety of electric cooking. It is perhaps not surprising that the Americans are the pioneers of this movement. We have noticed frequent references in the American papers to the Western Electric "Junior" electric range. Now we have had an opportunity of actually inspecting one of these admirable toys, and we think that they should prove extremely useful in doing missionary work for electric cooking. The adjoining illustration clearly shows the design and shape of the range. It comprises a simple oven with pull-down door, and a heating top with six circular recesses, each representing a hotplate. By moving four screws this top can be lifted off to expose the heating element. This latter is made up of nickel chromium spirals threaded through bushed mica strips and laid around three sides of the space forming the oven. There is a continuous length of wire, the ends of which are brought to a terminal block at the back of the range. The connecting flexible passes through a bushed hole behind the oven, and the ends are secured to the terminal block.

The heating element is rated at 600 watts, and the range can, therefore, be worked from an ordinary lampholder. It quickly heats up, and the cooking operations can be commenced almost at once. The "hot plates" are pierced with holes through which the glowing heating element may be seen, thereby adding reality to the appearance of the range. Four utensils are provided, a baking dish for use in the oven, and a frypan, a saucepan and a kettle for use on the hot plates. These utensils are very well made, and are



FRONT VIEW OF "JUNIOR" ELECTRIC STOVE.

designed to fit snugly upon the circular hot plate spaces. The apparatus is not lagged, so that the oven and the top of the range will get too hot to touch. The range is, however, raised clear of the table by four metal feet, screwed on at the corners. We gather from the circulars which are being sent out in regard to this little article that satisfactory cooking, that is, both baking and frying, can be carried out on the stove. It stands 15 in. high to the top of the hood, and the oven is 4½ in. wide by 2¼ in. high by 5 in. deep. The area of the hot plate is 88 sq. in. With each oven is provided a length of flexible cord, a totally enclosed push button snap switch and an adapter for connection to the lamp socket. The range would make a delightful and useful Christmas present. The Western Electric Co. are, we understand, expecting a supply of these ranges from the States, and they will be pleased to send particulars and prices on request.

One, Two & Three Phase MOTORS.
LANGDON-DAVIES MOTOR CO.
Head Office: 110, CANNON STREET, LONDON, E.C.
Works: Dermody Road, Lewisham, London, S.E.

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37, NOBLE STREET, LONDON, E.C.

Western-Electric

No. 84

INTERRUPTER

OR RINGING VIBRATOR,

should be Installed

ON ALL RAILWAYS.

THEY ARE NOISELESS AND SPARKLESS.

We claim many good features in respect to this piece of apparatus - may we send you full particulars?

Western-Electric Company Limited.

WORKS: NORTH WOOLWICH.

INDUSTRIAL ELECTRIC HEATING.

The use of electricity for heating dwellings, shops, showrooms, &c., has made considerable strides during the last year or two. Besides the growing use of electric heating in new factories, workshops and offices, cases are on record where a change over has been made from steam to electric heating, as the latter has been found to be pleasanter and more hygienic. One of these progressive firms which has carefully considered the question of steam, hot air, electric and other forms of heating for offices is Messrs. Edward Cook & Co., Ltd. (East London Soap Works, Bow). This firm tested steam heating throughout its new offices, and finally decided to replace it by an electric heating system. After they had gone most thoroughly into the question, the company's engineers advised the use of "Magnet" panel type electric fires throughout the offices. As a result, 30 1·5 kw. and 20 2 kw. "Magnet" fires were installed throughout the various offices, telephone operating room, typewriting and post departments, &c. The illustration above shows some of the "Magnet" electric fires in the general office. We need hardly remind our readers that "Magnet" fires are made by the General Electric Co. (Ltd.), at their Birmingham works.



PART OF THE GENERAL OFFICES OF MESSRS. EDWARD COOK & CO. (LTD.), SOAP MANUFACTURERS, HEATED THROUGHOUT BY "MAGNET" ELECTRIC FIRES.

POPULARISING ELECTRIC SUPPLY.

We have recently received copies of booklets and pamphlets from several progressive electricity undertakings which are regularly conducting campaigns on behalf of the domestic electric service.

The first of these, entitled "Modern Heating and Comfort in Cooking," is an attractive brochure issued from the electric shop of the Newcastle-on-Tyne Electric Supply Co. After an explanation of the tariffs in vogue in the district, the merits of electric cooking are pointed out. It is interesting to note that grills and cookers can be hired out at rates varying from 2s. 6d. to 6s. 6d. per quarter. Excellent illustrations of modern cookers and hollow ware cooking utensils are included. Immediately following is a useful section on electric fires, which may also be hired out at the rate of 3s. per quarter. A hot water circulator is illustrated, and its particular merits in furnishing a supply of hot water at all times are explained. The concluding page of the brochure is devoted to illustrations of electric kettles, electric irons and electric toasters. All these domestic appliances can be seen in actual operation on the premises of the electric shop, 85, Northumberland-street, Newcastle-on-Tyne.

"Electricity in the Home" is the title of an art paper pamphlet issued by Mr. Geo. Wilkinson, engineer and manager, electricity department, Harrogate. This has been prepared to explain the ratable value tariff which is in vogue in the Harrogate district. This tariff is based on a 15 per cent. charge on the rateable value of the premises, a fourth of which is invoiced quarterly, and in addition ½d. per unit for all electricity metered for lighting, heating and cooking

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OILED PRESSPAN. MICA-COVERED PRESSPAN, &c.

Silver Medal: Paris 1900. Grand Prix: Marseille 1908. Gold Medal: Berne 1914.

purposes. For hot-water heating, and similar apparatus having 100 per cent. load factor with automatic control, energy is supplied at 3d. per unit. A lucid explanation is given of the advantages of this tariff and its influence upon the economical operation of the household. Figures are given to show that an annual saving of about 25 per cent. can be effected by the adoption of electrical appliances. One of the chief economies is the reduction in labour, one maid less representing a saving of at least £20 a year in wages alone. Particular attention is drawn to the case of a local householder who removed his kitchen range and boiler and converted his premises into an electric house. The pamphlet is a convincing document and should materially assist in bringing in many new consumers.

The third publicity matter to which we have to draw attention is a three-colour folder issued by the Glasgow Corporation electricity department. This contains an excellent illustration of the outside of the new show-rooms in Sauchiehall-street. The premises look very imposing in the photograph, there being two exceptionally wide and high windows with central entrance door between them. These windows have been attractively set out with domestic appliances of all kinds. An interesting fact to which we are pleased to give publicity is the arrangement of cooking demonstrations with various types of electric ovens every afternoon except Saturdays from 2:30 to 4:30. A specimen menu will be found on the "Round Table" page.

"BROOKHIRST" SWITCHGEAR.

An attractive catalogue describing Brookhirst switchgear has just come to hand. This company, who have extensive works at Chester, have made a speciality of motor-starting panels for continuous-current work for many years past, and their products must be well known. None the less the catalogue will be welcome by present and prospective users of control gear, because it illustrates a complete range of the company's standard lines, and also gives full prices and overall dimensions. The opening pages contain complete specifications of ironclad motor starters and motor-starter panels. In addition to panels for the control of moderate size motors, the company also specialises in multiple lever starters and starting panels for motors up to 500 H.P. operating on 450 to 550 volts.

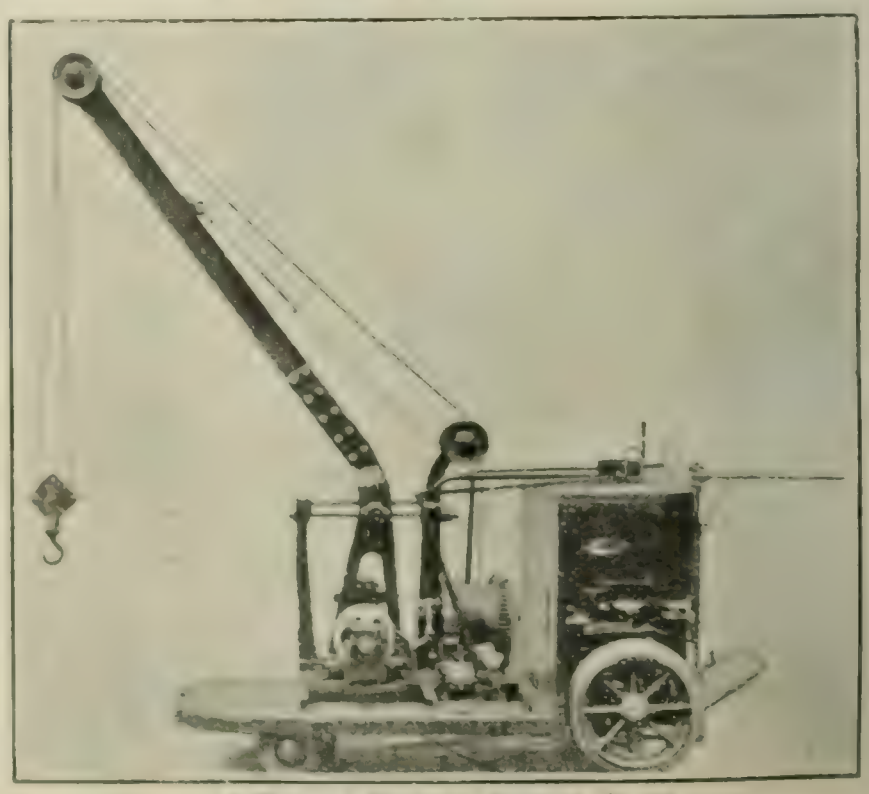
The catalogue has much to commend it as a printer's production, and further it gives indication of extreme care in the classification of the matter and the preparation of the illustrations and outline drawings. The latter are commendably clear, a fact which will doubtless appeal to users of the list.

"Brookhirst" standard ironclad switchgear is enclosed in wall or pillar type iron cases of robust construction and neat appearance. Doors are provided at both the back and the front to render the switchgear and resistances easily accessible. The front doors are hinged and have glazed windows, which enable the operation of the switchgear to be visible at all times. When the apparatus is required for exposed positions, expanded metal guards for the windows are recommended. These fully protect the glass, whilst still permitting a clear view to be obtained of the working parts. The back doors are fixed by set screws, and for ventilated gears the openings in them are provided with perforated steel plates. In the case of totally-enclosed non-ventilated and dustproof gears the back doors have solid steel plates, and the joints between the doors and the case are made with suitable packing.

The switchgear is mounted upon enamelled slate slabs in such a manner that all important working parts are readily removable from the front without interfering with the resistances or interconnections. The slabs are insulated from the case by means of mica or micanite bushes and washers, whilst all the live terminals and current-carrying parts in one of the poles are similarly insulated from the slate base.

Wall type cases are provided with detachable connecting boxes designed particularly for conduit or tube wiring systems. Owing to the inconvenience of settling drilling particulars before delivery, the boxes are usually supplied undrilled, but can easily be detached and drilled on site to suit the conduit used. They are drilled and tapped (without extra charge) to customers' requirements if instructions are furnished with order or a few days before date of despatch.

Pillar type cases are open at the base, and the cables are usually brought up through these openings. If preferred, however, the cases can be drilled to instructions, before despatch, at the back or the sides. When holes are drilled on site care should be exercised to ensure that the borings do not fall amongst the working parts and resistances. Wall or pillar type panels can be provided with glands for armoured cables at a small extra charge, but full particulars of the cables, especially the diameters over the insulation and the armouring, must be furnished.



A Typical Battery Driven Crane.
(See Electric Vehicle Progress Supplement, every month.)

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SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

FURNACES FOR MELTING
Tin, Lead, Zinc, Antimony, Aluminium, White Metals, Plastic Metals, etc.
WITHOUT OXIDATION.
MONOMETER MANUFACTURING CO., LTD.,
WHITEHOUSE STREET, ASTON, BIRMINGHAM.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, December 17, 1915.

THE ROUND TABLE.

By "KVA."

To all readers of the Round Table the world over I extend the Season's Greetings! Christmas 1915 cannot very well be a time of merriment; rather let it be an occasion upon which to renew our resolve to carry this war to a victorious conclusion for our staunch Allies and ourselves. Electrical men at the front and at home, in both arms of the Service, make one at least of the vital sinews of war.

* * * *

If gold were magnetic, what a run there would be on Igranic and Witton-Kramer "lifting" magnets. Still, a few of these might be sent to the front to deprive the Germans of their Iron Crosses.

* * * *

The answer to the little riddle, "Why was sol-e-noid?" is because he could not take meg-ohm! A correspondent in Manchester sends me a p.c. with the answer: "Alas! he had two good cores!"

* * * *

The turn up at the Harmonic was well below the average, and it was one of the topics of conversation between the turns. Speculation was rife as to the cause of it. Some said "Zepps," others the non-treating order, others the paucity of foot-candles in the streets. I think it must be because we all know so many members of the Anti-Aircraft Corps.



A View of the Lemington Glass Works where the Osram and Robertson Bulbs come from.

In the course of an interesting letter on his new showrooms, Mr. W. W. Lackie says: "I am pleased that you are interested in our cooking demonstrations. These will, I trust, continue after the war, and I hope by that time at latest you will be able to visit Glasgow, when our cooking demonstrator will try her latest creations upon you." At last I have something to look forward to at the peace!

Contemporary Sayings. "The Central Powers, with that remarkable degree of organisation in anticipation of events which distinguishes them, are already at work in order to organise an immense Customs Zollverein from the Baltic to the Ægean Seas, and to embrace also such small neutral Powers as can be persuaded or forced to enter it. Obviously this aggressive step for peace time must be counteracted if the balance in trade is to be maintained"—"Engineering"

* * * *

A jointer who had attested ("detested" he called it) under Lord Derby's scheme thought he would surprise his wife with a little present purchased out of the 2s. 9d., a day's pay and a day's "grub." He turned up at home looking very disgruntled, and threw a half crown on the table. "Say, missus, Lord Derby ain't 'arf 'ad me fur a mug; that 'arf dollar's a wrong 'un!"

* * * *

A most interesting film is being presented at the Phil(m)-harmonic Hall, W., just now. It shows motion pictures taken under the sea by the use of the Williamson tubular apparatus suspended from the bottom of a barge. The views put on the screen were taken in the Bahamas about 40 ft. below the surface of the sea, and they are very clear and most interesting. The Williamson tube is being used for the inspection of the footings of piers and under-water works of every description. We may expect to hear of its use for removing the barnacles from Atlantic cables.

* * * *

THE ELECTRIC RANGE.

Matchless and scratchless, worked by a switch,
Sootless and dustless, give it a twitch,
Gas-less and ash-less, cooks to a turn,
Hod-less and coal-less, browns but won't burn;
Odorless, dirtless, broils while you wait,
Wasteless and flameless, meals never late,
Faultless and blameless, never will change,
You guess, 'tis none less—the Electric Range.

Useful and helpful, brings peace to life,
Beautiful, joyful, gladdens your wife;
Cheerful and blissful makes every day,
Graceful, resourceful, drives care away.
Peaceful and restful, adds to one's health,
Faithful and truthful, takes little wealth;
Wonderful, dutiful, nothing more strange,
How we've lived without—an Electric Range.

[*Edison Life.*]

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), December 21, 1878.]

Electric Light Applied to Ships.—The electric light is finding extended applications. At Bremen a ship, bearing this light on its prow, has been able to sail down the river at full speed in the night. The Imperial dockyards at Kiel are now illuminated on the Jablochkoff principle.

The Power Transmitted by Wires.—At the electrotype works of the Societe Val D'Osne in Paris, M. Cadias, the engineer, has for the last two years employed 2 Gramme machines to transmit the superfluous power of an engine from one part of a works to another. The connecting wire is about 5 mm. and from 150 yds. to 200 yds. long. The power transmitted is said to be about 60 per cent. of that employed. The second machine drives another dynamo-electric machine, which furnishes the current to electroplate large surfaces, some of the articles electroplated weighing several tons.

All enquiries concerning
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SOUTHAMPTON—46, High Street.
Branches in Principal Towns Abroad.

CORROSION-PROOF WIRING.

The difficulties which have presented themselves to wiring contractors for many years past in the installation of electric light and power wiring in cold stores, chemical works, stables and permanently damp situations, have proved very real ones. Where corrosive fumes and moisture are perpetually present a close watch must be kept on the installation if it is carried out with tubing, either enamelled or galvanised. It is not always possible or expedient to house the installation in this way, and deterioration sets in at a more or less rapid rate. The consumer is ultimately faced with the cost of renewing the entire installation. Electrical contractors appear to be singularly averse from publishing particulars of their difficulties in this direction. Occasionally an inquiry will come through to us asking for advice on the best class of wiring and fittings to employ. Until recently we were unable to give a satisfactory answer.

Now, however, the problem would appear to have been satisfactorily solved by a class of wiring which will resist all the attacks to which previous systems have in time succumbed. In addition, the element of permanence can now be given to the installation by the employment of fittings which have been designed specially for the purpose. We have recently been given an opportunity of inspecting a line of junction boxes, ceiling roses, switches and lampholders, which the St. Helens Cable & Rubber Co. developed some time ago, and which they now assure us has stood the test of time in the class of installation with which we are dealing. The fittings are designed for use with cab-tyre sheathed conductors, now known throughout the trade as "C.T.S.," and of a quality as to electrical, mechanical and chemical insulation which we think it is not necessary for us to emphasise. The problem of the fittings has been attacked from a practical point of view, and we think it will be admitted from a study of the illustrations of these which we give herewith that they can be installed with a minimum of fini king on the part of the wireman. It is, perhaps, needless for us to remark that the system is a surface one, the whole of the fittings and wiring being in sight. Porcelain or ebonite cleats of various sizes are employed for the support of the conductors, the latter being fixed clear of the wall to admit of free moisture passing down clear of them. Fig. 1 shows external and internal views of the class of joint-box employed. It consists of three loose pieces, a trough, a terminal shield and a cover. It will be noticed that the trough is sufficiently roomy to accommodate the conductors to be jointed after they have been bent into the position shown. The enclosed wires are brought into a simple brass collar terminal provided with a single pinching screw. These occupy a vertical position in the trough and are protected by the porcelain terminal shield, which is provided with a ledge resting on the edge of the trough nearest the wall. The jointing of the conductors is done clear of the box, and after being bent into the required position they are put into the box, which has already been partly filled with a semi-fluid compound. The exterior view explains the neat manner in which the incoming and outgoing wires are cleated to the wall.

The principle of inverting the conductors is followed throughout the whole of the fittings used in the system. Fig. 2 clearly explains

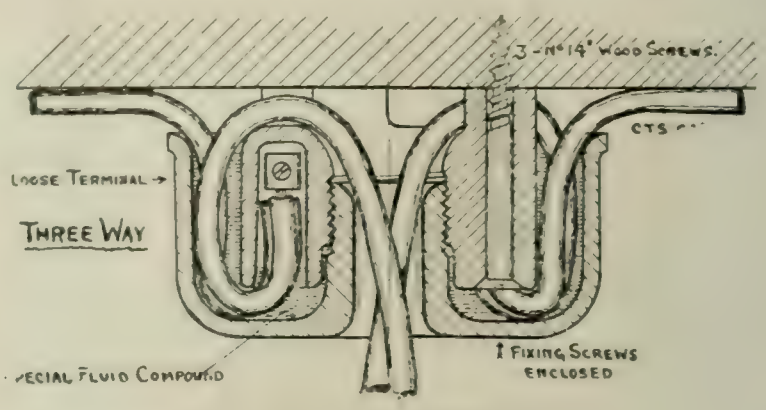


Fig. 2.—"C.T.S." Ceiling Rose.

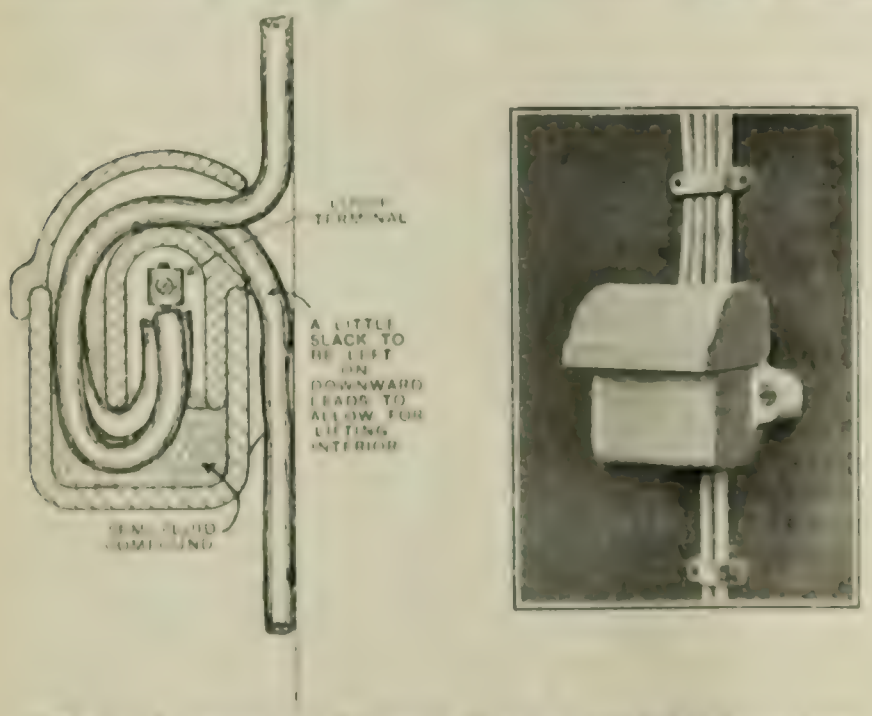


Fig. 1.—Interior and Exterior Views of "C.T.S." Joint Box.

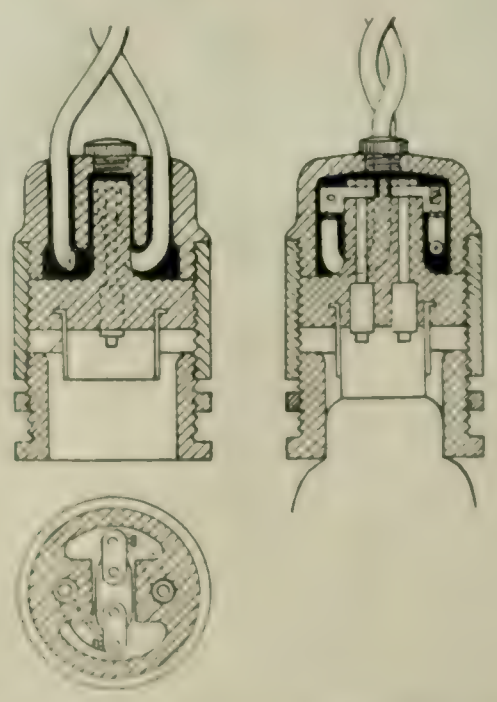


Fig. 3.—Sectional Views of "C.T.S." Lampholder.

LEAD MELTING FURNACES
(Hall's Patents)
For Cable and Pipe Presses, Accumulator Grids, etc.,
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
MONOMETER MANUFACTURING CO., Ltd., Whitehouse St., Aston, Birmingham

the method employed with the ceiling fitting. This comprises two porcelain pieces, a base which is fixed to the wood block or wall by three long screws and which accommodates in an annular recess both the incoming C.T.S. cable and the outgoing C.T.S. flexible to the lampholder. The latter passes out through a centre hole in the base. The second portion of the fitting comprises a trough-shaped cover having a central hollow stem which is threaded with an external thread to engage with an internal thread in the central portion of the base. The cover acts as a trough for the fluid compound, this material effectually sealing off the internal inverted terminals from the access of air.

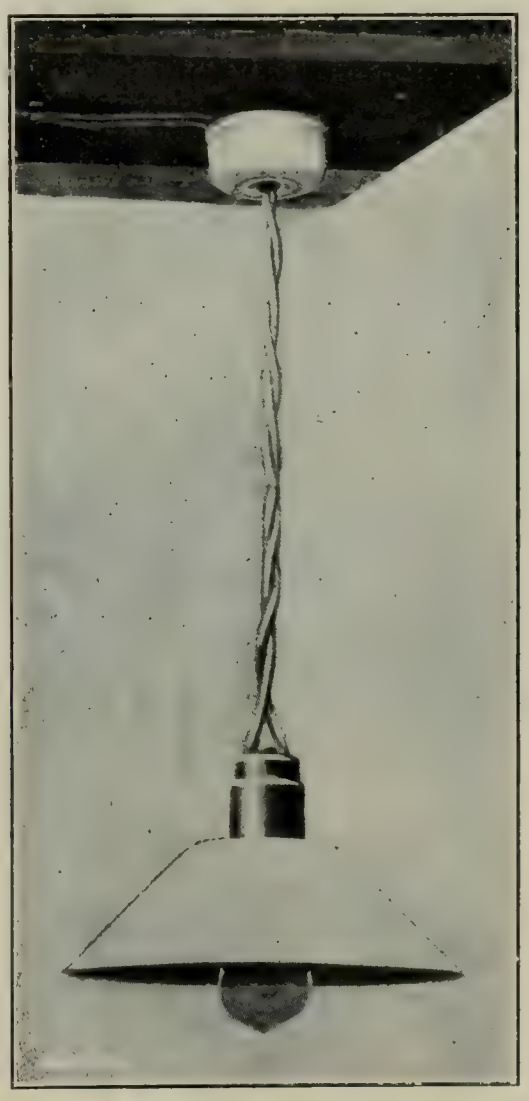
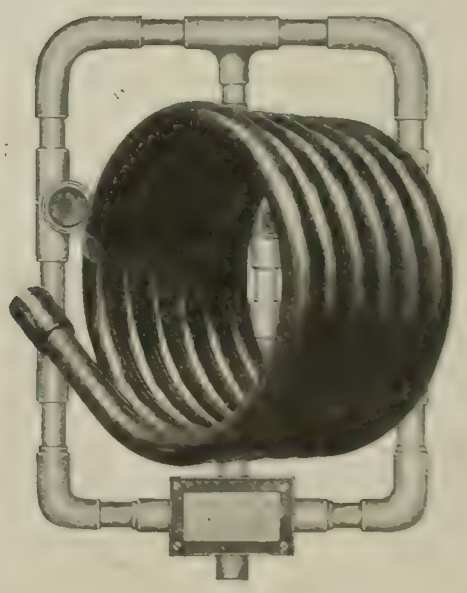


Fig. 4.—Complete "C.T.S." Lampholder and Ceiling Rose.

In the lampholder, which is shown in detail in Fig. 3, the same ingenious method is employed. The body of the holder is of a black moulded insulating material, and the upper portion contains the terminals which provide for the inversion of the incoming conductors in a similar manner to that employed with the fittings already described. These terminals are connected by screwed pillars which pass through the moulded material and make contact with the lampholder plunger. This construction is clearly shown in the illustrations. In this particular case the fluid compound is poured in through a hole in the centre of the cap which covers the terminals, and in this simple manner all metal parts are sealed off. The lamp end of the holder is fitted with a screwed ring provided with a lock nut. After the lamp has been inserted the ring is run down against

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Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

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—in Conduits and Fittings
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,, B.—Cranked.	150, 200, 300,
,, C.—Right angle.	400, 500, 600.

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LIONEL ROBINSON, 3, Staple Inn, London, W.C.
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the shoulder of the lamp bulb and in this position the lock nut is tightened up. The lamp is thereby securely fixed in the holder. Fig. 4 is taken from a photograph of the complete ceiling rose, C.T.S. flexible and lampholder. It should be explained that the locking ring also acts as a shade carrier, but the shade must be provided with a large diameter hole.

The switch fitting is designed on somewhat similar lines to the foregoing, there being a porcelain body with hooded terminals and a standard pattern tumbler switch which is actuated by a turn knob depending from the under side of the switch body. There are no exposed metal parts, and the interior of the fitting is completely sealed from the entrance of the external air.

The foregoing is a somewhat cursory description of a system which bids fair to solve one of the most troublesome problems which have confronted installation consultants and electrical contractors for many years past. The St. Helens Cable & Rubber Co. have, we understand, collected a quantity of unique data regarding the system, which space, of course, prohibits us from giving in detail. The company will, however, be pleased to furnish fuller technical particulars and prices on request.

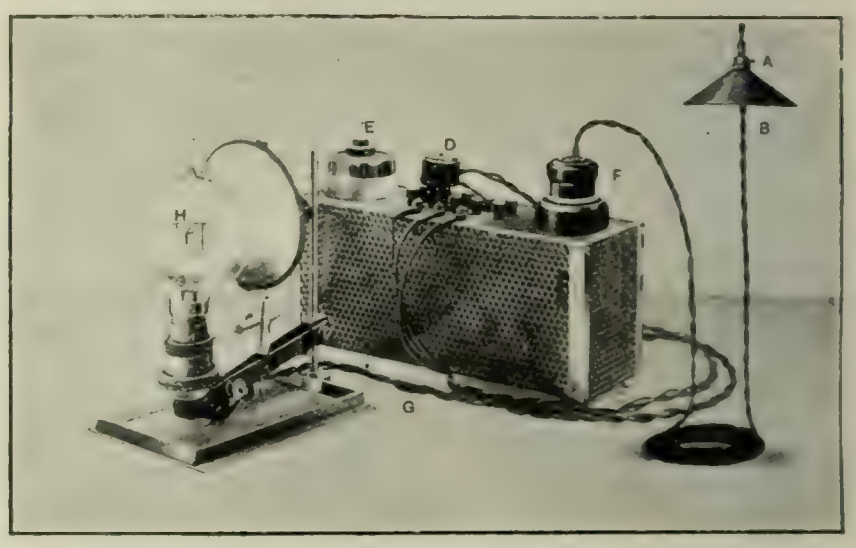
ROYAL EDISWAN "POINTOLITE" LAMP.

This novel and effective optical lamp, described in our columns last week (in Messrs. Gimingham and Mullard's Inst. E.E. Paper), marks an entirely new departure from ordinary lamp construction, in which a filament is used as the source of light. It forms an ideal lamp for optical and many other purposes, the light-giving portion of the lamp being a small ball of tungsten, which emits an intense white light. This light source can be effectively controlled by means of suitable lenses and reflectors, and when used in a projection lantern will give a perfect disc of light on the screen without any blurs and inequalities.

The illustrations show the lamp adapted for use in an ordinary projection lantern. The lamp is at present made only for use on direct-current supply. It may be connected to an ordinary holder, A, by using the adapter B, which is in circuit with the resistance C.

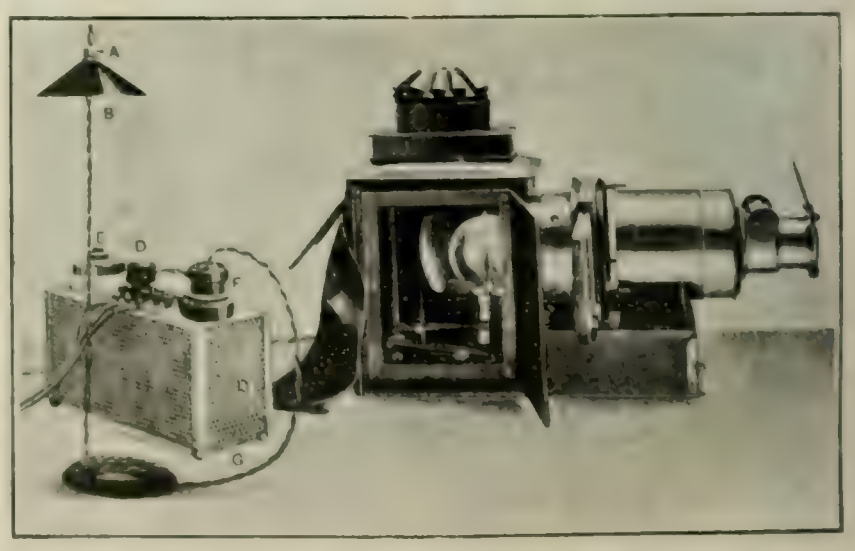
Three wires G and a three-pin plug connect the lamp to the resistance. These three wires are for a heater circuit which is needed to start the arc, which, after striking, is maintained from the tungsten ball I within the lamp bulb.

The standard pattern of resistance is capable of being used on all voltages—that is, 100 volts to 250 volts direct current. Care must,



"POINTOLITE" LAMP COMPLETE WITH RESISTANCE.

of course, be taken to use the proper resistance, which is clearly marked by placing the two prong plug D into the correct holes corresponding with the voltage of the main supply. The available supply of current having been connected to the resistance box, and the lamp also connected by means of the plug F and adapter B, all that is necessary to light the lamp is to push the switch E, which is fixed on

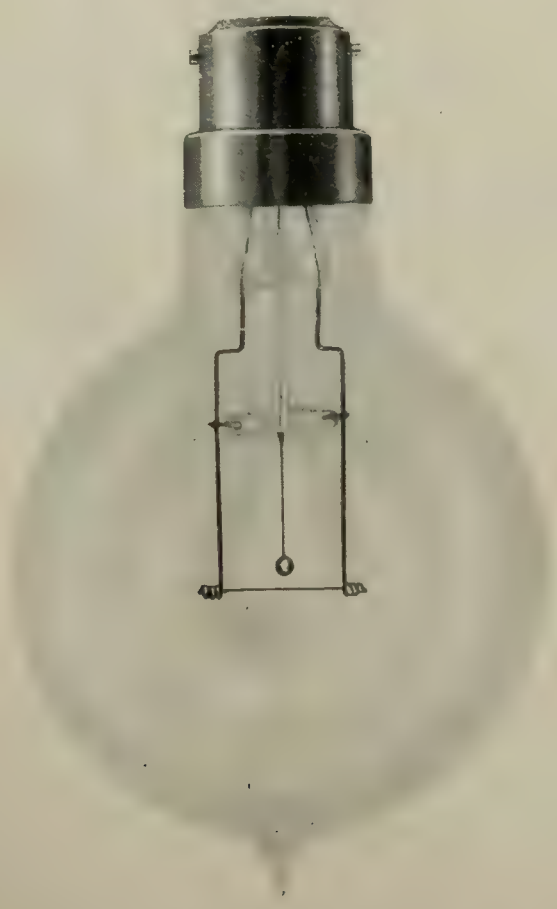


"POINTOLITE" LAMP IN PROJECTION LANTERN.

the resistance box C. The push switch E should be released as soon as the lamp is seen to light up, and if the arc does not strike very quickly, the adapter B must be taken out of the supply holder and turned round so as to change the polarity. When the polarity is correct the arc strikes immediately the push switch is released.



In leaflet No. L 2,134, just issued by the Edison & Swan Co., prices and further particulars are given, and a copy may be obtained on request to the company at Ponders End, Middlesex.



Royal Ediswan "Pointolite" Lamp.

"RUGBY" AND "WHITE STAR" LAMPS.

We have received from the Rugby Lamp Co. a copy of their latest 6-page pamphlet which describes, prices and illustrates "Rugby" carbon lamps and "White Star" drawn-wire metal lamps. The White Star lamps are supplied for all voltages and candle powers, and special attention is also drawn to candle and tubular lamps, marine and tramway lamps, and train lighting lamps. The tramway lamps are extremely neat, measuring only $2\frac{3}{4}$ in. diameter by 4 in., and are supplied in two sizes, 60-80 v. and 100-130 v., 16 c.p. and 25 c.p. in each case. There is also a full range of Rugby carbon filament lamps described and priced, including a marine type and double filament lamp for ships' navigation lights. The latter gives 32 c.p. and is supplied for 50-65 v. and 100-110 v. Rugby radiator lamps are also illustrated, these being of the standard tubular pattern $2\frac{1}{4}$ in. diameter by $11\frac{1}{4}$ in. long. These lamps are rated at 250 watts. Illustrations are given of the standard caps from which customers can make a selection according to requirements. The back page of the pamphlet is filled with a reproduction of the officially issued photograph taken at night showing one of the enemy aircraft near London clearly visible in the rays of two powerful searchlights.

MATHER & PLATT PROGRESS.

Messrs. Mather & Platt (Ltd.), Manchester, report satisfactory business in all their branches during the past year under the exceptional and difficult circumstances of the war. The output of the electrical department is far ahead of the previous record, and, with the exception of a certain amount of plant for shipment, practically the whole of the work turned out has been for war service contracts for a variety of purposes. They have taken the opportunity, so we are informed, to improve their large two-cycle double-acting high-speed vertical gas engine, so that when trade again becomes normal they will be prepared to manufacture these engines in large units of from 500 B.H.P. upwards.

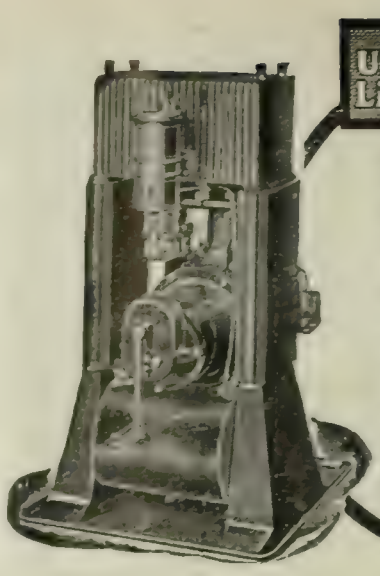
BELLING FIRES

Over 30,000 in use.

Tested by more than 400 Engineers during a period of 3 years, and generally recognised as being "The" practical and reliable electric fire.

A P.C. will bring our 40 page illustrated catalogue.

BELLING & CO., ELECTRIC HEATING SPECIALISTS.
DERBY ROAD, EDMONTON, LONDON, N.



UNI-LECTRIC Lighting Plant

NO BATTERIES. NO SWITCHBOARD.

Standard 110 volts—direct current.
Output 500 to 750 watts.

A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.

WRITE TO-DAY FOR COMPLETE DESCRIPTION

WALTER D. FAIR & CO.
43 LEICESTER SQUARE.
LONDON. W.C

STANDARD IRONCLAD PANELS.

In our last issue we referred to a new catalogue of their latest products which Messrs. Brook, Hirst & Co., Chester, have recently published. We are now able to illustrate two types of "Brookhirst" panels, which may be taken as representative of the class of control gear which this company manufactures. Fig. 1 shows a multiple

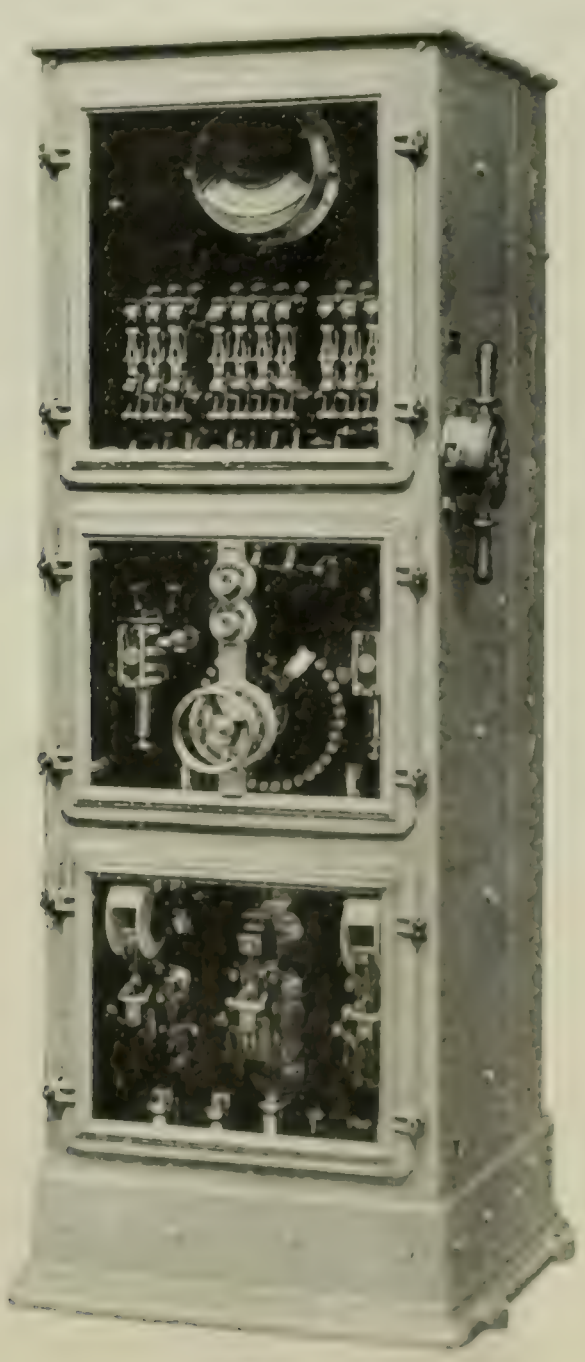


Fig. 1.

lever type ironclad panel which is divided into three main compartments. The upper compartment has an ammeter, and the lever switches, which are fitted with renewable carbon-copper starting contacts. These are operated by a slow motion ratchet starting handle, which is seen projecting from the right-hand side of the iron pillar, and is the upper of the two handles shown. The lower handle is provided for re-setting purposes.

In the centre panel is a shunt field regulator which is interlocked with the starter to prevent the motor being started up with a weakened field. Above the hand-wheel which operates this field regulator are two push buttons, the upper is depressed during the starting operation and the lower one is utilised for stopping. In the lower panel is placed a double-pole electrically-operated circuit-breaker of the magnetic blow-out type with no-volt release and two overload trips, one on each pole. The circuit-breaker interlocks with and is controlled by the handle of the starter. This design of panel is standard for use with shunt or compound-wound non-reversing motors. It is listed in five sizes, arranged according to voltage from 100-125 to 480-550 volts.

The horse-power controlled can be anything from 50 to 450. The panel for the latter is 38 in. wide by 85 in. high by 33¾ in. deep. Fig. 2 shows a wall-type ironclad panel which is divided into two compartments. In the upper division is a starter with no-volt release and shunt regulator interlocking with the starter to prevent



Fig. 2.

the running up of the motor with a weakened field. The lower division contains a double-pole magnetic blow-out circuit-breaker with no-volt and overload release interlocking with the starter, so that it can only be put on when the starter is off, and the handle of the circuit-breaker is free. Below the circuit-breaker panel a detachable connecting box for the incoming and outgoing cables is provided. This combination is offered for the control of motors ranging from ¼ H.P. to 100 H.P., and for voltages from 100 to 550.

FERRY | **FERROZOID**

CONSTANTAN | **CHRONIC**

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.,
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TELEPHONE: 6400 CENTRAL
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AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDUM, LONDON."

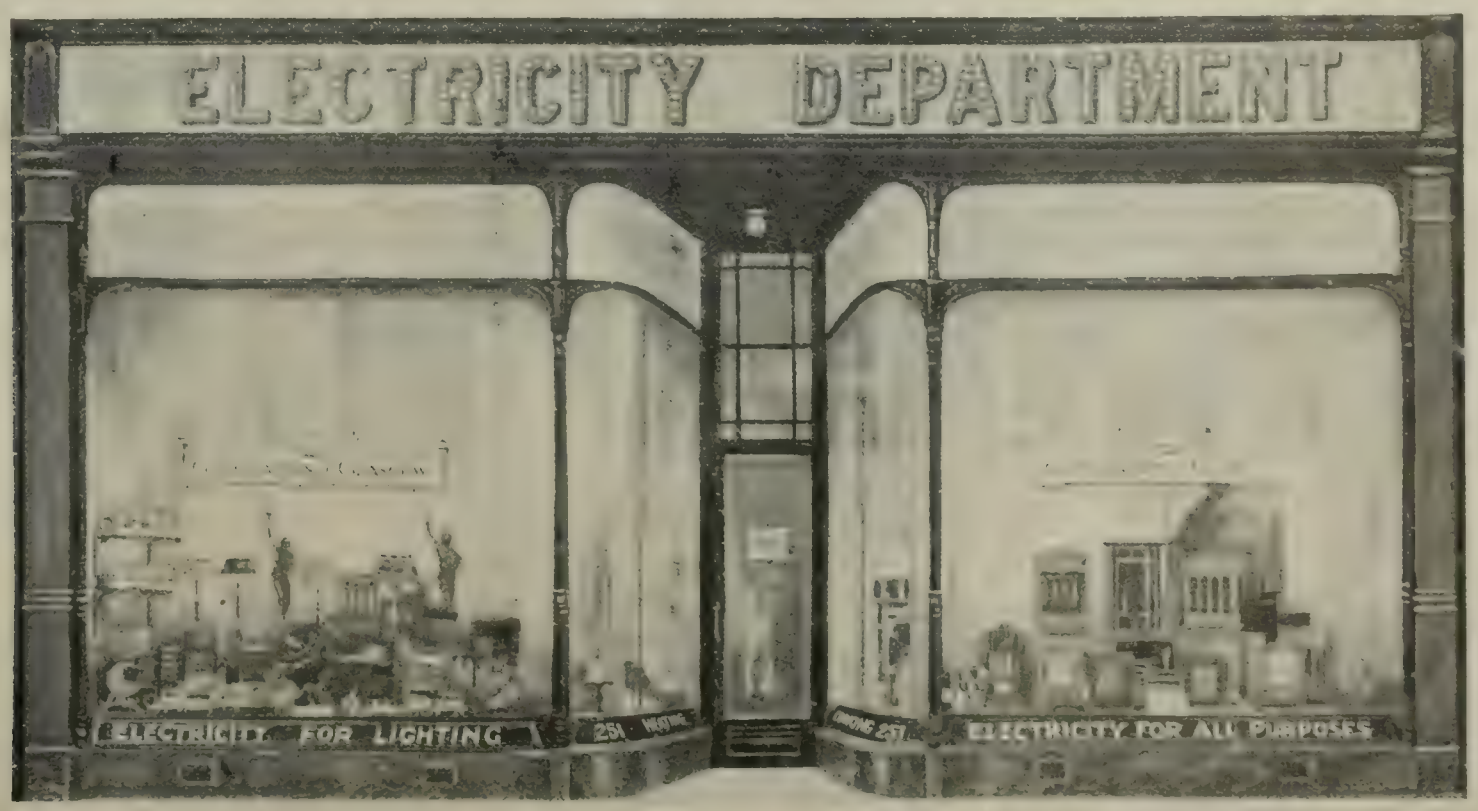
The regulator is suitable for a speed range not exceeding 50 per cent. The standard design of panel is provided with a ventilated case, but non-ventilated or dust and weatherproof cases can be supplied if required.

The dimensions of the 100 H.P. size of this panel are 67 in. high by $24\frac{1}{2}$ in. wide (centres of fixing brackets) by $20\frac{1}{4}$ in. deep.

A considerable number of other combinations of wall and pillar-type panels and motor starters are referred to in the list, a copy of which can be obtained from Brook, Hirst & Co., Northgate Electrical Works, Chester.

THE NEW GLASGOW SHOWROOMS.

We referred in our last issue to a neat pamphlet which the Corporation electricity department of Glasgow has distributed throughout the area in order to attract present and prospective customers to the new showroom. Through the courtesy of Mr. W. W. Lackie we are able to show a front view of the windows of this showroom, and it will be admitted that they are sufficiently lofty and capacious to enable the department to make an attractive show. It is interesting to note that below the ground floor is a basement which is fitted out



VIEW OF THE TWO LARGE WINDOWS OF THE SHOWROOM, GLASGOW CORPORATION ELECTRICITY DEPARTMENT.

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EVERYTHING
ELECTRICAL

THE ALL-BRITISH
HOUSE FOR ACCESSORIES

ROYAL
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Ebonite Fibre, Sheet, Tube and Rod.
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Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills,
PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.

with three flats, and there is also a workshop. The ground floor itself is devoted to sales, and immediately back of it is a saloon which is used for the cookery demonstrations to which we referred last week. On the first floor is an electric house, with drawing room, dining room, bedroom, &c., and the top floor is devoted to certain special lines and a demonstration of vacuum cleaning. Mr. Lackie informs us that, owing to war economies, the department has done practically no advertising, but there has been a great demand for show room goods. During the past 10 weeks we understand that upwards of 450 pieces of apparatus, equivalent to a demand of 750 kw., have been sold. This apparatus consists principally of radiators and irons, although there has been a good demand for small cookers, coffee percolators and vacuum cleaners.

NEW "BENJAMIN ELECTRIC" LISTS.

We understand that the trade is being supplied with new editions of the Benjamin Electric catalogue, which deals with half-watt lanterns, reflectors, fittings and accessories. Accompanying the catalogue are two folders which deal with Marbella opal reflectors and semi direct fittings, and also an addenda which is quite the most useful feature of the lists. It is virtually a tabular guide to the various specialities and fittings which appear in the company's L5 catalogue and also the supplementary section lists. It is made up of seven columns, which give the catalogue number, list letter, catalogue number superseded, section list number, list price each, and per dozen, and the advance due to the war. The catalogue numbers of new lines are printed in red, so that they are readily discernible in the table. The addenda should prove a simple and valuable form of reference to the Benjamin specialties. The catalogue of lanterns and fittings to which we have referred contains illustrations, prices and characteristic photometric curves of each design of half watt reflector fitting which has been standardised by the company. Examples of these reflectors and fittings are reproduced herewith. We were recently given an opportunity of looking through the company's works at 1a, Rosebery-avenue, London, E.C., and were much impressed with the machine tools which they have in operation for the production of steel and other metal reflectors, both directly in presses and also by the process of spinning. The contractor and illuminating engineer has an exceptionally full range of reflectors and fittings to select from, and he should be able to order direct from the catalogue without raising a query of any kind, the information given is so clearly set out both in table and diagram form. The list has the further merit of being printed in a convenient size for the pocket. In spite of lighting restrictions for shops and public places, there is, we understand, a brisk demand for half-watt lamps for industrial and commercial installations for interior service. Copies of the literature referred to may be obtained from the Benjamin Electric (Ltd.) at the address referred to above.



BENJAMIN HALF WATT LANTERN.



BENJAMIN HALF WATT REFLECTOR FITTING.

Printed and Published by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, DECEMBER 24, 1915.

THE ROUND TABLE.

By "KVA."

This Week's Chestnut.—The present gale (some gale, too !) blew down a galvanised iron shanty at the back of a contractor's premises. Being an electrical engineer and a man of resource he packed up the ruins and sent them to the Ford Car Co. In a few days he received a note to the effect that the company regretted the accident and the extent of the damage, but a new car would be ready for him in 10 days !

* * * *

A contemporary ascribes the new Royal Ediswan arc-incandescent lamp to "Messrs. Groningham & Mullerd." Mr. Gimingham will hardly feel flattered.

* * * *

Mr. George Wilkinson, Harrogate, has invented a thermostat for the control of electric fires. Out of compliment to the rival industry, he has placed the sparking contacts in an inert gas !

* * * *

Where are all the calendars, pocket wallets, card cases and other emblems of commercial activity, usually scattered abroad with so generous a hand at this time of year ? Let it not be said that Kultur has made even these superfluous !

* * * *

The electric battery van has begun to "butt in" on London traffic, and is making no little stir among users of motor transport. The adherents of this form of traction have never asked for anything but an opportunity to prove on the streets what they could only previously prove (and to themselves) on paper.



A TYPICAL 2-TON EDISON ELECTRIC IN LONDON SERVICE.

I find that I have overlooked the result of the competition which originated on this page, and in which a name was required for the Ferranti new season 2 kw. electric fire. Many names were sent in, but their recital would be rather uninteresting, if not a little humorous. Ferranti Ltd. reserved to themselves the right of adopting the name selected, but they adhered to their original decision to award one of the fires to the competitor who sent in what was considered the best name. That competitor was Mr. K. Younghusband, "Oakmere," Hawarden. I presume the fire is now cheering the early days of his married life !

An illuminating engineer who had a University education has dealt with a well-known nursery rhyme anent the twinkling star, as follows :—

Scintillate, Scintillate, globule vivific,
Fain would I fathom thy nature specific.
Loftily poised in ether capacious,
Strongly resembling a gem carbonaceous.

* * * *

Future electricity consumers in Haslingden will have to do their bit towards the war, for the Electricity Committee have decided that "future applicants for electric current can have no more than 8 ft. of cable for each service, the cost of any excess to be borne by the applicants."

* * * *

Apropos of the above the following story from the "Western Electric News" may be commended to the notice of Haslingden residents: "One of the Chicago service men recently telephoned asking that several lengths of cable on an order be increased. Upon being advised that the cable had already been stranded and that the lengths could not be changed, he subsided for the moment. The next day, however, he again broached the subject and asked whether something could not be done. Upon being asked for suggestions, he came across with 'Well, I don't know, but I thought you might be able to stretch the cable those few feet.' He was then painstakingly informed that lead and copper were in a class by themselves, not possessing the qualities of rubber, after which he again subsided, this time painfully and permanently."

* * * *

The mind of the public seems to run in grooves when it thinks of anything electrical. Some ladies turning on the electric light for the first time will remark that the switch seems to draw them towards it. According to the report of the proceedings at the inquest upon the unfortunate people who were recently electrocuted at Eastbourne owing to a motor car running into a high-tension feeder pillar, "a nurse said that before the collision the car was going gradually to the left. It seemed to be drawn in that direction." The Coroner : "She infers that it was being drawn ; she might as well suggest that the moon was doing it."

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), December 28, 1878.]

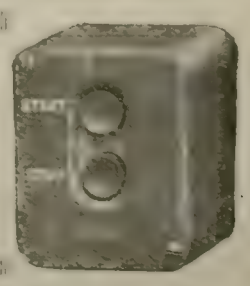
POOLE & THE ELECTRIC LIGHT.—We understand that in the experiments with the electric light a gentleman was sufficiently interested in the question to take diagrams in order to ascertain the horse-power really used. We believe the indication was that the Wallace-Farmer machine took 20 H.P. nominal, with 4 lamps in circuit. Some people are in a great hurry to burn their fingers.

THE ELECTRIC LIGHT.—The electric light was experimentally used at the London Bridge terminus of the L.B. & S.C. Railway on Saturday afternoon and evening, for lighting the open space between the main line and Crystal Palace line booking offices and the platform barriers. The Gramme machine and Suisse lamp were employed, the motive power being obtained from an engine some 250 yds. distant, which, in addition to working the magneto machine, also pumped up the water required for the general purposes of the station. The machine is the first of its kind made in England, and, together with the lamp, which is said to last about 12 hours without attendance, was supplied by the India Rubber & Telegraph Works Co., Silvertown, whose electrician, Mr. R. K. Gray, and the railway company's telegraph engineer, Mr. E. J. Houghton, carried out the experiment.

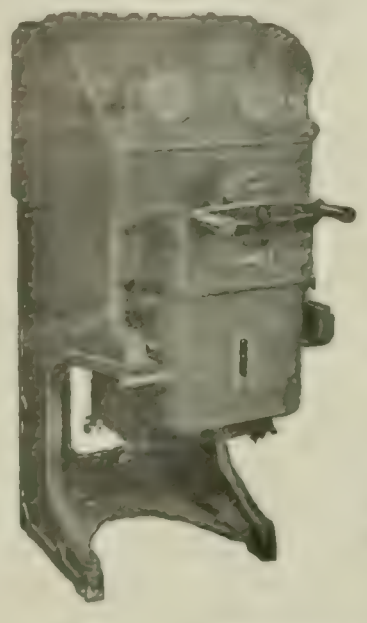
'IGRANIC'
MOTOR CONTROL GEAR.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

Controlling A.C. Motors by Push-buttons.

There is an "IGRANIC" Automatic Push-button Controller available for every type and size of A.C. Motor—that means that any application where an A.C. Motor is installed may be made thoroughly efficient and foolproof. The master switch of the system is too simple to allow of, error, the automatic control gear takes all responsibility for correct operation.



SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

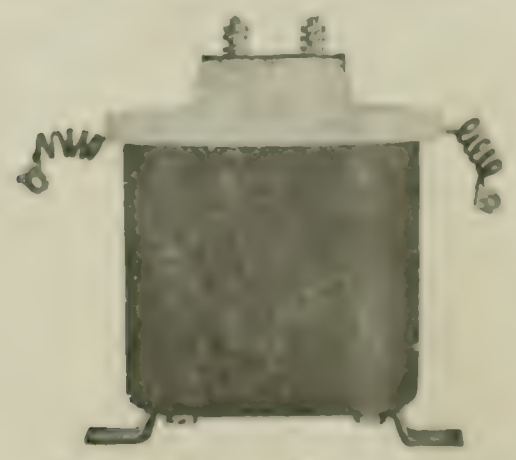
Illustration shows our Standard Cast-iron Mining Pillar suitable for pressures up to 3,300 volts.

Write for particulars to —

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GLASGOW—66, Waterloo Street | SOUTHAMPTON—46, High Street
Branches in Principal Towns Abroad.

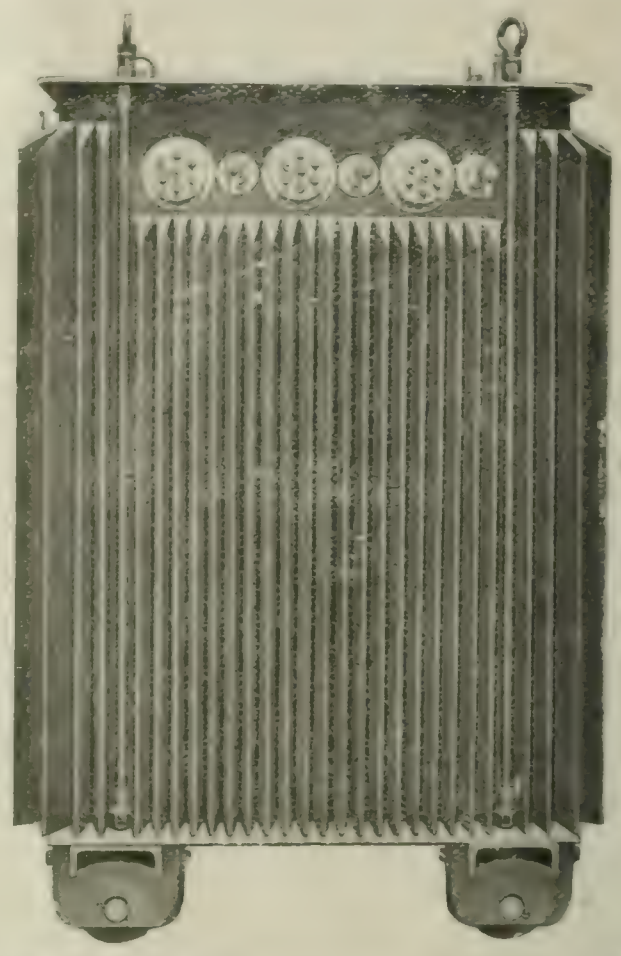
COMPLETE FERRANTI CATALOGUE.

A manufacturing establishment which turns out a considerable variety of products must, of necessity, devote separate publications or groups of publications to each item manufactured. The loose-leaf pattern of catalogue has grown in favour during recent years, and its popularity affords complete justification of the step which was taken only comparatively recently away from the general bound list. Provision should, however, be made in the compiling of the separate lists for the binding of them up into a complete list.



FERRANTI CURRENT TRANSFORMER.

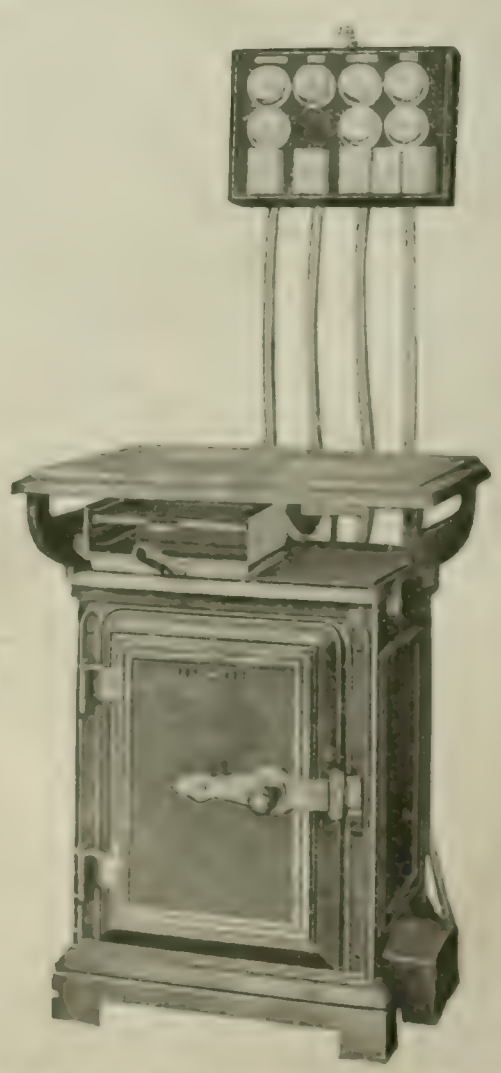
We have previously commented upon the method employed in the compiling of the Ferranti catalogue, and we now have before us a binding case which contains the whole of these grouped together to facilitate immediate reference not only to the various sections, but also to the principal items in each of the lists. The company's manufactures are grouped into eight sections, each of which is given a distinguishing letter. The sections are M, house service meters; H, heating and cooking appliances; T, static transformers; G, measuring instruments; S, switchgear; R, starters and controllers; P, panels; U, sundries. A thumb index with this distinguishing letter and the name of the section is provided at the right hand edge of the bound list. Immediately under the thumb index and forming the opening page of each section is an index and discount sheet. In this is a column devoted to the list numbers of each piece of apparatus. This list number is made up of the letter designating the section to which the list belongs, a small letter denoting the edition of the list,



FERRANTI THREE-PHASE TRANSFORMER WITH EXTERNAL "TAPPING" TERMINALS.

and the number proper; these numbers run consecutively through the complete catalogue.

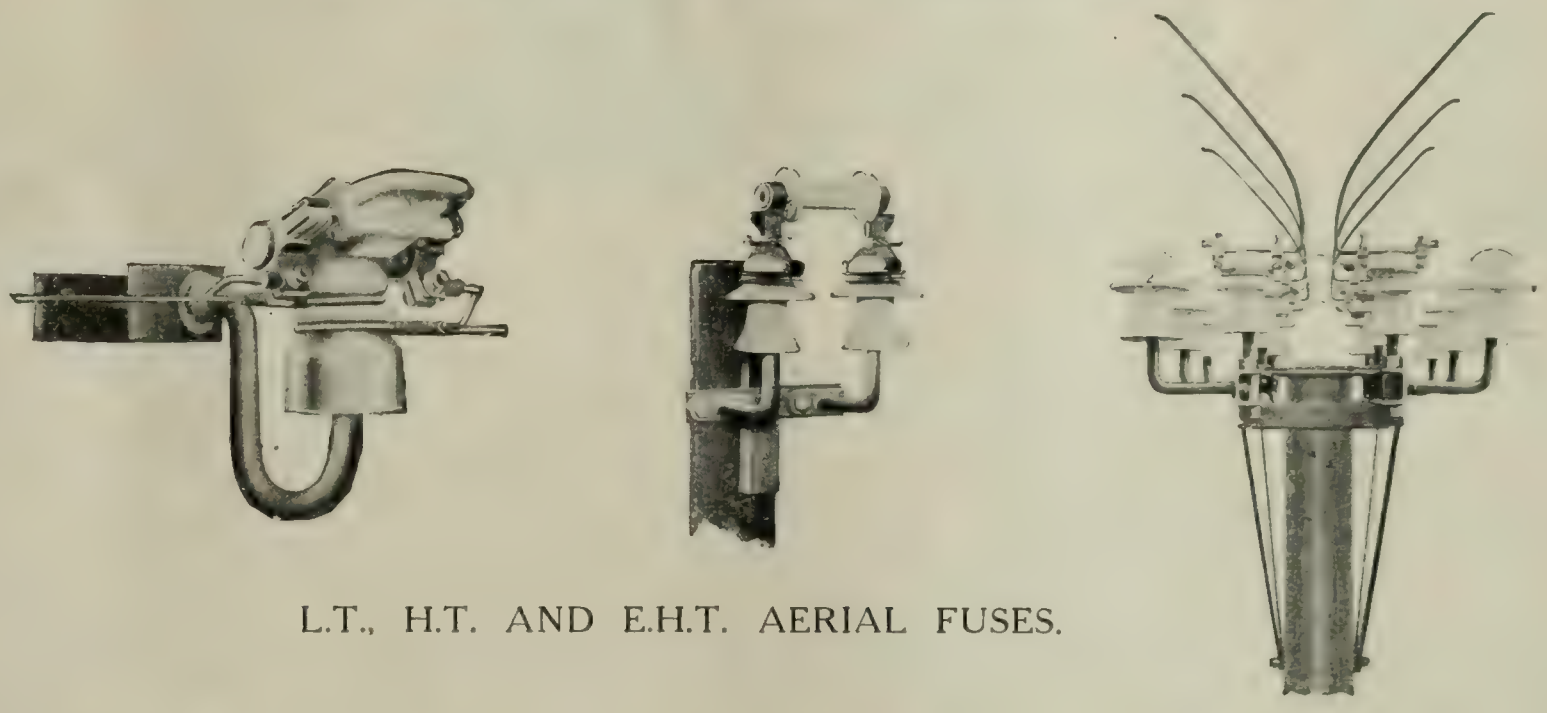
An ingenious scheme has been adopted with the code endings to be used in cablegrams. Each code word commences with a code root, and each root commences with the letter designating the section in which it is found; further, the roots are arranged in alphabetical order according to their position in the section. This method has, we understand, proved very helpful to exporters and buyers abroad.



FERRANTI ELECTRIC COOKER WITH WOODEN SWITCHBOARD.

The Electric & General Works, Ltd.,

15, Victoria Street, London, S.W.



L.T., H.T. AND E.H.T. AERIAL FUSES.

ELECTRICAL APPARATUS

up to 80,000 volts, 4,000 amperes.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC. LONDON."**

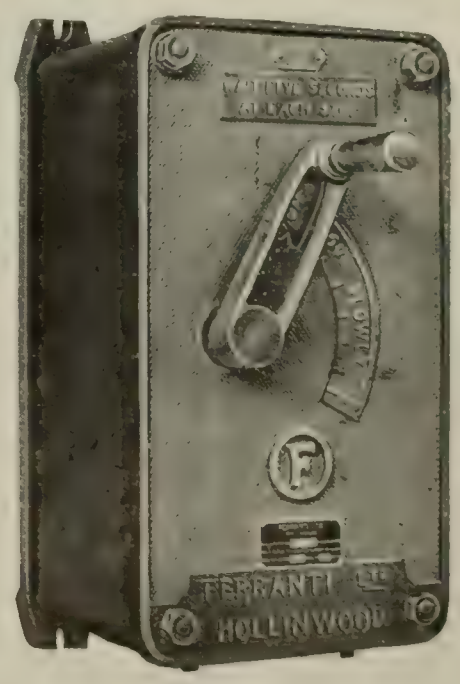
On the back of the index and discount sheets are printed the standard conditions of sale.

Each section contains in addition to prices and particulars of dimensions, weights, &c., a number of separate lists in which a technical description is given of the apparatus dealt with in that section. This description has been prepared on a preconceived plan,



FERRANTI D.C. AND A.C. METERS.

with headings which are uniform throughout the descriptive portions of the list. For instance, under the description of meters there are headings which deal separately with 1, general; 2, design; 3, principle of action; 4, construction; 5, technical data; 6, adjustment, &c. The diagrams of connections are clearly drawn and carefully explained. The user of the catalogue should experience no difficulty in becoming accustomed to an arrangement which saves him time and trouble in finding what he wants.



FERRANTI LEVER TYPE D.C. MOTOR STARTER.

There is a general list of the company's manufactures and index to catalogue sections on a separate leaf, which is inserted at the front of the bound list. On the back of this leaf particulars are given of the company's foreign branches and agencies, and the extent of the

Manufacturers of
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GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
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CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

TRADE MARK
CLIFFORD



THE UNI-LECTRIC Lighting Plant
NO BATTERIES. NO SWITCHBOARD.
Standard 110 volts—direct current.
Output 500 to 750 watts.
A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.
WRITE TO-DAY FOR COMPLETE DESCRIPTION
WALTER D. FAIR & CO.
43 LEICESTER SQUARE.
LONDON, W.C.

overseas trade becomes apparent through a study of these particulars. The company has representatives in the Argentine, the Balkan States, Chili and Bolivia, China and Japan, Russia and Siberia, Scandinavia, and in Spain and Portugal.

We have commented at various times on the principal products of Ferranti Ltd., and in the space at our disposal we cannot possibly do justice to these in detail. A glance through the list, however, is sufficient to convince the reader that the company is engaged upon important specialised work in the production of meters, transformers, instruments, switchgear parts and electric fires. In particular, we understand that they have made great progress in the last two years with transformers. The shop devoted to the manufacture of transformers has been doubled in size, and transformers are now being built of any size and voltage up to 3,000 kw. A number of improvements have been introduced into the design, several of which have been patented. We are asked specially to refer to two of these, one being a spring clamping device for taking up coil shrinkage, and the other an oil float to prevent sludging. The spring clamping device consists of a pair of metal flanges separated by a number of short compression springs. One or more of these devices is inserted between the coil sections, according to requirements. The anti-sludging device consists of a hollow steel float which rests upon the surface of the oil and rises and falls as the oil expands and contracts with the changes of temperature. A leather gasket fixed to the edge of the float serves to keep any air from passing between the float and the oil. The float is placed above the terminals, and the terminal bushes in the sides of the tank are rendered oiltight by the employment of suitable packing washers. In order to prevent the float from dropping on to the terminals, collars are fixed on the main bolts which secure the transformer in the tank. There is a valve provided in the lid of the tank to relieve any air pressure. It is especially emphasised that with the Ferranti float the oil is not under pressure, and the joint between the tank and the lid need only be splash proof.

We have selected a few illustrations from the group of catalogues which are fairly typical of the company's manufactures.

MATHER & PLATT PROGRESS.

We understand the textile department of Mather & Platt (Ltd.) continues to maintain a foremost place in the supply of all classes of bleaching, printing, dyeing and finishing machinery. During the year important contracts have been executed, both at home and abroad, for plant required in the manufacture of khaki, and a considerable number of electrolysers for the production of hypochlorite of soda by electrolysis have been made for use in textile works, and also for disinfecting purposes. Progress has been made with the manufacture of filter-presses of all kinds and for a great variety of purposes. The department has secured contracts for paper coating plants for all purposes, and has also supplied super-calenders for finishing baryta and art papers. Considerable attention has been paid recently to the requirements of the chemical industry and a new outlet has been opened in this direction.

In the Fire department a number of important installations of the "Grinnell" auto-sprinkler and fire alarm have been carried out. In view of the operation in the near future of the Merchant Shipping Act, in which the use of certain fire appliances becomes necessary for the protection of ships at sea, Mather & Platt's well-known chemical hand extincteur, the "Simplex," is being widely adopted.

During the past year Mather & Platt (Ltd.) have supplied turbine and centrifugal pumps in considerable numbers. Apart from their well-known high-lift turbine pumps for colliery purposes, of which they have many running for heads up to 2,000 ft., they, or their licensees, have supplied or are supplying large pumps for dock pumping, circulating water for condensers, up to 60,000 gallons per minute capacity. The number of boiler feed pumps of the turbine type being installed is rapidly increasing, and Mather & Platt are getting a large share of this business. In addition, the demand for their special lines of pumps for fire fighting purposes, motor fire engine chassis and paper pulp is increasing. They have placed upon the market a new line of pumps which they call "Medium Lift" for capacities from 200 gallons up to 25,000 gallons per minute, and for heads of from 75 ft. to 175 ft. In addition they also have a new low lift line of pumps for handling large quantities of water at low heads, specially designed for circulating water purposes. Mechanically these pumps are of the double suction outside ring oil-bearing design, and in sizes 14 in. and above have the cases and bearings split on the horizontal centre line. They have already been successful in disposing of a large number of these pumps.

In the standard cast-iron tank department, Mather & Platt have supplied a tank having a capacity of 200,000 gallons, for the Consett & Weardale Water Co., Durham. Some particulars regarding this tank will be of interest. The base covers an area of 5,400 sq. ft., and the dimensions are 100 ft. by 54 ft. by 6 ft. 6 in. deep, the weight when full amounting to 1,035 tons. The order was placed on Oct. 23, 1914, and the tank completed and filled on Feb. 18, 1915.

The installation of mechanical filters for Oldham Corporation waterworks has been successfully completed, and a further extension at Sheffield of a battery of six filters, making a total for the Sheffield Corporation of 61 filters. Filters have been installed at two large camps and at several big munition factories. For the city of Tramen, in Japan, an installation comprising 14 open-type filters, each 12 ft. in diameter, having a total capacity of 4,000,000 gallons per day, has been completed, also numerous other installations both at home and abroad.

TINNING FURNACE
For COATING WIRES with Tin, Lead, etc. For use as a BATH
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
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One, Two & Three Phase MOTORS.
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No. 261 Dog Grate illustrated is arranged for Carron Standard Stove Elements mounted in case under imitation logs which are illuminated by Electric Lamps from the inside, giving a most realistic effect. Loading is rated at two kilowatts.

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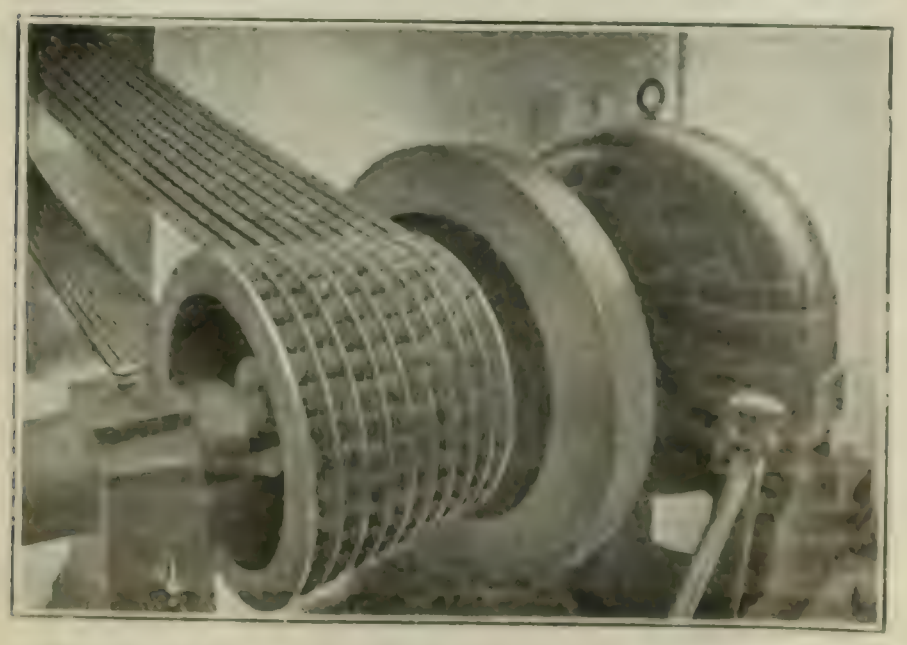
INSULATION BEADS

The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.

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WHITTLE BELTING.

In a pamphlet recently issued by Thos. Whittle & Sons, Warrington, some instructive details are given of a patent belting which the company has developed and which may be used for almost every class of power drive, particularly for electric motors. This belting is a combination of leather and steel links, and is so constructed that the surface in contact with the pulley is of leather only and of large

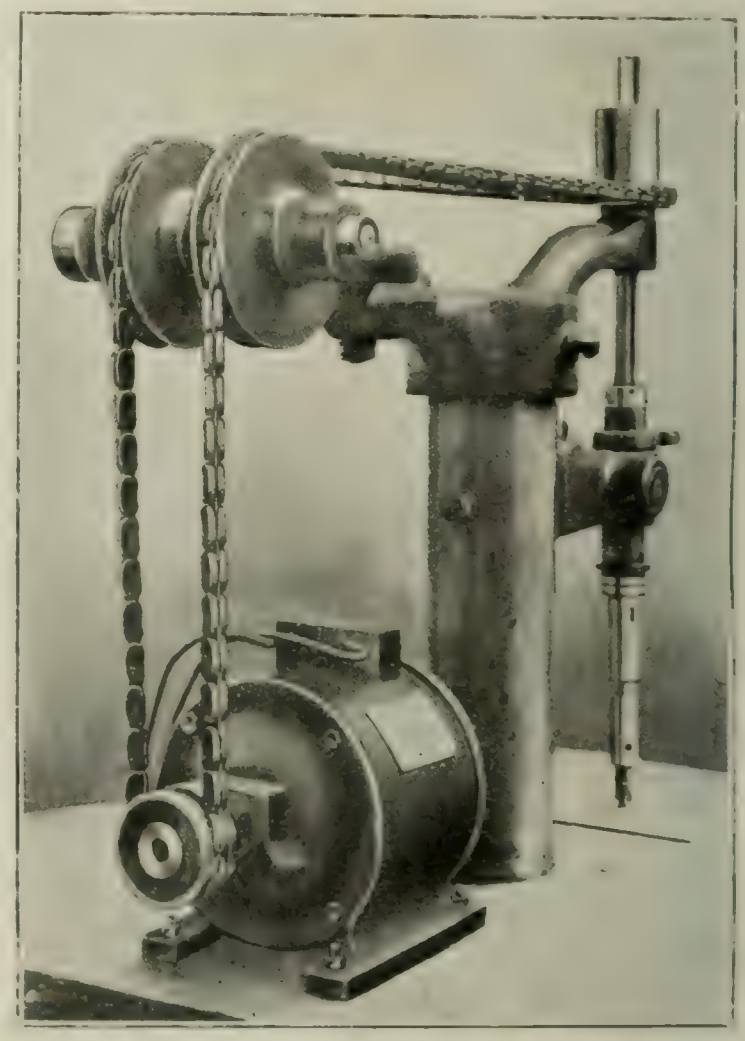


"WHITTLE" BELTING DRIVING LINE SHAFT FROM 20 H.P. MOTOR.

area. It is made for use in V pulleys, and owing to its flexibility grips the pulley so tightly that even when slack it will still drive. With this grip there is no tendency to jam in the pulley, for the belt leaves it quite freely, and runs equally well at high or low speeds. The bending or internal friction from which most belting suffers is, we gather entirely absent in this belting, and less power is thus absorbed. The belting is not affected by dust or grit, and works equally well wet or dry. A considerable advantage resides in the fact that no fastener is required, as a belt may be pulled apart at any link by unscrewing one screw, and in the same manner shortened.

The belting is made from the best selected leather, and is practically indestructible. The advantages claimed for it are : No belt fasteners required, no laces required, no splicing necessary, can be shortened in half a minute, perfect grip, great strength, absolute flexibility, will drive when slack and consequently the bearings keep cool, smooth running, no internal or bending friction, not affected by wet or dust, exceptionally durable, no power wasted, silence.

The Whittle belt runs equally well at high or low belt speeds. The company's works are equipped throughout with these belts, some of which have been in constant use for several years and show no signs



RIGHT-ANGLE DRIVE BY "WHITTLE" BELTING.

of wear. They supply V rims from 14 in. to 48 in. for fitting to existing flat pulleys to make them suitable for this belting, at a cost of a few shillings each. They can also supply V pulleys of any size. Cast-iron pulleys are the most suitable for V belts, and there is no advantage to be gained by using steel or hardened ones. Owing to the special construction of a Whittle belt, the power required to bend one, of any thickness, is nil. This proves its flexibility, and although it works perfectly round small pulleys, users should remember that the smaller the pulley the less gripping power it will have.

In order to give an idea of the extensive range of drives on which this belting is being used we may mention : Wood-working machinery, electric lighting systems, lathes, power presses, fans, pumps, governors, drilling machines, milling machinery, airships, organ blowing, speedometers, planing machines, &c.

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Central House, Kingsway, London, W.C.

SWITCHGEAR, TRANSFORMERS, METERS, ELECTRIC HEATING & COOKING APPARATUS.

Write for Binder "N."

Printed and Published by GEORGE TUCKER at the Electrical Engineering and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London. Thursday, December 31, 1915.

THE ROUND TABLE.

By "KVA."

May the New Year bring prosperity and health to all Round Table readers and peace with honour to the cause of the Allied Armies.

* * * *

The B.C.G.A. issue a monthly magazine entitled "A Thousand and One Uses for Gas." Rather what I suspected, but I did not look for such accuracy in gas statistics.

* * * *

The following from "London Opinion" is very happy: "Vermin-proof underwear warmed by electric batteries is the latest war invention.—'Electric Keating' for the trenches."

* * * *

My comment last week upon the dearth of diaries, pocket books, wallets, &c., has produced quite a budget, as will be seen by reference to page 97. At the moment of writing, however, several extra-hardy annuals have failed to put in an appearance.

* * * *

The adjoining illustration, taken from a contemporary, might depict the wreck of one of the enemy aircraft somewhere on these islands. In fact it shows the remains of a sub-station



—all that was left of it after a cyclone among the transmission line infested valleys of the Western Rockies.

* * * *

At last an anachronism has been removed from the streets of the metropolis. This remark may sound rather overpowering, but it is inspired by the sight of the new Osram lamp electric battery van threading its silent way through the London traffic. Petrol-driven vehicles and metal filament lamps are not a happy combination.

* * * *

In the latest series of "cigarette pictures" issued by W. D. & H. O. Wills in each packet of "Gold Flake," the subject of famous inventions is dealt with. No. 46 is, however, a departure from the paths of correctitude. The picture shows a "steam turbine"; the description reads: "Our picture shows one of the immense turbines which *are* worked by the power of the *water* of Niagara Falls." This must, of course, be a *wet* steam turbine.

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series). January 1, 1879.]

1878.—Before these lines reach the public eye, 1878 will be numbered with the years that are gone, and we shall have passed the threshold of the new year. It is a good old custom to greet our friends with kindly words of cheer and sympathy at the commencement of each new year. We are glad that the custom exists, as it enables us to thank all those who have aided our youthful steps, and will have aided us to bask in the sunshine or rest in the shadows of a new year. We heartily trust that the new year will be one of abundant prosperity and happiness to all who read these lines. We hope, with the continued aid which has been so generously tendered, to tread the hidden paths of the future in safety, culling and garnering the knowledge that nature is ever ready to give, and to assist in rearing a scientific structure that shall set forth clearly those great salient laws of electrical science, without a thorough grasp of which the student but goes onward to stumble. An ever-increasing support has hitherto attended our efforts, and we hope, with renewed care, to eradicate those weak points in our scheme and in our practice which to some may be obvious, and to make THE ELECTRICIAN a complete and faithful record of electrical science in all its multitudinous branches.

* * * *

ELECTRO-HARMONIC SOCIETY.

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HOLBORN RESTAURANT, LONDON, TO-NIGHT.

Unofficial Programme.

"Hello" Clay in the Chair.

"PEAK LOAD" CHORUS "Every Valley shall be Exalted" *Handel*
ALL CENTRAL STATION ENGINEERS.

I²R DUET ... ... "Ohm, Sweet Ohm" ... ... *Adapted*
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Prof. SILVANUS P. THOMPSON.

ZEPPELL INTERLUDE "We won't go home till morning" *Holt*
ANTI AIR CRAFT CORPS.

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Mr. PERREN "LEKTRIK" MAYCOCK.

ANTI-FRICTION SOLO "Won't you come to the Ball" ... *From The Dairymaids*
THE HOFFMANN MFG. CO.

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THE TIMKEN ROLLER BEARING CO.

ONE-PHASE THIRD-RAIL DUET "I'll make you want ME" *Long & Pelham*
Mr. H. M. HOBART.
Mr. PHILIP DAWSON.
(Asynchronous, by request.)

ALKALI-CELLO ..."The Golden Dustman"... ... *Elen*
"EDISON" WATSON.

IRONCLAD EXIDETTE "Have an Acid Drop" ... ... *Williams*
Mr. FRANK CRAWTER.

"POINTOLITE" DUET "The Light of Other Days" ... *Balfe*
Messrs. GIMINGHAM & MULLARD.

TRANSFORMER SOLO "The Humming Bird" ... ... *Eilenberg*
Mr. A. F. BERRY.

BATTERY VEHICLE DIRGE "The Place where the Old Horse Died" ... ... *Melville*
Mr. R. A. CHATTOCK.

A.E.G. FINALE ... "There was a Time" ... ... *Sullivan*
Mr. W. H. WILLIAMS.

GOD SAVE THE KING.



No. 74.—"Igranic" Direct-Current Contactor Switch, which forms the basis of all the well-known "Igranic" Self-Acting Starters for D.C. Motors, Float Control, Pressure Control, Remote Control, Tappet Control.

'IGRANIC'
CONTACTOR SWITCHES.
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No. 33.—"Igranic" Alternating Current Contactor Switch. By various combinations of these switches, "Igranic" Standard Starters control all types of A.C. Motors, either on the current limit or the time limit method for all purposes.



SIEMENS

ELECTRIC MOTORS

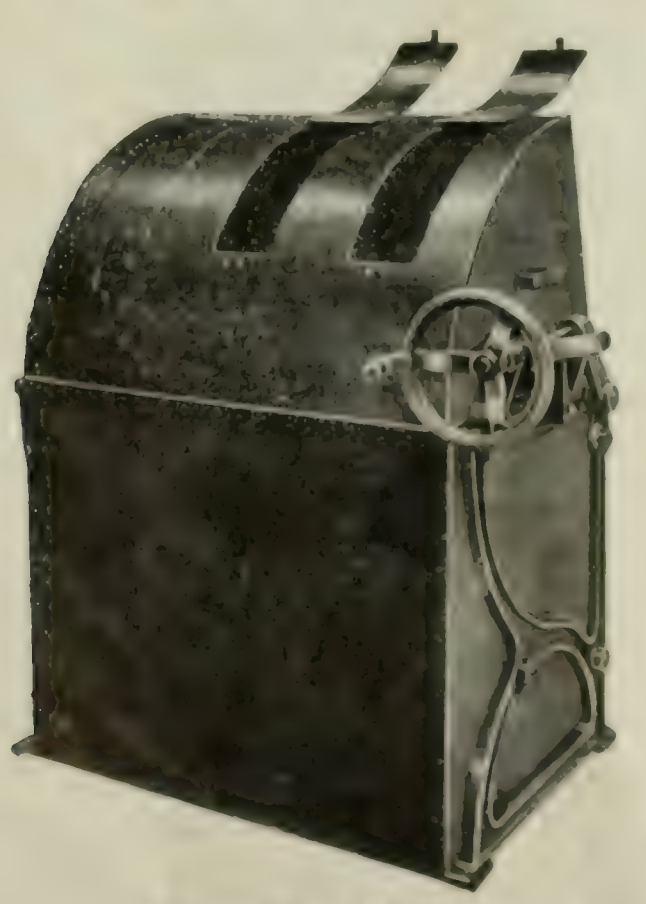


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"WITTON" MOTOR STARTERS AND CONTROLLERS.

The question of the supply at short notice of motor starters and controllers is at present a most urgent one, and the appearance of a comprehensive catalogue of these accessories will doubtless be

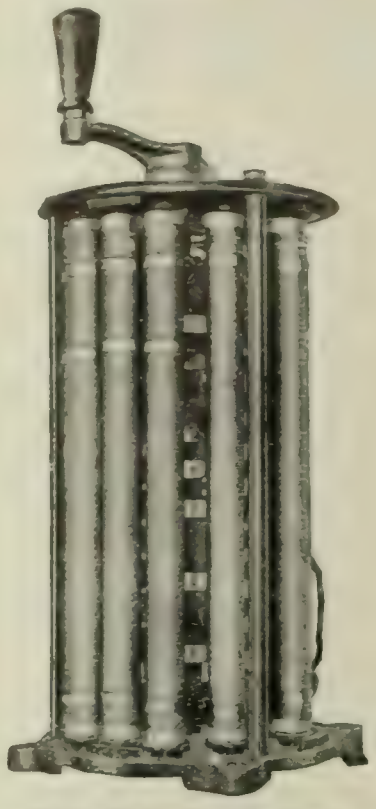


"WITTON" LIQUID STARTER

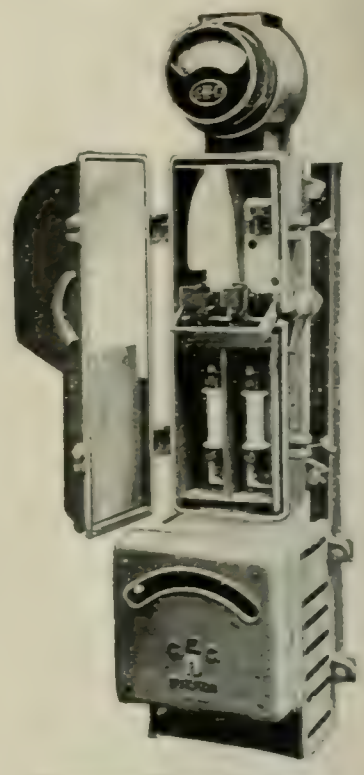
welcomed. In this catalogue of "Witton" starters, controllers and regulators designated "V Section Supplement, November, 1915," we note that the General Electric Co. is in a position to supply from stock

all kinds of "Witton" open, enclosed and semi-enclosed starters for continuous-current motors.

For three-phase motors "Witton" plain rotor starters can be supplied from stock to customers' requirements. These motor-starters comprise adjustable three-phase resistances, without automatic features, mounted somewhat similarly to those used in "Witton" standard continuous-current starters. The resistances

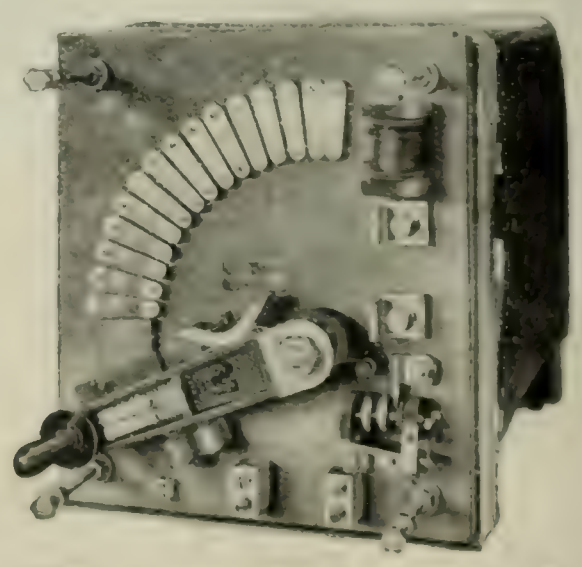


SIZE IAR CONTROLLER, SHOWING RESISTANCES.



FACTORY TYPE STARTING PANEL.

are adjusted to pass approximately full-load current on the first contact, and thus to start motors against full-load torque. "Off" contacts are provided. A spring return and "on" catch may also be provided at a slightly increased price. The starter arm is then held in the "full on" position by a catch against the tension of a spring. On depressing a knob the starter arm flies to the "off" position, thus avoiding the burning of contacts. For starting three-phase "squirrel cage" motors against loads not exceeding half full-load torque, "Witton" star-delta drum-type starters are recommended. The six



"WITTON" SEMI-ENCLOSED STARTER WITH COVER REMOVED.

ends of the stator winding are brought to fixed spring contacts on the starter. A movable drum of insulating material carrying massive brass contacts makes contact in turn with the fixed contacts, so that, at starting, the stator windings are connected across the line in star and when running in delta. These starters are suitable for motors taking a line current up to 50 amperes at 550 volts three phase.

Where squirrel-cage motors have to start against a greater torque than half full-load torque, an auto-transformer starter should be

SLATE

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GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of every description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

employed. "Witton" auto-transformer starters comprise an auto-transformer with tappings giving a voltage of 40, 60, 70 and 80 per cent. of the full-line voltage, together with a change-over switch, the whole being enclosed in a cast-iron case, and operated by an external handle. The transformer can be oil-immersed if desired. "Witton" liquid starters for continuous or alternating-current motors are also listed, and we understand arrangements have been made to hold a large stock of finished parts to facilitate quick delivery. By the use of these starters, motors can be brought up to speed quite smoothly.

In both continuous and alternating-current work it is an advantage to be able to reduce the labour of erection and connecting up on site. Especially is this so in the case of extensions to existing motor equip-



"Witton" Semi-enclosed Starter.

ment or new motor equipment in improvised factories and workshops. There are two types, known as the dockyard and factory types, of "Witton" motor-starting panels which are especially suitable. These panels consist of a Salford switch and fuse (two-pole for continuous current and three-pole for alternating current), one ammeter, totally enclosed in the dockyard, and open in the factory type, and one continuous-current or star-delta starter, totally enclosed in the dockyard and semi-enclosed in the factory type. The panel is bolted in position on site, and connected to the motor by three leads in the usual way.

For the control of small cranes and in other situations where space is limited, "Witton" size 1AR controllers are, we understand, in demand. They are of substantial construction, to comply with the arduous conditions of service. The drum is of cast iron, fixed



"Witton" Mistake-proof Auto-transformer Starter.

rigidly to a steel shaft with hard-drawn copper contacts screwed on. The cover is of sheet steel. They can be supplied either with crank handles or rope wheel. The resistances are mounted inside the case. They are carried on insulating tubes threaded on vertical steel conduits which are insulated from the case by porcelain insulators, and arranged well away from the arcing parts. Above 3 H.P. 200/250 volts, or 5 H.P. 420/500 volts, the resistance is separate from the controller and a magnetic blowout being desirable, is provided.

In addition to the foregoing, other controllers and controller resistances are listed, as are automatic motor starters, ironclad reversing switches, shunt regulators, main regulators, multiple switch starters, single-phase motor starters, &c., &c.

These starters are made by the General Electric Co. at "Witton" Works, Birmingham.

SIMPLEX

Shell Inspection Lamp

(*Approved by the Home Office*).

As supplied to many National Shell Factories.



Robust for hard factory use. Made with and without Switch in handle.

No. E6216. Price with Switch,

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No. E6215. Price without Switch,

14/-.

Complete with three yards flexible.

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Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, etc.

ELECTRICAL FITTINGS AND GLASSWARE.

A supplementary catalogue, which is intended for use in conjunction with their general catalogue of artistic electric fittings and glassware, has been issued recently by Messrs. J. & W. B. Smith, Farringdon-road, London, E.C. The list contains illustrations and prices of a number of new designs in brackets, hall lanterns, electroliers, adjustable pendants and semi-indirect fittings for use with electric lamps of moderate candle-power. There is also a line of artistic silk shade pendants for dining-room use which should prove popular at the present time. A section of the catalogue is devoted to electric cooking and heating apparatus, and deals with electric irons, nickel-plated hot plates, glue pots, kettles and toasters, shaving-water heaters and hot-water urns. The concluding section of the list is devoted to opal and enamelled iron shades, and a considerable variety of glass shades and semi-indirect lighting bowls. We have selected a few illustrations from this catalogue which are typical of the goods listed. Fig. 1 is a pretty design of wrought-iron bracket and lantern which makes a very suitable porch light. This measures 6½ in. by 1 in. at the back of the bracket, and has a projection of 8 in. If a low candle-power lamp is employed, the lantern as it stands will probably comply with the new lighting regulations. Fig. 2 depicts a semi-indirect lighting fitting of ornate design. This is listed in oxidised brass, with chain suspension and with moulded



Fig. 1.—A Neat Porch Light.



Fig. 2.—An Artistic Semi-Indirect Fitting.



Fig. 3.—Desk or Piano Lamp.

LEAD MELTING FURNACES

Hand Furnaces

For Cable and Pipe Presses, Accumulator Grids, etc.,

WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.

ENORMOUS SAVING IN RESIDUE.

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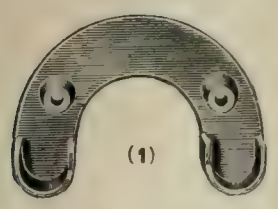
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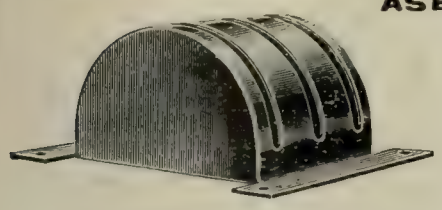
PRESSBOARD (Presspan) in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.

AMIANITE (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.

BAKELITE & CORNITE (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.

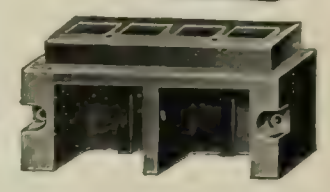
ASBESTOS-CEMENT in Plates, Arc Shields for Controllers, &c.





Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.





"radiac" glassware bowl 16 in. in diameter. This is a moderate priced fitting, and one which can be employed with the new bayonet cap half-watt lamps. Fig. 3 shows an adjustable table bracket which can be employed for use on roll-top desks, pianos, reading desks, &c. This is supplied in polished brass with double-knuckle joint and metal reflector. The base is 6 in. in diameter, the projection is 9 in. and the reflector is 7 in. wide. Fig. 4 depicts an electrical adaptation of our old friend the bed-warmer. This handy domestic utensil has an overall length of 36 in., and is fitted with an heating element which has an energy consumption of 250 watts. It is supplied complete with 4 yds. of flexible conductor. The bed-warmer heats up quickly, and is, of course, designed for warming the sheets only; it must not be left in the bed with the current turned on.

From the same source we have also received two pamphlets which

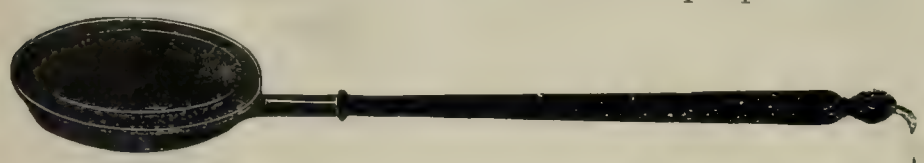


FIG. 4.—ELECTRIC BED-WARMER.

deal with "Glasmi" electric radiators of the luminous type and "Glasmi" electric fires of the red hot bar type. There is a considerable selection of the former offered, at prices ranging from the humble guinea for a simple two-lamp radiator without reflector, upwards. The hot-bar fires are listed in sizes from 2 kw. to 4 kw. We are asked to inform the trade that copies of these catalogues may be obtained on application to the company.

CALENDARS, DIARIES, NOVELTIES, &c.

SUN ELECTRICAL CO.—A useful desk calendar and daily reminder pad is being sent out this year by the Sun Electrical Co., Charing Cross-road, London, W.C. It differs from many of its predecessors of a similar character in that the advertising matter is most unobtrusive and there is plenty of room on the memo slip, which lies flat on the pad and is at the back of the next day's date. When turned over this slip is set at a convenient angle for reading and the day of the week, the name of the month and the date are all clearly in view. The date is in red, and can, therefore, be easily distinguished from the other printing. Immediately below the date are three panels, a centre one in heavy figures being a calendar of the month corresponding to the date in view, and on the left a calendar of the preceding month, and on the right a calendar of the subsequent month. The pad is supported by a repoussé coppered frame, which bears at the front the company's well-known Sun trade-mark and their trade slogan, "Everything Electrical." Interleaved at various points are reminders of the principal electrical lines in which the company specialises. A very welcome gift.

POPE'S ELECTRIC LAMP CO.—The Pope calendar this year is a monthly tear-off calendar with large and clearly legible figures on each of the tear-off slips. Surmounting the sheaf of tear-off slips is a bold design illustrating a workman holding up an "Elasta" lamp. The design bears the legends: "Pope Elasta wire lamps; Strength; the British lamp of World repute." We feel sure that this calendar will be widely used.

VICTA ELECTRICAL CO.—For many years past this company has sent out a monthly tear-off calendar, and the 1916 edition is now duly to hand. The company specialise in electricity meters, and with the calendar they send out a pamphlet entitled "Meter Repairs during War Time." In this they remind us that they specialise in repairing and re-standardising defective meters. They call the attention of central station engineers whose meter staffs have been depleted to the facilities which they can offer at their works at Queen's-road, Battersea, in the way of keeping meters up to standard. They state that they have had seven years' exeperience, and have a large number of satisfied customers on their lists. They also state that they will repair and readjust meters and return them completely renovated.

BASTIAN ELECTRIC HEATING SYND.—This company is sending out a useful pocket novelty in the shape of a 6 in. celluloid rule carrying at its extreme right-hand a rotating calendar which holds good from now till 1927. We may regard this latter as something of a vote of confidence in the Government. It is a species of optimism which at the present period of the war is most welcome. We may also presume that the company is in for a long spell of business, and is not afraid to suggest that the war will be over before its calendar is out of date. We should mention that the rule is marked off in meters as well as in inches, doubtless out of compliment to those who are engaged in the present controversy as to the value of the metric system.

KEY ENGINEERING CO.—We have forgotten how many years since we were first made recipients of this company's vest pocket yearly calendar printed on celluloid about the size of a visiting card. It is our experience that these useful reminders, both of the date and of Key fibre conduit, wear well throughout the year, in spite of the rough usage which they get cheek by jowl with fountain pens, pencils, watch keys and other pocket lumber.

B.T.-H., RUGBY.—In spite of the war and the fact that the making of munitions is now an accepted function of all engineering establishments, whether large or small, the B.T.-H. wall calendar has turned up as usual. It preserves the traditions of its predecessors for the boldness of its lettering (the sine qua non of every good calendar), and the artistic arrangement and selection of its illustrations. These latter typify the extremely wide range of B.T.-H. products, and each of the 12 slips carries its message on behalf of rotary converters, motors, turbo-generators, control panels, ironclad switchgear, industrial motor equipment, Mazda lamps, &c. As in previous years, each tear-off slip bears the dates of three months, the current month in a large central panel with bold figures, and the preceding and succeeding months in smaller panels but equally legible figures.

ELECTRIC CONSTRUCTION CO.—Once again we have to acknowledge with thanks receipt of the E.C.C. leather vest pocket card case,

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Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

ATTWATER & SONS,

Telegrams: Attwaters, Preston.
Telephone No. 1045 (2 lines).

Hopwood St. Mills, PRESTON.

Established 1868.
Codes: 5th Edition A B C & Western Union.

calendar and stamp case. This will take the place of a hard worked predecessor, which is, however, in sufficiently good condition to pass along for further service.

THERMIT, LIMITED.—This company is also sending out its hardy annual in the shape of a neat pocket-book, with a generous supply of blank pages for notes and a prefatory section in which the Thermit system of welding is described, and its numerous applications, particularly in electrical work, illustrated. Doubtless every tramway manager will have a copy of this and will frequently refer to its technical pages.

PARK ROYAL ENGINEERING WORKS.—A particularly handsome leather bound diary and notebook is to hand from this company, whose works we described in our issue of the 10th ult. The diary pages are interleaved with illustrations of the products of the company in the shape of special switchgear, circuit-breakers, fuses, fire extinguishers, instruments, switch pillars, &c. The pocket-book is complete with button clasp and a generous length of pencil.

LANGDON DAVIES MOTOR CO.—Electrical contractors, particularly those in districts in which an alternating-current supply is given, will welcome the neat notebook which this company is sending out. The notes pages are preceded by a number of useful tables giving the horse powers and synchronous speeds of one, two and three phase Langdon Davies motors; watts and kilowatts, with the equivalents in English horse-power, French horse-power and kilogrammetres; revolutions of motor and countershaft speeds and sizes of pulleys; sizes of belts, &c. There is also a table of the horse-powers and approximate speeds of direct-current motors for horse-powers ranging from ¼ to 65, for voltages of 100, 200, 230, 460 and 500.

LUNDBERG'S NEW LIST No. 1.

The new list No. 1 just issued by Messrs. A. P. Lundberg & Sons, Liverpool-road, London, N., is a well-printed quarto (8 in. by 11 in.) volume of nearly 90 pages, bound with flexible blue cloth cover.

The list, large as it is, we understand, deals only with four of the firm's many types of tumbler and other small switches—viz., single-way, twinob, double-pole and triple-pole.

This naturally omits many other types, as well as numerous wall-plug and sockets, ceiling-roses, and other accessories, which will, we understand, be dealt with in future new lists, pending the issue of which the old paper lists are still available.

The fact that 80 odd pages are now required for an adequate description and listing of only four out of the score or more of types of small switch made at the Pioneer Electrical Works, shows conclusively how this branch of electrical accessory work has expanded, and it is interesting here to recall the words of the poet:—

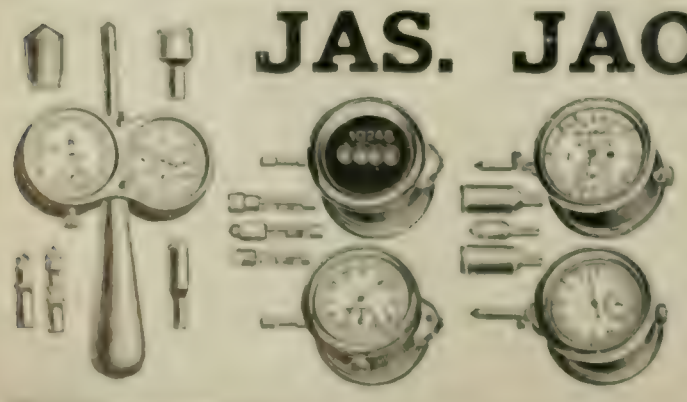
> Said the turbo to the switch,
> "You're a little chap it's true,
> And on my most extensive back,
> I could take a lot of you."
>
> Said the switch unto the turbo,
> "If numbers count at all,
> My fellows congregated
> Would make you look quite small."

The list contains over 200 illustrations, all of which are excellent woodcuts. The bulk of the list deals with 30 or more different kinds and forms of single-way switch and modifications thereof. These 30 kinds are divided into five groups: Tumbler, turn, push-and-pull, pendant and miscellaneous. As regards modifications, it may be mentioned that the well-known "Pivot" switch can be supplied with one or more of about 10 different modifications in its standard construction. These modifications do not include the numerous varieties and finishes of covers, which are illustrated and tabulated in a separate section at the end of the list.

It is impossible here to enumerate all the different kinds of single-way switch, but we may remark upon the "Pivot" switches with Admiralty-pattern terminals, the "Klymax" and "Mortise" flush-panel forms, the "Quadbreak" (quadruple-break) switch, and the "Neptune" push-and-pull quick-make-and-break switch. The now well-known "Twinob" tumbler switch (a combination of two on one base) absorbs a dozen pages for its adequate treatment, and a large number of connection diagrams show its varied uses in lighting, heating and small-motor control work. This switch can be as much modified as the "Pivot" switch, and one of the most recent of these converts the apparatus into a kind of miniature switchboard for an automobile. The new standard forms of this switch have knife-blade and spring-clip contacts.

The double-pole switches are either of the single or coupled-tumbler patterns, and the triple-pole switches are of the latter form. It is worthy of note that dimensions are given both in inches and millimetres; and the full range of catalogue numbers with or without modification and "finish" letters suffixed thereto will enable practically any and every requirement to be expressed in half a line on an order form.

No one should experience any difficulty in finding his way about the list, but should any trouble arise there are excellent indices to act as guide. Apparently the effective grouping and arrangement of the mass of descriptive, illustrative and tabular matter is the work of an expert. We are informed that all Messrs. Lundberg's regular customers will in due course receive a copy of the list; and others desirous of one should enclose a business card with their application.



JAS. JAQUET, Ltd., BASLE,

SWITZERLAND.

Combined Revolution Counters, with Chronograph.

Very Accurate Timekeepers.

CHRONOGRAPH AND STOP WATCHES.

Lists on Application.



Printed and Published for the Proprietors by GEORGE TUCKER at the Electrician Printing and Publishing Offices, 1, 2 and 3 Salisbury Court, Fleet Street, in the City of London. Friday, January 7, 1916.

THE ROUND TABLE.

By "KVA."

The latest in electrical weddings : The Husband-Quead Fire. This seems to possess all the elements of a happy union.

* * * *

"The Times" Engineering Supplement reports that Mr. H. M. Hobart delivered the James Forrest Lecture before the Institution of *Electrical* Engineers. This is rather an unkind way of returning the hospitality which the Institution of Civil Engineers extended to the Institution for so many years.

* * * *

Apropos of the above, Mr. Hobart does not hesitate to express himself forcibly on his pet subject of railway electrification. He says :—

"Within 10 years d.c. systems will employ line pressures of 2,000-3,000 volts, and these systems will, in all probability, have come into extended use. The single-phase delusion will meanwhile have been exposed."

I shall expect to hear of a duel à outrance between Mr. Hobart and Mr. Philip Dawson before many more phases of the moon.

* * * *

The "Sanitary Record" asks the momentous question :—

"Why have a kitchen range at all ; and we amplify the pertinent inquiry by asking why have a kitchen at all ? Gas, and *to a much lesser degree electricity*, now answers every requirement, and many new estates are providing no range."

When I read the italicised remarks I concluded that it was an impertinent inquiry.

* * * *

During a recent meeting of the Gateshead Town Council the hardness of the local water was discussed, and one of the aldermen said "that using the water for washing oneself was like using emery paper." A more sensible suggestion was that of a Mr. Wood, who said "the best way to purify the water is to put whisky in it." However, it was finally agreed "to call the water company's attention to the matter" ; in the water, I presume.

* * * *

According to the "Torquay Directory," which reported a recent gas explosion in the district—

"Miss Gillett, who had long been in the service of Mr. Pershouse as a nurse, detected a *small* of gas. . . . . A match was struck and at once there was a violent explosion ; the window was blown out, the door was smashed to matchwood, windows in the scullery and passage were also blown out, and other damage was caused."

I should think this was not quite such a *small* of gas as the lady at first evidently imagined it to be.

* * * *

The Electro-Harmonic concert on Friday last was fairly well attended, and the programme was well up to previous high standards. Prof. Anders successfully mystified the audience with his experiments in telepathy; he must have bought a batch of Marconi shares recently. A correspondent, writing me about the unofficial programme, remarks that I should not have nicknamed the chairman "Hello" Clay, but have called him Common Battery Clay, because his initials are C. B. Quite an oversight on my part ; that section of my brain must have been "busy" when I was trying to get through.

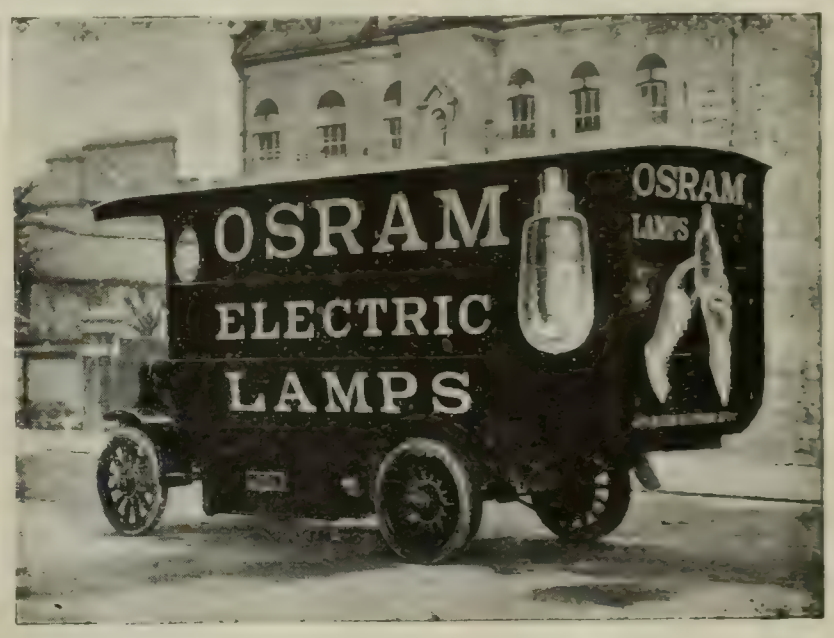
A salesman of hot-bar glowing wire element fires called upon a prospective customer recently, and was rather warmly received. "New electric fire, eh ? Humph, well don't bring any of those things with long bottles, not unless you fill 'em with whisky ; there would be some heat in 'em then !"

* * * *

A maker of electrical accessories has christened the moulded insulating material which he uses "Oldammit." I presume that the user has the option of placing the emphasis on the first or second syllable, according to the state of the weather, the progress of the war and his own condition of health at the particular moment.

* * * *

The Osram lamp battery vehicle, to which I referred last week, is illustrated herewith I hope it will soon be one of a



big electric fleet of lamp-delivery vehicles—both in London and the provinces.

* * * *

I hear a good story of a famous London Emporium proprietor who conceived the brilliant notion of devoting one of his departments into an "electric store." With the assistance of a prominent electrical supply house he filled it with fires, irons and many other domestic electrical appliances. It was then pointed out that the apparatus must be shown on circuit to induce the public to buy. But to do this quite a substantial feeder into the new electrical department was required, and the thought of this and the meter at the far end ticking off the units, even at "Point Five," was too much for the Napoleon of the Emporium. Naturally the public would not look at "dead" electrical stuff !

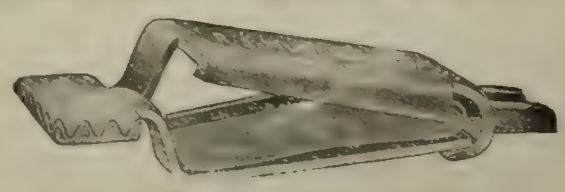
* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), January 11, 1879.]

THE ELECTRIC LIGHT.—Mr. Louis Schwendler, superintendent electrician of the Government of India, who has been on special duty in England, has addressed a communication, under date November 1, to the board of directors of the East Indian Railway Co., informing them that the results obtained from experiments leave a considerable balance of evidence in favour of the introduction of the electric light in Indian railway stations. He, therefore, recommends a practical trial of the electric light, either at Allahabad or at Howrah stations. Dynamo-electric machine A (supplied by Messrs. Siemens Bros. : construction, Siemens ; system, Hefner von Alteneck), was found the most efficient of the four under trial. He recommends its adoption, with such alterations as his own experiments have suggested. Of the lamps tried the Serrin lamp was found the most practical, and he recommends its adoption, with certain alterations.

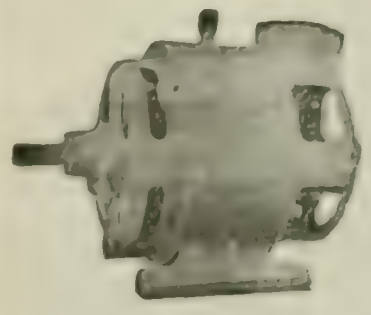
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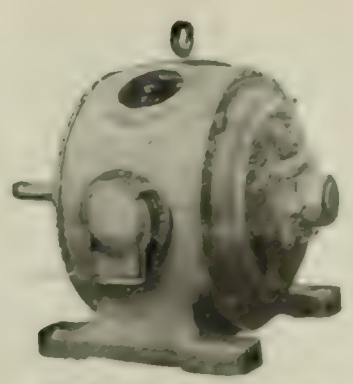
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TURBINE-DRIVEN CENTRIFUGAL PUMPS.

The plant illustrated herewith consists of a single wheel impulse turbine driving directly a high-speed centrifugal pump of special construction. The turbine disc and the pump impeller are overhung at opposite ends of a common shaft which is supported in two substantial bearings. These two bearings are carried in a cast iron pedestal to which are bolted the turbine and pump casings, thus forming a compact and rigid unit. Fig. 1 shows the general appearance of the plant. The central pedestal is mounted directly on the foundation block or girders, and sustains the weight of the pump unit.

We understand that at present the following sizes of pumps are stocked: No. 16, having a normal output of 1,600 gallons per minute; No. 24, having a normal output of 2,400 gallons per minute. These outputs are obtained in each case with a total manometric head of 50 ft., and when running at a speed of 2,000 revs. per min. They may be varied by alteration of the speed or total head. The complete net weight of No. 16 plant is 24½ cwt., and of No. 24 plant, 25½ cwt.

The impulse wheel of the turbine consists of a single disc carrying two rows of blading. This disc is made of high tensile forged steel, accurately machined all over, and it is fitted to the shaft by being driven on to a tapered seat, and is also keyed and held securely in position by a nut. The casing which encloses the wheel is of cast iron fitted with a large cover at the end and one on top. By removing the end cover the impulse wheel can be inspected or completely withdrawn. To the top cover is attached a plate carrying the fixed row of blading, so that this blading can also be withdrawn for inspection by merely removing the cover. A relief valve and an exhaust valve are arranged on the top of the casing. The positions of these valves may be interchanged, and the exhaust valve can, if desired, be placed on the end cover in two positions on the horizontal centre line.

Before impinging on the first row of running blades, the steam is expanded through a number of nozzles in a cast-iron nozzle plate which is bolted to the upper portion of the turbine casing. A steam strainer, having an area nearly three times that of the steam inlet pipe, is fitted between the inlet pipe and the stop valve. A special bronze valve of the screw-down type, with renewable seats, is fitted. This valve is also operated by the emergency trip gear when the speed of the turbine rises beyond a predetermined figure.

The blades are cut from drawn strip of a special non-erosive material, and the roots of the running blades are milled to fit into the grooves machined in the rim of the disc. They are supported by packing pieces, and a tang is left at the top of each blade which fits into a corresponding hole in the shrouding and is riveted over. Fig. 2 shows a view of part of disc with blading. Between the two rows of blading on the disc there is a row of fixed guide blades which are fitted into a cast-iron diaphragm attached to the top cover. The shaft is of forged steel, machined all over, having tapered seats at each end, one for the turbine disc and one for the pump impeller. It is carried in two bearings of ample design, a space between the two being left for the fitting of the emergency trip gear. The bearings are contained in a rectangular cast-iron pedestal, the interior of which is easily accessible by means of a hinged cover held down by one swing bolt and fly nut. As mentioned above, this pedestal also carries the turbine and pump casings which are attached to it by means of flanged facings.

The pump casing is of gunmetal, made in two halves, having a joint in the vertical plane. One half is flanged for bolting directly on to the pedestal. The suction branch is on the other half, and is arranged on the pump centre line. When bolted together the two halves form a volute water chamber of the usual type. The impeller is of gunmetal, and is specially designed to suit the high speed at which the turbine runs. It is of the enclosed single entry type, machined all over outside and carefully smoothed by hand in the water passages so as to reduce friction losses to a minimum. Equalising holes are drilled to eliminate as far as possible any lateral thrust, but any small out-of-balance which may exist is taken by a thrust collar. The impeller is cast with a long boss which is bored and keywayed to suit the tapered end of the shaft, and is held rigidly in position by a nut which is itself securely fixed by stop pins. The boss has a renewable gunmetal sleeve fitted on that portion which runs in the gland and which is in direct contact with the packing.

The position of the steam inlet flange may be varied by moving the stop valve body through an angle of 90 deg. each side of the vertical centre line. In addition to this the flange to which the strainer is coupled has eight holes equally pitched, so that there are a

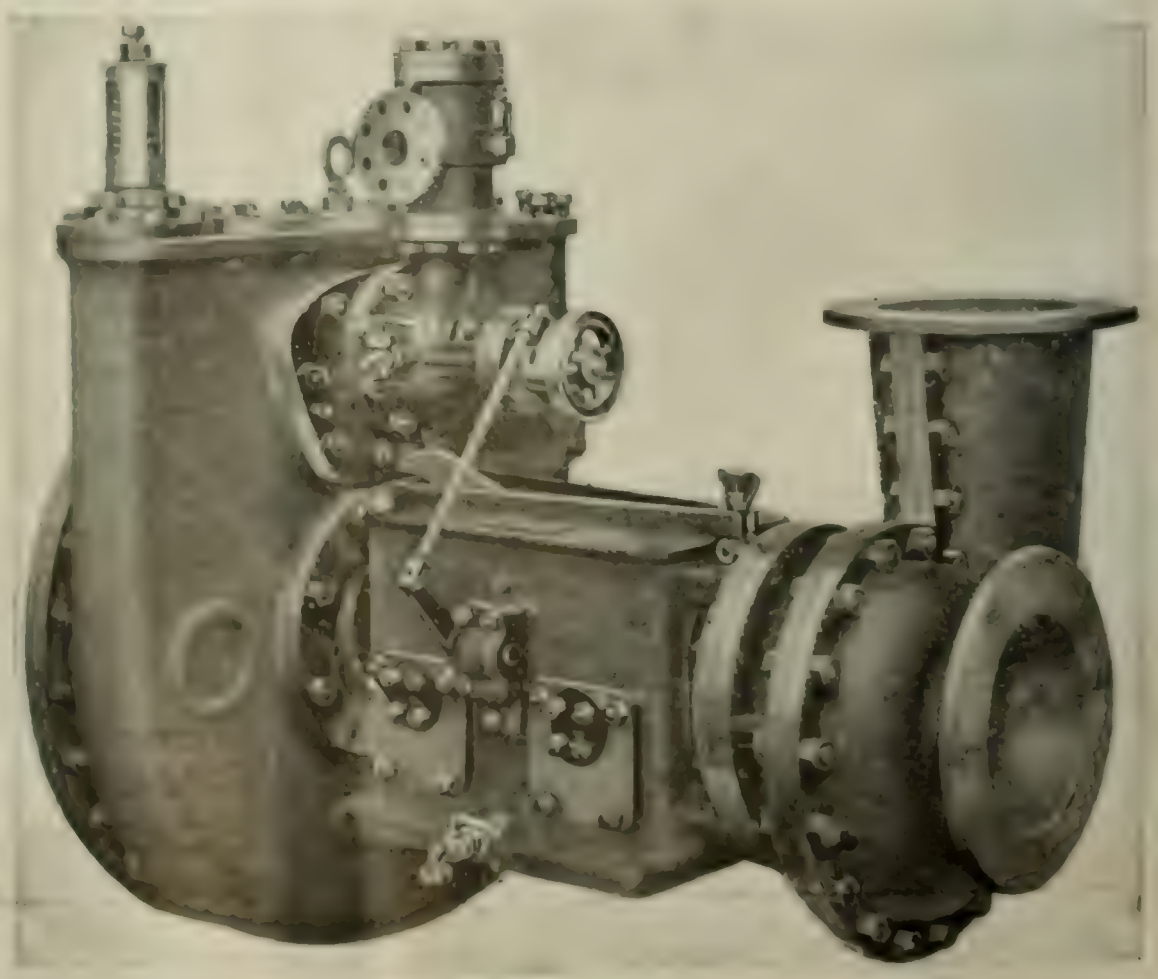
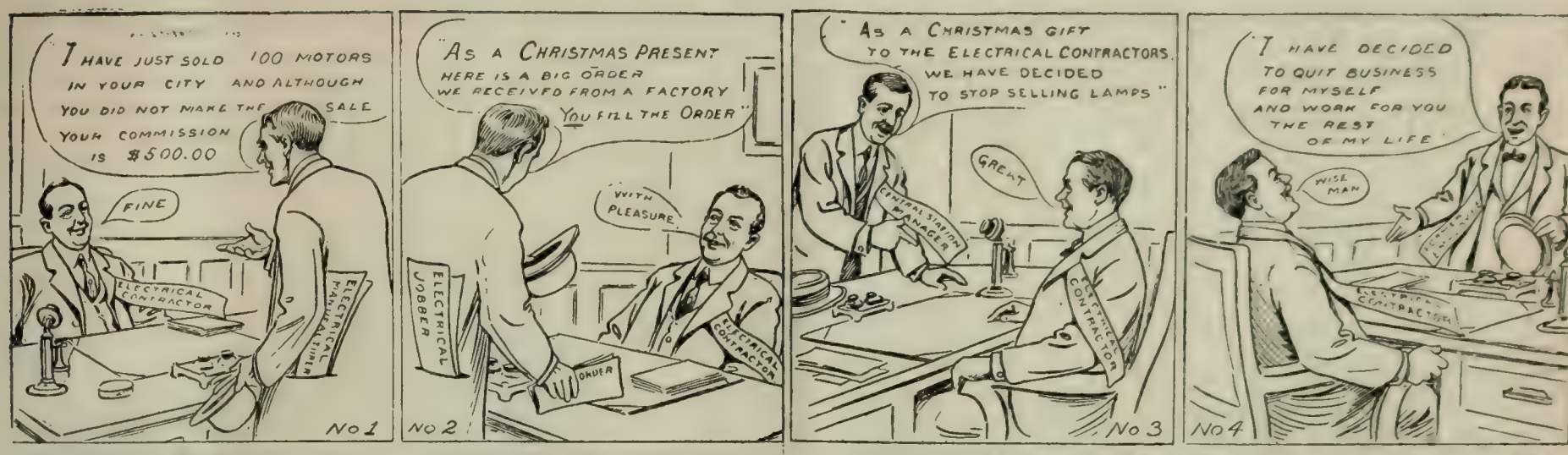


Fig. 1.—General View of Steam Turbine Pump.

THE ELECTRICAL CONTRACTOR'S DREAM.

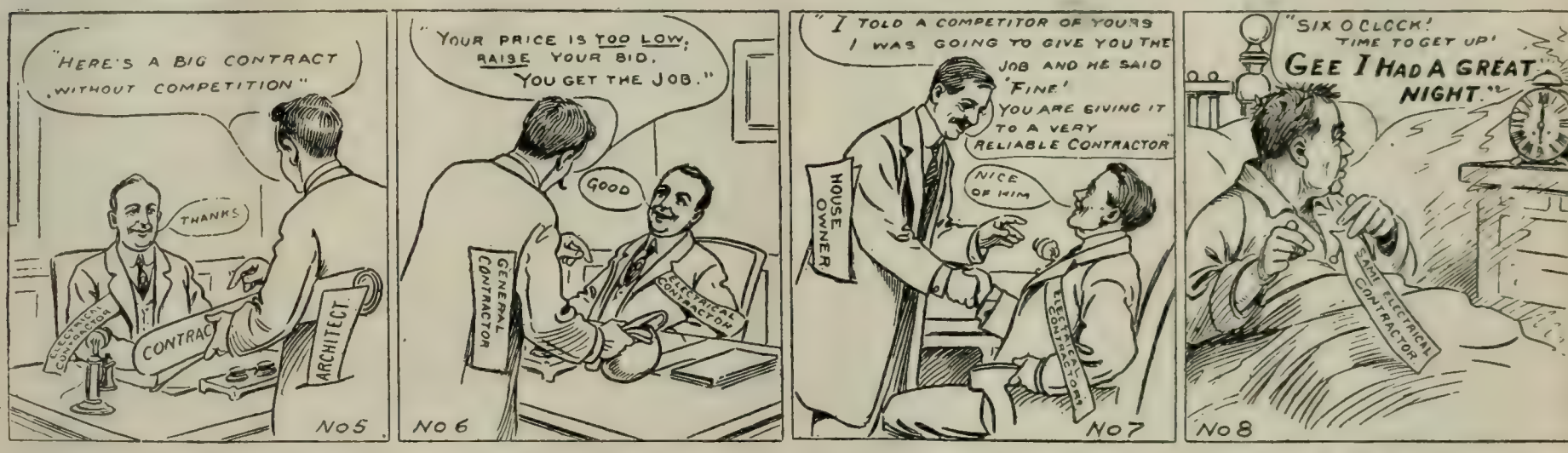


The Electrical Manufacturer calls on the Electrical Contractor.

The Electrical Jobber finally decides to be a jobber only.

The Central Station Interests grant the Retailer's request.

No more competition from the fellow with no office.



The Architect has decided the Electrical Contractor is perfect.

The General Contractor decides to let the Electrical Contractor make a profit.

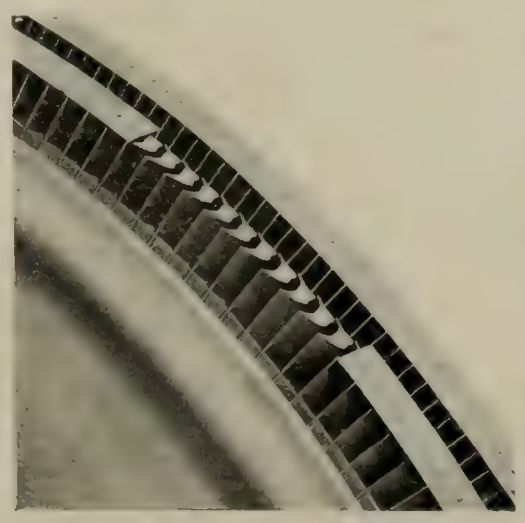
And even a Competitor who lost the job says kind words about him.

Alas! His happiness is of brief duration. Six o'clock and time to get up.

The above, reproduced from the official organ of the American Electrical Contractors' Association, is an apt commentary upon the situation as it exists among Electrical Contractors in this country.

---

variety of positions for the steam inlet to the strainer for each of the three positions of the stop valve. Six different positions can be arranged for the steam inlet. There are two facings on the top of the turbine casing, one for the exhaust valve, and one for the relief



View of Rotor Blading.

valve. The position of these valves can be interchanged if more convenient for the local conditions. Further, on the end cover, two similar facings are arranged, one on each side of the horizontal centre line, either of which may be utilised for the exhaust valve if necessary, but it is preferable to use the facings on top of the casing to avoid the necessity of breaking joints and removing pipes when it is desired to remove the cover. The pump discharge may be arranged in eight different positions, but as the suction branch is placed centrally its position cannot be altered.

These plants are made by Willans & Robinson, Rugby, from whom prices and a copy of the pamphlet from which the above particulars are taken can be obtained.

THE "OSRAM" ELECTRIC VEHICLE.

An electric battery vehicle has been added to the motors used by the G.E.C. for the delivery of Osram lamps. The van is handsomely finished in dark blue and presents a most imposing appearance. The gross weight is 2 ton 12 cwt., of which the Edison accumulator, which furnishes the propulsive energy, accounts for 16 cwt. The wheelbase is 10 ft. 8 in., and a load of 2 tons can be carried, the accommodation being sufficient for between 11,000 and 12,000 standard Osram lamps. The average speed on the flat is 10 miles per hour, and between 40 and 45 miles can be covered on one battery charge. Recharging is effected by a dynamo at the Osram-Robertson Lamp Works in Hammersmith. In addition to rheostatic braking a system of band brakes is provided. The adoption of this class of delivery van clearly proves that the Osram-Robertson Lamp Works appreciate the economical value of the battery vehicle for delivery service, and also that such a vehicle is in keeping with the making and distribution of electric lamps.

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The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
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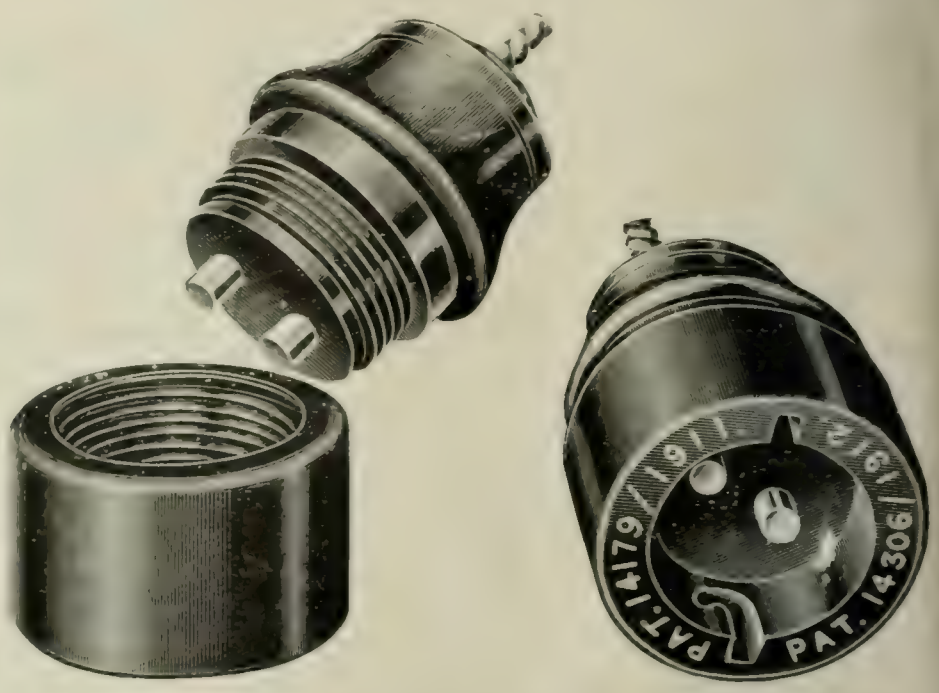
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A NEW LAMPHOLDER.

We illustrate herewith a new lampholder which is quite a departure from the ordinary types, and which possesses several new and advantageous features. The lampholder body and case is of Oldammit insulating material, and the only metal parts are the contact making plungers and wiring terminals. The wiring of these holders is carried out on the one part principle. The holder body consists of three parts—viz., the nipple, the body and combined shade ring and lamp support. Removal of the nipple allows the wired terminals to be placed in position without dismemberment of the body. Removal of the combined shade ring and lamp support permits the fixing of a shade around the annular space provided on the holder body, this space being sufficient for shades of various thickness. The combined shade ring and lamp support, as well as the holder body to which it is attached, are so designed that when they are finally screwed together the relative positions of the plunger contacts to that of the lamp contacts are ensured to make central contact with each opposing member when the lamp is in position and irrespective of the thickness of the shade used. The lamp pins on the cap are totally enclosed and insulated. The lampholders are strong and of good appearance and finish. Independent adjustment of shade fixing can be obtained by an independent ring operating on the outside of the combined shade and lamp support which would be screwed for the



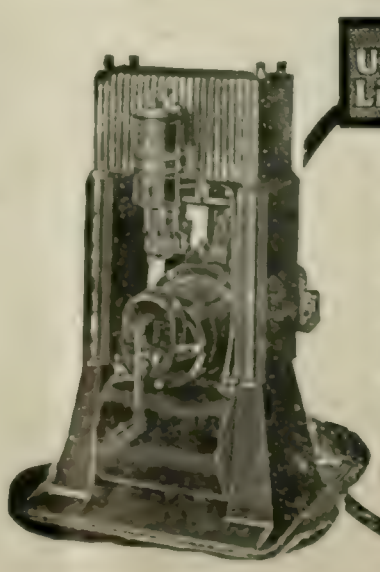
Details of New Lamp Holder.

purpose; further an insulating hood or petticoat can also be so fixed as to insulate the lamp cap to conform to the Home Office regulations.

The lampholders can also be made gas-tight by placing a rubber or other resilient ring over the lamp cap before placing the lamp in position; fixing the lamp in the holder causes compression and displacement of the ring between the collar of the lamp cap and the face of the combined shade and lamp support, satisfactorily covering the passages for admittance of lamp collar pins, as well as the annular space between the lamp collar and combined shade and lamp support. The holder in its present form can be used as a switchholder by slightly turning the combined shade and lamp support in a left-hand direction, thus causing the contacts of the coupled members to be disconnected at both poles. When used for this purpose the holder is supplied with a stop. Other designs for this purpose are being made in which the switchbreak takes place in the body with an insulating wall between each pole. These lampholders are made in various forms for everyday requirements, and can be supplied in different qualities of material to withstand heat, acids, gases and rough usage.

In conclusion, we may say that experience appears to prove that there is a considerable disposition on the part of both trade and electricity consumers to adopt insulated lampholders, doubtless owing to the fact that they confer greater immunity from shock, no discolouration, greater durability and cleanliness. The holders described are made by G. St. John Day, Mumps Electrical Works, Oldham, Lancs, and prices and further particulars can be obtained from them.

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UNI-LECTRIC Lighting Plant
NO BATTERIES. NO SWITCHBOARD.
Standard 110 volts—direct current.
Output 500 to 750 watts.
A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.
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If you will consider for one moment that "Elasta" Lamps have pleased every kind of buyer—that they are sold on generous terms—that stocking them means good profits to **you**—that they infringe no patents—and that no lamp is more satisfactory to handle and sell—you will place a trial order for

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THE WICKES CONTINUOUS ELECTRIC BLUE PRINTING MACHINE.

This interesting machine is the result of an effort by the makers to produce a convenient type of electrical mechanism for the production of copies of engineering and other drawings. As will be seen from the illustration, Fig. 1, the machine fulfils this requirement of convenience in operation. It stands very low, being only 2 ft. 6 in. above floor level, and the floor space occupied is 2 ft. 6 in. by 5 ft.; the printing cylinder is arranged horizontally. The whole machine is self-contained and is readily accessible in all parts.

Reference to the sectional elevation, Fig. 2, shows that the contact between the tracing and the printing paper is obtained by means of a single, wide, continuous belt which passes round the feed rolls and the printing cylinder, and is so arranged as to cover 92 per cent. of the circumference of the latter. The tension on this belt is regulated automatically by means of the bottom roll situated directly below the printing cylinder.

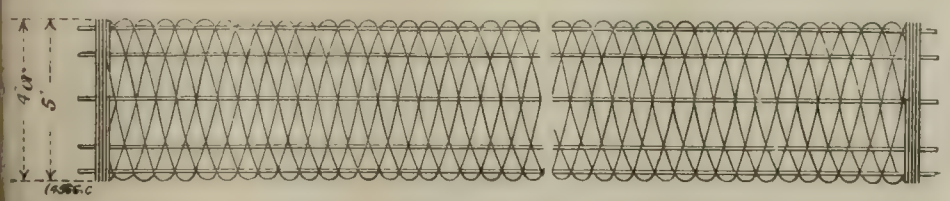


FIG. 3.—DETAIL OF SPIRAL CYLINDER.

Quite a new feature is represented by the printing cylinder, which is constructed of longitudinal and spirally disposed wires woven right hand and left hand. This tends to give a desirable ironing or spreading effect to each side of the tracing from the centre outwards, and ensures complete contact between the tracing and the printing paper. The cylinder is stationary, and so does not in any way obscure the light from the paper, and in point of fact, it is claimed, passes more light than the usual form of glass cylinder. Moreover, the trouble of cleaning and risk of breakage which makes the glass cylinder somewhat of a disadvantage are eliminated.

The lighting element is a mercury vapour lamp, and the low temperature at which this operates enables the printing operations to be undertaken much closer to the lighting element than is usual. In this machine the distance between the light source and the printing



FIG. 1.—GENERAL VIEW OF BLUE PRINTING MACHINE IN OPERATION.

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THE ALL-BRITISH HOUSE FOR ACCESSORIES

ROYAL
EDISWAN
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WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER MANUFACTURING CO., Ltd., Whitehouse St., Aston, Birmingham

surface is only 2 m. around the entire circumference. Naturally this ensures great rapidity of operation. The machine is driven by a small electric motor through a friction disc, which ensures absence of noise or vibration, whilst the machine can be run at varying speeds to suit different printing papers. The speed variation is effected by moving the motor by means of the screw (*see* Fig. 4), and thus moving the friction cushion situated on the motor spindle across the friction disc.

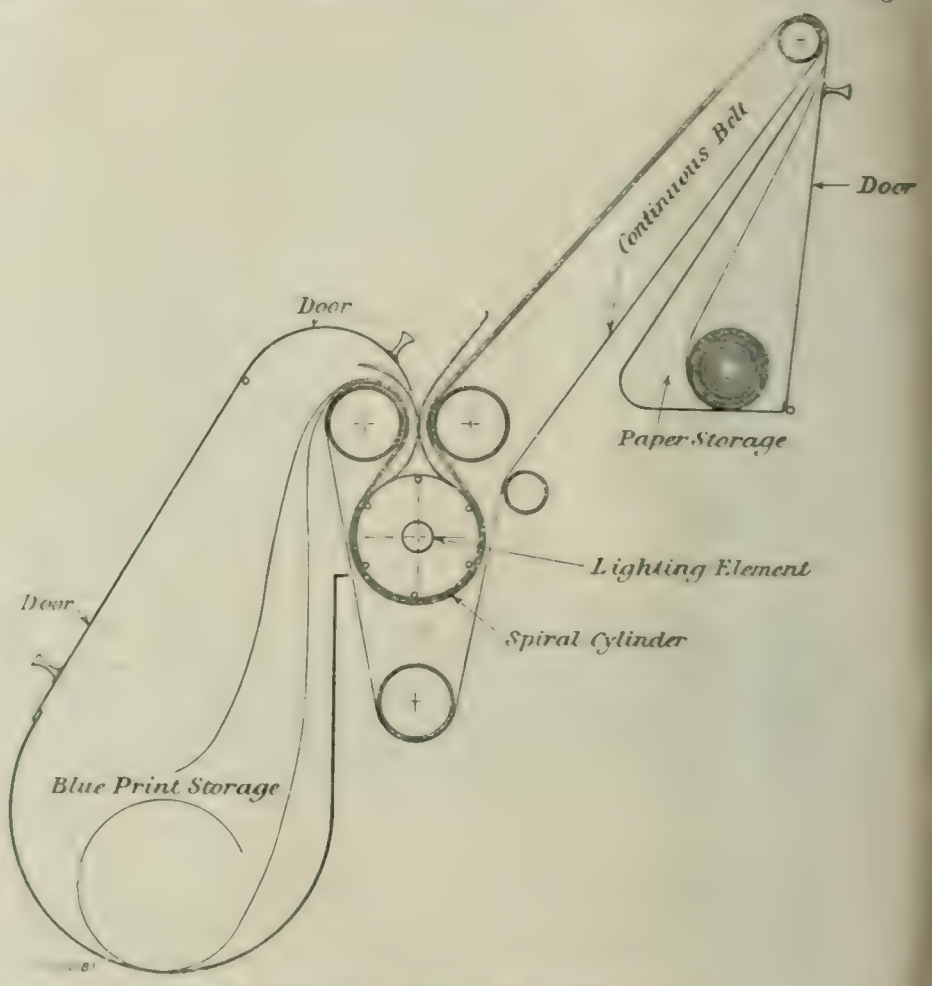


FIG. 2.—SECTIONAL VIEW OF MACHINE.

We understand that the machine is equally suitable for single prints or for continuous printing. When making single prints the tracing and sensitive paper are laid on the belt at the feed table as shown on Fig. 1. When printing continuously the sensitive paper passes from a roll in the storage chamber and down over the feed table as shown in the diagram. In either case the exposed paper is delivered to the blue print storage chamber, whilst the tracing can be delivered again to the operator. The machine will accommodate work up to 48 in. wide.

It may be observed that the light tight chamber below the feed table provides ample storage room for several rolls of sensitive paper. The machine, whilst being much more compact in form, and more convenient to operate than other types of blue printing machines, is highly efficient, very rapid and economical. The energy consumption for the motor and the lamp is 550 watts.

The machine is obtainable from Mr. F. A. Perry, of 63, Queen Victoria-street, E.C.

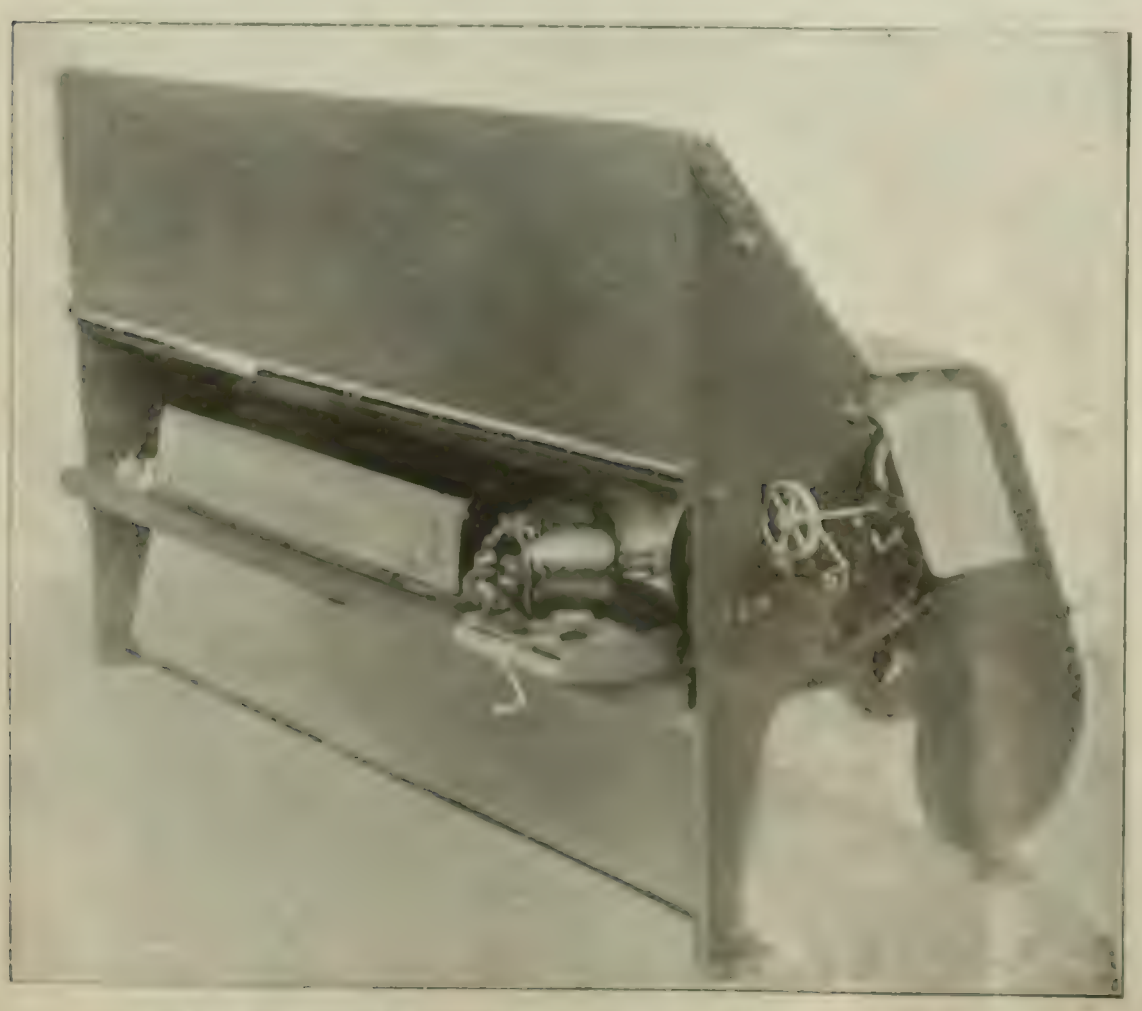


FIG. 4.—VIEW OF MACHINE [illegible]

BERRY, SKINNER & Co.—An effective perpetual calendar has been prepared by this company to keep the industry constantly reminded of the merits of "Ironsafe Switchboards." An illustration of a typical board of this class is shown framed by a metal archway which is the centrepiece of the calendar. The cards, showing the date, day of the week and month, are carried in a pocket at the right hand of the archway.

[illegible] LONDON: Friday, January 14, 1916.

THE ROUND TABLE.

By "KVA."

Le dernier cri is for female electricians, "wirewomen" in fact. We may soon hear of the formation of the Society of Artless Switchers with Mr. Perren Maycock as the first president.

* * * *

Aberystwyth has been put into darkness owing to a fire behind the switchboard at the local electricity works. A case of "abershortstwyth." Fortunately Welsh is a splendid language to swear in!

* * * *

The chairman of the Elland Urban District Council recently explained that the increased prices of electrical energy were due to the advanced price of coal. Thank goodness, they cannot be attributed to a rise in the engineer's salary or similar displays of patriotism.

* * * *

Which reminds me that the Leeds Corporation approved of an increase in the chief electrical engineer's salary (Mr. C. N. Hefford), in spite of an amendment that this should not take effect until the termination of the war. Alderman Kinder, who proposed this amendment, must be an optimist and economist rolled into one. The termination of the war indeed!

* * * *

The Swedish State Railways expect to complete the work of electrification, which will cost $2\frac{1}{2}$ million and save the import of 500,000 tons of coal, by the year 1924. Surely this beastly war will be over by then!

* * * *

The people of Eastbourne, as a result of the recent regrettable accident, are apparently convinced, after the evidence given at the inquest, that a roadside feeder pillar will cause a motor car to swerve into it. No explanation of this apparent phenomenon was forthcoming, even from the driver of the car. Can the explanation be that the chauffeur had previously taken an iron tonic and the "magnetic effect of the pillar" caused his nerves to skid?

* * * *

In my previous reference to the above accident I remarked that the victims of it were "electrocuted." A correspondent protests that the use of this term suggests that the unfortunate persons were "American criminals who suffered capital punishment." He gives it as his view that the expression electrocution should not be used in any other connection—and, or disconnection I suppose.

* * * *

Anent the electric light switching examinations which are announced in this issue, I may, at the risk of repetition, remind would-be competitors of the Lektrik parody of Hamlet's famous soliloquy.

"To switch or not to switch, that is the question, whether 'tis (k)nobler in the switch to suffer the sparks and flashes of outrageous switching, or to take up exams against a switcher's troubles, and by opposing switch for switch, to double break them."

In the words of the immortal bard, "Hold, enough!"

A tramcar at Dudley seems to have started without the driver and run a quarter of a mile in this condition. I hear of protests against women tramcar drivers, but what will the Trades Unions have to say to the "driverless" car?

* * * *

Wigan Corporation is at present in the throes of a struggle with local patriotism. The Electricity Committee, in extending the power plant, seem to feel it incumbent upon them to instal *Lancashire* boilers!

* * * *



WHAT MAY BE EXPECTED OF THE ELECTRICAL ENGINEERS OF THE FUTURE: AN ELECTRIC HOUSE AND AN ELECTRIC BATTERY PASSENGER CAR.

Electrical undertakings generally seem to be having a very exciting time just now. Breakdowns appear to be the rule rather than the exception (*vide* Aberystwyth, Halifax, Wallasey, Wigan, &c.), and to add to the engineers' troubles he must increase the price of juice!

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), January 18, 1879.]

TIME BALLS.—These useful indicators have been introduced into the German ports of Cuxhaven, Neufahrwater, Bremerhaven and Swinemunde, so that chronometers can be regulated at these places. The time indicated is Berlin time, and, as is the case in England and America, the ball is connected electrically with an astronomical clock in an observatory.

ELECTRIC LAMPS AND ORIGINAL INVENTORS.—So great has been the anxiety of men to do something in the way of inventing a new lamp that in more than one instance old and well-tried designs have been re-patented. We do not impute any sharp practice to those who have taken out patents, but we have no hesitation in saying that the patents should not have been taken out. For the moment, light by incandescence is a popular direction for experiment. Werdermann shows a light, Reynier straightway claims that Werdermann has derived the idea from him. Werdermann replies by showing that Harrison patented a lamp on the same principle years ago. Edison claims to work in this direction, but is met with the rebuff that Starr (in England King for Starr) had done the work before; and now Prof. Ayrton tells us that De Moleyns claims priority over all these men. The Wallace lamp is described in the "Mechanic's Magazine" of May, 1849, so that one begins to doubt if the money paid into the coffers of the Patent Office indicates any real progress. There is another reason, too, which makes us doubly doubtful of what has been done—real inventions are generally well tried before they are hurried into public gaze; and we question if many of the gentlemen who have favoured us with inventions really understand what is required.



No. 631.—Dynamo and Motor Field Regulator for Voltage or Speed Control by the insertion of resistance in the shunt field circuit. Properly graded for fine regulation, available in a wide range of capacity, voltage and ohmic resistance, adaptable to any convenient mounting.

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ELECTRIC MOTOR CONTROL

IGRANIC ELECTRIC Co LTD

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No. 38.—Compound Rheostat for the Control of D.C. Motors, first starts the motor up in the usual way and then regulates the speed by inserting field resistance. There is only one handle, an infallible interlock compels full field for starting, automatic overload and voltage failure release is provided.



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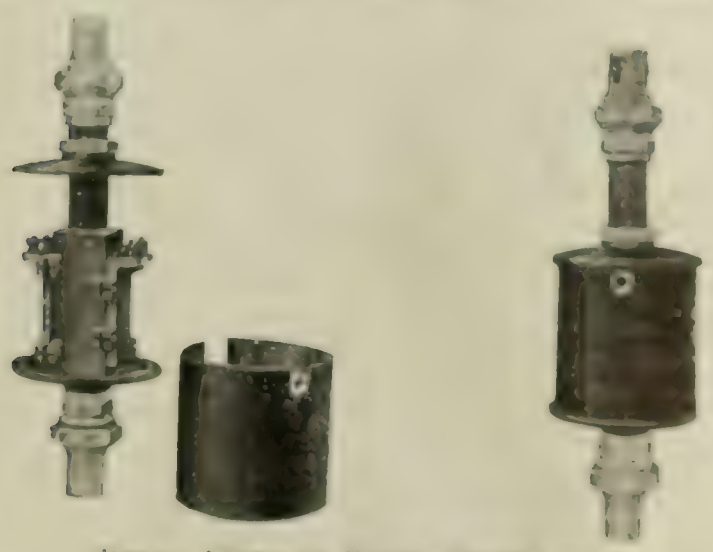
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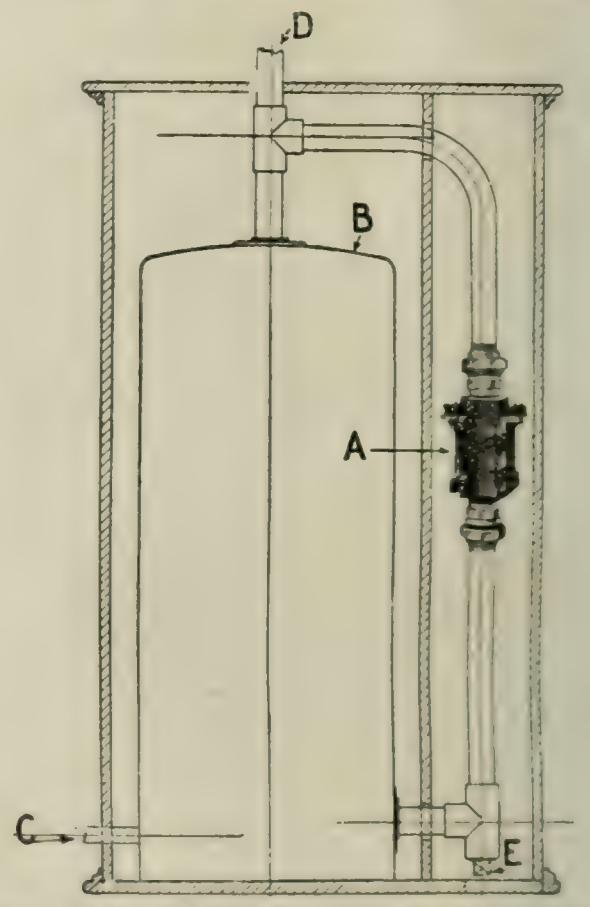
THE "FERRANTI" WATER HEATER.

A copy of list Hb. 145, describing the Ferranti electric water heater, is now off the press, and may be obtained from Ferranti, Limited, Central House, Kingsway, London, W.C., or Hollinwood, Lancs. This heater is offered in two designs, one a complete attachment for existing cisterns, and another the complete water heater with cistern. The heater may be used either separately or in conjunction with an existing boiler, and in the latter case the kitchen boiler may be used



DETAIL VIEWS OF WATER HEATER (CUT).

to assist the electric heater to meet abnormal demands for hot water. The heater comprises the heating element, contained in a rectangular chamber having circular outlets above and below. To these outlets are fitted unions for the attachment of the water supply pipes, inflow and outlet. The element is accessible by the removal of two clamping plates, one at each side of the rectangular chamber, and the connections are brought out to insulated terminals into which the circuit leads are brought through the bushed hole in the cylindrical casing which surrounds the complete heater. The heater is mounted on the circulating pipe connecting the top and bottom of the cistern, and when in circuit the water in the circulating pipe becomes heated. It then rises and flows into the top of the cistern, and is followed by cold water, which flows into the heater from the bottom of the cistern. A continuous circulation is then maintained, and the water in the cistern is gradually heated from the top downwards. We understand that the circulation is sufficiently slow to allow hot water to be drawn off after switching on the current. The heater is designed for remaining on circuit continuously in districts where specially low terms for electrical energy can be obtained for this class of service. The circulating pipe is 1¼ in. bore, and any deposit may be removed through a plug near the bottom of the pipe, where it enters the bottom of the cistern. The heater itself is provided with 1¼ in. screwed unions. The complete heater is offered in five sizes—23 gallons, 350 watts; 23 gallons, 500 watts; 34 gallons, 350 watts; 34 gallons, 500 watts; 34 gallons, 700 watts. The dimensions of No. 1 heater overall are 22 in. wide, 29 in. deep, 48 in. high; and of No. 5, 25 in. wide, 32 in. deep, 48 in. high. The net weight of the No. 1 heater with the cistern empty is 220 lb., and of the No. 5 heater 310 lb. The heating attachment only is obtainable in three sizes, rated at 350, 500 and 700 watts. The heating element is



VIEW OF COMPLETE FERRANTI WATER HEATER.

guaranteed conditionally for 12 months from date of despatch. The adjoining table, which is taken from the list, gives particulars of the performance of this class of water heater as obtained under actual domestic working conditions:—

Size No.	Gallons of water raised through 60° F.			
	Every ½-hour.	Every hour.	Every 6 hours.	Every 24 hours.
1 & 3	0·78	1·56	9·50	38·00
2 & 4	1·10	2·20	13·20	53·00
5	1·50	3·00	18·40	73·50

From the above it will be seen that with feed water at 50° F. the No. 1 size heater will give 1·56 gallons of water at 110° F. one hour after switching on or after all the hot water has been drawn off.

SLATE AND TUBE RHEOSTATS.

Electrical engineers generally will be interested in the issue of two new lists dealing with slate and tube rheostats by Isenthal & Co., Denzil Works, Willesden, London, N.W. The slate rheostats are described in list section I. In these the wire is wound on slate bars or slabs, the edges of which are grooved to keep the spiral fixed in position. The slate bars are mounted singly or in groups, according to requirements, and terminals are provided which enable the windings to be series or shunt connected. A graded winding can be supplied if required—that is, the winding space may be subdivided into anything from two to six sections, each of which carries wire of different gauge and pitch, gradually diminishing from the maximum

SLATE

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GROESLON, R.S.O., NORTH WALES.
Slates Drilled & Shaped to Specification.
Manufacturers of eve y description of
SLATE WORK for ELECTRICAL ENGINEERS.
Slate Masons, Turners and Enamellers.

to the minimum section. The resistances can be provided with slider bars, which are fitted with special contacts which ensure as nearly a perfect connection between the slider and the fixed wire as possible. The slider can also be arranged to be moved by hand or by a screw giving a fine or coarse adjustment, according to requirements. If the resistances are to be subjected to hard service, the makers recommend the use of graphite between the contact springs and the winding. The list describes a number of rheostats having various ohmic values, but it is pointed out, quite naturally, that these figures are only approximate. Slight differences in the gauge of the wire and small changes in the composition of the resistance alloy will naturally affect the resistance value; the values in the list can, it is stated, be taken as correct within 10 per cent.

The tube rheostats are, we understand, the result of a demand for rheostats of light weight and considerable energy capacity. The slate bars are replaced by solid drawn steel tubing of suitable diameter and length, which are fire enamelled and mounted in suitable bracket end supports. If the rheostats are required for high voltages, the wire is further insulated from the tube by a thin mica lapping The wire itself is specially oxidised, so that the turns can be in contact without fear of short-circuiting, and the maximum resistance value can be obtained from the winding spaces available. We understand that the oxide does not diminish the cross-section of the wire, also that it does not peel off and is not affected by the action of heat. The number of these rheostats, described and illustrated in the list, are sufficient to indicate the wide range of application of this particular design. We understand that a copy of the catalogue will be supplied to any of our readers upon request of the company at the above address.

MONOMETER FURNACES.

After an exhaustive study of English, U.S.A. and Continental systems, the Monometer Mfg. Co. have placed on the market their latest design of tilting furnace, which embodies many new and exclusive patented improvements. Messrs. the Rubel Bronze & Metal Co. (Ltd.), Birmingham, placed an order for 10 tilting furnaces, each of 600 lb. capacity, and Messrs. White & Poppe (Ltd.), of Coventry, have also ordered seven furnaces of the same size for melting delta metal swarf; the latter furnaces having turntables to carry a series of moulds.

The Monometer system of melting without oxidation and without crucibles gives such superior results that Wolseley Motors (Ltd.) have placed a repeat order, and orders have also been received for this type of furnace from the Waltham Ironworks (Ltd.), London; Crompton & Co. (Ltd.), Chelmsford; Joseph Lucas (Ltd.), of Birmingham, and many others. Soft metal furnaces for tin, lead, &c., are also ordered by Messrs. The John Dale Mfg. Co., of London; Messrs. The Lead Wool Co., of Kent; Mr. J. Branfield, Meadow Works, Sheffield (Antimonial Lead Alloy), &c. These furnaces have also been exported to the "Sydney Herald," Messrs. Claridge & Co., Bombay, and Messrs. Harper & Sons, of New York.

The only muffle on the market with automatic heat control has been fully appreciated for any process requiring an extremely accurate temperature, and amongst the firms who have placed orders are: Messrs. Daimler Motors (Ltd.), Messrs. Adam Hilgers (Ltd.), London; Messrs. Davies & Metcalf, Manchester; Messrs. Hack Saws (Ltd.), of Sheffield, &c. The Sheffield Corporation Tramways have placed an order for a 10 cwt. white metal furnace specially arranged to line white metal bearings. Messrs. Swan, Hunter, Wigham, Richardson (Ltd.), of Newcastle-on-Tyne, and Messrs. Foster & Co., of Epsom, have ordered shell-drying ovens, while the company's patented self-acting heat controller has been acquired by Messrs. Daimler Motors (Ltd.); Messrs. Chance Bros., of Oldbury; E. Williams, Esq., Smethwick, &c.

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THE
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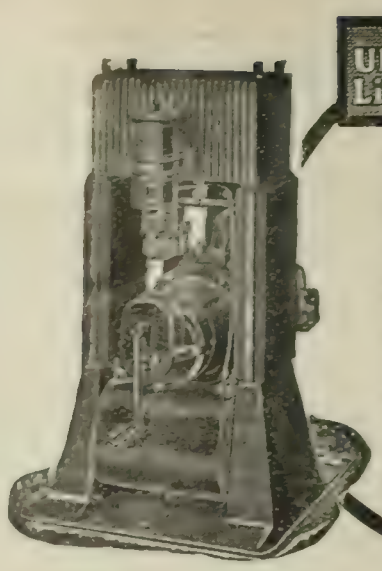
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Standard 110 volts—direct current.
Output 500 to 750 watts.

A complete electric lighting plant in one compact unit delivering current to the lamps, electric stove, electric fan, vacuum cleaner, pumping motor, or any other use, without the use of complicated switchboards and costly storage batteries requiring constant expense and care.

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LONDON, W.C.

UNIVERSAL TEST CLIPS.

It is often necessary quickly to make contact between fixed and flexible conductors in carrying out testing operations with instruments, motors, dynamos and similar electrical apparatus. We understand that a line of clips designed to carry current from 15 to 100 amperes is being put on the market by the L.P.S. Electrical Co., Adam-street, Strand, London, W.C. The adjoining illustrations show the general design of a 15 ampere clip. The views given are full size. The clips are made of copper and in one of the patterns illustrated the conductors are soldered on. The maximum spread of the jaws is $\frac{11}{16}$ in. and the complete clip weighs 1 oz. It will be observed that a powerful grip can be obtained when the clip is placed in the hand, there being no projections to cause discomfort. The clip also can be easily seen, as it stands out quite straight wherever it is applied, and will not sag down and make contact with adjacent conductors or terminals. The nose of the clip is thin, so that it can be used in narrow places. It is stated that tests can be made on terminal board pins set at only $\frac{3}{8}$ in. centres without risk of short circuit. It can also be used on bare wires, the side jaws being used; this is a convenience, because where the terminals are crowded there would be no room to apply the nose of the clip. The side teeth also mesh so that when applied to fine wire a good firm contact is made. On coarse wire or pin terminals there are always at least three good points of contact. One of the clips illustrated is No. 8, and it is stated that this has been adopted as standard by the telephone companies in the United States.

Where temporary connection only is needed on an insulated wire, the clip can be applied at the back of the blade of a pocket knife and the sharp edge be pressed through the insulation into contact with the wire. One of the clips shown herewith is fitted with an insulating sheath, and this can be provided and consists of a rubber sheath which is slipped over from the cord end of the clip. The No. 13A clip is copper, lead plated and is fitted with a screw connection for the flexible conductor. The spread of the jaws is $\frac{7}{8}$ in. The lead plating protects the copper from acid fumes and the steel spring is enamelled for the same purpose. This type is recommended for charging lead accumulators of all descriptions. Where batteries are required to be charged in series, as they often do, the flexible cord is made up in short lengths and fitted with universal test clips one at each end. The 100 ampere test clip, which is known as the "Big Brute," has a spread of jaws of 1 in. and weighs 5 oz. It is stated that this will carry 100 amperes indefinitely without heating, but it may be used for short tests up to 200 amperes. Copper sheaths under the spring carry most of the current picked up by the jaws of the clip. They also act as a shunt round the clip to protect it from heavy currents, which would otherwise destroy its temper. The sheaths have a combined conductivity equal to that of a No. 8 S.W.G. copper wire. This clip is also supplied with lead plating and enamelled protection for the steel spring. The connection for the incoming flexible conductor has a heavy clamp terminal.

We feel sure that these clips have only to be tried to meet with general approval. Full particulars and prices and a copy of list No. 103 can be obtained from the above-mentioned company.



Views of Universal Test Clips showing 100 amp. and 15 amp. sizes.

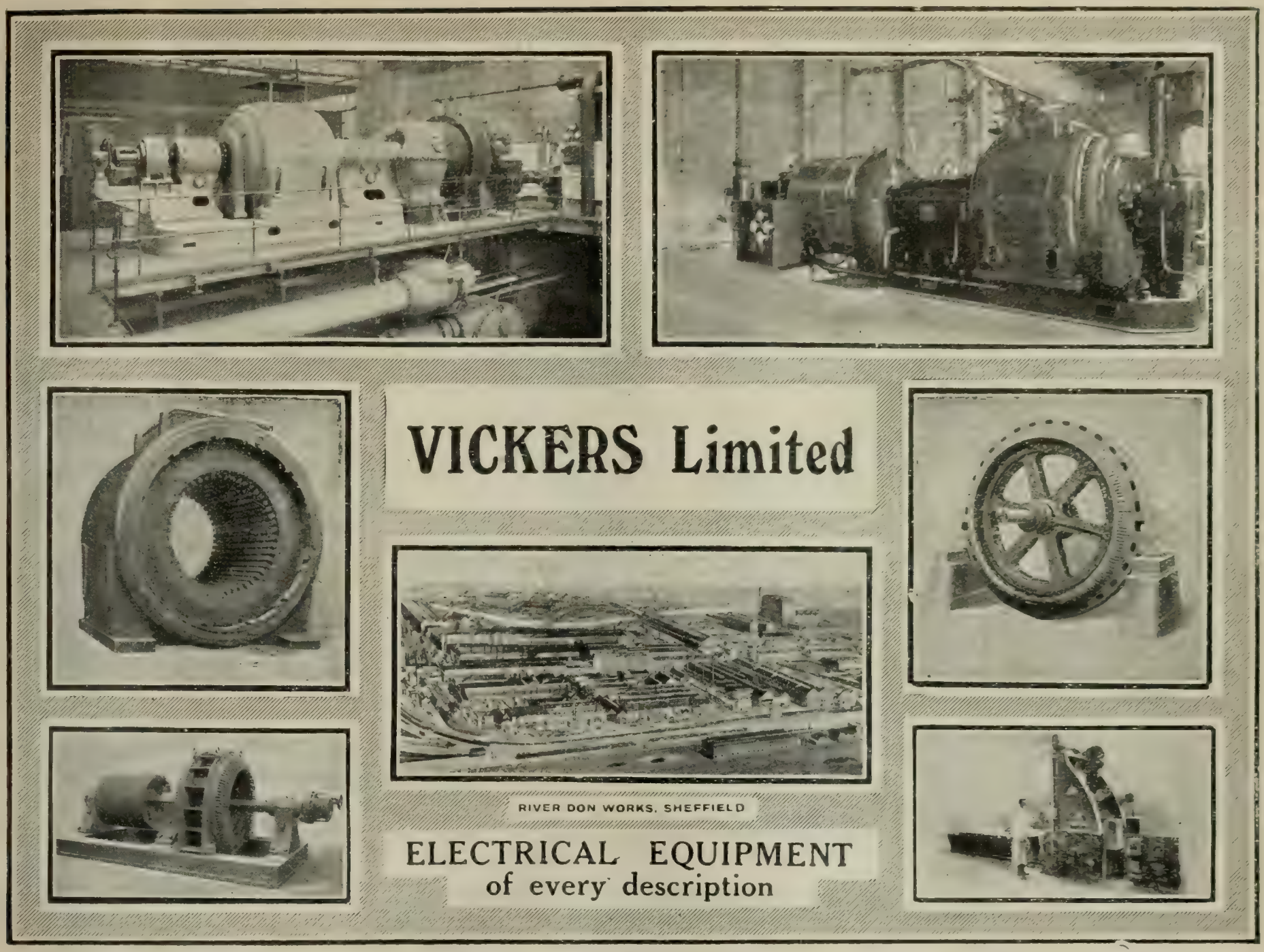
LEAD MELTING FURNACES

For Cable and Pipe Presses, Accumulator Grids, etc.

WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.

ENORMOUS SAVING IN RESIDUE

MONOMETER MANUFACTURING CO., Ltd., Whitehouse St., Aston, Birmingham.



NEW RADIATORS.

We have received from Messrs. Siemens Bros. Dynamo Works, Caxton House, London, S.W., a copy of a new pamphlet which deals with their "Cosy Corner," "Popular" and "Blaze" radiators. We illustrate each of these types herewith. The Cosy Corner radiator measures 13 in. high by 7½ in. wide by 6½ in. deep, and is fitted with a heating element which consumes 1 unit per hour. It is offered in



"The Blaze" Radiator.



"The Popular" Radiator.

three finishes, matt black iron, polished brass and polished copper. The Popular radiator measures 16 in. high by 13¼ in. wide by 5¼ in. deep. This is also of 1 unit rating, and is offered at the popular price of 30s. It is supplied in one finish only—namely, matt black iron. The Blaze radiator is 18 in. by 13 in. by 5½ in., and has three heating elements, which together consume 1,500 watts. It is also offered in three styles—matt black with brass ornamentation, polished brass and polished copper

The element in each case comprises a fireclay member with a number of projecting pins, around which are wound a continuous spiral of nichrome wire. The radiators are obtainable for all standard pressures from 100 to 250 volts. Electrical contractors who



"The Cosy Corner" Radiator.

are interested in electric heating should send for a copy of the pamphlet referred to. It may be obtained from the London houses or the provincial branches of the company.

POPE LAMP SHADES.

There has been such a demand for the Pope electric lamp shade that these have run temporarily out of stock. Orders for printing further quantities are well in hand, however, and delivery has been promised for the third week in January. Application for a supply should be sent immediately to the Pope Electric Lamp Co. (Ltd.), Hythe-road, Willesden, N.W. We understand that Messrs. Pope's Electric Lamp Co. have secured a renewal for the Nelson line of steamers of their contract for carbon and metal filament lamps during 1916.

BRITISH MADE.



For free advice or assistance on any lighting problem write to—
HOLOPHANE, Ltd., 12, Carteret St., London, S.W.

CALENDARS, DIARIES, NOVELTIES, &c.

County of London Electric Supply Co.—Although it can hardly be ranked as a calendar, the Telephone Card which this company is sending out will doubtless see arduous service throughout the coming year. It bears on the front page an ornamental design with the name and head office address of the company, and also the addresses of the principal show rooms. We would like to suggest that in the next issue a further column be provided for the name of the telephone exchange. There is ample room on the card for this addition, and we think it would be a useful improvement.

Alfred Graham & Co.—This company has always sent out a useful desk pad, diary and blotter, and the 1916 copy is now duly to hand. The diary is at the left hand of the blotter, and is interleaved with blotting paper, there being six days per page. Accompanying the blotter is an extremely useful publication in the shape of a pocket-book giving tide and speed tables. The information given is likely to be very valuable, and there is also a section giving explanations of electrical terms and a quantity of metrical tables.

Siemens Pocket Diary.—Another welcome handy manual which has just come to hand is the handy little pocket diary, issued by Siemens Brothers & Co. and Siemens Bros. Dynamo Works. As in previous years the opening pages of the diary are devoted to illustrations of the chief products of the two companies, these pages being interleaved with a quantity of useful data and technical information. Slipped into a pocket at the back of the book is a plain ruled memo book. The diary is provided with the usual pencil and hinged guarded tab.

Messrs. Johnson & Phillips (1916).—We have not previously received from this firm a desk blotter, but the specimen which they send us on this occasion is something quite out of the ordinary in this class of production. In addition to the blotting pad, there is at the left-hand an interleaved blotting diary, six days to a page, an engagement diary on a pad six days to a slip, and a week's memo scroll. To the right of the blotting pad is a long tear-off pad which can be used for tough notes. We feel sure that this blotter will be used throughout the year by those who are the fortunate recipients of it. The advertising matter is quite subdued; in fact, we may say that it is displayed in such a way as to be a dignified reminder of the company and its products in the way of cables, wires, transformers, cable making and laying machinery, electrical instruments, feeder pillars, and junction boxes, switchboards, arc lamps, dynamos and motors, and telegraph, telephone and transmission land line material. Accompanying the desk companion is a vest pocket diary neatly bound in black leather. This will also prove a useful adjunct to the blotting pad itself.

Simplex Conduits.—The handy pocket diary which Messrs. Simplex Conduits have issued for many years past has been published in the same size and form as previously, but the section giving technical and general electrical information has been considerably modified. The diary pages, as in previous years, are printed on squared paper, a fact which is of great assistance in making sketches. The section dealing with fuse and fuse wire now contains a number of curves and tables which relate to the alloys now used for this purpose. A number of electrical formulæ are included, and there is also a model specification for a screwed conduit electric lighting installation. The wiring capacity of conduits is dealt with in a useful table, and the section dealing with copper conductors and cable formulæ will prove most valuable. The diary is strongly bound either in leather or cloth boards, and, as in previous years, a generous length of pencil is included.

Pirelli Limited.—The daily tear-off calendar issued by this company bears, in addition to the tear-off pad, a patriotic design showing the flags of the Allied Armies borne along on a whirling wheel which is shod with a Pirelli tyre. The design is printed on sheet metal, and is a striking and artistic production.

"ENSIGN" FIRES.

The installation trade is doubtless familiar with the "Ensign" design of electric fire, which has been on the market for several seasons. We understand that these fires are now obtainable from the sole agents, F. Husband (Ltd.), Craven House, Kingsway, London, W.C. This company has recently issued a leaflet giving particulars and prices of this design of fire. The adjoining illustration gives an excellent idea of the construction. The heater is a solid firebrick with horizontal spiral elements, and this is built into a cast-iron box and then attached to the frame of the fire. The



"Ensign" Electric Fire.

heating spirals are brought up by the current to a cherry red, and the fire is therefore of pleasing appearance. A coppered wire guard protects the elements from external contact and mechanical damage, and the opening in the frame at which the element is fixed is provided with a shelf, upon which small utensils can be rested. The fire is a popular priced one, and is offered with black finish, loaded to 1½ kw. or 2 kw., and also with vitreous enamels of various colours and a special design with ruby enamel. Another pattern is obtainable in which the loading is increased to either 3 kw. or 4 kw., the finish of the frame being similar to the 2 kw. size. Messrs. Husband also market the now well known "Quead" fires, particulars of which can be obtained from them on request.

FERRY

FERROZOID

CONSTANTAN

CHRONIC

WRITE FOR PARTICULARS OF FOURTEEN GRADES OF

British-Made Resistance Materials

TO:—

MAKERS:

HENRY WIGGIN & CO., Ltd.,
George Street, Birmingham.

TELEPHONE: 6400 CENTRAL.
TELEGRAMS: "WIGGIN BIRMINGHAM."

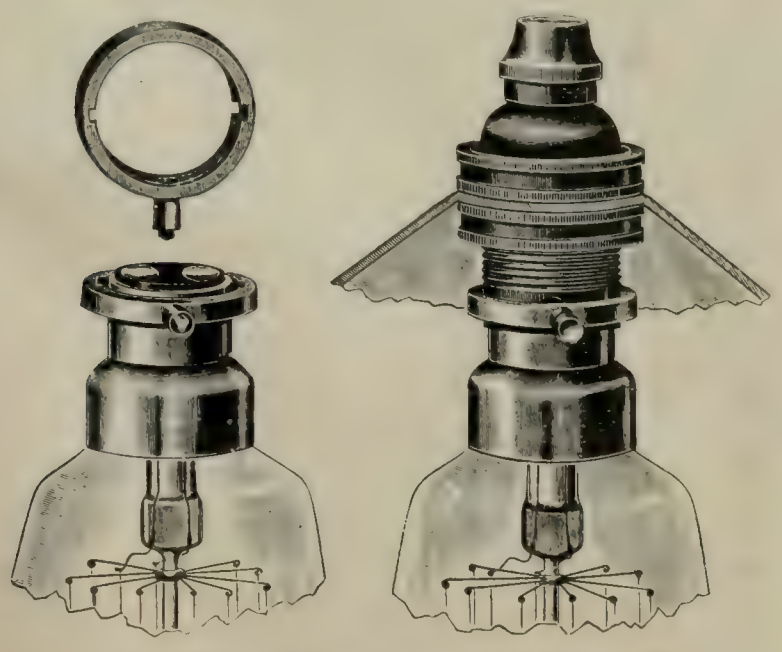
AGENT:

LIONEL ROBINSON,
3, Staple Inn, London, W.C.

TELEPHONE: 6323 HOLBORN.
TELEGRAMS: "FERRYDOM, LONDON."

A NEW LAMP LOCK.

The adjoining illustration shows a new pattern of electric lamp locking ring, which is being put on the market by C. H. Jeffcoat Ranelagh-gardens, Hammersmith, London, W. The operation of this ingenious device is clearly explained in the illustration. In placing it in position the bayonet pins are engaged with the internal



New Lamp Lock Applied to Lamp.

groove on the lamp locking ring through slots in the ring, and the lamp is then bayoneted into the holder; the ring is then turned until the locking pin is opposite the bayonet slot on the holder. When this position is reached the pin is screwed down into the bayonet slot, a special key being used which is provided for the purpose. When the lamp is locked in, a small cap is slipped over the boss of the ring. This accessory has the advantage of being applicable to any ordinary holder. It is only necessary to purchase a locking ring and a key, and any holder can be converted into a lamp locking holder. It should be noted that the holder can be plain, screwed, or of the batten type. Once the lamp is locked into position it cannot be removed without the use of the special key. These keys can be supplied right-angled or straight, as required. This is probably one of the most effective and least expensive forms of lamp-locking arrangement yet introduced. Full particulars are given in a circular which is being issued from the address mentioned above. From the same source we have also received particulars of the "Lamlok" lamp-locking holder. In this case the holder is of a special design, and within the body is a long pin screwed for a short distance at one end and provided with a sharp point at the other. This pin projects through the space at the side of the holder from the cord grip end. By means of a special key the pin can be turned round until the sharp point presses against the lamp cap, thus preventing the lamp being turned to remove it from the holder.

With so many comparatively expensive half-watt and high-candle-power lamps used at the present time, there are many firms who use electric light who wish to protect themselves against the risk of lamp thefts. They should obtain prices of these accessories.

CABLE CAPACITY GAUGE.

An extremely useful aid to installation work is being distributed by Simplex Conduits. It is made in brass and is $2\frac{1}{2}$ in. diameter over all. It consists of four discs, in each of which are holes which accurately represent the internal diameter of the eight sizes of Simplex heavy-gauge conduit, 2 in., $1\frac{1}{2}$ in., $1\frac{1}{4}$ in., 1 in., $\frac{7}{8}$ in., $\frac{3}{4}$ in., $\frac{5}{8}$ in., $\frac{1}{2}$ in.; the bore of the light-gauge conduit is slightly larger. The four discs are held together with a hinge pin, and each disc can be turned out for measurement purposes. Provided with the discs is a collection of cards bound together, and each bearing a group of continuous circles, which accurately represent the diameter over the insulation of the following sizes of conductors: 1/18, 3/22, 3/20, 7/22, 7/20, 7/18, 7/16, 19/14, or 7/14, 19/16 19/14, 37/16, 37/14. The centre one of

J. P. DEVINE CO., BUFFALO.

MANUFACTURERS OF

Vacuum Drying and Impregnating Plant.

(PASSBURG SYSTEM.)

The Devine Co. are well known in the United States and Canada as the leading manufacturers and experts in Vacuum Drying and Impregnating Plant and have over 1,500 such plants in successful operation.

AIR PUMPS, COMPRESSORS, VULCANISERS, CONDENSING PLANT.

Solvent Recovery and Derisinating Plant a Speciality.

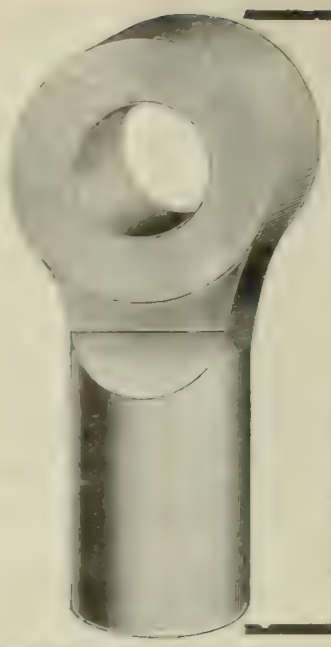
Sole Representative :

JAMES LIVINGSTON, LTD.,

30, GT. ST. HELENS, LONDON, E.C.

Telegrams and Cables : "CINERARY, LONDON."

Telephone : LONDON WALL 3151.



E. SHOWELL & SONS, LTD.,

STIRCHLEY, BIRMINGHAM.

Cast Cable Sockets.

Suite E74. Made in all Sizes.

Type A.—Straight.
.. B.—Offset.
. C.—Right angle.

Illustrated Dimensioned Showcard for Drawing Office use supplied free on application.

Sole Agent for the Electrical Trade :—

LIONEL ROBINSON, 3, Staple Inn, London, W.C.

TELEPHONE: *Holborn* 6323.

the circles is a cross-sectional drawing of the conductors and the surrounding insulation ; the others are plain circles.

If one of the discs is opened out from the others and placed upon the card containing the groups of circles the contractor can see at a glance how many of the conductors will pass comfortably through the conduit. In the ascertaining of this maximum, as is pointed out in the working instructions, "due allowance must be made for the actual run of the conduit, as it is inadvisable at any time to attempt to wire conduits to their full capacity."

We feel sure that this ingenious device will be generally welcomed by the electrical installation industry.

SWITCHING COMPETITION.

Full particulars (including the Problems) pertaining to next month's *Electric Light Switching Competition* may now be had from Messrs. A. P. Lundberg & Sons, 477-489, Liverpool road, London, N. Applications arriving late from overseas will be attended to. There is no space here to repeat what we have said many times before regarding the practical importance of the subject, and those who are not conversant therewith can easily write for the aforesaid particulars, and please themselves whether they will compete or not. There is no charge if they do, and there are opportunities for gain in more senses than one. When we say that the Problems set are based on the contents of a certain booklet which is now in its fifth thousand, and has been translated into French, it should be abundantly evident that there is something in the subject of "electric light switching." And anything novel to do with lighting safety concerns most of us.

LEASING MOTORS ON TRIAL SERVICE.

For a number of years the Brockton Edison Co. has made use of a trial motor offer which has proved itself a deciding factor in securing many important motor-service contracts. The plan is applied only to prospective customers who are already using mechanical drive, for it is not considered necessary to offer a trial motor installation to a new factory. Motors are furnished, however, for new factories on a lease plan originated to care for customers of from 1 H.P. to 25 H.P., who, as a rule, start business with little or no capital. To protect the company against loss, a plate is attached to each motor thus leased, stating that the motor is the company's property. The customer is then required to sign a lease and makes a cash payment of 10 per cent. of the cost of the motor, after 5 per cent. has been added to the list price to cover interest. The balance is covered in 11 equal monthly payments.

Leading up to a trial proposition, the practice is first to interest the man at the head of the company, who, if the plan appeals, is in a position to accept it without referring it to anyone else. With the consent of the owner or manager an investigation is then made of the power requirements, including methods of manufacture, arrangement of machinery, handling of products, &c. Estimates of wiring cost are made by local contractors, the lowest bidder receiving the job. Failing to gain the prospective customer after a reasonable effort, the trial proposition is offered in order to convince him of the company's faith in its report. The central station agrees to instal at its own expense all electrical equipment required and to allow it to be used for one year. The company does not, however, furnish belting and shaft pulleys, since these items can be cared for by the customer at little cost. It is figured that if at the end of the trial period the customer should be lost, second-hand belting and pulleys would be of little value, whereas the motors would have depreciated but little. The customer pays in equal monthly instalments, as a rental, 15 per cent. per annum on the total cost of the installation. The customer at the end of the year is the judge as to the value of the service, and if it is acceptable he agrees to purchase the equipment at cost less 60 per cent. of the amount paid as rental.

Since 1906, out of trial propositions with a total connected load of 2,500 H.P., only one proposition (one of 115 H.P.) has been lost. The cost to the company for these installations was $42,400, or an average of $16·96 per horse-power, all of which was returned with 6 per cent. interest, with the foregoing exception. The average gross yearly income from this 2,500 H.P. has been $65,200, or $26·08 per horse power of motor rating per year.—"Electrical World."

BELLING FIRES

Over 30,000 in use.

Tested by more than 400 Engineers during a period of 3 years, and generally recognised as being "The" practical and reliable electric fire.

A P.C. will bring our 40 page illustrated catalogue.

BELLING & CO., ELECTRIC HEATING SPECIALISTS.

DERBY ROAD, EDMONTON, LONDON, N.

Printed and Published for the Proprietors by GEORGE TUCKER, at the Electrical Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON. Friday, January 21, 1916.

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The 60,000 kw. steam turbo-generator is prophesied for the very near future.

* * * *

A Contractor's Reasons for Delay.—"Replying to your letter dated 6th inst., we regret to advise you that it has not been possible to commence on the date promised you, and the only reason we can give for the delay is that the work has been delayed in progress by work on other orders which had also been delayed."—"P.O. Electrical Engineers' Journal."

And so *ad infinitum*.

* * * *

Are you "Anti-Cacophonous"? If you are then you are an efficient unit in the Great Machine. This weird expression (which might have been used as a test for alcoholism before the war) heads an advertisement of the New Process Gear Corpn., a concern which produces noiseless pinions by the hundred gross. The advertisers are considerate enough to give Webster's definition, otherwise there might have been some jaws broken; the explanation is "harsh sounding, or in place of a combination of harsh sounds."

* * * *

The letter reproduced below makes most humorous reading:

41, Kissy-street, Freetown, Sierra Leone,
West Africa, October 31, 1915.

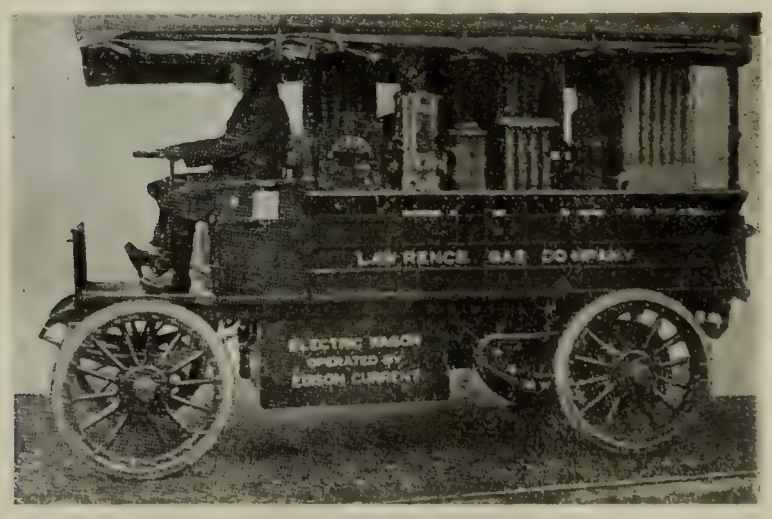
Messrs. the Bastian Heating Synd. (Ltd.),
185, Wardour-street, London, W.

GENTLEMEN: Your reply of Sept. 22 received. Never mind Mr. George Newnes. I have heard from him. I will deal with you direct. From your letter it appears that the pyro-ring and the other heaters are sold separate from the voltage. Your price list to me, then, is misleading, or, perhaps, I am at fault. I am a telegraphist, and know all about these things. I am not keeping voltage nor electrical batteries. Please, therefore, let me know what voltage you recommend for the pyro-ring, and whether heaters are sold apart from voltage, and prices for them.

Thanks re ordinary kettle, &c., but I am in doubt. Has the pyro-ring a voltage attached? If not, state price of voltage, and what voltage do you recommend. Your customers would prefer your recommendation.—Yours faithfully, H. NORMAN.

* * * *

The attached illustration should make some of the gas advertising experts pause. It must be remembered that hundreds of gas works use electric motors for driving scrubbers, elevators, cranes, &c., but the public does not see them and does not know they are there. The Lawrence Gas Company, as the picture shows, are evidently also not afraid to show that they use not "gas," but electric vehicles



An eminent engineer wrote to a well-known locomotive engineer, asking him to recommend a reliable assistant for the Colonies. As a p.s. he added: "For God's sake send no one who wears a wrist watch."

* * * *

Mr. Henry Thornton, the American general manager of the G.E.R., says that "it is a sign of healthy optimism throughout England that there was discussion, not as to whether we shall win the war, but what *we* are going to do with Germany after she is down and out." I have italicised the "we."

* * * *

In our last issue we reported a hearing of the case for the winding up of a certain company. A curious misprint crept into the account of the judge's remarks. "He recommended that the parties lay their heads together and come to some *disagreement*." His lordship must have realised that something of the kind could only result from laying the parties' heads together.



WHERE THE "ELECTRIC" SCORES OFF THE "HAY MOTOR." THE LATTER SITS DOWN ON GREASE.

One of our readers reminds me that an all-electric house has no chimneys, and suggests that they should have been omitted from the sketch reproduced last week, which showed the electrical engineer's house of the future. I think he will find chimneys on future domiciles, none the less. Otherwise what will the storks do with the babies and Santa Claus with the children's toys?

* * * *

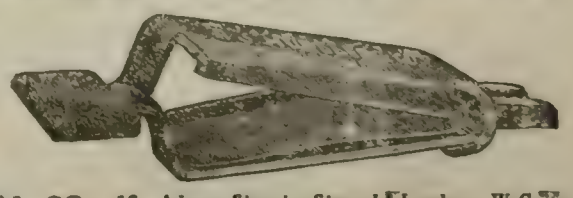
THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), January 25, 1879.]

THE DEVASTATION.—This double-turret ship, at present undergoing a refit at Portsmouth, is ordered by the Admiralty to be provided with the electric light.

ESCAPE OF A BURGLAR BY A LIGHTNING CONDUCTOR.—According to the daily papers, a notorious burglar has just been captured, who two years ago on being chased, ran into a church, and, mounting to the tower, escaped by sliding down the lightning conductor. Perilous as such a freak must appear, it nevertheless points to a necessity of rendering conductors inappropriate for such purposes, for though, perhaps, the ascent may have been a very different task, it is not impossible that a determined thief may gain access to a building by a lightning rod. It may be of sufficient interest to telegraph engineers, when erecting a conductor, to remember that a "path to electricity" has at least once conducted a thief safely out of the reach of his pursuers.

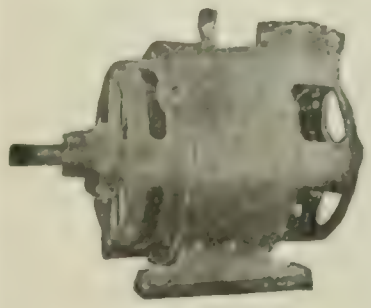
PLATINUM for WAR MATERIAL
supplied by permission of the
MINISTRY of MUNITIONS.
J. BLUNDELL & SONS,
GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Golsilplat, Ox., London." 4746 Gerrard.

The UNIVERSAL TEST CLIP
Time savers in any electrical work requiring quick temporary connections.
Best for every test—in the factory, or repair shop; in the laboratory, or in the field.

THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

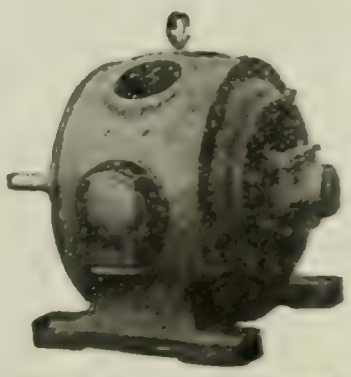
SIEMENS

STANDARD

ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

for

ALL OUTPUTS, SPEEDS AND VOLTAGES.

SIEMENS BROTHERS DYNAMO WORKS LIMITED.
HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Telephone: GERRARD 860. Telegrams "SIEMBRALOS, VIC, LONDON."
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
Telephone: CITY 5350 Telegrams: "SIEMOTOR, CENT., LONDON."
HOME BRANCH ADDRESSES:
BIRMINGHAM—Central Ho., New St | MANCHESTER—196, Deansgate.
BRISTOL—30, Bridge Street | NEWCASTLE—64-68, Collingwood
CARDIFF—89, St. Mary Street | SHEFFIELD—22, High St. [Bldgs.
GLASGOW—66 Waterloo Street | SOUTHAMPTON—46, High Street
Branches in Principal Towns Abroad.

PHOTOGRAPHIC LAMPS.

"The Mazda Lamp in Photography," is the title of Bulletin 26 which has just been issued by the Engineering Department of the National Lamp Works of General Electric Company. This Bulletin presents in simple language such data and information in regard to the Mazda lamp, and its application to the processes of photography as will assist photographers in their work, and acquaint the electrical public with the principles involved. The first part of the Bulletin is devoted to a description of the photographic process and its relation to the Mazda lamp. Particular attention is paid to the special photographic bulb Mazda C lamp, and its application to the lighting of portrait and motion-picture production studios. The use of Mazda lamps for taking interior views, for copying, printing, enlarging, and photomicrography is likewise discussed. Copies of this Bulletin may be obtained from the Engineering Department, National Lamp Works, Nela Park, Cleveland, Ohio.

WILLANS-ODDIE STEAM PUMP.

The Willans Oddie direct acting steam pump is a modern example of the simplex pump, and embodies improvements, based upon the experience of many years with this class of pump. Its general design and manufacture follow well tried and accepted lines of modern pump construction, the essential outstanding feature being the valve gear. It is an economical type of pump, and we understand that no attempt is made either in design, construction or workmanship to rival the cheaper grades on the market. The Willans-Oddie valve gear conforms to the principles underlying the design of all simplex valve gears, but we gather that it possesses hitherto unattainable advantages in simplicity, reliability and economy. Kinematically the gears of all simplex and duplex pumps are identical, the many variations in design met with in actual practice being really only different methods of arranging the following four motions:—

1. A steam slide valve (usually called the auxiliary valve in simplex pumps) operated by means of a lever from the pump rod.

Manufacturers of

PHOSPHOR BRONZE,

GUN METAL, MANGANESE BRONZE,

Brass & Copper

Tubes, Sheets,

Rods, Wire, and

CASTINGS.

PHOSPHOR TIN.

PHOSPHOR COPPER.

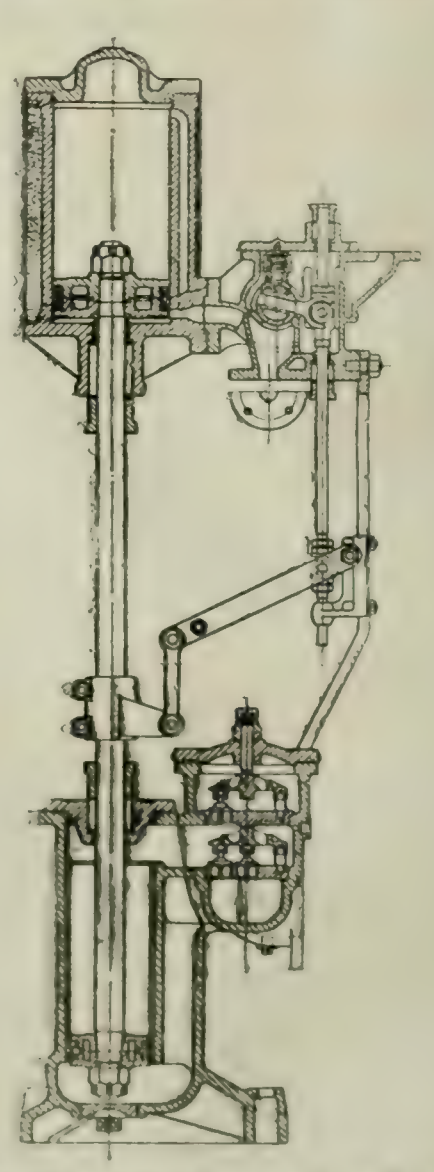


CHARLES CLIFFORD & SON, Ltd.

BIRMINGHAM.

2. A piston moved by the auxiliary valve in the same way that the piston of an engine is moved by the slide valve. This piston is frequently referred to as the shuttle piston in simplex pumps.

3. A second (or main) valve moved mechanically by the piston referred to in 2.



SECTION THROUGH BOILER FEED PUMP.

4. A piston moved by the main valve by reason of the steam distribution. This piston is the pump piston, thus completing the chain.

In a duplex pump the piston in (2) also has a pump attached to it, in which case the auxiliary valve (1) and the main valve (4) both control steam to the pump cylinders. But although kinematically the same, the simplex pump is superior to the duplex pump in that the simplex pump always travels its full stroke, thus working with the

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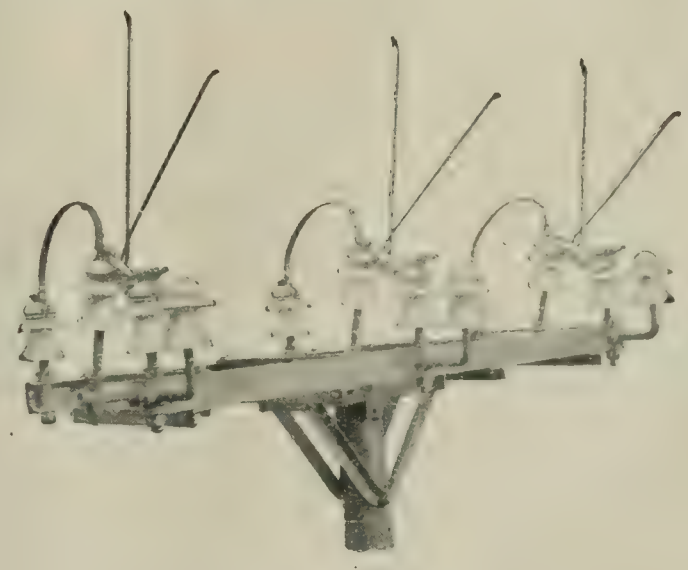
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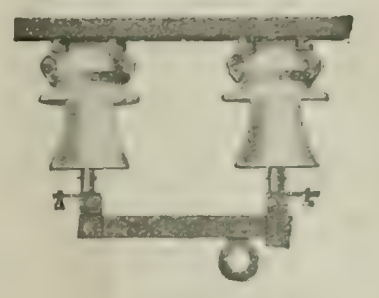
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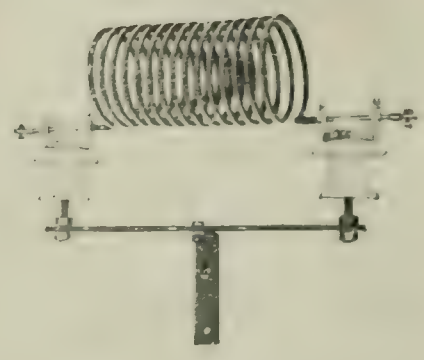
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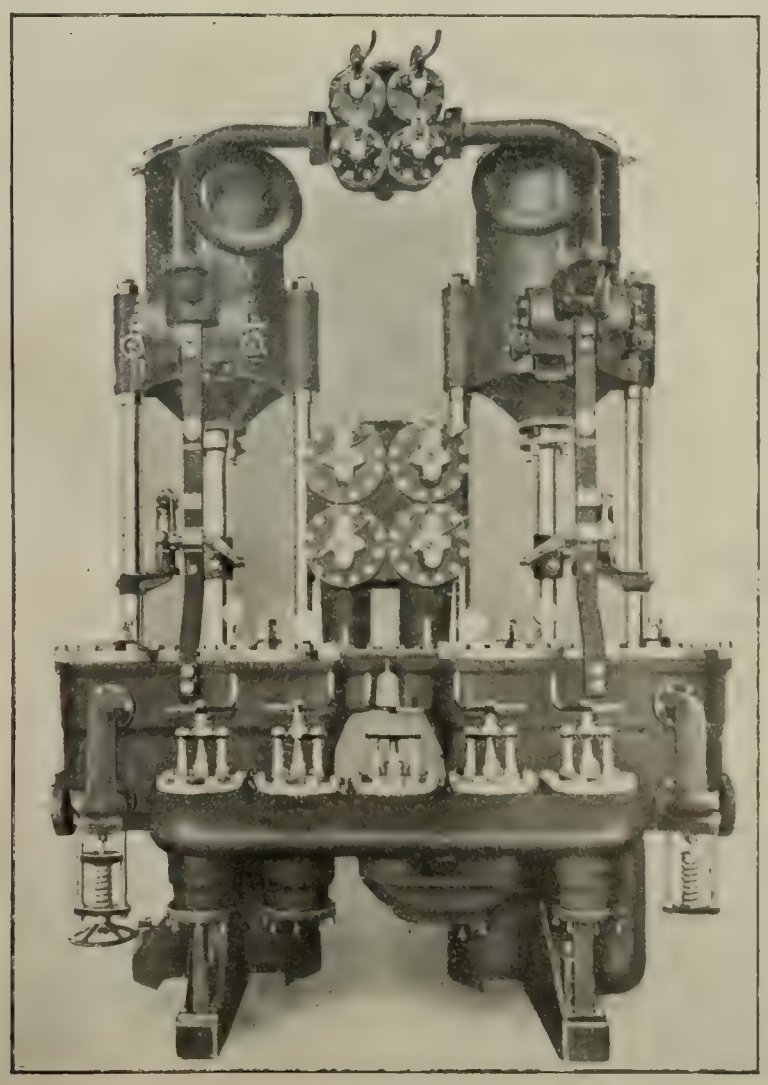


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A PAIR OF BOILER FEED PUMPS. Size: 500×350×800.

minimum number of reversals per minute, while the tendency of the duplex pump to shorten its stroke increases the steam consumption by reason of the excessive clearance. For this reason duplex pumps cannot be used as air pumps, &c., or for any service except where an incompressible fluid fills the pump at each stroke. The simplex pump has only half the number of cylinders, stuffing boxes, joints, &c.

In nearly all simplex pumps the above functions are carried out by separate parts. An auxiliary valve operating the shuttle piston which in some examples forms the main valve, but in others is attached to it. In a few pumps only, as in the Willans-Oddie, are the functions of auxiliary valve, shuttle piston and main valve combined in one single piece. The particular feature of the Willans-Oddie pump resides in the fact that this single combined valve is completely balanced.

The Willans-Oddie valve gear combines all the above functions in one valve. The unbalanced parts of the valve are exposed to exhaust steam only, and the valve thus becomes truly balanced. For reversal the movement of the valve itself admits full pressure steam to one end of the valve while it places the other end in communication with the exhaust; the action being quite positive, the valve cannot stick. The valve is being moved in a rotary direction by the pump at the moment of reversal, and the steam has only to change the direction of motion and not to start the valve from rest, nor overcome unnecessary "stiction." The steam is slowly admitted to start the pump from rest after reversal, and full advantage is taken of the expansive force of the steam to bring the moving parts to rest and complete the stroke. The steam distribution permits the pump stroke to begin and end slowly, thus enabling the valves to lift and return to their seats without shock.

It is generally admitted that the direct-acting pump is the best pump, superior for boiler feeding. It has proved itself capable of meeting all the exacting and arduous conditions due to this service. It gives an even and continuous feed, maintaining a constant water level. It deals with heavy or light loads with equal certainty and reliability. It feeds hot or cold water without readjustment or resetting. It accommodates itself in speed to meet the most

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difficult conditions of pipe lines, allowing the mass of water to be slowly accelerated and slowly brought to rest and permitting the valves to quietly re-seat. We understand that no other type of pump fulfils all the requirements of successful boiler feeding except the simplex direct acting steam pump.

The Willans-Oddie standard pumps have cast iron water ends, fitted with hard gunmetal liners; the valve chest is cast in one piece with the pump cylinder, and is fitted with valves of the group type cut from the solid bronze bar. Pumps can be made with all gunmetal water ends and can also be provided with separate valve chests bolted to the pump body.

For all feed from condensers automatic float control gear should be fitted. By this means the feed to the boilers is delivered at the rate of evaporation, keeping the water level constant without special attention. In addition to this a steady feed promotes easy steaming.

Standard sizes of automatic float tanks are arranged to suit all sizes of feed pumps. The tank is of cast iron, fitted with an open top float having double levers and counter-weight. The discharge water from the air pump or feed heater flows into the float and keeps it filled. The tank is normally half full, and any movement of the float due to alteration in the water level in the tank opens or closes the throttle valve supplying steam to the pump, thus automatically regulating the speed of the pump to the required capacity of the plant.

The above details are abstracted from a new pamphlet just issued by Willans & Robinson, Rugby. From a copy of this many further interesting details can be obtained.

FUME REMOVAL IN DOPING ROOMS.

Now that the aeroplane industry has developed so largely, and a great number of new manufacturers are making the planes for these machines, the question of removing the noxious fumes from the rooms in which the planes are being doped is of some importance. Unless properly ventilated the fumes may prove harmful to the workmen. It is essential that a system should be adopted which will ensure that these fumes are immediately extracted away and fresh air supplied to the rooms. Three systems devised by the Ventilating Engineering Department of the Crypto Electric Co. (Ltd.), of 67, Queen Victoria street, London, E.C., to meet different conditions are of interest.

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A diagram of an efficient system is shown in Fig. A. In this system the fumes are extracted at a uniform velocity from all parts and carried up for discharge above the roof. A centrifugal fan

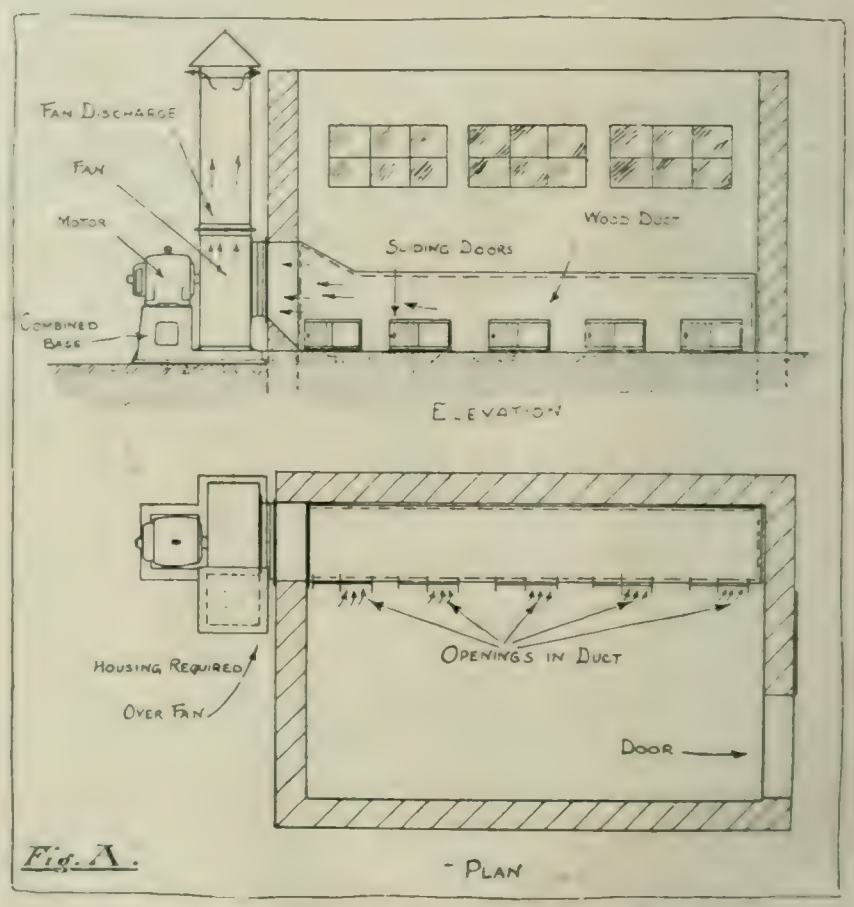
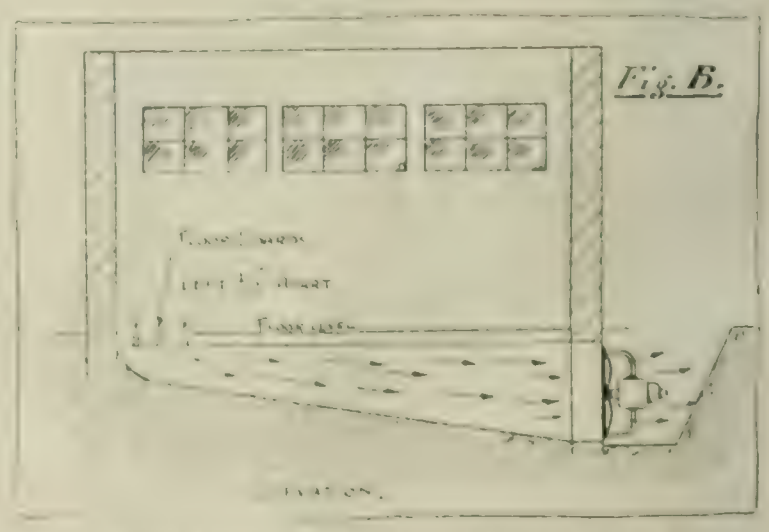


Fig. A.

Room Ventilation through Sliding Doors.

direct-coupled to a "Witton" motor is used. On the intake side is a duct fixed the full length of the shop, having openings with adjustable sliding doors at the floor levels and on the discharge side is a duct at the side of the building, taken to a point just above the roof,



Room Ventilation through Floor Boards.

and fitted with a cowl suitably designed to ensure the fumes being discharged upwards and efficiently dispersed. If the dope shop is a building by itself the duct can be erected in any convenient position at the side or in the middle of the building. In those cases where

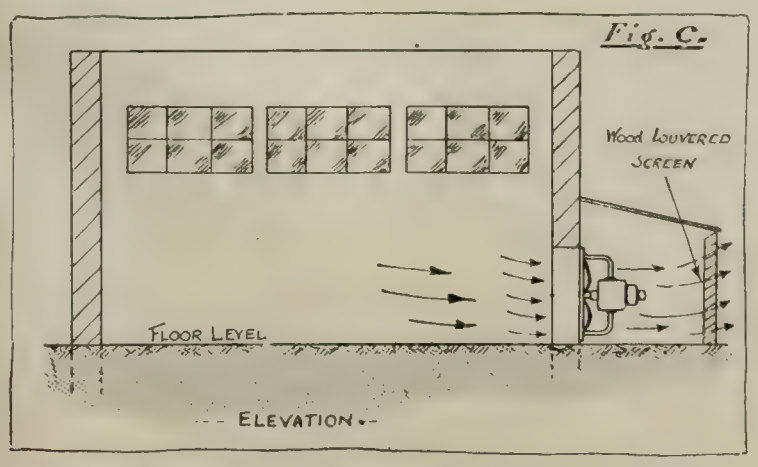
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to ask the "ELASTA LAMP" people for prices and discounts. Every day you delay you are losing money, because "ELASTA LAMPS" mean substantial profits to you. Send that enquiry along to-day and you will be a satisfied man to-morrow.

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the dope shop happens to form part of a large area of workshops the duct can be arranged so as to carry the fumes to a convenient position for fixing the fan and discharge arrangements. By means of the sliding doors it is possible to regulate the area of the openings to obtain uniform extraction at all points, as naturally the opening furthest from the suction would have to be of the largest area. In selecting a suitable fan there are several points to be considered. First, the exact cubic contents of the shop must be ascertained. Secondly, the length and size of intake duct which would be most convenient must be decided upon, taking into account the fact that the larger the area allowed the smaller will be the fan required.



Room Ventilation through Large Fan Outlet.

Thirdly, the length and size of the discharge duct. It is recommended that a great number of changes should be allowed even to the extent of 60 times per hour. It is possible to fit a speed regulator to the motor, so that the output of the fan can be varied according to circumstances. When fixing it should be arranged that the motor is not subjected to the fumes, and, alternatively, it must be fume and flame proof. Suitable protection from the weather should be provided for the fan and motor. The supply of fresh air is just as important as the exhausting of the fumes and fresh air. Inlets of liberal area should be provided, preferably in the wall furthest away from the ducts when fitted on one side or on both parallel sides when the duct runs down the centre.

Fig. B is a diagrammatic sketch of a system using a special propeller blade exhaust fan as supplied by the G.E.C. with fume and flame proof motor. To cope with the fumes and obtain a fairly even velocity over the floor, a tapered cellar is provided with the floor boards left ½ in. apart. The fumes are then drawn down through the spaces, and owing to the tapering are drawn at practically equal rates from both ends of the room. It is preferable to have small fans of high speed, rather than large fans of low speed, so that the fumes are discharged and dispersed at a higher velocity.

Where it is not possible to arrange the fans in this way they can be fitted as Fig. C on the floor level, and in order to avoid dead corners it is advisable to employ two or more fans according to the width of the room. It is, of course, equally important in these cases, as in that of Fig. A, to make ample provision for fresh air. These two systems are, of course, cheaper in both initial and running cost than the system as Fig. A, but can only be employed when the resistance to the flow of air is low. In arriving at the fixing position for the fans in Figs. B and C, due consideration must be given to the direction of prevailing winds; in fact, it is advisable to erect on the discharge side louvre ventilators to neutralise the effect of strong winds blowing on the fans and causing back draughts.

TUNGSTEN TARGETS FOR X-RAY TUBES.

Until recently the anodes of most X-ray tubes have been made of platinum or iridium, but the high cost of these metals has made it impracticable to employ such massive blocks as are technically desirable. The great increase in the demand for X-ray equipment during the last few years—quite apart from the entirely abnormal demand for army medical purposes—has made the whole problem of target construction of considerable importance. Careful investigation has shown that tungsten targets are quite satisfactory if suitably prepared, and, as compared with platinum or iridium targets, they have the advantage of being much less expensive. The metal tungsten has a large atomic weight combined with a high

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melting point, which enables it to resist the intense heat of the cathode ray bombardment. At the same time, its relatively low cost permits a more substantial block of metal to be employed than is commercially possible where platinum or iridium is used.

The practicability of building tungsten targets suitable for X ray



View of Tungsten Cathode.

work depends essentially on the preliminary production of ductile tungsten. This problem has been solved satisfactorily in connection with electric lamp manufacture, and it is interesting to note that the British Thomson Houston Co. (Ltd.), 77, Upper Thames street, London, E.C., is now prepared to supply from stock to X-ray tube manufacturers tungsten targets manufactured in accordance with their patents. The target itself consists of a block of ductile tungsten brazed into a copper block or cup, and providing a smooth tungsten surface upon which the cathode discharge impinges. The whole is ready for immediate mounting in the tube, and undoubtedly constitutes a further important advance in electromedical manufacture.

MAZDA LAMP PROGRESS.

We hear that production has been so much increased in the B.T.-H. Lamp Works at Rugby that new plant has trespassed on the normal storage space, leaving insufficient room to accommodate the stock held to meet all contingencies. The B.T.-H. Co. had, therefore, to arrange for more storage capacity, and took over the well-known



The Exterior View of the New Mazda Lamp Store.

Rugby Skating Rink. We give an illustration showing the exterior of the rink. The annexe itself is already crowded, and a second floor has to be built immediately to facilitate working in the building and add to its capacity. At the same time the existing medley of lighting devices will be replaced by high efficiency units on the well-known B.T.-H. principle. The Mazda lamps, as fast as they are made in the works, are packed on to an electric vehicle, which performs a number of daily journeys between the works, the new store and the railway station, which is quite near the factory and the stores.

France.—*Proposed Patent Legislation.*—A Bill was recently passed by the Chamber of Deputies (Government Bill No. 1388) to give power to the Ministers of War and Marine to exploit, in State or private factories, inventions of interest to the army and navy, which are patented or deposited for patent.

A clause has now been inserted stipulating that the Minister of Commerce will, in cases where the publication of patent rights would present inconvenience or danger to the State, dispense with such publication. Patents will not be allowed to be deposited abroad, either by French subjects or foreigners domiciled in France, if referring to inventions of interest to the navy or navigation, aviation, aerostation, armaments, artillery, telegraphy, explosives, gunpowder or military engineering.

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Printed and Published at the Electrician Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of London, Friday, January 28, 1916.

THE ROUND TABLE.

By "KVA."

BON MOT OF THE WEEK.—"We have magnificent traditions, and we have still the finest engineering stock in the world. Let us make use of it, and not crab it by constant depreciation. Aggressive self-confidence makes for success, and, after all, it is not much more disagreeable than aggressive pessimism." Mr. L. Pendred in the "Daily Chronicle."

* * * *

Newspaper accounts state that an elephant is in use as a tractor in the Sheffield district. Why not an electric battery vehicle? Mr. Fedden must surely regard this as a challenge to his trunk main!

* * * *

"Point Five" writes: Having become the possessor of a Mazda rotating lamp shade, I am now in a quandary as to whether in connecting it on the power circuit I am liable to prosecution by the local supply undertaking. Please say.

* * * *

I hear that the Batti-Wallah Society has decided to hold an "Informal" Meeting on the evening of Friday, February 25. The "Battis" have not foregathered for many moons, and doubtless this opportunity will be taken to defy the Zepps and spend a pleasant time. We want cheering up.

* * * *

Our American cousins do take the biscuit for bluff in business. I hear of a firm in the Eastern States who advertise largely and who at one time put out a bold announcement of lighting "plants" for yachts, motor boats, &c. An inquiry came from Eastern Europe and the prospective buyer was surprised to receive a leaflet containing details of port and starboard fittings with lamps supplied from *dry batteries*. Some plant that!

* * * *



The illustration is a good example of modern illumination (Wotan-Benjamin units) in a factory devoted to the making of tin boxes. They look like something else, but they are not.

According to the "Canadian Electrical News": "A slogan is a terse, yet complete expression of the goodness, excellence or opportunity-giving qualities of a community." If that is really so, then Heaven defend us from such things.

* * * *

Our tame artist has endeavoured to give an impression of the effect of a bursting gauge glass upon the accountant of a certain electricity works who had attested under Lord Derby's



scheme. He had come into the boiler house to accustom himself to sounds resembling shell fire. He got them!

* * * *

I read in a transatlantic contemporary that "'dead' towns are lightless, signless towns, poor places to live in. 'Live' towns are always judged by their after-dark brilliancy—their power to attract people from neighbouring, unlighted, unprogressive towns. 'Live' towns get the lion's share of the buyer's money—at the expense of dead towns." Which, being so, there is not a town in Western Europe that is not only dead but damned!

* * * *

One of the unrecorded short-circuit incidents is that of the driver of a steam roller which was doing some repairs in a large yard. While manœuvring over an awkward stretch of ground he butted with the front roller a group of four 1 sq. in. joint boxes, main L.T. feeders backed by a 3,000 kw. plant. A huge hole was melted in the rollers and the effect of this and the flash on the driver was immediate. It is said that he left hurriedly without drawing his wages.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), February 1, 1879.]

A CURIOUS THERMO-MAGNETIC MOTOR.—Profs. Houston and Thomson contribute a note on this subject in the "Journal" of the Franklin Institute. During investigations on the increase in the coercitive force of steel by changes of temperature, they devised a thermo-magnetic motor, which, however, they state to be only of scientific interest. A disc or ring of thin steel is mounted on an axis. The edges of the wheel are placed opposite the poles of a horseshoe magnet, and the wheel is thus magnetised by induction. The singular phenomena is that any section, say, midway between the N and S poles, being sufficiently heated, the disc revolves in the direction from S pole to N pole. The heated section, say the authors, has its coercitive force increased, and being less acted upon by the S pole than the section immediately adjacent, motion in the direction previously indicated takes place. To ensure success the disc must be sufficiently thin as to prevent its acquiring a uniform temperature. The same effect takes place if the source of heat is applied to diametrically opposite portions of the disc. The amount of heat expended is enormous when compared with the force developed, so that no practical result is expected to arise from this discovery.



No. 29-1.—Self-Acting Starter for D.C. Motors up to 15 H.P., on voltages up to 500. The starting resistance is cut out by a succession of contacting fingers which make circuit on to solid copper butt contacts, the extremely simple construction & operation making this starter entirely reliable and satisfactory on any automatic service.

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No. 30-1.—Self-Acting Starter, having in addition to the Rheostat a Magnetically Operated Main Circuit Breaker, fitted with Magnetic Blowout, this being interlocked with the starter so that the main current is never made or broken on the starter contacts. Suitable for most forms of remote or automatic control.



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ELECTRIC MOTORS



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ELECTRICITY IN THE PAPER MILL.

There is hardly a modern paper mill in the country in which electric power is not employed for one purpose or another. There is certainly no mill in which electricity could not be adopted with advantage. The question of lighting is of little concern, for the use of electricity for this purpose is, in most cases, a foregone conclusion. Its employment for driving the many machines, ranging from the large breakers, beaters and refiners down to the smallest cutters that comprise the equipment in a paper works is, however, of industrial importance.

In the great majority of cases electricity could, no doubt, be adopted advantageously, but there may be mills in which its benefits would not be so apparent. Every mill must be individually studied. So far as the smaller machines are concerned, electricity has no rival at the present time. With electricity the motor can be placed on a bracket overhead or bolted direct to the ceiling; it can be placed alongside, or it can be accommodated in a pit underneath. There is no waste of valuable floor space that can be used to better advantage in the production of material; the speed can be controlled at will, and energy is only absorbed in direct proportion to the work done.

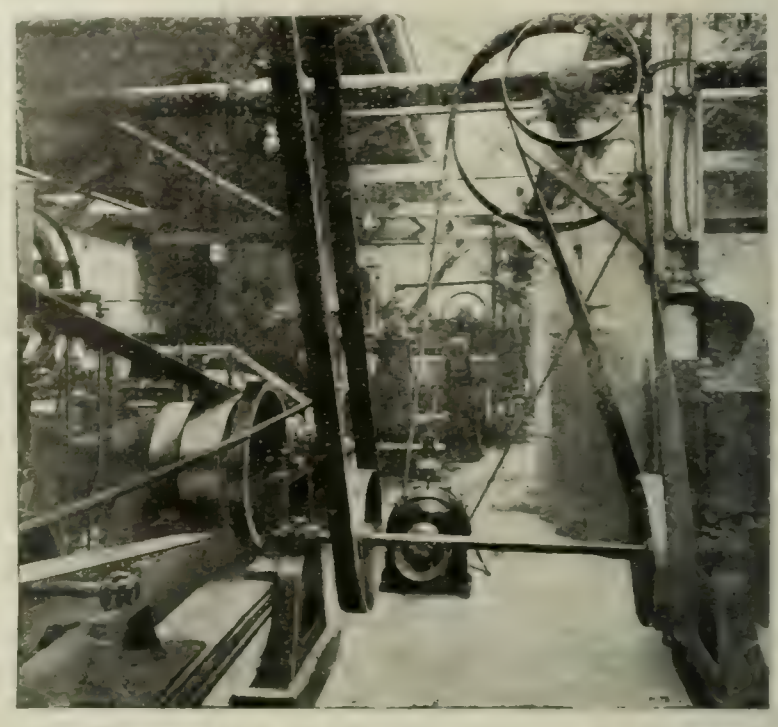


FIG. 2. BREAKER IN PAPER MILL, BELT DRIVEN BY A 50 H.P. PIPE-VENTILATED MOTOR.

As to the source of the power, many mill owners prefer to generate their own supply, others find it more convenient and economical to take a supply from a public undertaking.

These remarks will serve to introduce a new catalogue from Messrs. Mather & Platt (Ltd.), Manchester, which appeals to the paper-making industry directly, and is also of considerable general interest. The firm has for many years built machinery for the textile and paper trades and has also specialised in the electrical equipment of many mills and factories.

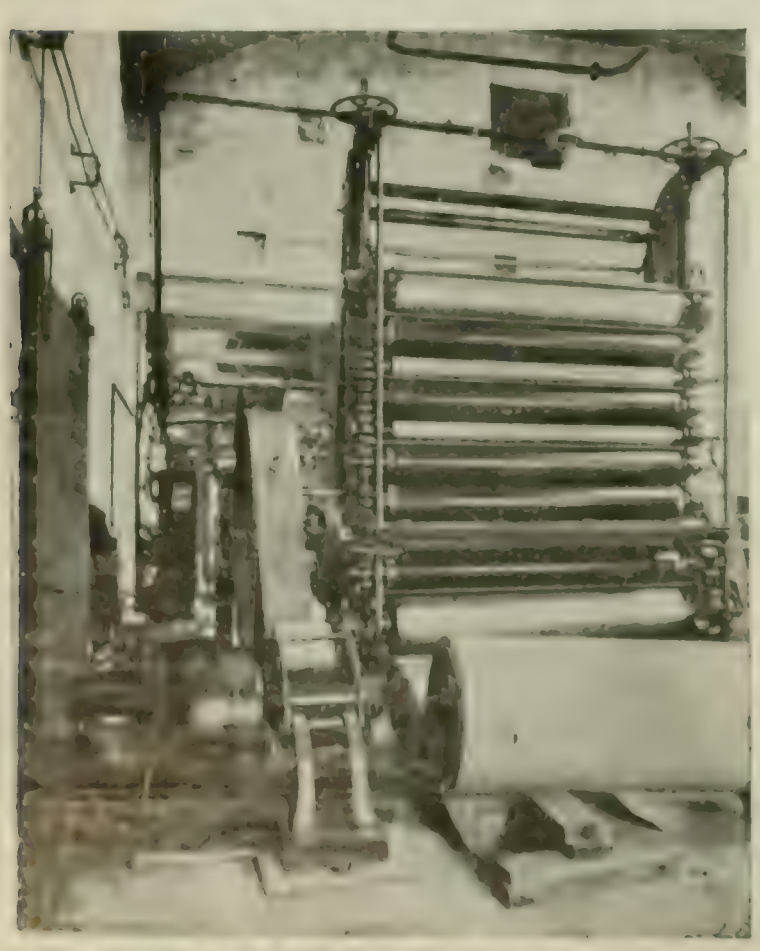


FIG. 1.—100 H.P. P" TYPE SIEMENS, DRIVEN BY A 10 ROWT SPEED GEARED

Any speed between 30 ft. and 300 ft. per minute can be obtained with the special method of speed control by the movement of a small hand wheel.



FIG. 3.—22 H.P. P" TYPE MOTOR, DRIVING WET END OF "M.G." PAPER MAKING MACHINE.

This motor runs continuously from Sunday midnight to Saturday afternoon.

The catalogue deals not with paper making machinery itself, for the firm does not produce this class of plant, but with auxiliary machinery that is of equal importance in paper mills. Several pages are devoted to the question of water supply, a most important consideration. Turbine and reciprocating pumps for boiler feed, water

LEAD MELTING FURNACES
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WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
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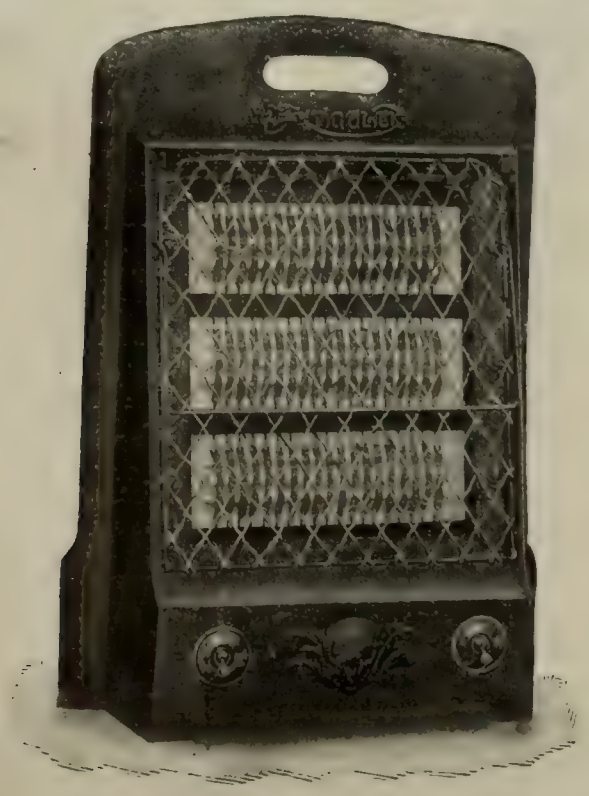
supply, fire protection and the pumping of paper pulp are illustrated and described. A section is concerned with the "Grinnell Sprinkler" system of fire protection, while special machines for calendering and others for coating photographic papers and cards form the subject matter of several pages.

Turning to the purely electrical matter in the catalogue, many illustrations are given of motors that have been supplied to paper mills throughout the country. More than one installation has been in operation for upwards of 12 years, the machines employed being of the Mather & Platt variable-speed d.c. type. An interesting application is shown in Fig. 1, which illustrates a 100 H.P. "P" type motor-driven booster coupled to a 10-bowl super calender. This arrangement permits of minute variations of speed at any intervals, over wide range, without loss through the employment of resistances. Fig. 2 illustrates a 50 H.P. pipe-ventilated motor, belt connected to a breaker in a large paper mill, while Fig. 3 is of interest as showing the reliability of the Mather & Platt motor design. The machine is of the firm's d.c. "P" type, and drives the wet end of an "M.G." paper-making machine which is continuously in operation from Sunday midnight to Saturday afternoon. Among the largest paper mill installations for which Mather & Platt have been responsible may be mentioned that at the works of the Culter Mills Paper Co., Peterculter, Aberdeen, where upwards of 30 motors, mostly of the pipe-ventilated pattern, with an aggregate capacity of 500 H.P., have been installed. The Darwen Paper Mill Co. uses a d.c. 200 kw. Mather & Platt generator, and Messrs. Chas. Marsden & Co. (Ltd.), Barnsley, employ a rope-driven 350 kw. generator and a smaller set with an output of 85 kw. The motor equipment includes one of 100 H.P. and about 30 others with a combined horse-power of something like 550. At the East Lancashire Paper Mill, Radcliffe, also, 30 similar motors are running, totalling over 500 H.P., and taking current from three generators with an output of about 550 kw. These examples serve to indicate the possibilities of electric drive for paper mills, and the extent to which Messrs. Mather & Platt have laid themselves out to provide the most suitable electrical equipment.

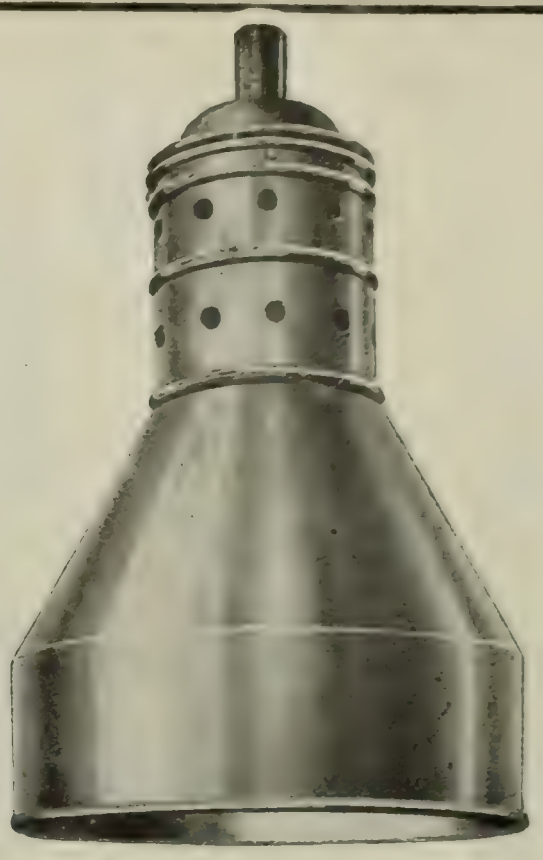
Station engineers, consultants and others whose duties bring them into touch with the paper industry should obtain a copy of this informative publication.

"ANGELUS" ELECTRIC FIRE.

Particulars of a new pattern of electric fire are being issued to the trade by Messrs. Strode & Co., St. Paul's-churchyard, London, E.C. The fire itself, which is shown in the adjoining illustration, is fitted with fireclay bars, across which are wound vertical spiral nickel



ANGELUS FIRE WITH GUARD RAISED.



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Anti-Zeppelin Reflectors

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For the general lighting of large factories these reflectors are unequalled.

THE

Reflectors

are made in two types Extensive & Intensive

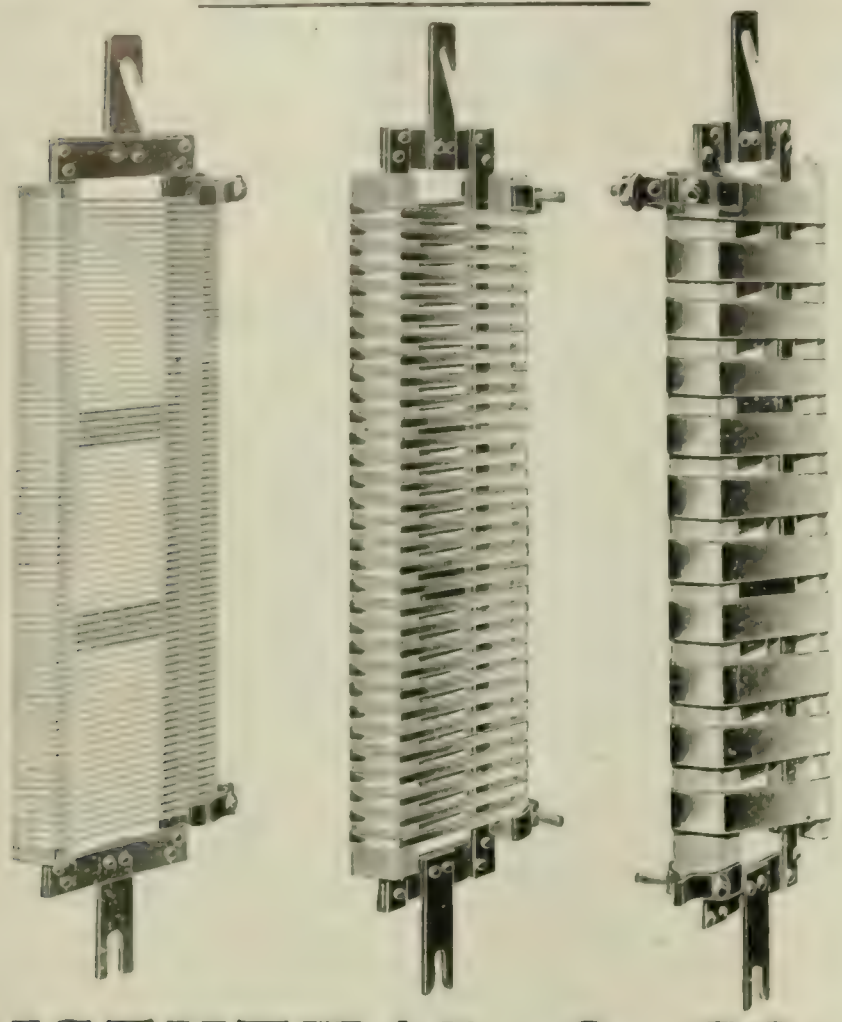
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MANCHESTER—
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GLASGOW—
72a, Waterloo Street.
BRISTOL—
11, Denmark Street.
NEWCASTLE—
61-65, High Bridge.
LEEDS—
6, White Horse Street.
LIVERPOOL—
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Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, &c.

chromium heating elements. Each of these bars has a load of 1 kw. They are mounted in a horizontal position and are screened from direct contact by a coppered wire guard. This guard is one of the most interesting features of the fire, which is so designed that it can be released from its position at the top of the fire and drawn down, when it can be given a horizontal position a few inches above the floor level, and rigidly supported so as to act as a shelf upon which plates or food can be kept warm in front of the heating elements. A close examination of the illustration will show how the guard is constructed to carry out this interesting function.

At the back of the fire body there is also a coppered wire frame which can be drawn up and pulled out into a horizontal position, in which it furnishes a means of support for articles of clothing which require airing or drying.

The complete fire measures 20 in. high by 15 in. wide by 5 in. deep, and weighs 18 lb. The elements are controlled by two tumbler switches which are sunk into the front portion of the fire body. These two switches turn on two of the bars, and the third bar is put into circuit when the plug is placed in the connecting socket. The frame is of high-grade cast iron, and is finished in art black or golden brown porcelain enamel. We understand that the company is able to supply these fires for all standard voltages.

CONTROL EQUIPMENTS FOR MACHINE TOOLS.

It has long been recognised by manufacturers and users that to operate a machine tool at its highest efficiency there should be possible a wide variation in speed in each individual tool. When tools are driven from long lines of shafting this is not economically possible, but when tools are individually driven by electric motors they may be operated at any speeds independent of any other tool in the works. To obtain the maximum efficiency, therefore, it is not only necessary to adopt individual motor drive for the machine tool but the control of the driving motor must be simple, free from complications, and enable the operator to obtain the maximum output with the minimum risk.

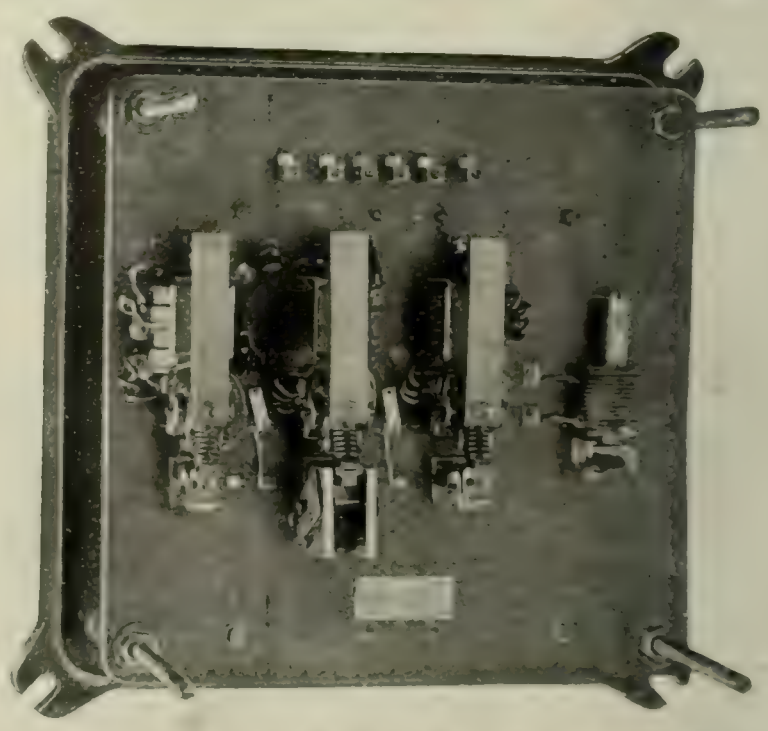
The motor control should be entirely automatic, requiring no attention from the operator beyond pressing the control button or throwing over the control arm and enabling him to devote his whole attention to the work in hand. The automatic control should ensure that the motor starts, reverses or stops in the shortest safe time when required, and that it is protected against excessive overloads at all times.

The following control equipments have been developed to meet the foregoing requirements. They are fully automatic, require no attention from the operator except for him to press the control button or throw the control lever to the forward "reverse" or "off" position.

The equipments are classified under four headings, as follows :—

(*a*) Non-reversing control without dynamic braking.
(*b*) Reversing control without dynamic braking.
(*c*) Non-reversing control with dynamic braking.
(*d*) Reversing control with dynamic braking.

The apparatus comprising the complete equipment is determined to an extent by the conditions of service, but all equipments have a common feature in the accelerating unit, which is an automatic



Accelerating Unit for Machine Tool Control with Cover Removed.

device giving full protection to the motor, and ensuring that the machine starts or stops in the shortest safe time. All these equipments are for constant speed machines, but they can be used for variable-speed machines in conjunction with a field rheostat and a relay. Standard equipments are designed for capacities up to 10 H.P. and for voltages up to 550. Non-reversing control equipments without dynamic braking can also be supplied up to 15 H.P. at 200-250 volts, and up to 25 H.P. at 400-550 volts.

Operation.—When the control switch is closed current flows through the motor armature, which is then in series with the full starting resistance and the first coil of the series contactor or accelerator, and the motor starts up slowly. As the speed increases, the current taken from the line decreases, and when it reaches the value for which the accelerator is set the first contactor closes and cuts out a section of the starting resistance. This results in a fresh current increment, and the operation is repeated by each contactor until the whole of the starting resistance is cut out and the motor is connected to the line. The accelerator is designed so that each section of the resistance is cut out in the shortest safe time while the motor current is kept within safe limits. Each contactor switch is automatically locked

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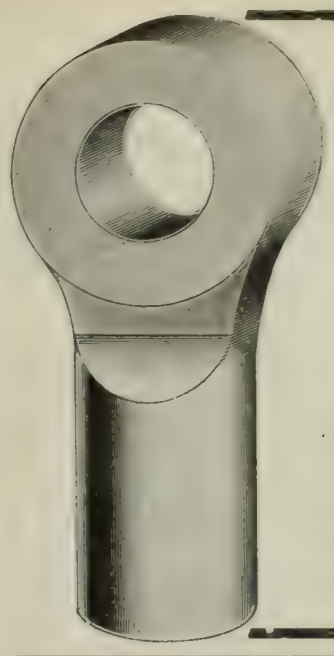
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open so long as the current flowing through its coil exceeds the value for which it is set. The motor is thus protected against excess current at each step of the accelerator. On moving the control switch to the "off" position the motor is disconnected from the line and consequently comes to rest.

Where a quick step is required this is accomplished by means of a controller arranged for dynamic braking. When the handle of this controller is moved to the "braking" position the connections



Main Controller for Machine Tool Equipment.

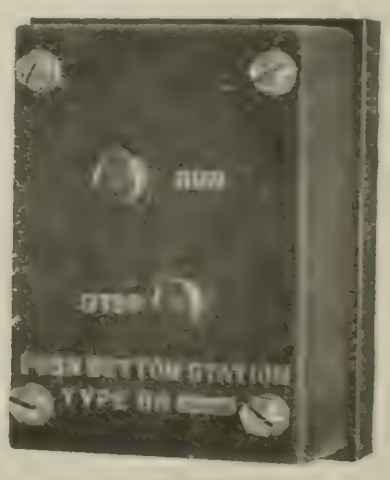
are changed so that all the starting resistance is connected in series with the motor armature. The motor is then quickly brought to rest by dynamic braking, the contactor switches in this case acting as a retarding device and cutting out the resistance step by step as the speed of the motor decreases.

Accelerators.—The accelerating unit consists of a number of series contactors, or electrically operated switches, mounted on a slate base, behind which the starting resistance is mounted, the whole unit being totally enclosed in an iron box suitable for attaching to a wall. Each contactor when closed short-circuits a section of the starting resistance, so that when all the contactors are closed the motor is connected direct to the line. The special feature of these contactors is that they remain open if the current passing through the series operating coil exceeds a predetermined value, and close immediately the current decreases to that value. The first contactor coil is connected in series with the starting resistance, so that on closing the control switch the current passes through this contactor coil. As the motor accelerates, the current decreases until it reaches the predetermined value at which the contactor is set to operate. The first contactor switch immediately closes and short-circuits the first section of the starting resistance, at the same time completing the circuit through the second contactor coil. This short-circuiting of the starting resistance causes an instantaneous current increase which locks the second contactor in the open position until the current again decreases to the predetermined value due to the speeding up of the motor. Each section of the starting resistance is short-circuited in a similar manner.

The whole device is extremely simple, due to the fact that the coil used for closing the contactor is also used to hold it open until the current has decreased to a safe value. The coil, being a series coil, is wound with wire or strip of ample section so that it is not likely to be damaged by the instantaneous current rushes.

Controllers.—The controllers supplied for these equipments are three-way switches built in the form of drum type controllers and are supplied for reversing or non-reversing. The controllers supplied for non-reversing control equipments, as well as those for reversing control equipments, are fitted with crank handles which can be moved to any of three stops. In the case of the former for forward running or for braking positions, and in the case of reversing controllers with dynamic braking, these stops correspond to forward running, braking and reverse running positions. For those without dynamic braking, the stops correspond to forward running, off and reverse running positions. Controllers are fitted with magnetic blow-out coils, and are suitable for breaking the main current. The main switch fuse is of the double-pole quick-break type enclosed in a cast-iron case.





Main Switch Fuse and Push Button Switch for Machine Tool Control.

Push-button Control.—Equipments without dynamic braking can be supplied with push-button control, in which case the connections are specially arranged, so that the results obtained on pressing any one button is maintained after releasing the button, and continues until a separate button is pressed. The construction of this control switch is shown in the illustration. The contacts are mounted on a slate base and enclosed by a metal case through which the push buttons project.

Speed Regulation.—When variable-speed control is required, the foregoing equipments must be supplemented by a hand-operated field rheostat and a field relay to prevent the motor being started with a weak field. The relay supplied for this extra equipment

BRITISH MADE.



HOLOPHANE. Ltd., 12, Carteret St., London. S.W.

permits the motor to be stopped and then started again without the risk of starting on a weak field, and without the operator having to pay attention to the position of the rheostat handle. Thus when the field rheostat has been set for a certain cutting speed the motor will automatically run up to that cutting speed when re-started after a stoppage.

The control equipment described above is supplied by the British Thomson-Houston Co. (Ltd.), of Rugby, and is we understand, giving satisfactory service, not only in their own but in many other works throughout the world.

AIR REGULATING DEVICE FOR DIESEL ENGINE COMPRESSORS.

The working of a Diesel engine is improved if the pressure of the air which blows the fuel into the cylinders is regulated according to the quantity of fuel to be blown in, or according to the load on the engine, as the quantity of fuel used varies with the load. The present practice is for this regulation to be effected by hand, but the objection to this is that it demands considerable attention. Automatic devices to effect this control have been tried, but we understand without practical success. The principal cause of failure in previous devices has been that they did not provide for variation in the working efficiency of the compressor. In an arrangement introduced by Mirrlees, Bickerton & Day this difficulty has been overcome, and a practical apparatus has been developed, as will be seen from the following description.

The apparatus is made in two types, viz., the electrical control type and the mechanical control type. In a pamphlet just issued by the company the electrical control type alone is dealt with. In Fig. 1 the current from the dynamo is passed round the coil *(a)* in such a way that this controls the finger *(b)* as the finger of an ammeter is controlled. The finger is arranged to move round the scale of a [illegible] and point to that blast pressure which is best for the engine for the amount of power being generated at the moment. The pressure gauge finger is connected up with the blast pipe, consequently its finger *(c)* points to the blast pressure. Both fingers are provided with contact pieces *(d)* and *(e)*, shown in detail in Fig. 2. The two fingers are insulated from each other, but are connected up with a source of electricity. The amount of current used is small; therefore the fingers can, if necessary, be connected to a battery. The supply is also connected with the solenoid *(g)* in which the plunger *(h)* works. This plunger is connected with the stem of the air compressor throttle valve *(j)*. Normally this throttle valve

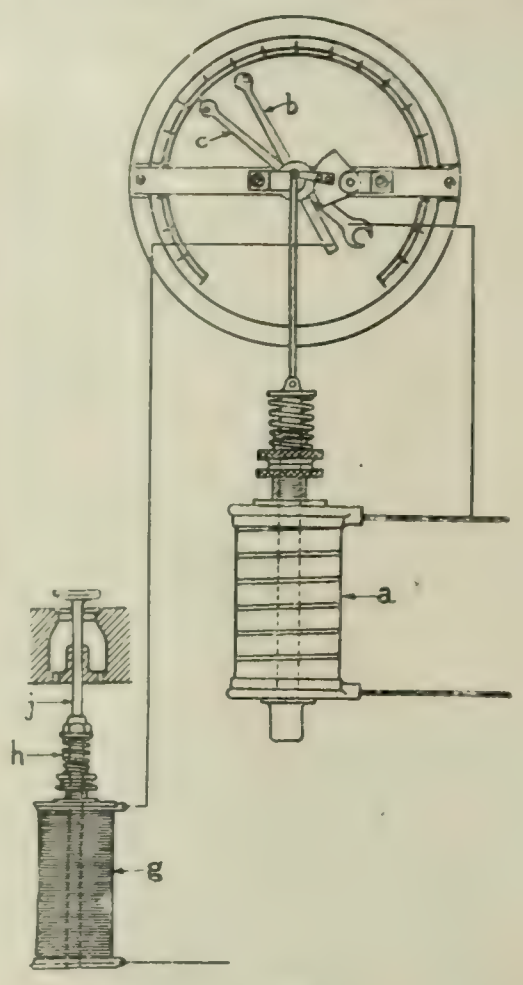


Fig 1

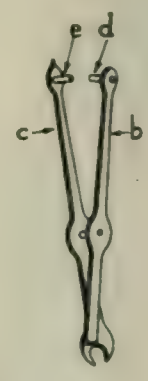


Fig 2

would be wide open and admit a full supply of air to the air compressor, in which case the pressure in the blast receiver would with any load on the engine rise rapidly, as the air compressors are always made with a substantial margin of capacity.

If now that the engine is at work and the pressure in the air



Fig. 3. View of Complete Air Regulator.

receiver is lower than that indicated by the finger *(b)* as being the proper pressure for the load, the air compressor would pump at its full capacity into the receiver and rapidly increase the pressure, so causing the finger *(c)* to overtake the finger *(b)* and make contact between the contact points *(d)* and *(e)*. When this occurs, current

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will flow through the solenoid (*g*), and the plunger will be drawn downwards into the solenoid, thus closing the throttle valve, and this valve will be held closed whilst the two fingers remain in contact. As soon as the pressure drops a little and the gauge finger (*c*) falls away from contact with the finger (*b*), then the circuit will be broken and the throttle valve will re-open. In this manner the pressure in the air receiver will be automatically regulated in accordance with the load on the engine.

The following advantages are claimed for the apparatus: The control of the blast pressure according to the load on the engine undoubtedly is beneficial for the engine, and results in smoother and better running. Automatic control considerably reduces the amount of attention required from the man in charge of the engine, and will enable him to look after more engines or take over other suitable duties. Where alternators are run in parallel the regulation of the blast pressure is important. With this device the attendant is freed from anxiety, and both putting dynamos into parallel and working them in parallel are facilitated. A small saving in fuel is effected, especially in the case of engines working on variable loads, as in such cases engine attendants commonly adjust the blast pressure to suit the maximum load: consequently the compressors are always working at maximum output. The control of the output from the compressors in accordance with the load on the engine reduces the power absorbed by the compressors, and therefore correspondingly lessens the engine fuel consumption.

The device (Fig 3) is applicable to all makes of Diesel engines, but when sending inquiries for the device to work in connection with other than Mirrlees-Diesel engines, we are asked to state that full information should be given as to the air blast pressures required at different loads; also a drawing should be given of the throttle valve and its casing, and information as to whether the current is continuous or alternating, and of the voltage, periodicity, number of phases and number of amperes at full load.

"LAMLOK" SPECIALITIES.

Messrs. the Edison & Swan Company (Ltd.), Ponders End, Middlesex, have forwarded us copies of their leaflets Nos. A. 3,128 and A. 3,130, dealing with "Lamlok specialities."

One of these is a lamp-locking lamp-holder which can only be unlocked with a key, which would be held by the person responsible for the lighting arrangements. A pin passes through a channel in the lamp-holder, and when locked by turning the key the rounded end of the pin engages with the lamp cap, thus preventing the upward movement of the lamp necessary to release same from the bayonet catch.

List A. 3,130 deals with a lamp-locking ring which can be used with any existing bayonet holder, plain or screwed, or batten holder. Once the lamp is locked it cannot be removed until it is unlocked by special key provided, which is sufficient to control any number of lamps. When the lamp is securely locked a small cap is slipped over boss on ring.

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Sinking Funds and Depreciation of Plant.

The Financial Proposals of the L.C.C. Report on London Electricity Supply and the Annuity or Sinking Fund Theory of Measurement of Depreciation of Plant.

BY P. D. LEAKE, F.C.A.

This booklet contains a short critical analysis of the financial proposals of the L.C.C., which will be useful as a guide to the principles of sound finance in connection with loans incurred for Electric Lighting, Gas, Tramways, Water and other trading undertakings.

It shows in the simplest language the common shortcomings of Municipal Finance, and suggests the nature of the means to be provided—with the aid and co-operation of engineers and accountants—for keeping a close and continuous connection at all times between the existing condition and prospects of each class of plant, and the rate at which the expiring value is being taken out of the yearly revenue receipts.

An interesting illustration is given showing a possible distinction in the method of treatment between long-life and short-life plant, and the nature of the financial provisions necessary in cases where it may be desired to maintain the capital value in the undertaking in addition to repaying the loans out of revenue.

It contains a demonstration in a popular and easily understandable form of the practical objections to the Annuity or Sinking Fund theory of measurement of depreciation of plant. This demonstration, which is quite new, is of particular value to those advising Municipal and Local Authorities, and should be in the hands of all who are interested in the finance of the trading undertakings of public bodies.

PRICE 6d. NET, POST FREE 7d. (5 copies post free for 2/6.)

Printed and Published at "THE ELECTRICIAN" Offices, 1, 2 & 3, Salisbury Court, Fleet Street, London, E.C.

HALF-WATT PROJECTORS FOR THEATRE.

Some tests have recently been completed on Wotan half-watt lamps in the stage projectors and flood lamps at the Kingsway Theatre, London. Previous to these tests the ordinary type of stage arc lamp was employed. The half watt lamp requires a slightly larger projector box to that used for arc lamp work, but when fitted up is quite easy to focus, and is, of course, much steadier and gives a better quality of light for stage purposes.

One of the objections to the use of a filament lamp of the usual type for focus work is the projection of an image of the filament on the object. With the half-watt lamp this effect is practically imperceptible, and a thin frost medium quite diffuses even a small image without appreciably affecting the light. One of the great advantages of the half watt lamp is its regularity. There is no necessity to watch the lamp, as in the case of an arc, and the light never suddenly fails, as it sometimes does even with the most careful arc operator. Naturally there is no objectionable hissing, as with an arc.

A further good feature which the tests revealed is the ease with which effects can be produced with the aid of a dimmer. With a standard Igranic dimmer it was found possible to dispense with the iris screen on the projector box when "opening up" or "fading away" the object. This convenience is undoubtedly a great advance on the older method, since a spot of intense light is thrown on to the object when "opening up" with the iris diaphragm. With the half-watt lamp the smooth and even distribution of light enables a beautiful effect to be obtained.

The lamp relieves the operator of much labour and responsibility, and for this reason is to be preferred to the arc lamp.

The lamp, as far as the tests at the Kingsway Theatre have gone, appears to burn satisfactorily at any angle, even when on during



THE KINGSWAY THEATRE STAGE LIGHTED BY WOTAN HALF-WATT FOCUSSING LAMPS.

practically the whole of the evening. The illustration shows the stage lighted by Wotan half-watt projector lamps. The tests have been carried out by Mr. Siday, the electrician at the theatre.

NEW CATALOGUES.

ANTI-ZEPPELIN REFLECTORS.—Particulars are being circulated by Simplex Conduits of patterns of Anti-Zeppelin reflectors for half-watt and ordinary metal filament lamps. These reflectors are made in two patterns, extensive and intensive. The half-watt reflectors have a tube, screwed $\frac{5}{8}$ in. brass, and are suitable for 100, 150 and 200 watt lamps. If the tube is removed the reflector is suitable for a Goliath holder for 300 watt lamps. The extensive type should be placed a distance apart equal to twice the height above the working plane, and the intensive type about $1\frac{1}{2}$ times this distance. The reflectors for ordinary metal filament lamps are made with $1\frac{1}{8}$ in. hole for attaching to shade carrier holder. These reflectors can be supplied for use with special watertight holder with nipple screwed $\frac{3}{4}$ in. Simplex.

ROBERTSON CARBON LAMPS.—Pamphlet R1951, issued by the General Electric Co., deals with Robertson carbon lamps of standard pattern for high and low voltage, tramcar and traction lamps and plain or candle lamps. Tubular lamps, both with ordinary bayonet caps and of the strip light tubular pattern, are dealt with. The heating lamps include both the vertical and horizontal types. The list is concluded with a page which prices and illustrates battery lamps and Robertson lamps for illuminated signs.

WIRUM LAMPS.—The Brimsdown Lamp Works, Kingsway House, London, W.C., have now issued to the trade a neat pocket price list which describes, prices and illustrates Wirum metal filament lamps of all classes. The pages are separately printed and form loose sheets which are held together in an expandable folder. Further lists will be issued and may be included in this folder from time to time.



Jas. Jaquet, Ltd., Basle.

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CHRONOGRAPH AND STOP WATCHES.

Lists on Application.

Published at the Editorial, Printing and Publishing Offices, 1, 2 & 3, Salisbury Court, Fleet Street, in the City of LONDON, FRIDAY, FEBRUARY 4, 1916.

THE ROUND TABLE.

By "KVA."

The recent campaign in the daily Press advising gas consumers to use gas fires to a greater extent than before has been somewhat nullified by the outcry on the part of a certain halfpenny Jeremiah for the raising of the prices of both gas and electricity in order to restrict their use.

* * * *

A correspondent sends me the following amusing item :—

"A customer sent us the order to repair a motor. We asked if it was for 'munitions.' The answer read : 'It is to blow an organ at a chapel, so you see it is for *saving souls*, which is more important than shell making.' We have told the chapel to be blowed, so all parties are satisfied, including the ministry."

* * * *

In Other People's Views in "The Motor" the subject of static electricity and petrol is discussed. I make the following abstracts :—

Static electricity is a most wonderful thing, and perhaps your correspondent is unaware that it can be readily extracted from the hairs of a cat, and, when a boy, I myself used to bottle it up in Crosse & Blackwell's pickle bottles. One pickle bottleful would make a healthy navvy swear, while six taken at once would be nearly a fatal dose for a person with a weak heart. *I also used to extract this electricity from whisky bottles*, blocks of wax, and resin, &c., and it is quite within the bounds of possibility to fire a motor with it through an ordinary sparking plug. If you disbelieve the above, ask any authority such as Sir Oliver Lodge. Every word is true. Soon I think the sparks may fire the whisky.

* * * *

While on the subject of whisky, I hear that the munition workers, in a famous Scottish city, club together and purchase a number of bottles, and then pawn them, redeeming each bottle as wanted. The reason for this extraordinary action has only just transpired : the members of the clubs are unable to trust any one of their number with so many drams at once.

* * * *

The illustration, which I have taken from an advertisement of a well-known lamp firm, is of interest at the present time.



It will be observed the works are not visible through the lamp bulb. Presumably this opacity is to comply with the new lighting restrictions.

A Twisted Pair.—The result of interfering with the Postmaster-General's plant. The bird had evidently flown against the wires and been flung head-over-tail several times by the momentum of its flight. The wires are the A and B lines of a



subscriber's circuit near Datchet, and are of 40 lb. bronze. We are indebted to Mr. J. H. Thow, Reading, for the photograph of this most remarkable "fault."—P.O. Elec. Eng. "Journal."

* * * *

A designer of alternating-current machinery complained to a friend that he had two carbuncles on the back of his neck. He was asked if they were in phase, but answered sadly : "Certainly not, they are in quadrature !"

* * * *

At the special informal meeting of the Batt'-Wallahs Society, which I announced last week for Friday, Feb. 25, Lieut. H. T. Harrison, R.N.V.R., will take the chair. The gathering is timed for 6-6:30 p.m., and will be in the official "dug-out," Victoria Mansions Restaurant, Victoria-street, London, S.W. According to the Hon. Sec.'s notification, there will be the usual "cheery chat, chop and chant," time honoured of all Battis. As the meeting is below ground it will not be necessary for members and guests to bring their respirators.

* * * *

THIRTY-SEVEN YEARS AGO.

[From The Electrician (Second Series), February 8, 1879.]

The Electric Light and the San Francisco Gas Company.—The establishment in California of an electric lighting company has had the effect of depreciating the gas shares from 110 to 70 dollars—the greatest depreciation yet recorded.

The Billingsgate Experiment.—It is stated that the cost of the electric light during the experiments carried on in Billingsgate Market, including interest, and depreciation on plant, engine power, attendance and carbon, was upwards of £4 per night, against rather less than £2. 10s. per night for gas.

Gas Engines.—In M. Cernesson's report on electric lighting presented to the Municipal Council of Paris, it is stated that the cost of working the Lenior gas engine is 5½d. per horse-power per hour. From this it would appear that the engine in question is by no means the most economical of its kind, since the Otto gas engine, manufactured in this country by Messrs. Crossley Brothers, is said to consume but 22 ft. of gas per horse-power per hour, at a cost of about 1d. The Otto engine was the one used at the Royal Institution for Prof. Tyndall's lecture.

The UNIVERSAL TEST CLIP

CURRENT CARRYING.

Time savers in any electrical work requiring quick temporary connections.

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THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.

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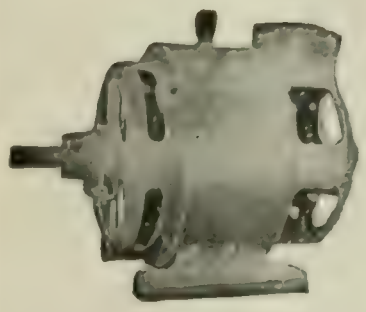
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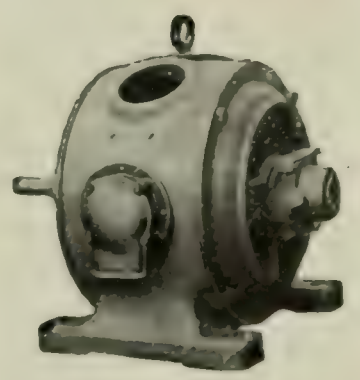
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For Three-phase Current.

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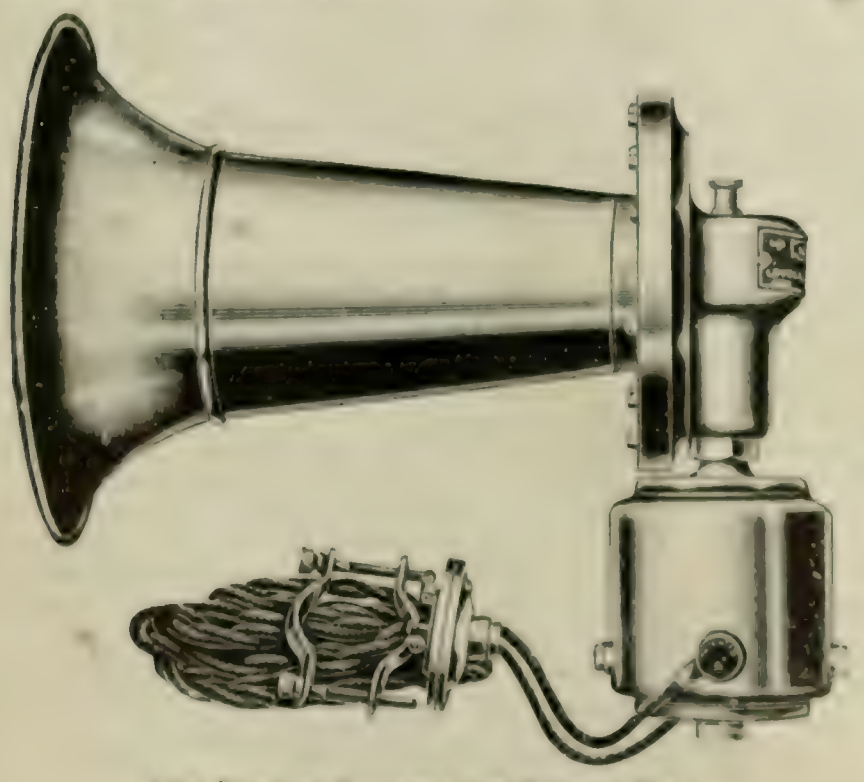
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A HIGH-VOLTAGE KLAXON.

For some time past there has existed a demand amongst shipyards, factories, engineering works and similar establishments for a reliable electric warning signal to replace the steam whistle now becoming obsolete on account of the growing employment of electricity in place of steam as motive power.



Side View of High-voltage Klaxon Horn.

We understand that the industrial Klaxon horn has been specially designed for this purpose, and after exhaustive tests has proved satisfactory for all purposes where a loud, penetrating, and distinctive alarm is required.

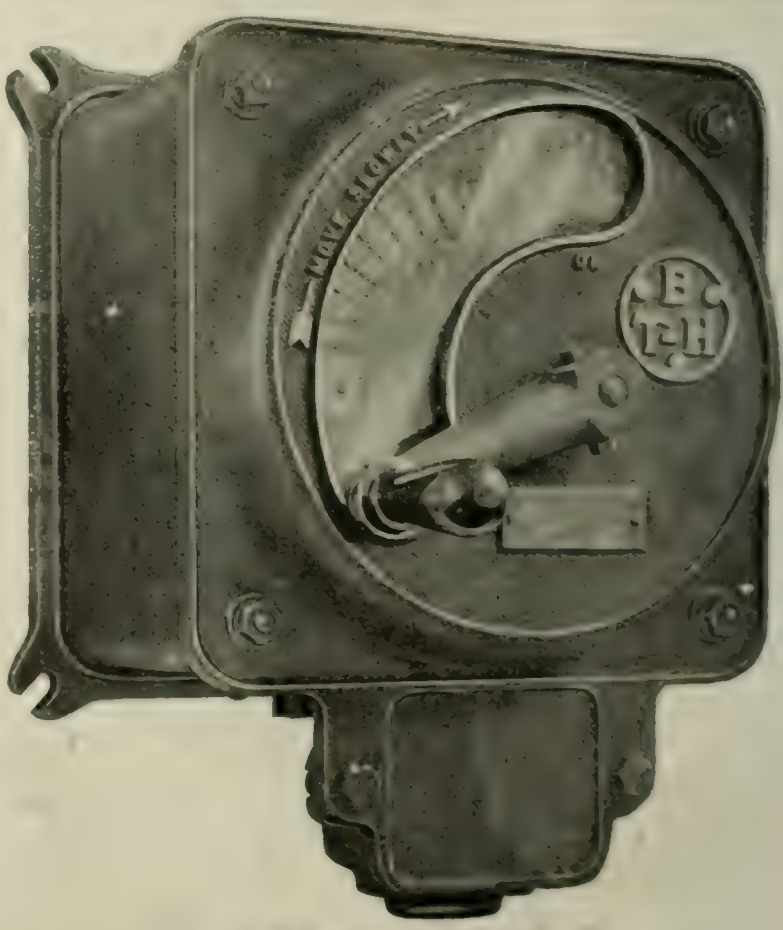
The Klaxon is operated by a ¼ h.p. self-contained motor revolving a toothed wheel, which strikes against the tempered steel button of a chrome vanadium steel diaphragm, producing a loud piercing sound which can be heard above the noise of machinery, &c., and in the open air, for a considerable distance, even under adverse atmospheric conditions. At a recent independnet test made by the British Military authorities in France, the Klaxon could be distinctly heard over undulating ground, at a distance of almost two miles. The Klaxon can be supplied suitable for use with any electricity supply from 8 to 500 volts direct current, up to 260 volts alternating current of not less than 25 cycles.

Numerous Klaxon signals have been supplied for use as factory hooters, fire alarms, code signals for ships and workshops, harbour works, &c., and have now been adopted as part of the standard equipment for all factories erected by the Ministry of Munitions. The price, which is given in a new leaflet, will be found to be extremely reasonable, compatible with the high quality of design, material and workmanship inherent to Klaxon manufactures for so many years.

The Klaxon Company, King-street, St. James', London, W., will be pleased to furnish further particulars or to advise on any scheme in which warning signals are needed.

D.C. STARTING RHEOSTATS.

Reliable starting devices are necessary for the satisfactory working of all motor installations. The new forms of B.T.-H. starting rheostats dscribed and illustrated in list No. 5,100 A have been specially designed to meet the growing demand for a rheostat in which both switch and resistance are enclosed in such a manner as to prevent access of dust or flying particles or accidental contact

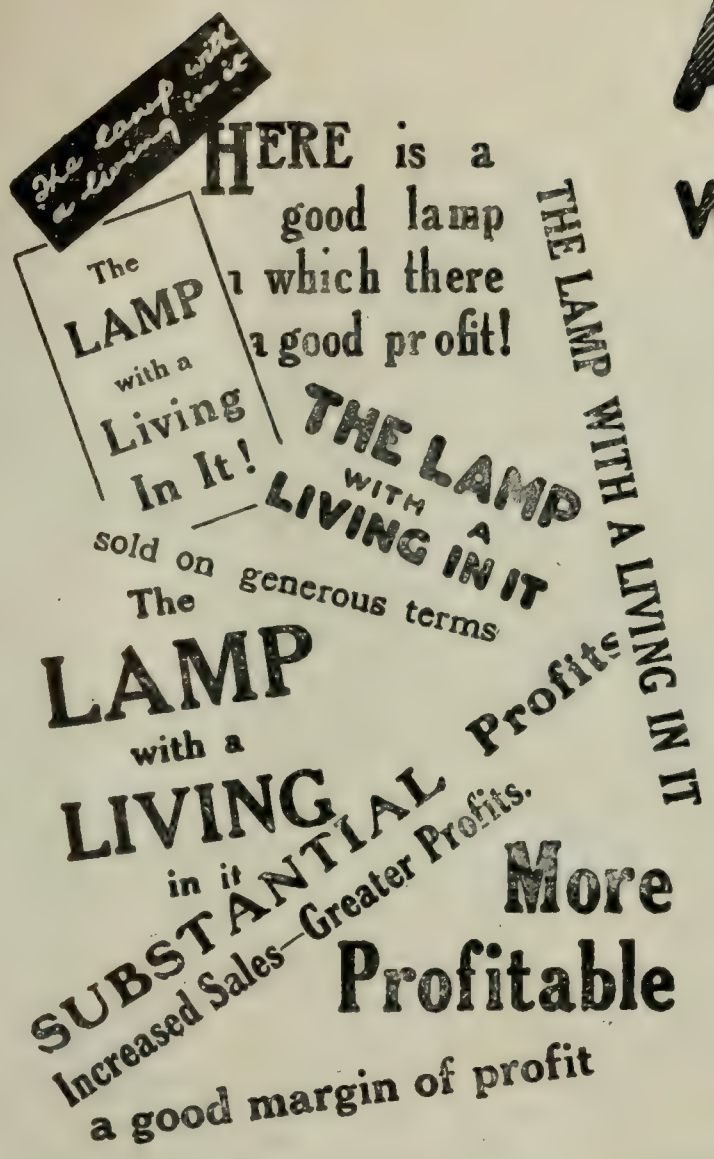


10 h.p., Form F, Starter.

with live parts. These rheostats are simple in design, and comply with the Home Office rules for the use of electricity in factories. They can be supplied for circuits up to 550 volts and in various sizes from 0·25 h.p. to 40 h.p.

In the smaller sizes (Form D) the switch is fitted with a brush of the "skate" type, which is pressed on to the contacts by a steel spring. The larger starters (Form F) have a combination brush consisting of a carbon portion, which reduces sparking to a minimum, and a brass portion, which carries practically all the current; both brushes being self-aligning and independent of each other. Certain of the larger sizes are also fitted with carbon rollers and with laminated short circuiting brushes. The break at the "off" position is wide and positive, the contact brush finally resting on a liberally proportioned fireproof insulating piece.

A no-voltage and overload release device is fitted to each rheostat. The overload release can be set to operate at 100, 125 or 150 per cent. of full load. The no-voltage release magnet is excited by a coil in series with the motor shunt field, so that, should the supply voltage fail, or the field circuit be accidentally broken, the switch arm will automatically return to the "off" position. When installed with series-wound motors or variable-speed motors (particularly with



A STATEMENT
which loses nothing by repetition
so here it is
again.

POPE
Elasta
British Made Wire
Lamps

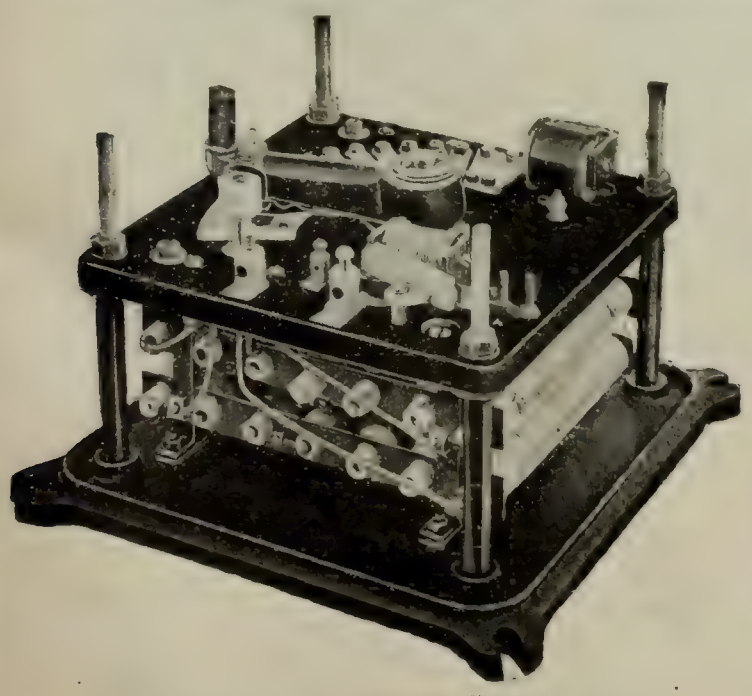
The lamp with a living in it

Advt. of Pope's Electric Lamp Co., Ltd. —— Also makers of Carbon and Radiator Lamps. —— Hythe Road, Willesden, N.W.

motors fitted with commutating poles), where a wide variation in speed is obtained by varying the strength of the field current, it will be necessary to connect the coil of the no-voltage release across the line, a separate resistance being furnished for connecting in series with the coil.

The resistance element consists of a number of fireproof tubes wound with a special non-corrodible wire and fitted with porcelain insulators at each end, the whole unit being coated with a special cement. The winding, being encased in cement, is not released in the event of a "burn-out," and there is, consequently, no danger of detached wires making contact with the frame or other parts. The connections to the resistance and between the different units are made with screwed clamps, the whole forming both mechanically and electrically a reliable unit. The method of supporting and connecting the units has been adopted as a result of long experience with starting rheostats. The supporting frame is fixed directly on the switch base, thus providing additional insulation for the resistance. The arrangement also ensures that the leads between the resistance and switch, which are made with stiff bare copper wire, will not be displaced or crossed when the resistance and switch are taken out of the case for inspection.

Each starter is fitted with a cast-iron switch cover of neat appearance. A glazed opening is provided for inspection purposes, so that the condition of the contacts can be periodically noted. The switch arm is operated by means of a double lever pivoted in the cover, so that no slot is necessary



Form F Starter, showing Construction.





Form D Starter, Opened Out.

In the smaller sizes (Form D) the frame consists of a cast-iron tank with suitable supporting feet. In the larger sizes (Form F) the switch and cover are carried on four corner bolts which are fixed into a cast-iron base. A plain sheet-iron side cover, which is made from a single piece of metal, slips over the four corner bolts, and is held firmly in position between the cast-iron base and the switch.

On starters up to 9 H.P. 125 volts and 12 H.P. 200 550 volts the

armature and line terminals are made in the form of clamping pillars. For larger capacities cable thimbles are provided. The field terminals for all sizes are of the pillar type. Form D starters are suitable for a single pipe connection, the frame being tapped for 1 in. simplex conduit. This tapped hole is fitted with a cable bush when pipe connections are not required.

A bushed cable box is fitted to the Form F rheostat, and is arranged normally for leads approaching the rheostat from the back. This cable box can be reversed, however, to take leads approaching from below the rheostat.

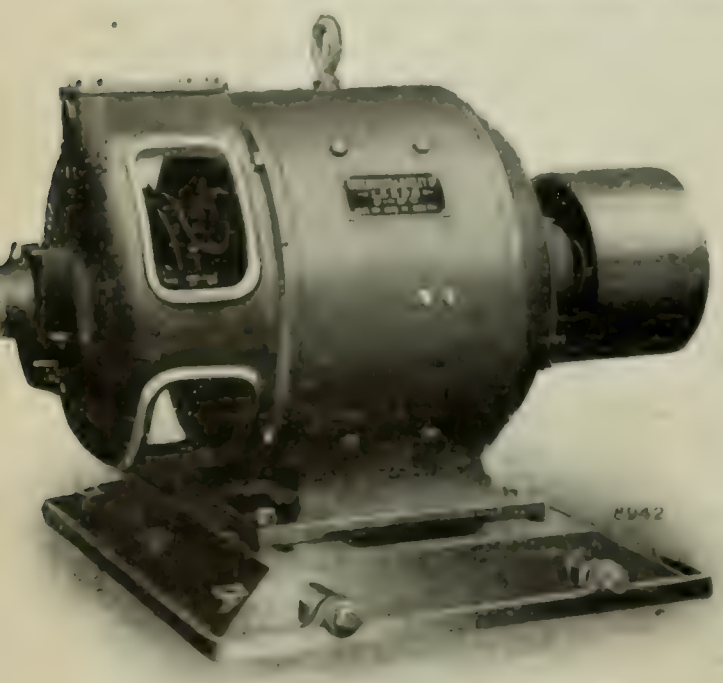
The list referred to, and from which the above details are taken, may be obtained from the B.T.-H. Co., Rugby.

D.C. DYNAMOS AND MOTORS.

Price list No. E.9a, issued by Messrs. Greenwood & Batley, Leeds, gives description and specifications of low, medium and high-voltage direct-current motors. These are made by the company in open, semi-enclosed and totally-enclosed patterns. They are cooled by natural ventilation without the use of fans larger in diameter than the armature. The smaller sizes have a square outer frame forming the yoke, and in the larger sizes the frame is cylindrical. All frames are of cast steel, and the end shields are of heavy pattern in cast iron and carry the main bearing. Except in the three smallest sizes, which are two-pole machines, all the motors listed are fitted with four poles. The four standard voltages for which the machines are wound are 110, 320, 440 and 500. They may be used without alteration, but with a slight increase in temperature rise on voltages about 10 per cent. lower than those stated. The speeds given in the list are within 5 per cent. when the motor is warm.

The machines will give their specified rating continuously whether as open, semi-enclosed, ventilated enclosed or totally enclosed. After six hours running the temperature rise is stated not to exceed 72°F. for open or semi-enclosed machines, 80°F. for ventilated enclosed machines, and 90°F. for totally enclosed machines. Overloads of 25 per cent. for one hour and 50 per cent. for short periods can be sustained without injury or over heating.

Interpoles are fitted to these machines, thereby ensuring sparkless running under fluctuations of load and wide speed variations. The motors are so designed that the efficiencies of three-quarter and half

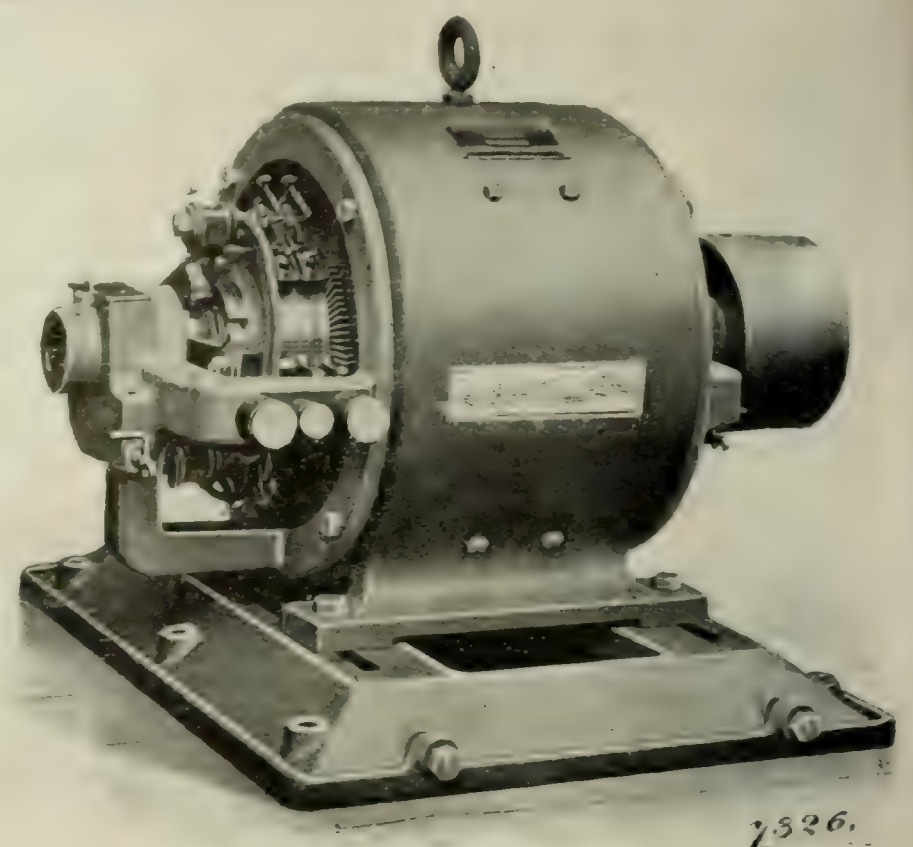


Semi Enclosed Motor.

load are unusually high. The efficiency at three-quarter load is generally equal to the full load efficiency and slightly less at half load.

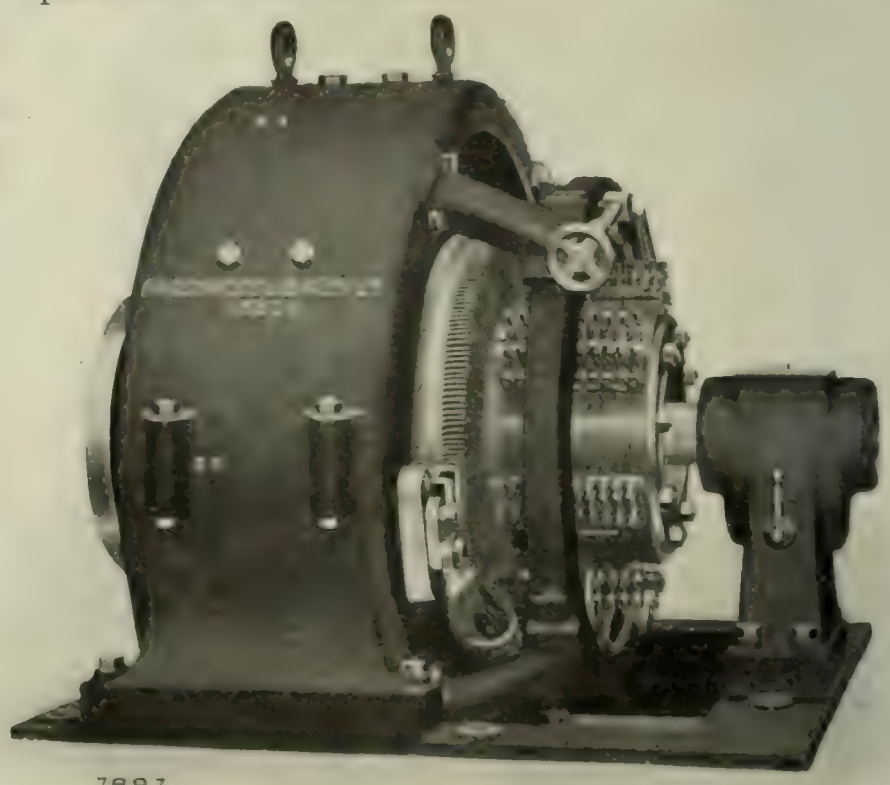
The brushes are of the carbon type, and the holders are provided with adjustable tension springs; they are supported on gunmetal spindles fixed to a rocker, which is fitted on a turned seat on the end shield. The current density of the brushes is said to be about 25 amperes per square inch, and the main current is carried by flexible leads, there being no dependence upon sliding contacts. On the top end shield is a large box which accommodates the terminals. The latter are readily adjustable for interchange or for altering the direction of rotation. The screwed conduit carrying the power leads can be taken directly into the terminal box if desired.

A useful feature is a small brass plate and pointer fitted to all machines for setting the position of the brushes. Upon this plate are three marks, and the pointer must be opposite one of these, according to the rotation required. In the central position the direction of rotation can be changed at will; if the pointer is moved to the left the motor rotates anti-clockwise, and if to the right in



Open type Motor on Slide-rail Bed.

clockwise direction. A line of variable-speed motors is listed, the output of which ranges from 0·9 H.P. to 70 H.P. Starters and starting panels are also described in the list.



Large D.C. Dynamo for Direct Coupling.

Price list E.10z deals with direct-current generators, the specification for which follows somewhat the lines of that for the motors. Copies of these lists can be obtained from Messrs. Greenwood & Batley on request.

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It does not matter how large or small an earthing device may be, its essential qualification is reliability. This is completely secured with a Paragon Cone, because it is made of pure copper filled with charcoal, and in consequence attracts and retains moisture.

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56, Victoria Street, London, S.W.

CROSS HEAD TYPE DIESEL ENGINE.

The particulars which are being issued in a special pamphlet by Messrs. Mirrlees, Bickerton & Day describing their cross-head type of Diesel engine will, we feel sure, be read with interest. This particular pattern of engine is now in process of development. The

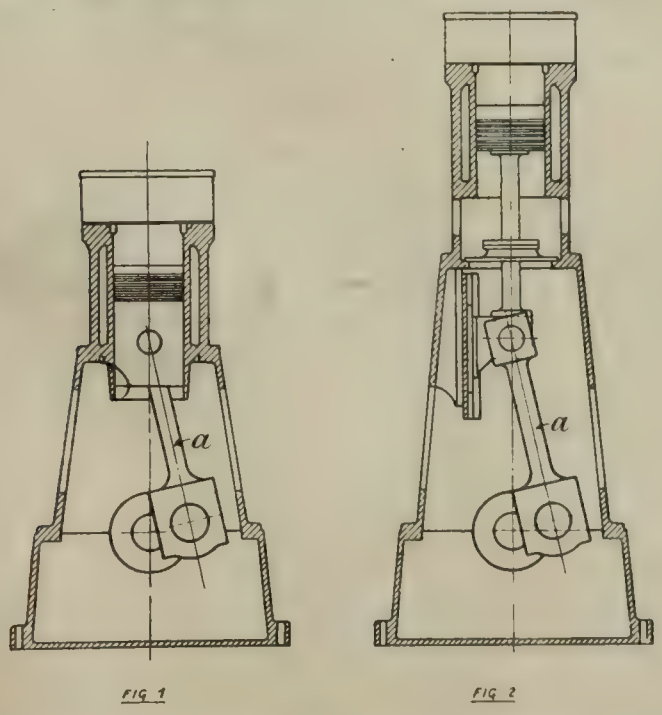
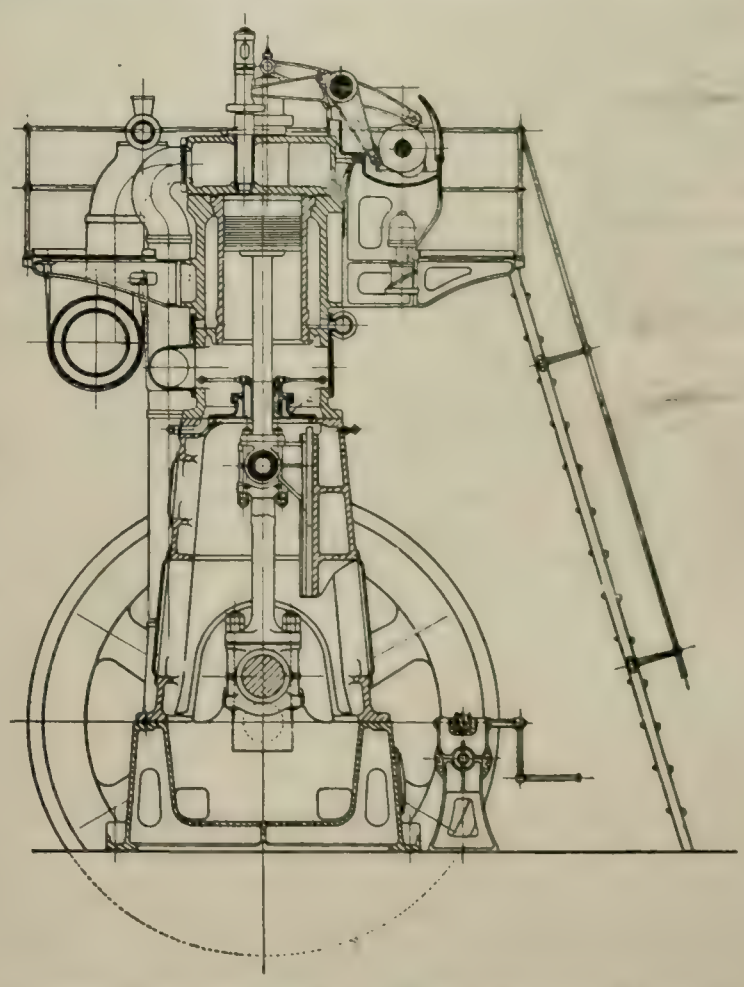


FIG. 1.—SECTIONS THROUGH TRUNK AND CROSS-HEAD TYPE ENGINES.

views in Fig. 1 are sections through engines of the trunk piston and cross-head type respectively. It is claimed that the cross-head pattern of engine possesses great advantages in the large sizes. These advantages are: (1) Piston troubles reduced to a minimum; (2) smoother running; (3) minimum risk of trouble with connecting rod top end bearings; (4) cylinder wear reduced; (5) lubrication of the bearings obtained without splashing of oil on to the cylinders; (6) a reduced consumption of lubricating oil; (7) a minimum amount of attention to lubrication. As an offset to these advantages are placed the greater cost of manufacture of an engine of this type, and



SECTION THROUGH COMPLETE CROSS-HEAD TYPE ENGINE.

an increased height of the engine, though it is said that the latter does not necessarily mean increased head room in the engine room.

The trouble with pistons is minimised, because a piston of the

cross-head type can be given plenty of play in the cylinders without risk of knocking; this increased play allows for expansion of the cylinder when heated. Such generous clearances are not permissible with a piston of the trunk type. Where such clearances are given, knocking will occur owing to the piston being forced by the connecting rod from one side of the cylinder to the other. With engines of the two-stroke type the piston conditions are even more severe, as there is little opportunity for cooling. It will be understood that with the cross-head type of engine the cross-head itself is not subjected to high temperatures and small working clearances are permissible with perfect safety; exceptionally smooth running can thus be obtained without any risk of piston seizure.

It is claimed that with the cross-head type of engine the top end bearing of the connecting rod can be kept at a reasonable temperature. The lubricating oil is cooler because the bearing is well away from the heated piston, and the bearing itself can be made large in size, thus reducing the pressure per square inch. The wear on cylinders is reduced because of the elimination of side thrust, and with a completely enclosed crank chamber forced lubrication can be taken advantage of. In this latter connection the consumption of oil is minimised owing to the lubricant being kept in circulation, and consequently used over and over again, a filter being fitted in the oil circuit to remove impurities.

Attention is called by Messrs. Mirrlees, Bickerton & Day to the fact that trouble has previously been experienced in forced lubrication engines with moulding sand washing out of the castings and finding its way with the oil into the bearings. They state that they have quite removed this difficulty by coating all cast surfaces exposed to the oil with an oil-resisting enamel, painted on after the surfaces have been thoroughly cleaned. They claim that this simple expedient has proved completely satisfactory. To all the engines made by Messrs. Mirrlees, Bickerton & Day a small hand pump is fitted in connection with the lubrication system. Just before starting the engine the attendant uses this pump to prime all the pipes and bearings with oil, thereby ensuring that from the moment of starting the supply of oil in liberal quantities will be continued to the bearings.

Regarding the statement that the cross-head type of engine is more costly than the trunk-piston type, the makers claim that reliability should be the primary consideration. Production of the engines in large quantities and the employment of modern methods of manufacture will also tend to reduce the initial cost. The makers do not attach much importance to the increased height of the engine, as with an engine of the trunk type sufficient head room must be allowed for the piston and connecting rod to be lifted clear of the cylinder; in the cross-head pattern of engine the piston only need be removed, there being no difficulty in disconnecting it from the piston rod while in situ.

The foregoing details have been abstracted from the pamphlet referred to, and this interesing publication may be obtained from Messrs. Mirrlees, Bickerton & Day, Hazel Grove, near Stockport.

TINNING FURNACE
(Hall's Patents.
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER MANUFACTURING CO., Ltd., Whitehouse St., Aston, Birmingham

HOLOPHANE INTERIOR ILLUMINATION.

We have at various times referred to the importance of introducing standardised glassware and uniform grouping of light units for the illumination of large interiors, such as banks, schools, public libraries, churches, and of museums and similar institutions. It is satisfactory to note that good work has been done in the past few years in manufacturing glassware which is employed in conjunction with high candle power lamps and will furnish well-diffused illumination. A study of the many problems by specialists has been productive of these excellent results. It is true that the work of installing many of these efficient lighting units for interior illumination has to some extent been checked by the war, while it has practically put a stop to all exterior work. Still, there are many notable examples of interior lighting in which the selection of the units and their grouping and suspension have given a restful illumination, which cannot fail to have impressed itself upon the public mind. It is, after all, the public who are being made the ultimate judges in this matter of good lighting. The illuminating engineer has been at work for over 10 years in this country, and at the time of the outbreak of war there was a prospect of a boom in lighting installations planned on scientific lines and employing scientific glassware. During the period of war it is not to be expected that the activities of illuminating engineers will be utilised in this peaceful direction. It is, however, instructive to observe that in such completing of large offices and business premises that is now going on illumination is entrusted to consultants and contractors who will carry it out on modern lines.



HOLOPHANE LIGHTING IN A LONDON BANK.

We have from time to time commented upon the pioneer work of the Holophane Company in the designing, developing and marketing of scientific glassware. Quite recently the company issued a booklet, in which are included groups of photographic reproductions depicting typical holophane installations. In almost every case each of these photographs is a work of art. The pictures were taken by the light of the lamps themselves, and we understand were reproduced without retouching of any kind. Probably the most beautiful of the series are those illustrations which deal with interiors. The opportunities for the production of artistic effect are greater with an interior than with an exterior installation. Unfortunately, space does not admit of our reproducing a number of these excellent illustrations. The booklet is, however, essentially a piece of missionary literature, and may be obtained on application to Holophane Co., Carteret-street, Westminster, London, S.W. It is purely a pictorial production, and deals with results, as it is intended it should. It is, therefore, of intense interest to the layman, who cannot for a time be expected to appreciate the scientific problems connected with illumination. It is his business to deal purely with results.

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ELECTRIC HEATING & COOKING APPARATUS
Write for Binder "N."

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 95/97, NOBLE STREET, LONDON, E.C.

Printed and Published at the Proprietors' "The Electrician" Printing and Publishing Co., Ltd., at the Editorial, Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, February 11, 1916.

THE ROUND TABLE.

By "KVA."

We are asked to deny the rumour that Mr. P. A. Mossay, the electric vehicle expert, was recently arrested at Ipswich and hailed before the beak on a "boosting charge."

* * * *

"The North Metropolitan Electric Power Supply Co. has allowed the Barnet Council off the account for public lighting during the past quarter," which clearly proves that there is a war on somewhere.

* * * *

"Wollongong (N.S.W.) Council have decided to call for tenders for the installation of electric light." In a district with a name like that gas would be impossible of use; it would be blown out every time the name was uttered.

* * * *

I think there must be few chief electrical engineers who can claim three officer sons with the forces. The photo-reproduction shows the three sons of Mr. T. P. Wilmshurst (Derby), one of the stalwarts of municipal electricity supply. Reading



from left to right they are Lieut. G. R. Wilmshurst, 29th Royal Welsh Fusiliers; 2nd Lieut. A. P. Wilmshurst, R.E.'s; and 2nd Lieut. R. B. Wilmshurst, 4th Lincolns. Two latter boys are with the Northumberland Fusiliers and have been scrapping at the Front and have both been wounded.

* * * *

Do you clean your billiard table like this? (*See* p. 136.)



To all electrical engineers, Scottish or otherwise, who play golf the following touching little poem is dedicated. It has been written by a Scotch-American, and is taken from the "Western Electric News."

JOCK TAE SANDY.

Och, Sandy mon, thy've went an' gone
An' spoiled the guid auld game.
They ca' the puttin' green a "lawn."
'Twud be a crime back hame!

The mashie, putter, niblick – all.
Are "bats" an' strokes are "whacks":
Thè diel knaws what they ca' the ball.
A cleek na dout's "an ax"

They *con*vairse on the links, mon, too,
Like auld wives ower tea.
They gared me draw a game th' noo,
When I had it dormy three.

Aye, Sandy, aye, auld times are by.
Things gang frae bad tae woarse.
Tongues wat wi' Scotch keep sad een dry—
Ye'll buy yer ain o'course.

* * * *

Anent the above, the golf ball (sic) illustrated was picked up on the links "somewhere in England" frequented by a well-



known central station engineer and a salesman of plant and machinery of good repute. Will either of them claim it?

* * * *

OUR HOT PLATES

No. 200 to—

Private J. A. Moffat, erstwhile salesman Ferranti Ltd., for his request to them for a complete set of catalogues to be sent him at the front. "There are plenty of collieries about the firing line, all electrically equipped, and I know enough French to pay them a call when we advance."

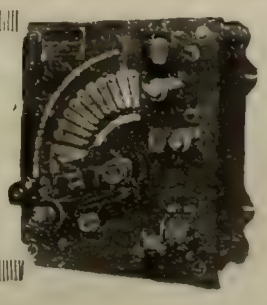
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THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), February 15, 1879.]

NONSENSE.—Some of our young amateurs, and some of our ignorant editors, seem determined to write and publish the most astounding nonsense that can be obtained with regard to the electric light. A short time ago several papers advocated the idea suggested by a youthful bicyclist that a small dynamo-machine should be connected with the wheels of the bicycle, and a light obtained. Now ordinary carriages are to be fitted with electric lamps, and also railway trains. We wonder whether the method of these statements is not that by making enough of them (the wilder and more improbable the better), some may hit a mark, and the producer be rewarded. Railway trains may be furnished with the electric light, provided a special engine be carried in the guard's van; so may a carriage, if Jehu has an engine under the hammarcloth; but a bicycle—never.

No. 38 Compound Starter and Regulator is a useful Controller for Motors requiring speed variation by shunt control. There is only one handle, the operation is simple, and it is impossible to start up with a weakened field, because full field is automatically restored when the motor stops.

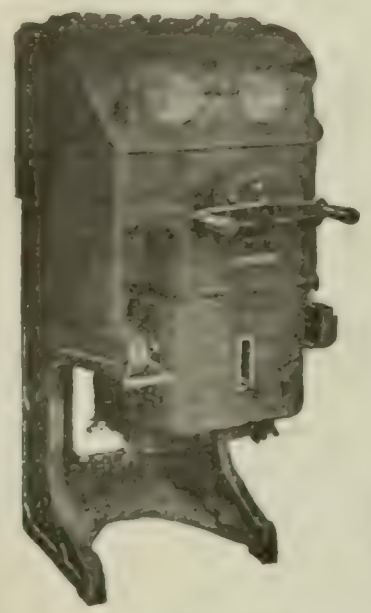


'IGRANIC'
MOTOR CONTROL GEAR.
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.



No. 631 Plate Type Field Regulator, used as speed controller for motors and voltage regulator for dynamos. Neat and simple in construction, readily adaptable for any mounting, available from stock for a wide range of voltage capacity and ohmic resistance.

SIEMENS



IRONCLAD SWITCHGEAR FOR ALL PURPOSES

Control Pillars
Distribution Boards
Main Switchboards

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"LEKTRIK" SWITCHES.

Those who are inclined to ignore electrical accessories in general, and who have not given much attention to tumbler and other small switches, will probably be surprised should they glance through the new list we recently received from Messrs. A. P. Lundberg & Sons, Liverpool-road, London, N., and which we mutually noticed in our issue of Jan. 7.

They will be more surprised when they find that the 86 pages in this attractively bound quarto list deal with only four of the score or more of electrical types of small switch available for use in lighting and kindred work. Special switches for heating and small motor controls, would, we understand, bring the types up to over 30 in number.

The term "type" or "electrical type," as used here refers to what the switch does electrically, irrespective of its form or size. Thus, the two switches shown in Figs. 1 and 2, are both single way—that

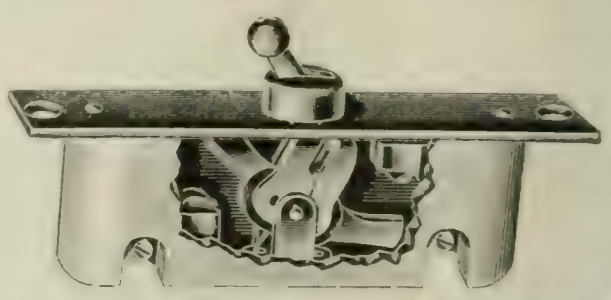


Fig. 1.—"Mortise" 2½-Ampere Single-way Flush Panel Switch.

is to say, they are both of the same *electrical type*, in that they both serve to make or break the connection between two leads. Fig. 2 might be said to belong also to a distinct sub-type, as it has an independent quick-make and quick-break action.

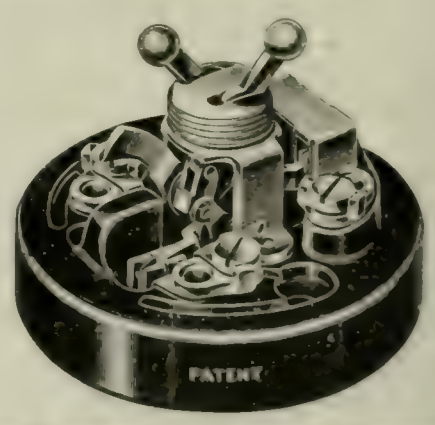


Fig. 4.—New Pattern Knife-blade "Twinob" Switch.

On the other hand, the form or pattern of the switches in Figs. 1 and 2 is obviously different, and so is their action; that in Fig. 1 being *tumbler* and that in Fig. 2 *push-and-pull*.

The four types dealt with in the list referred to are single-way, "Twinob," double-pole and triple-pole, and the 30 different kinds or forms of the first-named type are grouped under the following headings:—

Tumbler, Turn, Push-and-Pull, Pendant, Miscellaneous.

This will partly explain why the list is so large, and another reason is to be found in the fact that it has no fewer than 200 illustrations, including many connection diagrams. The latter are all interesting.

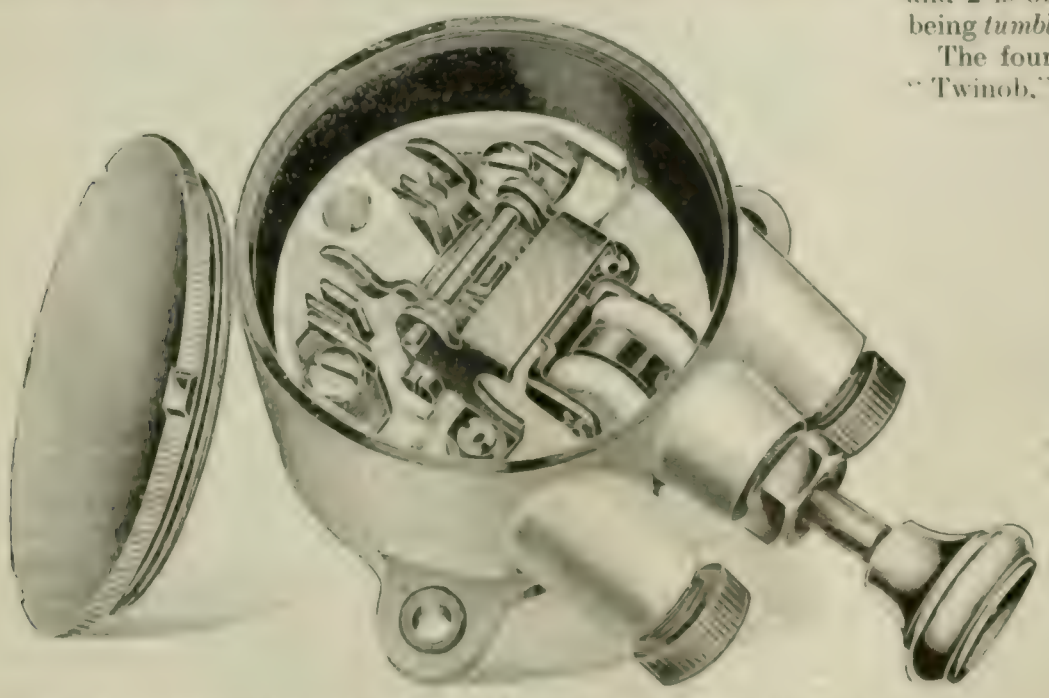


Fig. 2.—"Neptune" (Regd.) Watertight Q.M. Q.B. 10-Ampere Single-way Push and Pull Switch.

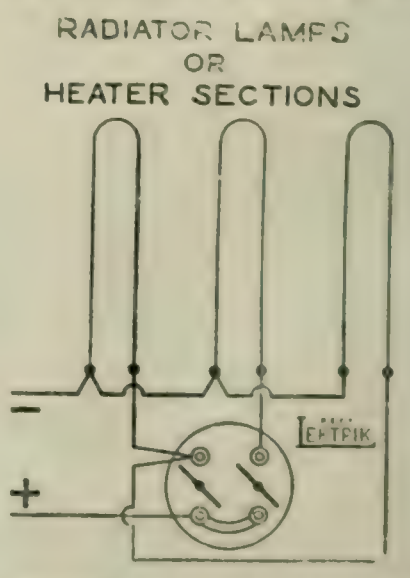


Fig. 3.—"Twinob" Switch Controlling Three-lamp Radiator, and Enabling One, Two or all Three Lamps to be Put on.

but we were particularly struck with those illustrating the use of "Twinob" switches on radiators.

One of these diagrams is seen in Fig. 3. The "Twinob" switch, it may be explained, is a combination of two single-way switches on one base, and obviously makes for compactness as well as economy. Thus, the switch in Fig. 3 takes the place and does the work of two separate single-way switches.

Fig. 4 shows a "Twinob" switch fitted with Admiralty-pattern terminals. It may, of course, be had with ordinary terminals, the cost being the same in either case. The advantages of "A.P." terminals are briefly as follows :—

(*a*) They give secure connection and excellent contact.

(*b*) The screws are accessible in the most confined situations.

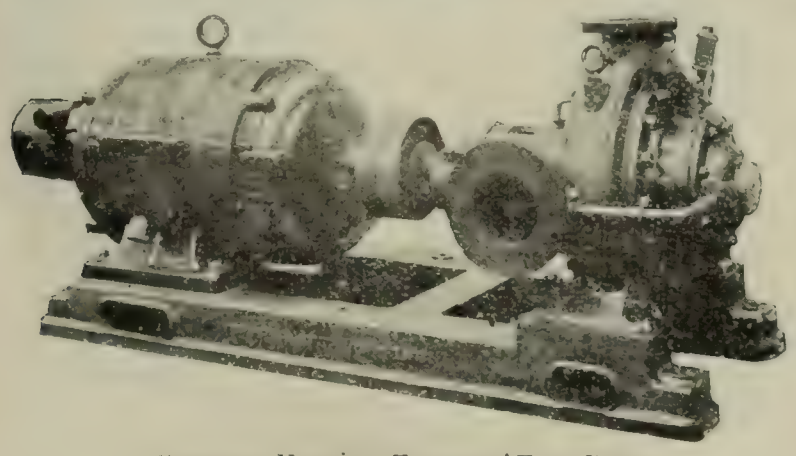
(*c*) In flush switches, the wires need not be brought through from the back.

The "A.P." terminal, by the way, is also fitted on the firm's well-known "Pivot" tumbler switches (single-way, two-way and intermediate).

ELECTRIC PUMPS FOR SHIP'S FIRE DUTY.

While the Board of Trade specifies in its regulations dealing with fire-fighting apparatus for ships that a certain number of pumps of definite capacity must be installed on all vessels, the type of pump is left to the discretion of the owners. It has been usual to instal reciprocating steam pumps, but there seems no valid reason why the centrifugal pump should not be employed for fire duty. It is of light weight, it occupies little floor space, and its output is large for its size, also it can be coupled direct to an electric motor. The Board of Trade regulations call for a pump capable of delivering 250 gallons per minute against a pressure of 100 lb. per square inch. In practice this means that each pump must be able to throw two jets to a height of 67 ft. or horizontally to a distance of 52 ft., each jet being supplied through 100 ft. of canvas hose fitted with a $\frac{7}{8}$ in. nozzle.

A two-chamber turbine pump of the pattern supplied by Mather & Platt (Ltd.), Park Works, Manchester, when running at 1,400 revs. per min., will throw two jets horizontally about 60 ft., the water



General View of Electric Fire Pump.

being supplied through 50 ft. of 2½ in. canvas hose with $\frac{7}{8}$ in. nozzle. This absorbs about 23 H.P. and a motor of about 28 H.P. would be suitable for driving it. A motor-driven turbine pump of this type is illustrated, both the pump and its motor being manufactured by Messrs. Mather & Platt. Current would normally be drawn for the ship's lighting and power installation, but provision can be made for connection to the emergency set which is now usually carried on deck to permit of some lighting being maintained and also a supply for wireless purposes in the event of failure of the main units There must be no risk of a breakdown or failure of supply in connection with fire fighting, and a duplicate source of supply for motors driving fire pumps is most desirable.

Messrs. Mather & Platt have just published a catalogue dealing with fire protection on board ships. It gives much useful information as to the number and type of appliances that must be carried on various classes of vessels in order to comply with the Merchant Shipping (Convention) Act, 1914, the provisions of which are about to come into operation.

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THE NEW PREMIER ELECTRIC SUCTION CLEANER.

There has been a tendency among engineers to imagine that an electric cleaner operated by a motor of small horse-power must of necessity be in the nature of a toy. Only a few years ago a standard electrical work published a statement that as most of the supply companies serve consumers on 200 or more volts, progress of the domestic electric service was checked, because small efficient and yet cheap motors for so high a pressure could not be commercially built.

The design and manufacture of small motors has, however, been the subject of special study in recent years, and perfectly satisfactory motors to operate on any voltage up to 260 are now a standard electrical product. In consequence there has been a noteworthy development in motor-driven appliances for domestic purposes.

The Electric Suction Cleaner Company, whose Premier machine has been on the market for some considerable time, and has previously been referred to in our columns, have been so successful in improving the design and detail of their cleaner motors, that they can offer machines suitable for any supply pressures from 25 to 260 volts, and for periodicities ranging from 25 to 133. The merits of the machine are enhanced by the fact that there are in operation to day, in this country, Premier cleaners of every voltage and periodicity. The need for meeting each particular kind of circuit imposes most onerous conditions upon the manufacturers of the machine for, if nothing else, it necessitates a large and mixed stock. In the new model Premier suction cleaner, the motor and its fan have been considered as a separate unit to be added on. By this simple expedient the motor can be wound for the circuit voltage and periodicity at which it gives its most efficient speed. Previously an average was struck in both high voltage and low-voltage motors, which meant that only those motors run on the middle or most accurate pressure gave the best results. As is well known, the efficiency of these small fans falls considerably with reduction in speed.

The general type of cleaner as represented by the new Premier is fairly well known, but there are unusual features in its design that merit some attention. A vertical high-speed motor is connected to a fan which gives off air at a low pressure and large volume, which is desirable for cleaning carpets and hangings, otherwise there might be a risk of injuring delicate fabrics. At the same time the combination of motor and fan in the Premier machine produces quite surprising results to those who believe that a fan machine cannot be made powerful and effective.

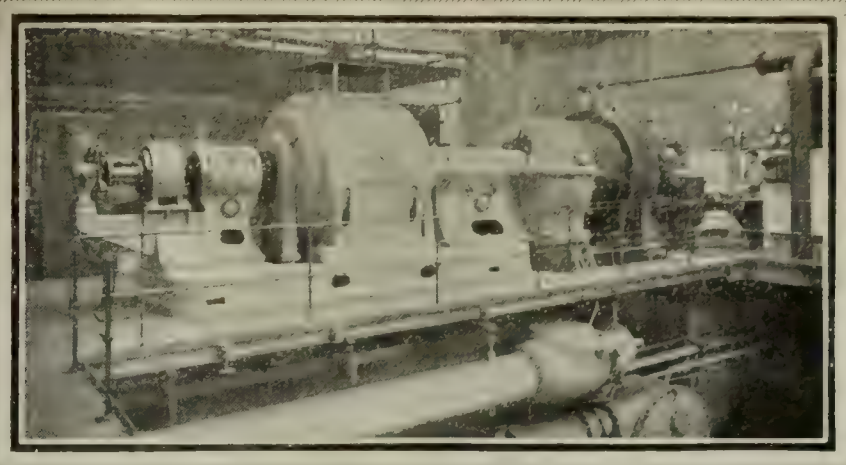
Detail of Premier Domestic Cleaner, showing Detachable Motor

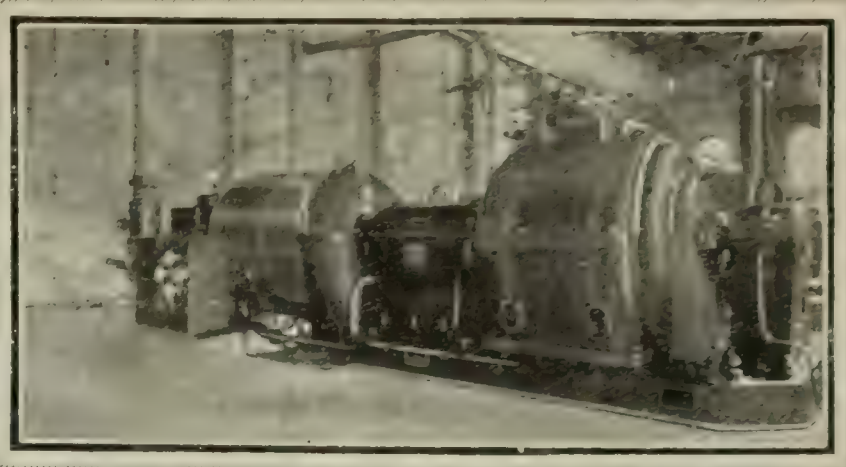


Premier Industrial Cleaner, shown as used in the Hand

The shape and grouping of the fan blades exercise an important influence on the efficiency. Special experimental work has been necessary in connection with the design of the Premier cleaner in order to arrive at the best and most accurate form of blade construction to give the best results. A curved blade of special shape is now used in the Premier cleaner, and we understand the machine has been tested by independent experts who found that it gave an actual pressure of $\frac{5}{8}$ in. mercury gauge which was equivalent to a little more than 10 in. water gauge.

As already explained, the motor and fan are a complete unit held by two set screws which permit the motor to be taken out, and







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another one replaced in a few seconds. Another conspicuous feature—and one which is, we believe, confined to this machine—is the use of a revolving brush in the mouth of the machine. This is rotated by a jet of air at a high speed, and while the brush itself has no cleaning value it is useful to pick up threads and light fabric cuttings. The machine is mounted on three castors, two forward and one behind, the latter being adjustable in order to raise and lower the nozzle so that the machine can be readily operated on thick pile carpets and ordinary closely woven fabrics.

The machine is provided with a hose attachment which "short-circuits" the wide suction nozzle, and dispenses with the need for closing this latter with a slide or pad. The jet which drives the rotary brush is closed with a hinged shutter. The driving handle is slightly turned down at its end, and a rotary snap switch is enclosed at this point, where it is easily operated. The connecting flex when not in use can be "laid up" on opposed hooks on the handle.



PORTABLE CLEANER AS USED ON CARVED FURNITURE.]

There are the usual tools provided with this cleaner for the purpose of cleansing carpets, upholstery, stuffed furniture and the like.

An interesting development of this cleaner is a form of Premier





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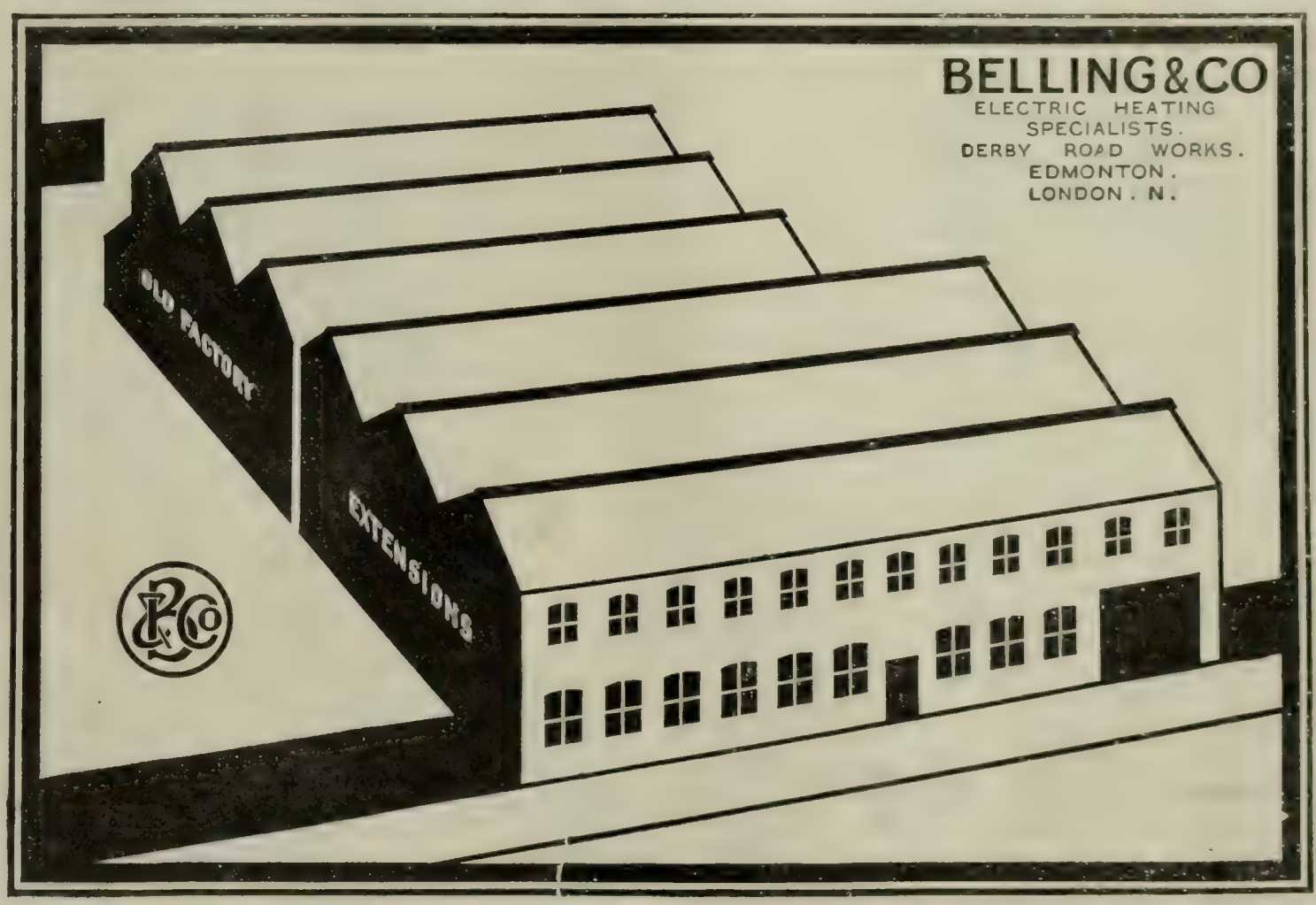
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which has been specially designed for industrial work, and is now being used largely in stores, shops, factories, libraries, museums, billiard saloons, clothing establishments and so on. It consists of a high speed motor and fan contained in an aluminium case, which can be carried either in the hand or strapped to the body. There is a bag receptacle into which the dust is drawn. The motor is of special design for suction work, and is similar in its electrical features to the one used in the domestic cleaner described above. A modification of the fan enables this machine to develop a higher pressure than the domestic type, this feature being a rather essential one in the conditions under which the machine is intended to operate. The device has, we understand, proved to be exceedingly effective for switchboards, and is especially useful for cleaning filter cloths in turbine stations.

There are many other uses to which the machine can be successfully applied, in fact the field for this form of machine seems to be almost unlimited.

Full prices and particulars are obtainable of the Electric Suction Cleaner Co., 56, Victoria street, London, S.W.

RAILWAY ELECTRIFICATION CABLES.

The importance of the cable system of a railway electrification scheme is exemplified in the case of the Manchester-Bury suburban electric line of the Lancashire & Yorkshire Railway, recently described very fully in our columns. Upon the reliability of all the conductors the continuity of the tram service depends.

The cables supplied by W. T. Henley's Telegraph Works Co. were as follows:—13,000 yds. of three-core 19/14 S.W.G. shaped conductor, paper insulated lead covered cable (Fig. 1), with galvanised steel wire armour, for a working pressure of 10,000 volts; 3,200 yds. 0·5 sq. in. single-concentric insulated cable (Fig. 2); 700 yds. 1·0 sq. in. paper-insulated bitumen insulated cable (Fig. 3), for a working pressure of 1,200 volts; 250 yds. of the same size cable, but for a working pressure of 100 volts; 1,000 yds. 7/15 S.W.G. twin paper insulated lead covered steel tape-armoured and yute served cable (Fig. 4); and 1,600 yds. 7/18 S.W.G. paper insulated lead covered unarmoured cable, to similar construction.

The 1,200-volt cables supply direct current at this pressure to the novel form of side running third rail, which Mr. J. A. F. Aspinall has devised for this system, and the operation of which will be followed



FIG. 1.—CROSS-SECTION OF THREE-CORE 19/14 CABLE. FULL SIZE.

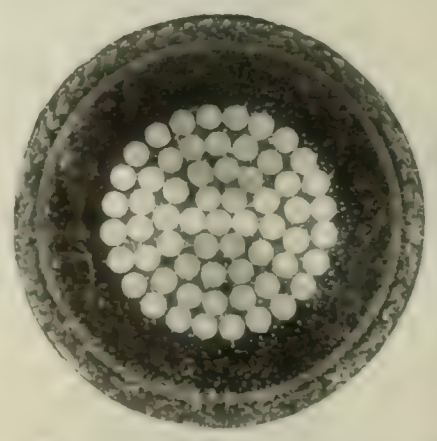


FIG. 2.—CROSS-SECTION OF 0·5 SQ. IN. BITUMEN CABLE.



FIG. 4. CROSS SECTION OF 7/15 S.W.G. PAPER INSULATED CABLE.

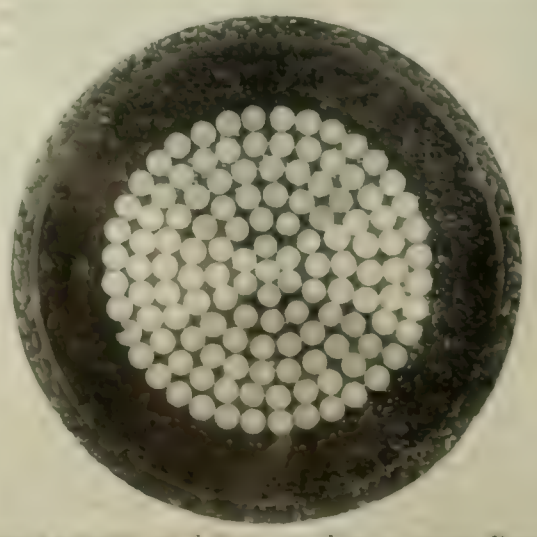


FIG. 3. CROSS SECTION OF 1·0 SQ. IN. VULCANISED BITUMEN CABLE.

with the keenest interest by railway engineers in all parts of the world.

Printed and Published by the Proprietors, THE ELECTRICIAN PRINTING AND PUBLISHING CO., LTD., at the Electrical Printing and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON. FRIDAY, FEBRUARY 18, 1916.

THE ROUND TABLE.

By "KVA."

An Islington Councillor suggests in the London Press that ruddy rays should be thrown by our searchlights to warn the public of the approach of enemy aircraft at night. The anxious Councillor says it can easily be done by placing ruby glass in the projector, but he should have made the experiment with his motor car headlights before he wrote to the press; he would then have seen how far these ruddy rays penetrated. Besides, fancy London with searchlights more ruddy than they are at present!

* * * *

But a Midlands "electrician" goes one better. He attaches a bladder to the gas pipe, suspends a weight so that it rests gently on the bladder, and attaches the cord holding the weight to a contact maker in a bell circuit. To quote the "Daily Chronicle," which hails this marvel:—

"When the gas works receive notification of the presence in the country of Zeppelins and reduce the pressure of gas, the weighted tin on the bladder falls, bringing the switch into operation, and the warning bell is rung."

Very s'nice, too; but what if the night shift at the local munition factory wanted tea at 2 a.m. and start up all the gas "rings"!

* * * *

In a recent advertisement for gas fires, cookers and hot-water apparatus, a guest is shown (in a sketch) arriving at a hotel equipped with these emblems of modernity. The grandfather's clock in the hall stands at 7:35, and part of the conversation which ensues between the head waiter and the guest is as follows:—

HEAD WAITER: The bathroom *is* ready, sir, always. There's plenty of 'ot water, you'll find clean 'ot towels in the 'ot cupboard in the bathroom and the Gas Fire lighted in your room.

GUEST: Right O!—and dinner at 8 sharp, please!

As George Robey would remark: "I shud shay sho!"

* * * *

A correspondent suggests that the sketch correctly represents the unkind manner in which the Pukkah Wallah takes to his duties of serving out rum to the troops at the front. All of



which reminds me that the *Batti* Wallahs meet to-night in the dug-out, 26, Victoria-street at 6-6.30, weather, the war and Zepps notwithstanding.

From a recent lecture (the italics are mine):—

The common version of the Golden Rule as applied to business is: Do others first, or they will do you, and love your neighbour as long as you can fleece him. Not that you should love your neighbour more than you should love yourself or *do for him* in trade more than you would have him *do for you*, but *as much*.



ENGINEERING TERM ILLUSTRATED "CONTINUOUS TORQUE"

[*Western Electric News.*

Petrol in U.S.A. is now 20 cents (10d.) per gallon and motorists are already turning towards battery vehicles for some relief from such extortion. In war-worn Europe we have to be satisfied with "seconds" at 60 cents!

* * * *

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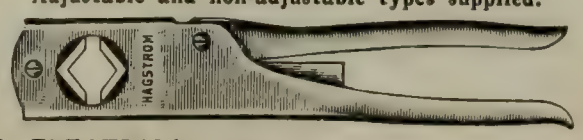
[From THE ELECTRICIAN (Second Series), February 22, 1879.]

USE OF "EARTH" FOR COMPLETING A TELEGRAPHIC CIRCUIT.—According to Mr. John Finlaison, Prof. Alfini, about the year 1802, sent the current from a battery of 80 cells across Calais Harbour through a wire supported on the masts of boats, using the sea for the return current. It was not until 1837 that Steinheil perfected his telegraph, and showed that the return wire between two stations might be dispensed with; whilst the experiments of Mr. Alexander Bain, at the "Serpentine River," in Hyde Park, in which water and moist earth were made a portion of the circuit, did not take place until 1842.

ELECTRICITY APPLIED TO RAILWAY TICKETS.—An electro-magnetic railway-ticket counter, to indicate the number of passengers going by a particular train, and so the number of carriages of each class required, has recently been adopted, says the "Engineer," at the station of the Kaiser Ferdinand's Nordbahn, in Vienna. The date press of each of the three ticket boxes is furnished with an electric contact, actuated each time a ticket is pushed to be stamped. Three lines connect the presses with a clock-shaped counter in the office, where the train is arranged, having discs with numbers and pointers, so that the number of passengers booked can be seen at once. The arrangement conduces to promptness in ordinary circumstances, and, where great crowds are travelling, successive trains can be quickly despatched without overloading with passengers. Messrs Meyer & Wolf, of Vienna, supplied the apparatus.

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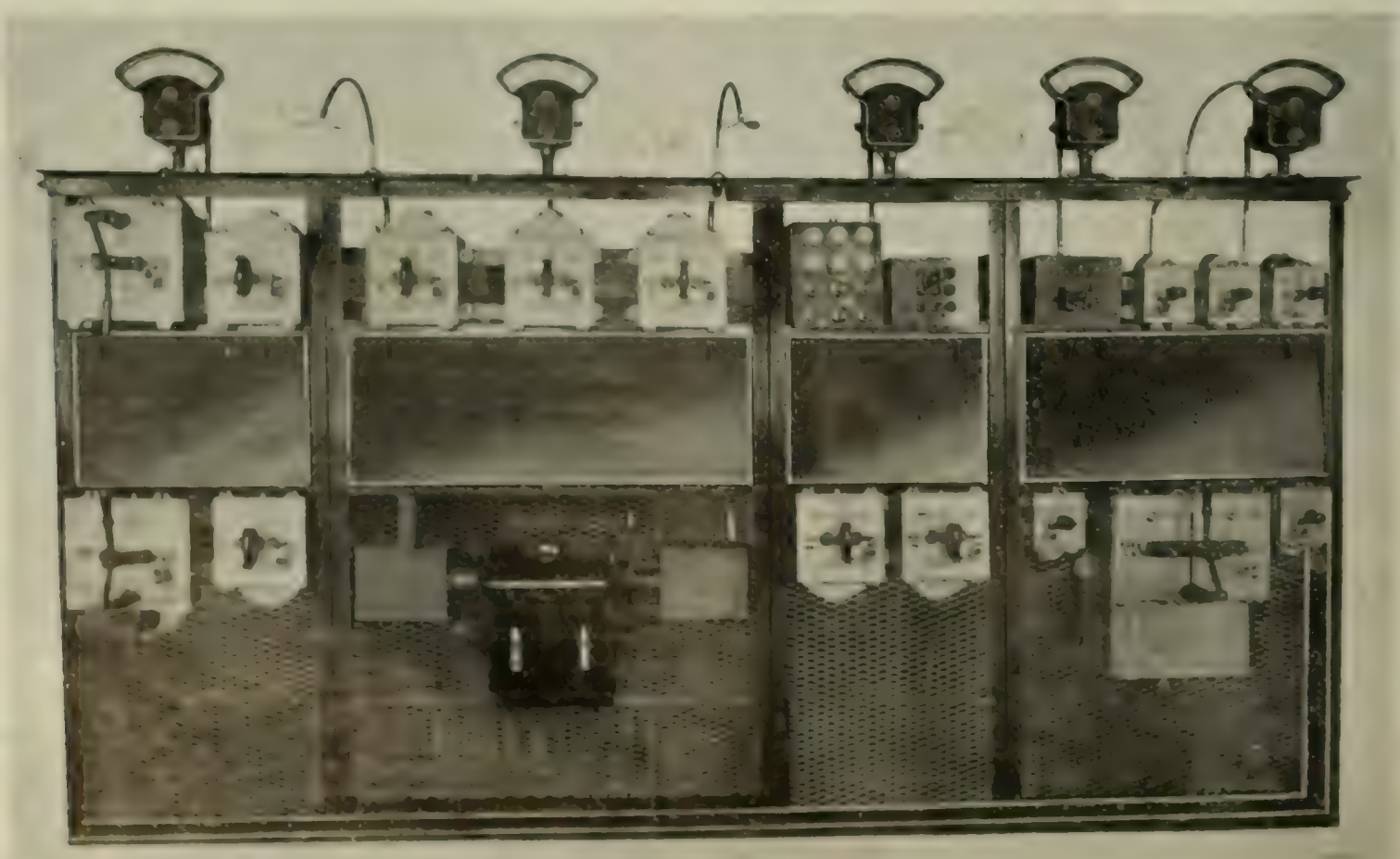
Branches in Principal Towns Abroad.

"IRONSAFE" SWITCHBOARDS.

Electrical equipment for power-circuit control in factories and workshops has made considerable advances during recent years. Workshop installations at the present day are chiefly noteworthy for the substantial character of the plant: in particular this remark may be said to apply to the distributing gear. Until quite recently switchboards, even for heavy duty, had a somewhat naked appearance, and were not unlikely to convey the impression of danger in the vicinity, especially when copper switch blades and other exposed pieces of apparatus were in view, and, further, it was borne in mind that these were "alive." It must in some measure be admitted that danger was not entirely absent in cases where there was anything like congestion on the premises, and it was on this account



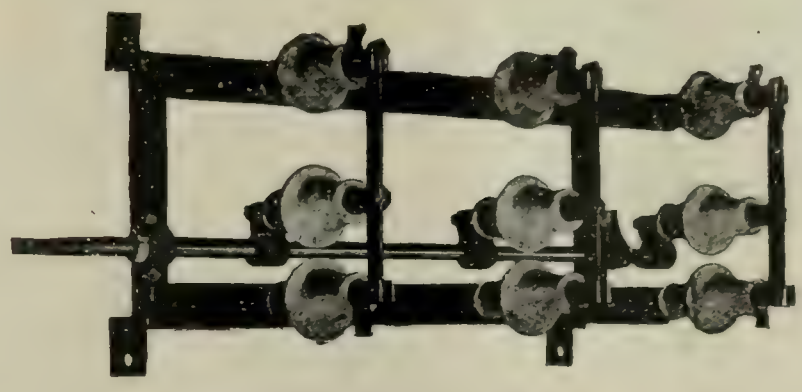
WALL PATTERN "IRONSAFE" BOARD



LARGE "IRONSAFE" SWITCHBOARD

The Electric & General Works, Ltd.,

15, Victoria Street, London, S.W.



E.H.T. MULTI-POLE ISOLATING SWITCH.

ELECTRICAL APPARATUS

up to 80,000 volts.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC. LONDON."**

that Home Office regulations demanded that rails or doors should set limits to the "danger zone" in order that unauthorised persons should be kept clear of the switchboard. A perusal of the annual Home Office accident and fatality report to a great extent confirms this view.

A workshop switchboard of modern design which can truly be described as totally enclosed, yet having every unit immediately accessible, and which occupies just the area of floor space upon which it stands, is now an acknowledged boon to factory owners and those interested in the distribution of electrical energy for lighting or power purposes in works and factories. A type of gear has been developed by Messrs. Berry, Skinner & Co. exclusively for the purpose in view, and described under their patent design as the "Ironsafe" switchboard. Illustrations of this class of gear are given here. We are informed by the makers that they turn out hardly two boards alike, but these will serve to convey an impression of what may be done in the way of switchboard construction on substantial and efficient lines.

The switchboards comprise foolproof fuse switchgear of Berry's patent type, and the necessary meters and instruments mounted either above or below (or both) a chamber containing the 'bus bars. The method of supporting these bars is most instructive, inasmuch as the arrangement employed admits of complete insulation from the framework. A reference to one of the illustrations will make it clear that the 'bus bars are self-supported by the connections from them to the circuit switches. These connections are of heavy gauge copper rod, and the greater the number of connections to be made the more rigid are the 'bus bars. The circuit switches are bolted to cross bearers and mounted tight up to the 'bus-bar chamber. They are also set back from the main frame to ensure a flush front to the whole board. Each separate unit is interlocked, and a 'bus-bar chamber provided where necessary with a locking bar and padlock, rendering the 'bus bars accessible only to the responsible man in charge.

All connections are under cover, but it should be noted that they



FLOOR PATTERN "IRONSAFE" BOARD.

ing or the front of the board, a foot which enables the board itself to be fixed directly against the wall. Erected in this manner, the switchboard conforms with the requirements of the Home Office



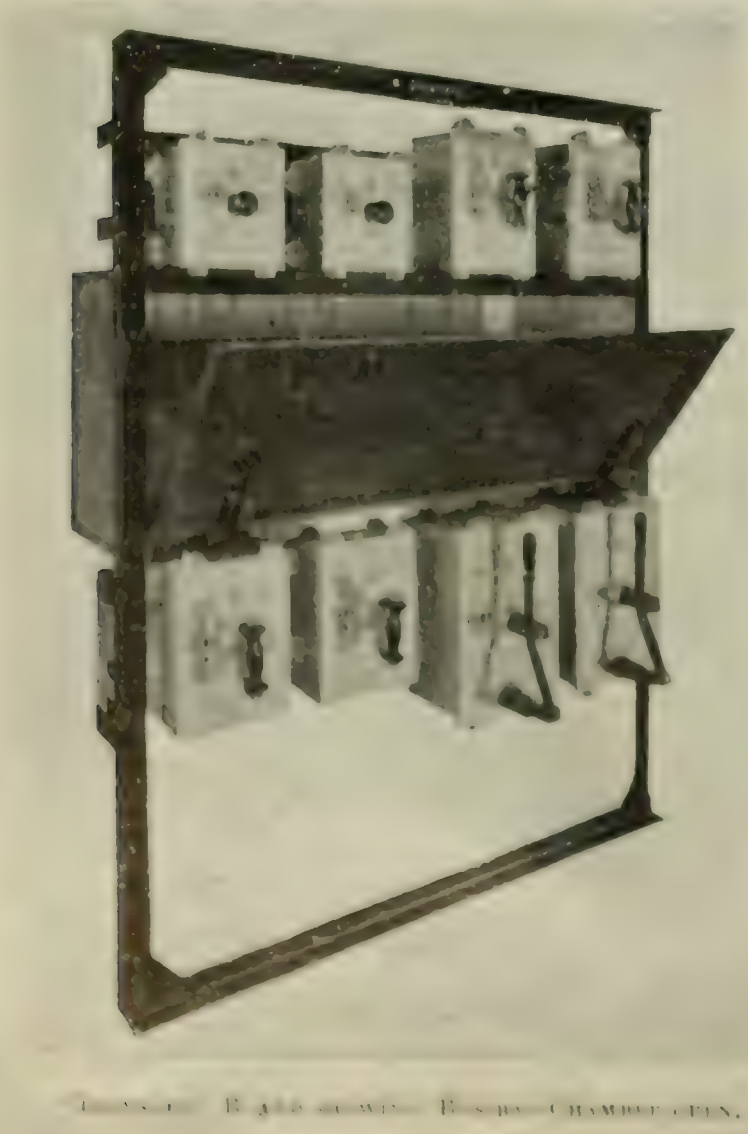
[Self-contained Pedestal-type "Ironsafe" Board.

without screening doors or gangways in front. To realise exactly what a great space saver an "Ironsafe" switchboard can be, the case of an "open" type slate or marble arrangement may be considered. Assuming the overall length of this "open" type switchboard to be 15 ft. at the back, a 3 ft. clearance is required to give safe and convenient access to the connections. Further, the Home Office regulations call for a railed off gangway in front of 4 ft. 6 in. for the safety of workpeople. Taking the depth of the switchboard proper with apparatus as 18 in., there is a total depth of 9 ft. by a length of 15 ft., representing 135 sq. ft. of floor space occupied. An area of 30 sq. ft. is all that is really necessary for an "Ironsafe" switchboard of the same length. At the present moment, when munition factories and Government contracting works are running at high pressure, the saving of 100 or more square feet per switchboard of a factory floor is a matter of vast importance. In every case the space saved must assist in reducing standing charges. We have only dealt with one; there are several other particular features of this design of switchboard which should be given notice, amongst them being the following:—

1. The system lends itself admirably to the adding of extension panels, which can be constructed uniformly with existing sections.
2. The whole board is practically watertight; can be made absolutely so if necessary.
3. It is dustproof and flameproof.
4. Fuses can be replaced in a few seconds in any unit, and by an inexperienced person if necessary, without the possibility of receiving shock. The covers of switches can be opened only after first removing the switch to the "off" position, when the fuse carrier parts are "dead."

The 'bus-bar chamber or circuit switches can be made suitable for receiving any size or class of cable.

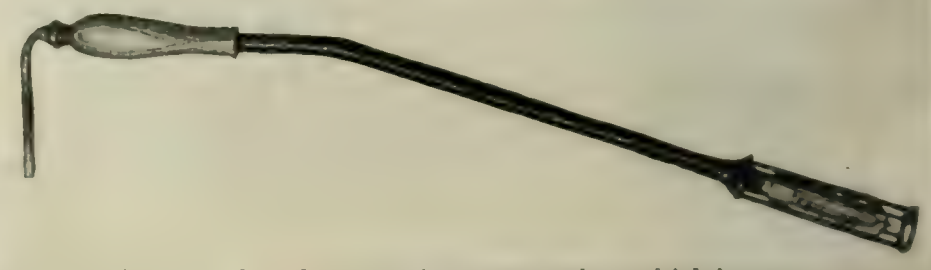
The method of auto-locking the 'bus-bar chamber to prevent this being opened until the 'bus bars have been made "dead" by the removal of the main switch to the "off" position is shown in one of the illustrations.



[Self-contained Pedestal-type "Ironsafe" Board with Bus-bar Chamber open.

EDISWAN SHELL INSPECTION LAMP.

This fitting is provided with an earthing device, and is sent out wired complete with lamp-holder (S.B.C.), and 3 yds. of three-way (two-way and earthing wire) circular workshop quality flexible cord.



The chief points of the lamp are its construction, which is extra strong with a view to hard factory use; also its moderate price, it being listed at 12s. 6d. only.

THE LIGHTING OF DRAWING OFFICES.

For the lighting of drawing offices the British Thomson-Houston Co. advise the use of Mazda half-watt type lamps in "Lumina" semi-indirect lighting fittings. A number of drawing offices have



B.T.-H. "Lumina" Half-watt Fittings.

been equipped in accordance with this recommendation, and we understand that in every case satisfaction has been expressed by the draughtsmen themsleves. This system of lighting is used by

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
H. HARTJEN & CO., 35/37, NOBLE STREET, LONDON, E.C.

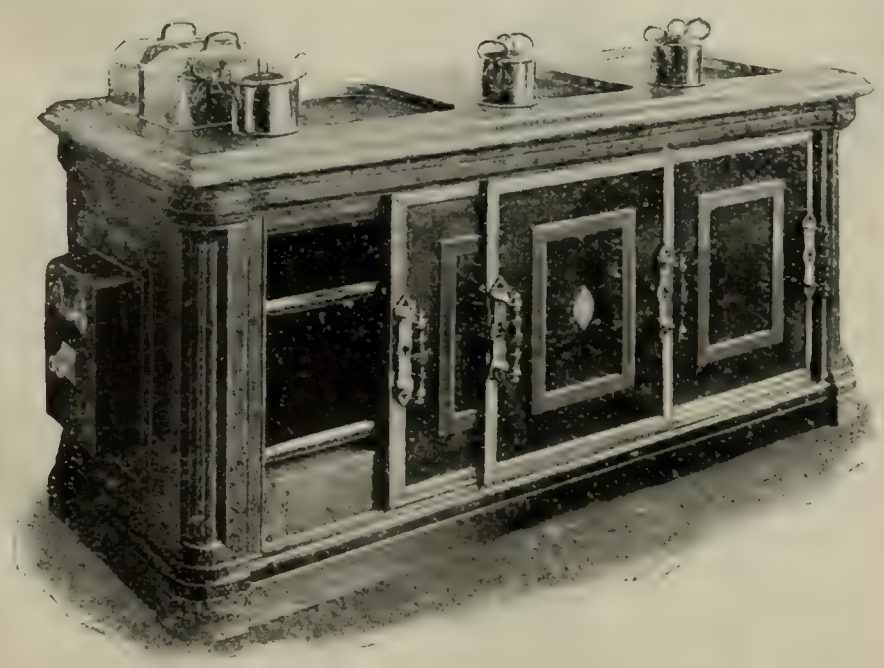
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No. 527.—HOT CLOSET AND CARVING TABLE.

Strongly constructed of cast-iron, having polished top with O.G. mouldings all round, copper water bath underneath hob fitted with draw-off cock. Can be made in various sizes.

Hob is fitted with three carving recesses. gravy wells and vegetable warmers, made of heavy gauge copper, tinned inside with pure tin, carving recesses fitted with block tin covers hinged to hob at back. Bright mounted wrought-iron sliding doors with brass mounted handles are fitted on both sides, etc.

By Appointment Ironfounders to H.M. the King.

The limit of possibilities in the application of electric energy is realised in

CARRON ELECTRIC COOKING APPARATUS

They are thoughtfully designed, and combine in simple form those features that make for perfect cooking.

Full particulars of this and other Carron Electric Appliances are given in No. 17E Pamphlet, sent post free on request.

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SOCKETS & PLUGS

FOR HARD SERVICE.

Sizes up to 200 amps.
D.P. and T.P.

Also Combined Switch and Plug Boxes.



DORMAN & SMITH, Ltd.,

Ordsal Electrical Works,
SALFORD,
MANCHESTER.

an engineering and shipping firm of world-wide reputation in the Newcastle area. The engineer was, we gather, in conversation recently with one of the B.T.-H. lighting experts, and the lighting of the drawing office was mentioned. The engineer stated that he had great difficulty in preventing the draughtsmen using the new lighting during the daytime—they declared it better even than daylight.



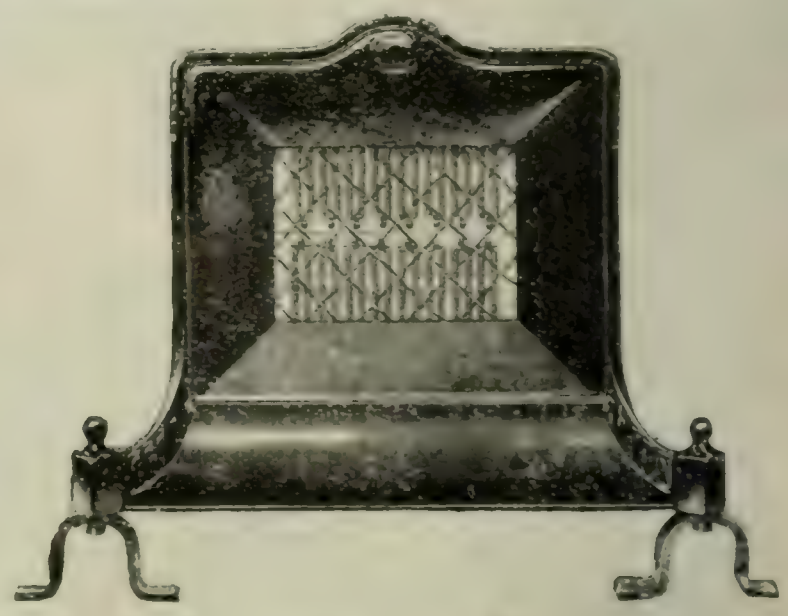
General View of Drawing Office Lighted with B.T.-H. "Lumina" Fittings.

This is striking testimony to the efficacy of the work of the B.T.-H. illuminating engineering department. We give a reproduction from a photograph of a drawing office, and also illustrate the close ceiling and the pendent patterns of "Lumina" fittings.

"ARORA" ELECTRIC FIRES.

These new and interesting fires are manufactured in Loughborough under a British patent by the Arora Co. The element is built of an extra heavy section of wire, which, we are informed, would not glow under ordinary circumstances, but owing to the patented form of construction a pleasing glow is obtained at quite low current density and with the production of a maximum of radiant heat. With the Arora heavy elements it is claimed there is a minimum risk of oxidation. The elements are mounted on a stout fireclay body, and the framework is of cast iron throughout in two main parts—the fire unit and the front. The former is a complete unit forming a standard part which is interchangeable with any front of the three [illegible] It contains two 750-watt bars, two switches, two heavy terminals complete with 2 yds. of 70/36 S.W.G. flexible cord, and is attached to the front by two bolts only. The fire bars are also interchangeable and may be obtained at the low cost of 3s. 3d. net per 750-watt bar.

Arora fires as shown herewith were put on the market in the middle of January this year, and, we are informed, that within a month orders were executed for over 40 corporations. Many repeat orders for large numbers have since been received, and high opinions have been expressed as to the pleasing high-temperature effect. A similar fire to that illustrated, but 3 in. higher, to allow the addition of a third fire bar, is going through the shops, and will be ready shortly. We also understand that a boiling plate of the open type will soon be put on the market to meet the demands of the public and many central station engineers for a quick and reliable boiler at a moderate price.



"Arora" 1½ kw. Fire.

We may remind our readers that the Arora Co. was started in the summer of 1915 by Mr. Eric W. G. Burdar, a keen member of the Loughborough Electricity Committee, having engineering works and foundry in Loughborough. Having met Mr. F. S. Grogan, who had patents pending, and has, of course, had a unique experience of the public needs, their joint experience was put into operation with the object of producing at the foundry solidly built and reliable electrical apparatus for heating and cooking at popular prices. The works extend over many acres on the outskirts of Loughborough, and, besides having their own private railway siding, goods can be dispatched on two main railways, ensuring prompt delivery to all parts of England.

Catalogues pricing and describing Arora apparatus are now available from the company at Loughborough.

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SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
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THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK.—The adjourned Inst.E.E. "alien enemy" meeting, at which amendments to the resolution could not be put and the resolution itself wasn't!

* * * *

The aforesaid meeting was divided into (i.) The Down and Outers, (ii.) The Hit and Misses, (iii.) The Wait and Sees. Which are you?

* * * *

There is a rumour that after the war Mr. Perren Maycock will more than ever indulge in methods of switchfulness. If it be possible.

* * * *

The manager of the local gas undertaking writes to the "Worthing Gazette" complaining that the installation of the electric light at the Grange (a local mansion used as a military hospital) "is prolonging the war and heaping up the indebtedness and taxation of the country." In a half-column letter he gives vent to a despairing appeal for the use of gas in war time. I am not surprised to notice that his initials are "S O S."

* * * *

The "one and only" Informal Meeting of the Batti-Wallahs Society, held on Friday evening last, was unanimously voted a complete success. The 80 members and guests who attended agreed that the Committee were fully justified in getting the men together once this season. "Admiral" Riggs made an excellent chairman, and the programme of song and music put up by the members and their friends was "top notch." The newly formed B.-W. Band, with Bébé Beevor as the big bassoon, was a "howling" item. Both the hon. secs., Pooley and Greenly, are to be complimented on the large muster and the entertainment. The Annual General Meeting has been fixed for March 20.

* * * *

The Edison & Swan Co., in spite of U-boat frightfulness and high tariffs, is keeping the flag flying in the antipodes. The company's Melbourne showroom, illustrated herewith, is well



stocked with fittings, radiators, fires, &c., which the Australian is very keen upon. The electric idea has caught on "down under."

Just to remind "Round Table" readers that the summer is coming, I reproduce this breezy little picture from a Los Angeles (where the films come from) illustrated paper.



* * * *

At the San Francisco Exhibition a competition was recently held among "broom stick" suction cleaners upon a square of heavy carpet. This fabric was covered with a mixture of dust, fluff, shavings, swan's down and wool waste, generally admitted to be "some" test! The successful competitor has just had an attack of spring poetry which has produced the following result:—

Ten little Suction Cleaners started out so fine,
One wouldn't pick up fluff, and then there were nine.
Nine little Suction Cleaners worked at such a rate,
One bust its motor up, and then there were eight.
Eight little Suction Cleaners (three less than eleven),
One fired all the matches, and then there were seven.
Seven little Suction Cleaners showing all their tricks,
One overheated and then there were six.
Six little Suction Cleaners, see how they strive,
One missed a dozen threads, and then there were five.
Five little Suction Cleaners, working on the floor,
One left a patch of dirt, and then there were four.
Four little Suction Cleaners, as busy as can be
One began to rattle, and then there were three.
Three little Suction Cleaners—not much left to do—
One couldn't stand the strain, and then there were two
Two little Suction Cleaners—now they're nearly done—
One broke off a fan blade, and then there was one.

Modesty (or shall I say trade etiquette?) forbids that the "one little suction cleaner" remaining be mentioned by name.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 1, 1879.]

MAGNESIUM AS A POSITIVE ELEMENT.—A pound of magnesium will generate nearly three times as much electricity as a pound of zinc.

ELECTRIC LIGHT.—Sir J. Anderson has induced Mr. Latimer Clark to deliver a very interesting lecture, illustrated with experiments, on the electric light, in aid of the funds of St. Saviour's Church, at the Eyre Arms Assembly Rooms, on Wednesday evening, March 5th, to commence at 8 o'clock. Tickets can be obtained on application to 16, Warrington-crescent, Maida Vale, 2s. 6d. and 5s. each.

THE TELEPHONE AND THE TORPEDO.—M. Marey, who is known as a physiologist, has been studying by means of the telephone the electric discharge produced by certain fish. He finds that, with suitable arrangements, the torpedo produces the note mi of 185 vibrations. This result coincides exactly with that already obtained by means of the graphical method, which necessitates the use of delicate and cumbrous apparatus.

'IGRANIC'
IGRANIC ELECTRIC Co LTD
147, Queen Victoria Street, London.

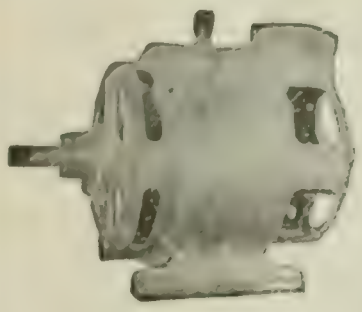


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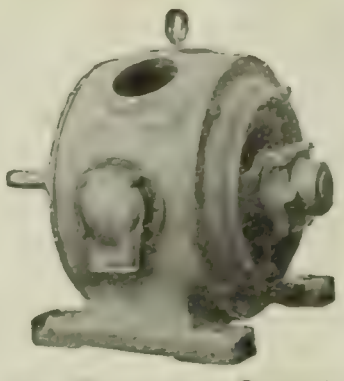


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STANDARD
ELECTRIC MOTORS



For Direct Current.



For Three-phase Current.

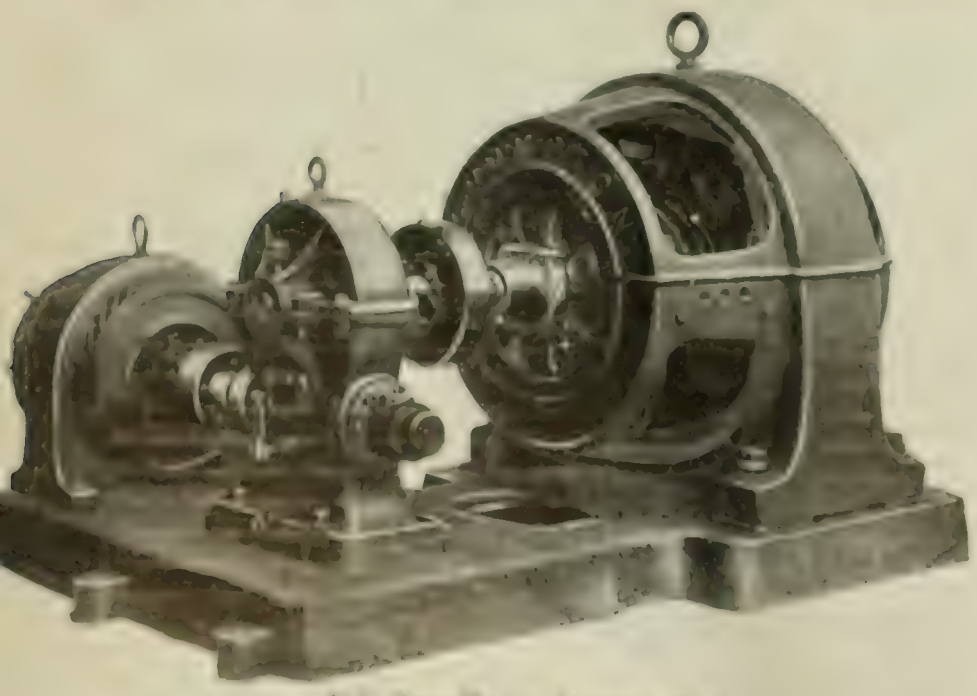
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KOHLER PRINTING PRESS CONTROL SYSTEM.

The [illegible] type control, illustrated herewith, was designed to meet the demand for an efficient equipment at a moderate cost where the conditions did not warrant the installation of a full automatic equipment and first cost required consideration. Inching and leading in speeds are controlled from any of the push button

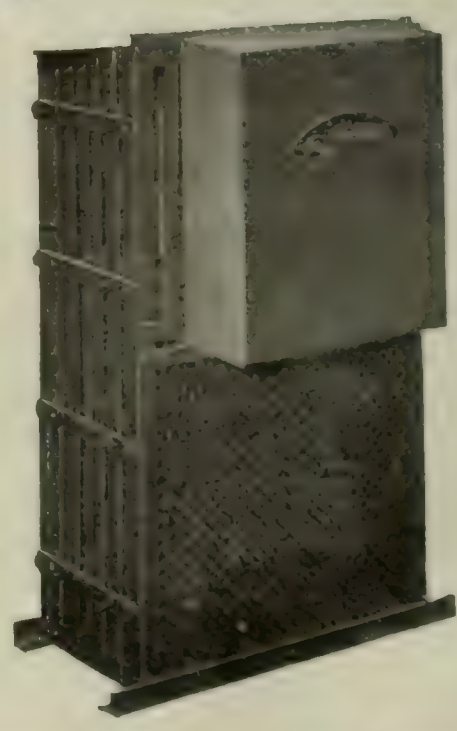


D.C. Two-Motor Driving Unit

[illegible] motor equipment operates as follows: The push-button stations are located wherever desired on the press. Each station contains four push buttons, marked "on," "off," "run," "safe-stop," and from any station the pressman can "inch," start the press running on slow motion or stop. For putting on blankets or plates the cylinders can be brought to any desired position. A movement of $\frac{1}{8}$ in. can be made.

For threading paper through the machine the pressman can run the press at a slow speed of approximately 6 revs. per min., or less if required, of the plate cylinders by pushing the "on" button, enabling him to handle the paper from point to point with great rapidity and ease. Before working in the machinery the pressman protects himself from injury by pushing the "safe-stop" button at the nearest control station. The press cannot then be started from any point until the "run" button at that particular station has been pressed, thus releasing the "safe." It is impossible, regardless of how the press-





Controller for A.C. Two-Motor Equipment

[illegible] man manipulates the push buttons, to start or stop the press with a jar or jerk. The acceleration of the press from slow motion to printing speed is accomplished by manually operating the lever on the main controller, which is located within convenient reach of the pressman.

By means of the automatic brakes provided the press can be instantly stopped from any push button station while operating at

[illegible] boxes placed on the press or from the controller itself; but when it is desired to run up to printing speed on the main motor it is necessary to hand operate the main rheostat on the controller panel. Each stop or safe operation can be stopped from any push button station as well as from the controller.

The driving equipment, which is also illustrated, is precisely the same as that supplied with Kohler full automatic equipments. The

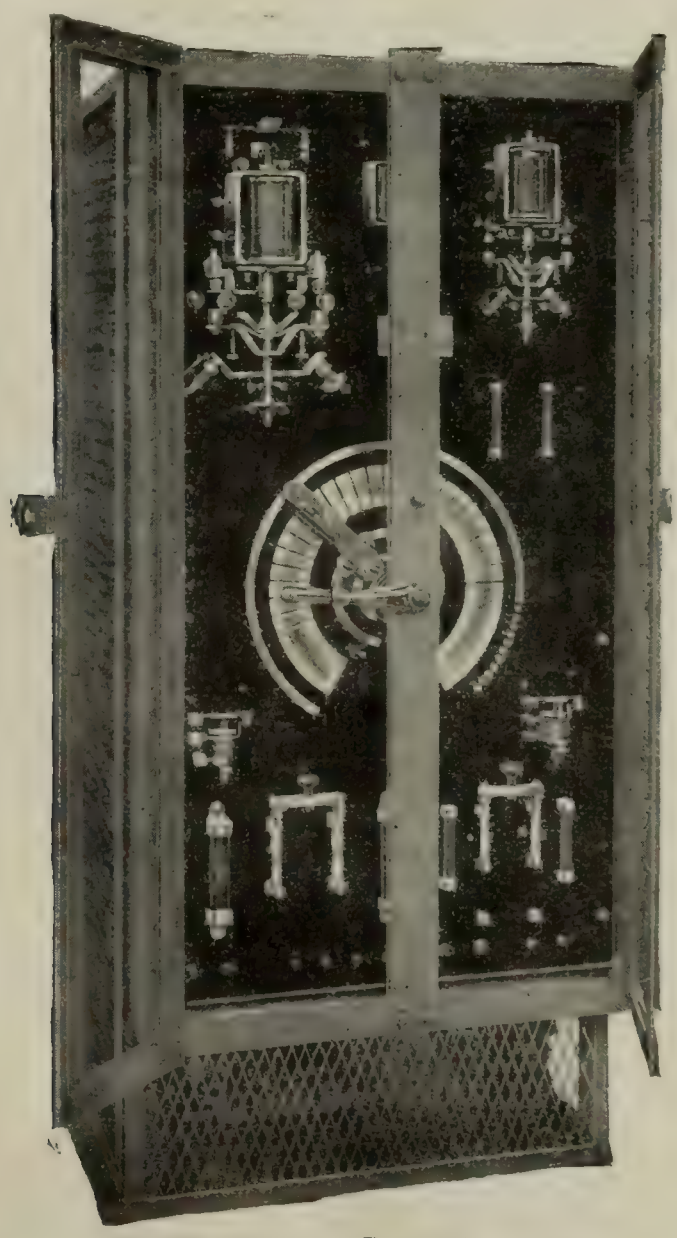
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GROESLON, R.S.O., NORTH WALES.
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Manufacturers of every description of
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(Hall's Patents)
For Cable and Pipe Presses, Accumulator Grids, etc.,
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
ENORMOUS SAVING IN RESIDUE.
Easy Payments arranged in special cases.
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any speed, the time required to stop being only the few seconds necessary to prevent stripping of gears. If for any reason, whether by failure of current, mechanical accident or design the press is stopped, the controller lever must be returned to the starting point before the press can again be started, owing to the system of electrical interlocks. The above description for the two-motor equipment also applies to the four-motor equipment, either when the presses in the combination are run independently or as one press.

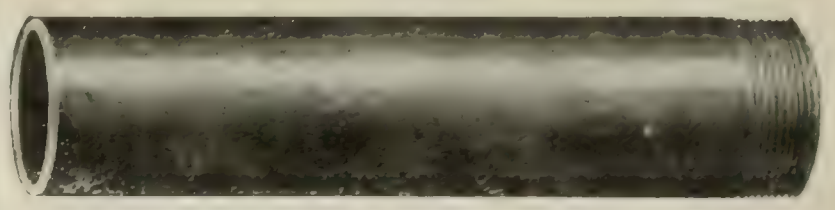
The controller front is equipped with the necessary automatic switches for the control of the power plant. These switches are all of the double break pattern, fitted with laminated phosphor-bronze brushes and carbon breaks, or alternatively of the clapper type.



"N.K.S." Printing Press Controller.

Both types are fitted with powerful magnetic blow-outs. All making and breaking of circuits is carried out on these switches, and not on the automatic regulating rheostat. The rheostat is of the radial arm pattern, and is provided with heavy copper renewable contacts. An ample number of speed steps is provided, varying according to the load and amount of shunt regulation required. Wherever possible, all speed variation is carried out from lowest to highest printing speeds by shunt control. On the four-motor controller automatic paralleling and equalising switches are provided, and a mechanical coupling gear interlocking the two starting rheostats,

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consisting of oven 22 ins. × 13 ins. high inside, two cooking plates 8¾ ins. diameter, and surface general heater, nine adjustable heats.

Also one . . .

ELECTRIC OVEN

size 16 ins. × 9 ins., cooking plate on top 8¾ ins. diameter.

Both for 240 volts, absolutely new. To clear at less than cost price.

Of the well-known "Electra" make.

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Contractors to the Admiralty, War Office, India Office, Colonial Office, Postmaster General, etc.

which makes it possible simultaneously to operate both equipments from either controller or any push button station. The gear may easily be disengaged when the equipments are required to run separately.

An auxiliary control station is provided, which gives the pressman absolute control over the press from the controller as well as the control stations on the press. When specified, the controller front is totally enclosed in sheet iron cover, with double doors, fitted with wired glass. All parts are built to jig and template, and are therefore interchangeable. The armature or rotor resistances are usually furnished with controller in one complete unit situated at the back and attached to the controller panel. They are built entirely of metal and wire, and of the grid pattern contained in iron frames. All connections between resistances and rheostat are solid copper rods. Resistances can be furnished separately from the controller if so desired.

The worm reduction gear is enclosed in a cast iron case, with oil bath, inspection door and oil level indicator. The worm wheel shaft is extended and fitted with automatic free wheel clutch, engaging and disengaging with the main motor shaft. The worm is cut out of a solid forging, running in phosphor bronze self oiling bearings, and fitted with double ball thrust bearings. A substantial cast iron bed plate, heavily ribbed, and with planed facings, is provided, on which the motors and slow motion gear are mounted, aligned and dowel pinned in position before leaving the works, thus ensuring a thoroughly sound mechanical job. Each piece of operating being provided with dowel pins always ensures correct alignment on final assembly on site. The general lay-out of the alternating current power plant is similar to the direct current plant, but in addition a magnetic friction brake operated by a solenoid is provided.

The motors are specially designed to suit individual jobs, and are of the enclosed ventilated type, continuously rated, compound wound and fitted with interpoles. The 25 H.P. sizes and above are provided with hand-hole split light frames to give easy removal of the armature without disturbing the rest of the plant. This is an important feature as in many cases the space in the press pit is so limited that it is impossible to withdraw the armature in the usual way.

A pamphlet dealing with this equipment has been prepared by Kaye Brothers, 56, Lodge-hill, London, E.C., and may be obtained on application from them.

"LEKTRIK" SWITCHES.

Referring further to Messrs. A. P. Lundberg & Son's new List I., upon the issue of which we recently commented, although it only deals with the single-way "Twinob," double-pole and triple-pole types of small switch, two-way switches may be priced and ordered from it, about 20 of the 30 different forms of single-way switch being made in the two-way type. This fact will make the list of increased value to contractors, &c., as the use of the two-way switch is increasing daily.

As illustrating the exactness with which a customer may choose precisely what he wants, and order it in less than half a line, an example from that portion of the list dealing with the firm's well-known "Pivot" variety of tumbler may be taken. (*See* Fig. 1.) First he decides on the capacity, which may be 5 or 10 amperes. Supposing the former will do, and no special modification is required, he next decides whether he wants a surface or flush switch, and between ordinary and Admiralty-pattern terminals, the latter being seen on the switch in Fig. 1. If the customer chooses the surface



Fig. 1.—"Pivot" Single-way Switch. (One of various patterns.)

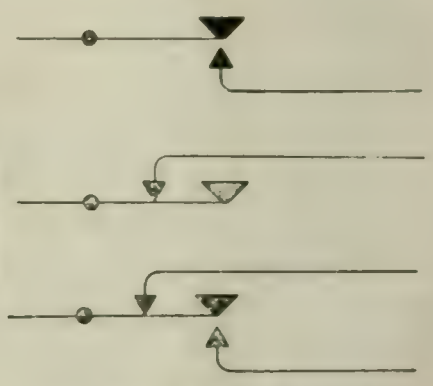


Fig. 2. "Key" Action of Modified Tumbler Switches.

form he can ask for black or cream (vitreous) porcelain. Now comes the question of cover, of which there are a dozen varieties, one being in porcelain. If a metal (*i.e.*, brass) cover be chosen it may be obtained in any one of 16 different finishes.

The following specimen order is given on p. 21 of the list :—

12 doz. 1702 VB BF F2.

The catalogue number covers the type, form, colour of porcelain base and the cover, the modifications being VB (vitreous-porcelain base), BF (fibre lining to cover), and F2, which signifies "steel-bronze relieved," as being the finish desired.

One of the interesting features of the construction of certain types of Lundberg switch is that they may be modified to have either spring-on or spring-off action, and so correspond in principle with various kinds of signalling or testing key. Thus Fig. 2 shows diagrammatically what can be done with "Pivot" single and two-

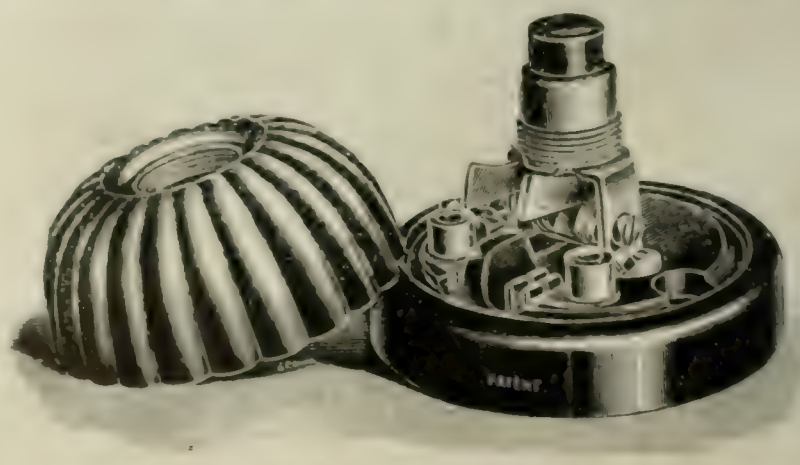


Fig. 3.—Spring-off Push Key.

way switches, it being remembered that the contact is of a better nature than that in an actual key. These switch-keys, as they may be termed, resemble an ordinary switch outside, in that they have the usual knob or dolly, or else the movement may be fitted with push-button action like Fig. 3.

Accessories of this type have quite a number of uses that are not immediately obvious. "Pivot" single and two-way switches may be fitted with a slot or groove in the base as in Fig. 4; and they are then adapted for use with surface wiring when wooden switch blocks are dispensed with. The flush forms of "Pivot" and "Twinob"

Canadian and Indian MICA

CUT, SLAB & SPLITTINGS.

MINIMUM STOCK 200,000 lbs.

Peerless Leatheroid Insulation.

Dynamo Tapes, Hollow Braid, Empire Cloth.
Pure Asbestos Ribbons, Paper, Tubes and Sheets.
Pure Asbestos Woven Tape and Hollow Braid.
Vulcanized Fibre Sheet, Tube and Rod.
Ebonite Fibre, Sheet, Tube and Rod.
Presspahn and Insulating Papers, Felts, Baize.
Electrical Pure Rubber and Adhesive Tape.

WE HAVE BEEN AWARDED THE CONTRACT FOR THE WHOLE OF THE MICA REQUIRED BY BRITISH ADMIRALTY OVER 1910, 1912, 1913, 1914 and 1915.

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Hopwood St. Mills, PRESTON.

Established 1868. Codes: 5th Edition A B C & Western Union.

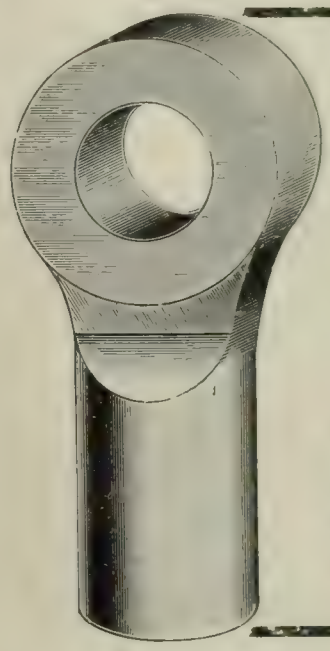
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„ B.—Offset.
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switches are often supplied in bushed brass boxes for wood casing and similar work; and they can be had without these particular boxes, and may be fitted in ordinary conduit boxes.

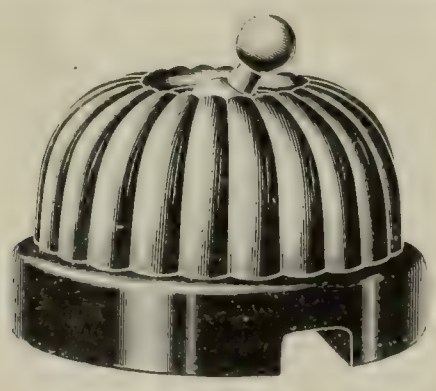


FIG. 4.—GROOVED OR SLOTTED SWITCH BASE.

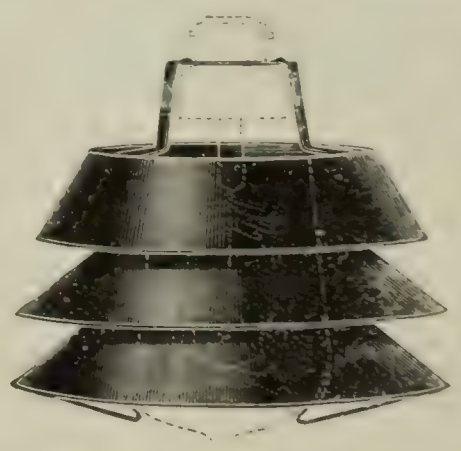
The list gives complete dimension of the various switches, &c., in inches and millimetres, and a copy of it should be applied for from A. P. Lundberg & Sons, Liverpool-road, London, N.

THE "DIFFUSA" ANTI-AIRCRAFT LIGHT SCREEN.

The necessity of providing some alternative to the present expedients adopted for complying with the street lighting restrictions in force in areas liable to attack by aircraft is constantly urged by local authorities and the public alike. The introduction of the "Diffusa" Anti-Aircraft Screen is an attempt to satisfy this want. At present, not only have the number of lights been reduced, but the means adopted to render those remaining invisible from above, by shading, painting the tops of the globes, masking the greater part of the depth of lanterns, or, in the case of exposed electric glow lamps, coating them with opaque lacquer, has resulted in spotty illumination. The sudden transition from a comparatively bright patch to almost total darkness is a public danger and a not infrequent cause of serious accident.

Experience has also proved that the practice of coating electric glow lamps with opaque lacquer is unsatisfactory, weather conditions and the temperature of the lamps necessitating frequent attention, while the life of the lamps is seriously shortened.

The "Diffusa" Screen has been designed to remedy the drawbacks of the expedients referred to, and consists of a series of conical metal rings, finished dead black, placed one above the other. Its use will cut off all upward rays, avoid the production of bright spots of light



METAL "PETTICOATED" ANTI ZEP SHADE.

which results when plain conical reflectors are used, and yet afford satisfactory and well-diffused illumination at all angles below the horizontal. It is equally suitable for gas or electric light, and requires no alteration to existing lanterns or reflectors.

Samples will be sent on approval to lighting authorities and engineers interested on application to Falk, Stadelmann & Co., Farringdon-road, London, E.C.

GYRATORY FOUNDRY RIDDLE.

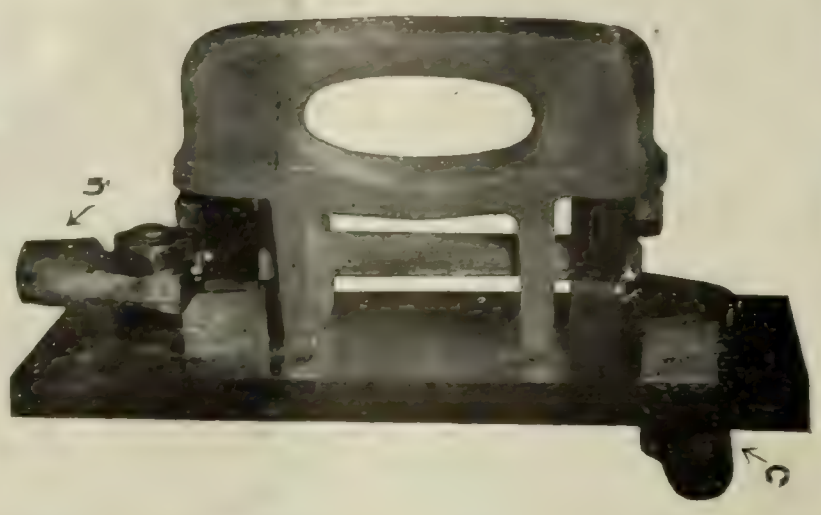
The device illustrated has been designed to reduce the cost of labour in making castings. The machine is a foundry riddle of the gyratory type. The motion of the riddle is obtained by the inertia effect of an unbalanced flywheel which causes every part to gyrate. The sand travels around in a circle. The outfit complete weighs about 90 lb. and can be easily moved from place to place as it is

D. & S.
"HANDLE" FUSES.

50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.



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needed. The riddle is particularly useful suspended from a trolley running on a cable stretched parallel with the line of moulders in the foundry. Owing to its design there are no obstructions in the way of a shovel, and, being supported from above, a wheelbarrow can be run under the riddle for receiving the sand.

The riddle, which is described in the "Electrical World," is operated by a Westinghouse totally enclosed ⅛-H.P. vertical motor made especially for the Great Western Manufacturing Company of Leavenworth, Kan., the maker of the outfit. A cord and plug are provided which may be connected to any lamp socket. The motor is equipped with a ball thrust bearing, and a total of only three bearings are used in the drive, all of which are dust proof. The riddle is provided with a sieve 20 in. in diameter, and is designed to do as much work as would be performed by a crew of 10 men sifting sand by hand in the old fashioned way.



MOTOR DRIVEN RIDDLE IN OPERATION

B.T.-H. INCANDESCENT ELECTRIC LAMPS.

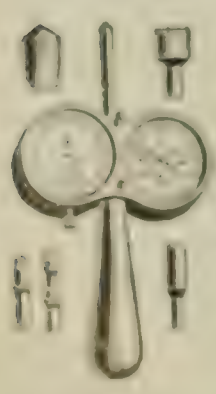
In 10 years' time improved types of incandescent lamps have been evolved in such variety that a 48-page catalogue is now needed to describe and price them. The latest price list of incandescent lamps, just to hand from the British Thomson-Houston Co. (Ltd.), Mazda House, 77, Upper Thames-street, London, E.C., is of more than usual interest, not only to those who are engaged in buying and selling lamps, but to electrical engineers generally. It contains data regarding Mazda lamp characteristics that is of value to those who are concerned with modern illumination. No fewer than 49 distinct types of Mazda lamps with tungsten filaments are now listed. Most patterns are made for a range of voltages, and in a number of wattage sizes, and can be obtained with two or more alternative styles of caps.

For alternating-current circuits in conjunction with house transformers, Mazda lamps are available in units as small as 5 British c.p., the smallest lamp of all being one for use with a portable battery and giving 1 c.p. at 2 volts. At the other end of the scale is the Mazda half-watt for street lighting, giving 3,000 c.p., for an energy consumption of 1,500 watts. Between these two extremes are to be found lamps of every size and shape for ordinary and special applications. The lamps are listed with bulbs that are pear-shaped, spherical, conical, twisted, or of tubular form, buyers being given the option of bayonet, centre contact, or Edison screw caps. The standard lamps with drawn-wire filaments are made in sizes up to 200 c.p., higher candle-powers being catered for by the half-watt lamp, which can now be obtained for high voltage circuits in units from 100 to 1,500 watts.

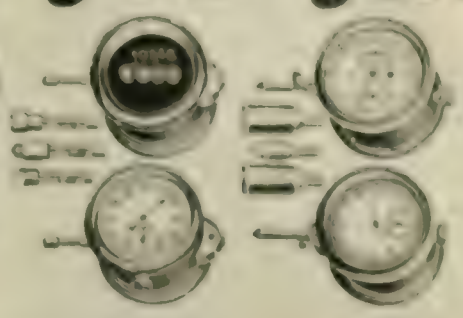
Among special forms of Mazda lamps should be mentioned the focussing type with bunched or with grid filaments. These are useful where a concentrated beam of light is required, for all kinds of light projectors.

A complete range of half-watt lamps is included, the smallest unit, apart from the automobile type, being of 15 watts for 25-volt circuits, a projector model with grid-shaped filament, being offered for photographic and for cinematograph lantern work. The present catalogue also includes details of B.T.-H. carbon lamps in the standard, radiator and decorative types.

A copy of the list, which brings up-to-date information regarding the entire range of incandescent electric lamps made by the British Thomson-Houston Co., can be obtained on request to Mazda House, 77, Upper Thames-street, London, E.C.



Jas. Jaquet, Ltd., Basle
Switzerland.



Combined Revolution Counters, with Chronograph.





Very Accurate Timekeepers.

CHRONOGRAPH AND STOP WATCHES.

Lists on Application.

Printed and Published by the Proprietors, "The Electrician" Printing and Publishing Co., Ltd., at the Electrical Press and Publishing Offices, 1, 2 and 3, Salisbury Court, Fleet Street, in the City of LONDON, Friday, March 3, 1916.

THE ROUND TABLE.

By "KVA."

Siemens and Ediswan footballers met on Saturday last at Ponders End, and the latter lifted the Challenge Cup given by the former, the scores being 3–1. I hear, quite unofficially of course, that the referee is a Middlesex poultry keeper.

* * * *

An amendment which was *not* put at the meeting of the Inst.E.E. on March 1st :—

"Mr. President, I beg leave to propose an amendment that the honorary solicitor be, for the purposes of this meeting, declared out of order, and d——n the consequences."

* * * *

I hasten to congratulate my old colleague Capt. F. H. Masters upon his promotion to the rank of Major in the London Electrical Engineers (T.F.). In the early days of the Round Table he wrote many breezy little stories under the nom de plume of "Geraldine." I will award him a hot plate *pour le mérite* next week.

* * * *

At a certain technical institute the Professor of Mechanical Engineering was rather fond of quotations at the head of his examination papers. One of these read : "Work is for the living." A few days later this was pinned on the notice board, and under it was written : "O Death, where is thy sting !"

* * * *

The name of Grogan's new electric fire, the Arora, gave one of our "comps." pause. He must have been guided by Grogan's former experiences as a cook. He then decided that the name should be ATORA, the famous beef suet ! Such is the association of ideas, and fame !

* * * *

I am permitted to disclose the hidden meaning of the name which "Kukri" Grogan has adopted for his fire. Like another Irishman famed in story, he has a leaning to acrostics. Therefore Arora means All Radiant Over Right Area. One thing Grogan has not yet explained to me, why he wanted a name which read the same backwards and forwards.

* * * *

My note last week regarding the unpatriotic letter of the manager of the local gas company to the "Worthing Gazette," who signed himself "S.O.S.," decrying the installation of electric light at the Grange, has brought me a letter from Mr. H. Willock Ravenshaw, A.M.Inst.C.E., in which he tells me that the Grange is not a *mansion* at all. It is a large house on the front at Worthing, which is being run by a Committee of City of London men for wounded soldiers. Mr. Ravenshaw suggests that we should contribute to the fund which is being raised to pay for the installation. After passing round the hat to our sadly depleted staff, I have collected half-a-guinea, which has been duly forwarded to the Matron, The Grange, Marine Parade, Worthing ; Mr. Ravenshaw may now redeem his promise to send a similar amount to the fund. I shall be delighted to forward to the Matron any sums, no matter how small, which my readers may care to send me for this laudable object. "S.O.S." will then have to swim for it !

* * * *

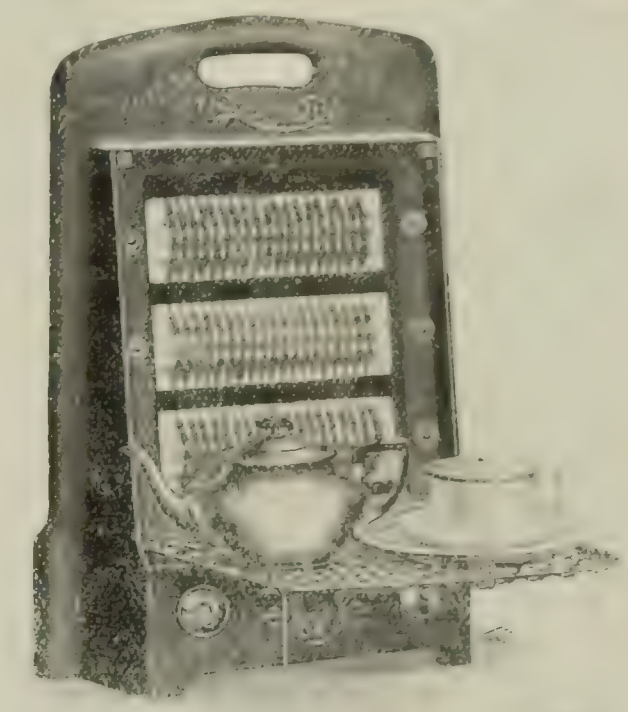
Apropos the above, I understand that the patients are a cheery lot, and make excellent company in a car. Any of my motoring readers are at liberty to call, give the pass word "KVA," and they will receive a hearty welcome.

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MINISTRY of MUNITIONS.
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GOLD, SILVER & PLATINUM REFINERS, 199, WARDOUR STREET, W.
"Golsilplat, Ox., London." 4746 Gerrard.

Now that their portraits have been published, I shall expect to see an announcement that Belling's Belles will shortly be ringing the changes in Radiant Revue.

* * * *

I will not apologise for the length of my hot plate list this week. In view of the Inst.E.E. adjourned meeting on Wednesday evening I could make it much longer. Never before in the history of the Institution has there been such "liveliness."



THE ANGELUS FIRE (STRODE & CO.), OR THE BACHELOR'S BREAKFAST IN WAR TIME.

* * * *

OUR HOT PLATES

No. 202 to—

Mr. Albert Gay (Islington) ("Albert the Good"), for his vigorous contributions to the "Proceedings" at the "Alien Enemy Meeting" of the Inst.E.E. on the 1st inst.

No. 203 to—

Mr. E. Macgregor Duncan, who made bold to disagree with the spirit of the "Proceedings" at the Inst.E.E. on the 1st inst.

No. 204 to—

Mr. J. Cuthbert Wigham for describing the alien enemy meeting at the Inst.E.E. as "piffling" or what we call in Oireland "pathriotism."

No. 205 to—

Western Electric Co., for their new and most excellent convertible interphone.

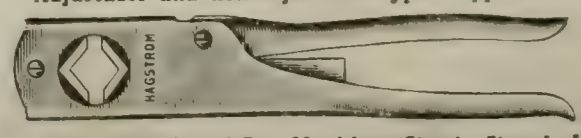
* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 8, 1879.]

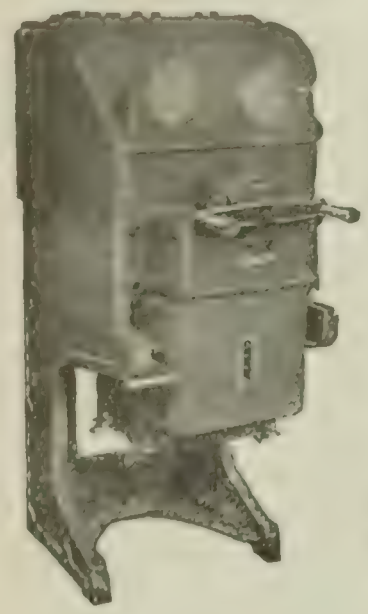
THE DAVY CENTENARY AT PENZANCE.—At a lecture given in the St. John's Hall on this occasion the electric light was shown. The following is a report from the *Cornishman* : "The electric light was lighted to the complete astonishment and eventually the admiration of all those present who had never seen it before. Many were the looks all round, to see the effect on ceiling and floor, decorations of the room and human faces divine. But the light will certainly have to undergo several changes or modifications yet, until it is generally accepted ; especially is this desired by the ladies, some of whom evidently considered its effulgent rays too strong for their complexions, and, consequently, took means to prevent any injurious effects by shading their faces with their fans, or programmes. It is also too strong for the naked eye to look upon for any time, unless one is possessed of the proverbial eagle eye, which looks the sun in the face without winking."

THE HAGSTROM ARC LAMP CARBON CUTTER.
Will sever carbon without crushing. Leaves straight, clean edge.
Adjustable and non-adjustable types supplied.



THE L.P.S. ELECTRICAL CO., 18, Adam Street, Strand, London, W.C.
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Write for particulars to —

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HEAD OFFICE: CAXTON HOUSE, WESTMINSTER, S.W.
Supplies Dept.: 38 & 39, UPPER THAMES STREET, E.C.
HOME BRANCH ADDRESSES:
MANCHESTER—196, Deansgate.
Branches in Principal Towns Abroad.

LIGHTING A SHIPYARD OFFICE

A typical example of a lighting installation carried out on scientific principles is that of the new offices of Sir W. G. Armstrong, Whitworth & Co. (Ltd.), Walker Shipyard, Wallsend-on-Tyne. Four



THE DRAUGHTS GROUP.

hundred and fifty lighting points are contained in the scheme, which, as we believe, has been [illegible] on a large scale in the Newcastle district to be equipped throughout with "Eye rest" semi-indirect fittings. [illegible] department throughout the entrance premises has been lighted with due regard for the purpose it serves, the treatment [illegible] to the class of lighting employed and the [illegible] candle power of the lamps used. The accompanying illustrations, selected from a number of special photographs [illegible] by the writer, [illegible] the results obtained.

The whole of the electric lighting equipment was supplied by the B.T.-H. Co. through the Newcastle-upon-Tyne Electric Supply Co. (Ltd.), the wiring work being carried out by R. W. Cairns, who acted as sub-contractor. The architects responsible for the buildings were Messrs. Cackett & Burns Dick. In the drawing office, which measures 84 ft. by 34 ft., are installed 22 "Lumina" semi-indirect fittings of the pendent type, each equipped with Mazda lamp



CORRIDOR LIGHTING.

"Lumina" semi-indirect fittings are also employed in the tracing and general offices. The close-ceiling type of fittings are used in both cases, Mazda half-watt lamps of 200 watts being employed for the tracing office and similar lamps, but of 300 watt size being employed for the general office. The tracing office lighting was



THE TRACING OFFICE.

intended originally to be effected by standard lamps, but with the introduction of low-candle-power half-watts these lamps were adopted. The lighting on the flat boards is, we are informed, in excess of that provided for in the specification.

With the indirect system the source of light is, of course, concealed

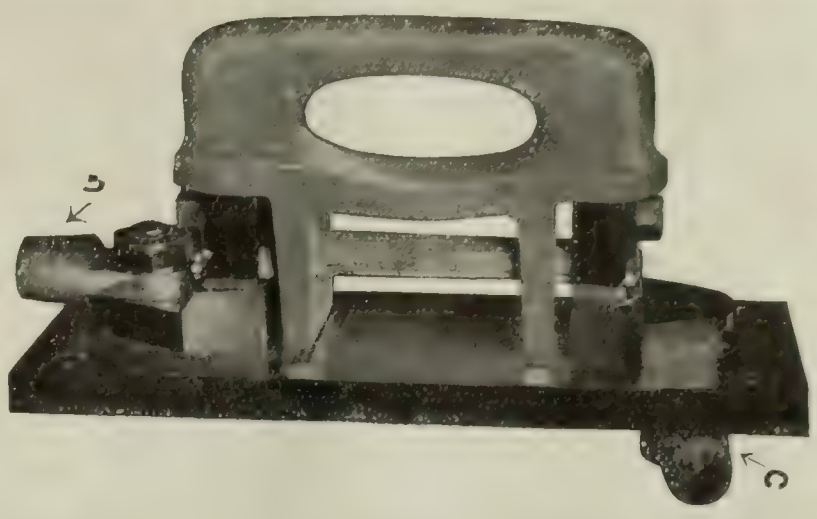
TINNING FURNACE
Hole's Patents
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER MANUFACTURING CO., Ltd., 14, Whitehouse St., Aston, Birmingham

D. & S. "HANDLE" FUSES.

50 amps. and upwards. 600 volts.

Asbestos sheathed fuse wire. Substantial porcelain carrier, effectually shielding hand from "live" metal.

THE IDEAL FUSE FOR POWER CIRCUITS.



DORMAN & SMITH Ltd.,

Ordsal Electrical Works.

SALFORD, MANCHESTER.

entirely, and for this reason many users have expressed the view that there is something wanting in the effect. To meet this objection the B.T.-H. Co. supply a range of fittings in which the lower portion of the "Eye-rest" bowl is of white or coloured glass. No alteration has been made in the reflector equipment, with the exception that a lamp of low candle-power, enclosed within a diffusing globe, lights up the lower translucent portion of the bowl, removing the dark effect of the indirect bowl without impairing in the least the efficiency of the system. These luminous bowl fittings can be supplied with bowls having panels of white glass or glass tinted to match the surrounding colour scheme.

The luminous bowl fittings are used in the directors' office, which is lighted by two "Eye-rest" pendants, with 24 in. panelled composition bowls, each fitted with two 100-watt standard Mazda lamps. The illumination is quite uniform, and such details as the pictures and the patterns of the carpet are brought out with remarkable clearness.

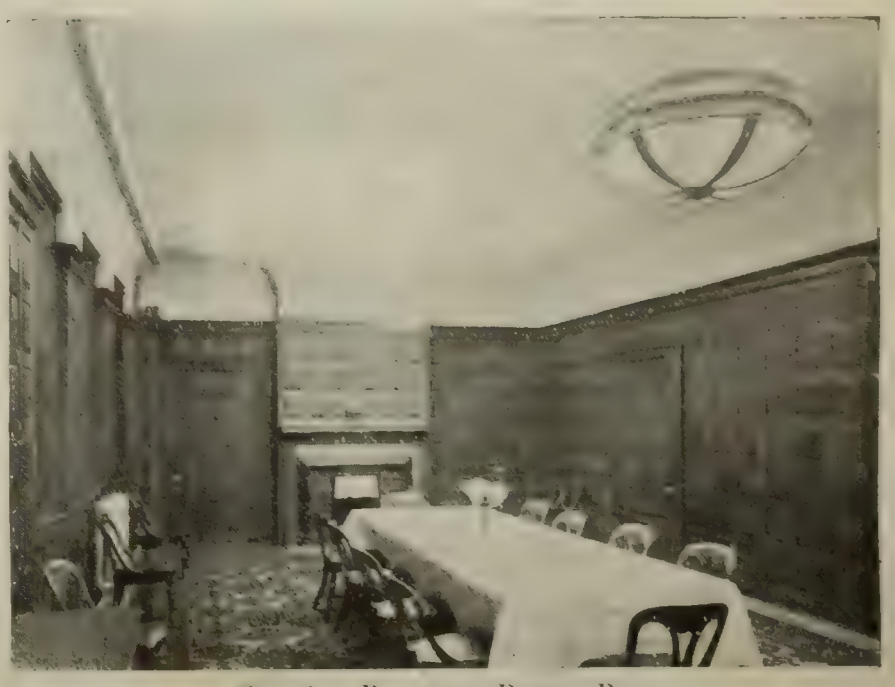
The dining room for certain of the company's officials is an apartment measuring 20 ft. 6 in. by 32 ft. 6 in., and panelled in dark oak. As lighting experts know, the lighting of a panelled room is not an easy matter. Excellent results have been secured in the present case by the use of two "Eye-rest" luminous bowl fittings, each equipped with six 60-watt standard Mazda lamps. The illumination is effective in spite of the dark tone of the panelling, the illustration showing that the pattern of the carpet is brought out, and also the outline and details of the articles of furniture and panelling. The whole of the cooking for the officials and staff, as well as for the workmen, is carried out electrically, the installation being one of th largest yet put down in the country.

Corridor lighting is another difficult problem, and those at the Walker shipyard offices are arranged on a curve, thus adding to the difficulty. Uniform and adequate lighting has, however, been secured by the adoption of ceiling fittings carrying smal spheres of ribbed "Alabas" glass, equipped with standard Mazda lamps. In the correspondence office four plain brass "Eye-rest" pendants, each with a 200-watt standard Mazda lamp, have been employed, ample light without glare or shadow being at the disposal of the staff, who are thus enabled to do their work in comfort and under ideal lighting conditions.

In the model room are arranged in glass cases models of warships and other vessels constructed by Messrs. Armstrong, Whitworth. The room, which is 25 ft. high, measuring 35 ft. by 45 ft., is lighted by four ornamental "Eye-rest" pendants with composition bowls, each fitting concealing a 500-watt Mazda half-watt lamp. The walls are dark red, and, far from assisting reflection, they absorb a great deal of light; but it will be admitted that the effect with the units employed is highly satisfactory. Every detail of the models can be easily followed, while the hanging pictures and the mural paintings show up with surprising clearness. It should be mentioned that the photographs here reproduced were taken by the unaided light of the Mazda units installed, and have not been retouched in any way.



THE MODEL ROOM.



THE OAK-PANELLED DINING ROOM.

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE.
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
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CHARLES CLIFFORD & SON, Ltd.
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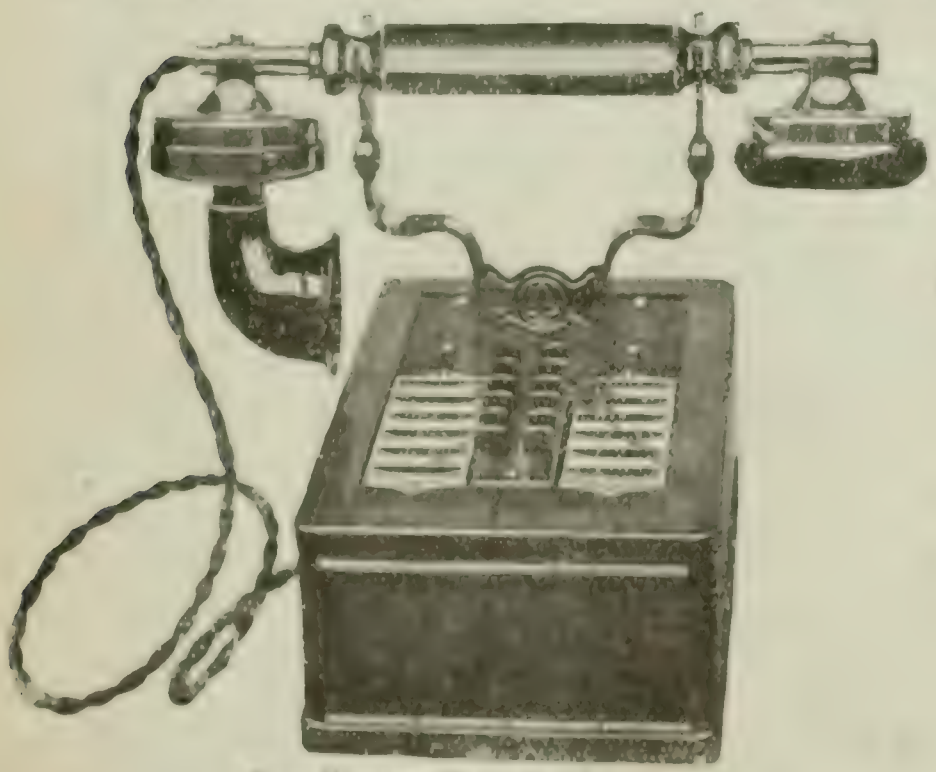
INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
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A NEW INTERPHONE.

Most of the intercommunication telephones now on the market fall naturally into two classes: (1) cheap and flimsily-built instruments, which are not effective nor strong enough to stand the heavy work put upon them; and (2) strongly built instruments, which are heavy in appearance and are unpopular owing to their size and cost.

The new Western Electric interphones are substantially built, but are not in the least clumsy in appearance. They are fitted with hand micro-telephones, and they operate on the central battery principle, one battery of four or five dry cells supplying the speaking current and another group the ringing current. Like all battery-ringing telephones, they are limited, under ordinary conditions, to a line of about 2,000 ft. between the two most distant instruments.

By the judicious use of light metal frame-work and light woodwork



New Western Electric Interphones.

and ornamental plated fittings, the company have constructed an instrument which is sufficiently strong to stand heavy service, and is at the same time neat and ornamental in appearance.

The woodwork employed is polished walnut, and the case of the instrument is made to open in two places: (1) the top lifts open on a hinge for connection and adjustment; (2) the whole body lifts open from the bottom on a hinge, allowing the terminals perfectly free for connection and examination of the cabling.

The hand micro-telephone is strongly made, and is fitted with a push-button switch and lifting cradle. All manufacturing conditions permitting, it is understood that the micro-telephone will be provided with an improved moulded metal handle, but it may be necessary to supply it with bone handle.

In the pattern which we have examined the metal handle is fitted, and it is noticeably of a peculiar shape, a form which is more comfortable for the hand than the usual handle.

The cradle switch is one of the most striking and novel features of the instrument. It is very strong and reliable in action, and the two hooks can be turned at an ordinary screwdriver, by means round at right angles, enabling the wall set to be converted to a table set, and vice versa. In so simple yet effective a manner one of the most troublesome problems of the inter-communication telephone has been solved.

The company's now well-known push-button system of selection is used, and it is only necessary to press one button to both select and call the line required. This system has been proved to be efficient and reliable in practice. The buttons are automatically replaced when the hand micro-telephone is restored to the cradle. To reply to a call it is only necessary to remove the micro-telephone from the cradle and speak. No movement of the buttons is necessary, and great comfort to the user of the instrument is thus assured.

The ringing buzzers are of the small metal-cased type, and they require no adjustment, giving a clear and distinctive call sufficiently loud for all ordinary purposes, and less harsh in tone than a bell. Where a louder call is required, the buzzer can be replaced by a low-resistance bell. The retardation coil fitted regulates the current from the speaking battery, so as to give clear and efficient speaking, and at the same time makes the system free from cross-talk or over-hearing between the various lines.

The number of instruments which can be connected up on a system is one more than the number of buttons per instrument; thus, 7—6 button interphones, 13—12 button interphones, &c., can be installed together. A diagram of the internal connections and of cabling is supplied with each outfit. A neat metal framework for name plates is fitted so that each button can be plainly marked.

To make a call, the micro-telephone is removed from the cradle, and the button of the required station is pressed right down. This operates the buzzer at the required station. The button is then released and returns half way to the normal position. In this intermediate position it leaves the line correctly connected up for speaking.

To answer a call, it is only necessary to remove the micro-telephone from the cradle. When the micro-telephone is put back on the cradle any depressed button automatically returns to its normal position.

The number of wires required in the cable for connecting up these instruments is one pair of line wires for each instrument fitted, plus two pairs of battery wires; thus, a seven-station equipment requires a cable with seven pairs of line wires and two pairs of battery wires.

Four cells are usually sufficient for speaking, and the following number for ringing: 500 ft., 3 cells; 1,200 ft., 5 cells; 2,000 ft., 7 cells.

This pattern of instrument has a high standard of quality in intercommunication telephones, which electrical contractors should note and endeavour to maintain.

Prices and fuller particulars of these instruments are now available from the Western Electric Co., North Woolwich, or branches.

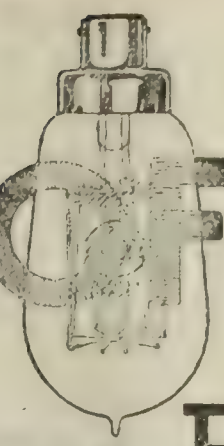
G.E.C. ELECTRICAL PLANT FOR CHINA.

Much has been written of late respecting the value of foreign markets to British engineering manufacturers. As an example of what can be done, we may refer to a few electrical contracts which have recently been secured in China by the General Electric Co., of China, Ltd., whose head office is in Shanghai, with a branch office in Hong Kong.

A contract for the electrical lighting of the ancient city of Ningpo has recently been secured. The new plant will consist of a 120-kw. Witton steam-driven three-phase high-pressure alternator, complete with switchboard, feeder panels, transformers, &c. The generating station is situated in the Chinese quarter of the city, and will transmit energy to the European quarter.

Another recent contract is that for the complete electrical plant for lighting the city of Yungchow. Electric light has not hitherto

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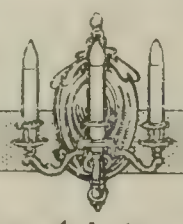
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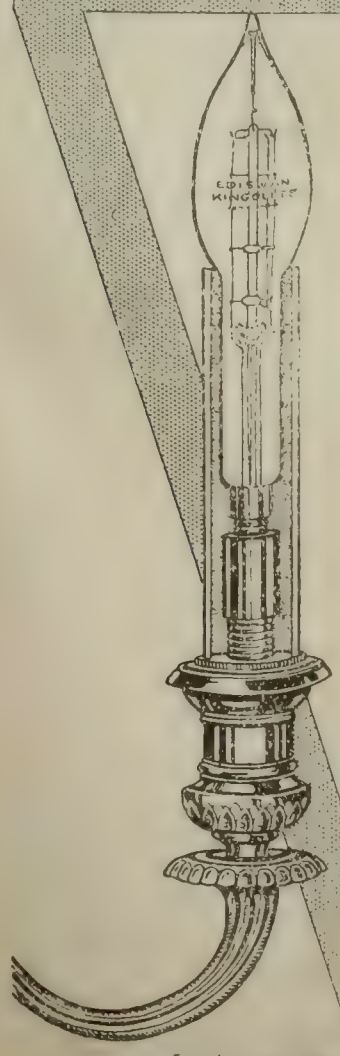
and cannot get out of the perpendicular.

The

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Our illustration on the left shows a section of the candle with the **3 separate parts,** which are sold separately, thus bringing forward a question of Economy, which is a good selling point—should **one part** get broken you renew **one part only.** Our illustration on the right shows the absolute Rigidity of the candle when in use.

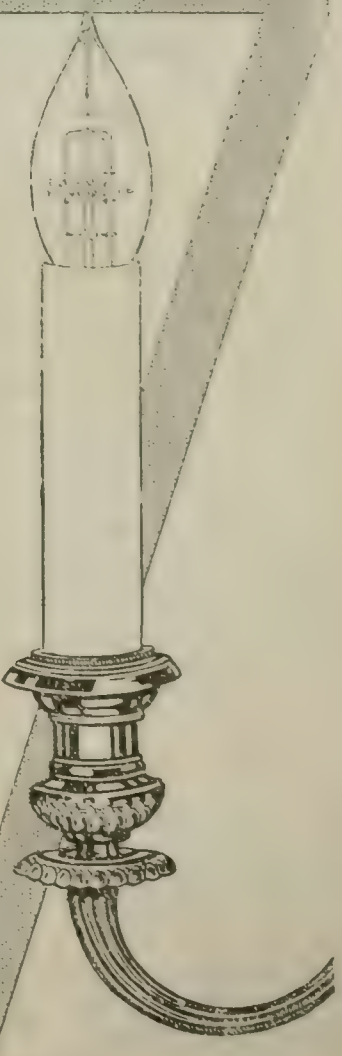
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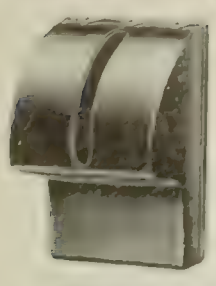


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MAKERS OF PRESSPAN AND INSULATING MATERIAL.

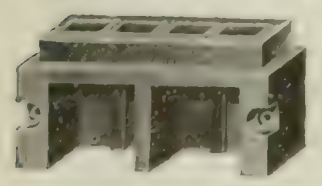


Pressboard -Presspan in Sheets, Rolls and Tapes, Oiled Presspan, Black Presspan, Presspan Tubes and Stampings.

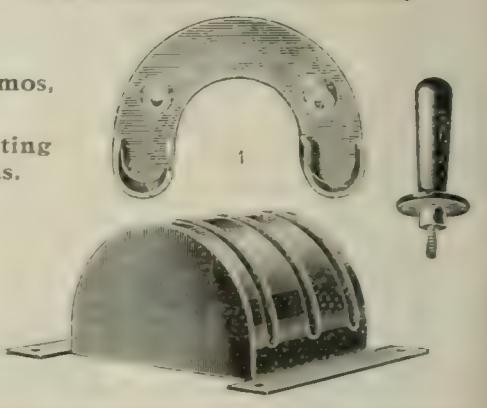
Amianite (Vulcanised Asbestos) Coil Frames, Spools for Apparatus, Dynamos, Motors and Transformers. Insulating Blocks, Tubes, Plates, Boxes, &c.

Bakelite & Cornite (high tension material) Handles of Switchgear and Heating Apparatus, Controller Insulation, Moulded Pieces, Terminal Covers of all kinds.

Asbestos-Cement in Plates, Arc Shields for Controllers, &c.



Mica and Substitutes, Insulating Pearls, Transformer Spools.
Japanese Felt and Paper in rolls and tapes.
Oil-Varnished Linen, Diagonal Tapes, Oil-Varnished Silk & Paper.
Artificial Leather Discs for Friction Drive.
Insulators for Electric Furnaces, Tramways, &c.

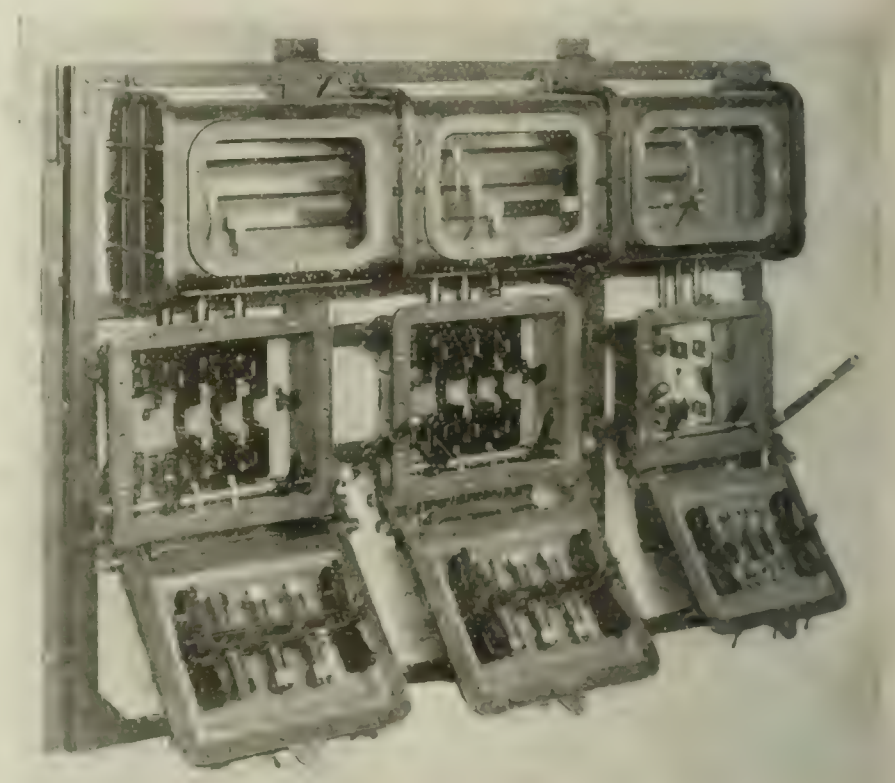


been used here, but the first demand is for plant of 160-kw. capacity. As in the case of Ningpo a "Witton" high-pressure alternator is direct coupled to a Belliss & Morcom steam engine supplied with steam from Babcock & Wilcox boilers.

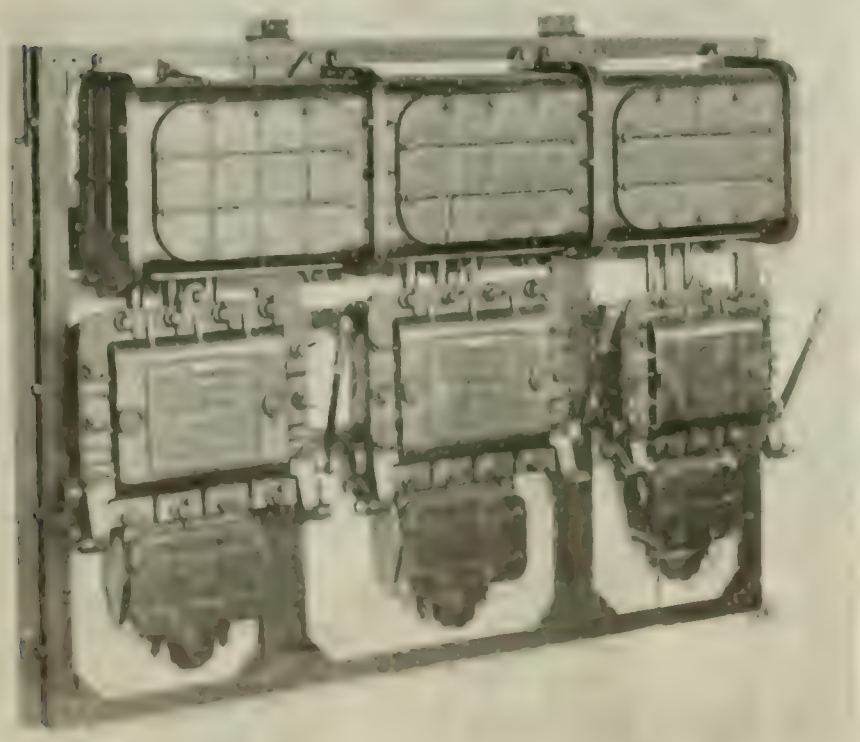
In the South of China a contract was obtained for four complete lighting sets for the City of Kweilin. In addition to the above, plant and switchgear have recently been supplied to the Fatshan Electric Co., the Nanking Electric Co., Funshun City, &c. Several further contracts are now being negotiated. Besides the foregoing, the General Electric Co., of China, Ltd., has just supplied a 125-kw. three-phase "Witton" alternator, ten 10 H.P., one 25 H.P., and several smaller "Witton" motors for a Chinese cotton and rice mill at Yungchow.

"FIRIMINE" SWITCHBOARDS FOR MINES.

The problems arising out of the distribution of electric power in mines are many and varied. "Safety first" is now the motto of switchgear designers, and it must needs be applied not only to the mine as a whole, but also to the lives of individual workmen. Under the first heading comes the question of absolutely preventing explosions by sparking at switch and fuse contacts. The "Firimine" ironclad switch of Berry, Skinner & Co. was introduced some years ago, and has, we understand, already proved its merit under severe



Another View showing Switches and Fuses Removed.



Mining Switchboard of "Firimine" Construction.

service conditions. It is a combined switch and fuse made for one, two or three-phase circuits, with absolute interlocking action, whereby the circuit can only be made and broken with the iron cover of the device closed. Reinforced mica insulation only is used, and the entire construction is a sound engineering job. The switch cover is provided with wide flanges which are machined, and make a faced joint with similar flanges on the box itself. The effect of these flanges is immediately to cool any hot gases which may be fired in the interior of the switch; such gases pass harmlessly and without flame to the outside of the switch.

The illustrations serve to show how neatly these switches may be built up on an angle-iron frame to form, with 'bus bar chambers and connecting boxes, complete boards for use in the underground workings of mines and collieries, especially where firedamp is known to be prevalent. It will be noted that both the switches and the 'bus bar chambers are rendered completely accessible, and that the boards are built up on the unit principle.

Boards of this kind are made and supplied by Berry, Skinner & Co., 78, Upper Thames-street, London, E.C., and they will submit drawings to requirements and quotations on request.

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THE ROUND TABLE.

By "KVA."

It transpired at the adjourned Institution meeting on the 8th inst. during the discussion of the matter of expelling "alien enemies," that if Turkey makes peace and comes over to the Allies, "there will be another general meeting."

* * * *

In the next column will be found the "unofficial" programme of the last Electro-Harmonic concert of the present season. I hope, if it is my good fortune to write the programmes for next season (I am in group 44) that the curtains of peace will have been rung down over this terrible scene of war. It is this thought that I have endeavoured to express in the last item in the programme.

* * * *

In a recent issue "The Ironmonger" published a letter from a correspondent asking for details of the electrical equipment for the lighting of a football field. Among the letters in answer they published the following, which seems to me it would be difficult to "cap" for sheer humour :—

SIR: Replying to "Listokam's" inquiry, I can answer the first part by stating that a football match was played by electric light at Ross, Herefordshire, 35 years ago, when illumination by this means was in its infancy.

The lanterns (as far as memory serves) were 12 in number, standing about 5 ft. high by about 15 in. to 18 in. square, made of galvanised iron and glazed. They were placed at equal distances apart on and round the ground.

The lamps were made by Perkins & Bellamy, a firm no longer in existence, I think. The power was derived from a traction engine, while the wire installation was fitted up by a Mr. Brain, who resided somewhere in the Forest of Dean. This letter is in the nature of a reminiscence, and I am sorry that I can give no information as to the candle-power and other details. The game will doubtless be remembered by the player who was unfortunate enough to break a leg on the occasion, if he is still alive. Yours faithfully,

March 8. MILMAR. (38/40.)

* * * *

Mr. A. C. Evans, secretary and superintendent of the Grange Convalescent Home, Worthing, in acknowledging our modest contribution of half-a-guinea towards the electric light fund for that institution, tells me that it is the first sum which he has yet received. Will readers of the "Round Table" note that about £60 is needed to pay for the installation. The work is being done by Page & Miles, electrical contractors, Brighton, who certify that the material used is of British manufacture, thereby nailing the ear of "S.O.S.," the gas manager at Worthing, to his own suggestion that foreign material would be employed. Economy, comfort and hygiene will result from the electric lighting, and, further, a radiant heat bed which is required for certain treatments will fit quite naturally into the installation. This bed is being hired and is not included in the £60 mentioned above. I now wish to repeat the appeal which I made last week for contributions to this fund. They may be sent to THE ELECTRICIAN direct, or to Mr. A. C. Evans, Balfour House, Finsbury-pavement, London, E.C., who will forward a prospectus of "The Grange and its Work" on request. Hurry up, everybody, or "S.O.S." may be tempted to contribute !

OUR HOT PLATES

No. 206 to—

President C. P. Sparks for his temper, his tact and his twinkle during two trying and delicate alien enemy meetings at the Inst.E.E.

No. 207 to—

Major F. H. Masters (erstwhile "Geraldine") upon the double event of his promotion from Capt. R.E. (T.F.) and of his forthcoming marriage.

* * * *

THE ELECTRO-HARMONIC SOCIETY.

(30TH SEASON, 1915-6.)

To-night at 8 p.m., King's Hall, Holborn Restaurant.

Chairman : Mr. J. H. RIDER.

(*Unofficial Programme.*)

"NATURALISED" CHORUS	"Let us Scatter Seeds of Kindness"	*Vail*
	SOME OF THE COUNCIL OF THE INST.E.E.	
HYMN OF HATE	"I rage, I melt, I burn"... ... (When Germans are about.) Mr. C. H. WORDINGHAM.	*Strafed*
FIRESIDE REVUE	"Always 'Reddy' and Bright" ... BELLING'S BELLES.	*Adapted*
TRICITY APPLES SOLO (AND CREAM)	"O Taste and See" ... ... Mr. A. F. BERRY.	*Goss*
C.I. PILLAR SOLO	"I dare not go to Easthourne" Mr. A. P. TROTTER.	*After Lawrence*
AMENDMENT "BLOW OFF"	"We really had a most delightful evening" ... ... Mr. ALBERT GAY.	*Shand*
HIT OR MISS MEDLEY	"Come out and shine, Mr. Moon" ANTI-AIRCRAFT CORPS.	*Jones*
T.R.C.P.* BALLAD	"I fear no foe in Shining Armour" "C. T. S." BROOKING.	*Pinsuti*
WHITE HOT SOLO	"Come and see me do the Oomt-Arora" "KUKRI" GROGAN.	*Forde*
T.N.T. EXTRAVAGANZA	"What a game it is, Wow, Wow" BRITISH COMMERCIAL GAS ASSOCIATION. (Introducing the "S.O.S." Band.)	*Fay*
ALIEN STRAFETTE	"Will ye no' come back again ?" [Not if we know it !] THE "DOWN AND OUTERS."	*Opit*
GRAND FINALE	"How Lovely are the Messengers" THE BELLIGERENTS IN THE GREAT WAR.	*Mendelssohn*

GOD SAVE THE KING

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 15, 1879.]

A NEW METHOD OF PLANTING TELEGRAPH POLES.—"A new method of planting telegraph poles," says the *Scientific American*, "has been introduced in Pennsylvania. The ground is staked off at distances of 200 ft. apart ; a man starts off with cartridges of 'electric powder,' and with a crowbar in his hand. The bar is driven 4 ft. or 5 ft. into the ground, a cartridge with a lighted fuse is dropped into the hole, and the man proceeds to the next stake ; but before he reaches it the cartridge has exploded, making a cavity as big as a flour barrel in the ground, and a gang of men who follow plant a telegraph pole in the spot. In this way four men will set up 100 to 150 poles per day, and at a cost two-thirds less than by the old way." We trust the authorities in England will think twice before adopting such an ingenious, but, we fear, totally impracticable plan.

* Tough Rubber Compound Protection. (*See* new Inst.E.E. Wiring Rules.)



No. 27.—Patent 'Inching' Starter with self-contained magnetic circuit breaker is a valuable starter for workshop use, being robustly built for hard service, and is fitted with our patent device which allows unlimited 'inching' without damage. Automatic release and enclosing covers fitted as required.

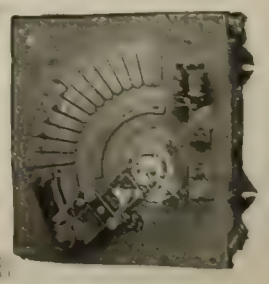
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MOTOR CONTROL GEAR.

IGRANIC ELECTRIC Co LTD

147, Queen Victoria Street, London.

No. 10A.—Heavy Duty Starting Rheostat is intended for use with motors taking heavy starting currents, or requiring very frequent starting. This starter is built for arduous service, mechanical strength is allied to ample electrical capacity in all parts.



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CONTROL EQUIPMENT FOR WINDERS AND HOISTS.

The apparatus illustrated and described in the B.T.-H. Co.'s list No. 5,314 has been specially developed for the control of motors used for winding and surface haulage in collieries, and furnace hoists in steel works. Each equipment consists of (i.) a drum type master controller, (ii.) a panel on which electrically operated air-break contactor switches are mounted, and (iii.) control resistances of the air cooled type. The operator can start, stop and reverse the motor by means of the master controller, the contactors closing auto-

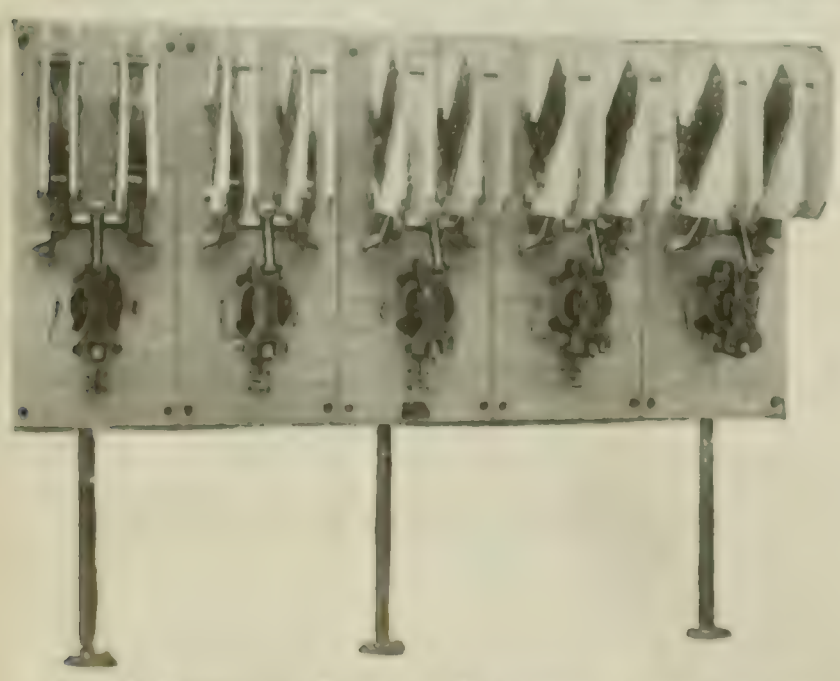


Fig. 1.—Contactor Panel for Reversing Hoist Circuits.

matically when the controller handle is moved. The closing of the contactors can only occur in the correct sequence, and each contactor remains open until the motor has accelerated sufficiently to permit additional resistance to be cut out of circuit without excessive current being taken from the line. Thus even if the operator moves the control handle too quickly from the "off" position to the "full on" position, the current limiting relays on the contactor panel will automatically protect the motor against damage and permit it to be started up in the shortest time compatible with safety.

These contactor equipments are particularly suitable for winders

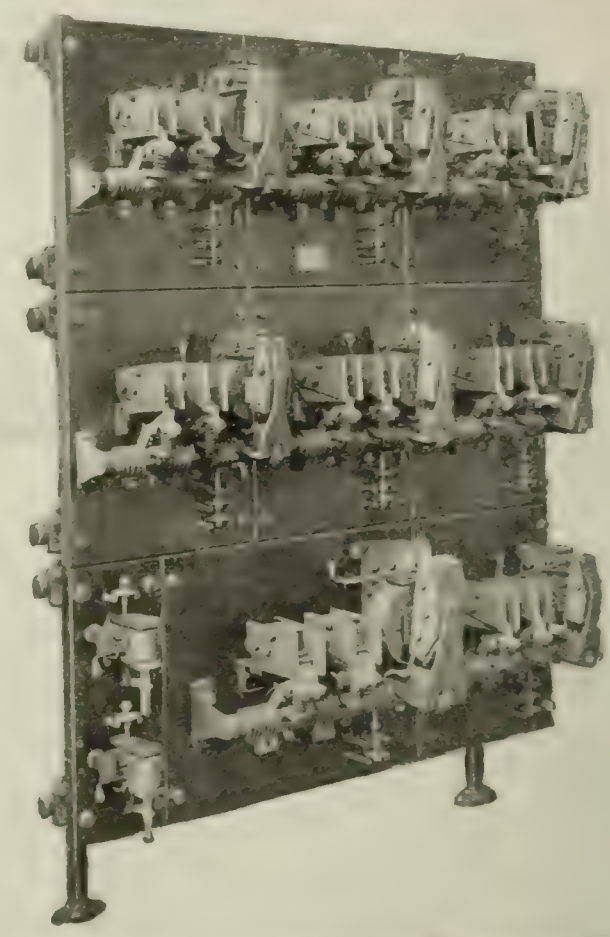


Fig. 2.—Contactor Panel for Rotor Resistance Circuits.

and hoists, and possess the following advantages in particular over liquid controllers:—

(*a*) No heavy work is imposed on the driver in operating the control lever.

(*b*) No energy is wasted in continually pumping electrolyte.

(*c*) The full speed of the motor is obtained, as, when the last rotor switch closes, the rotor is metallically short-circuited.

(*d*) No energy is wasted in the rotor resistance during the period of full running, but only during the periods of acceleration and retardation.

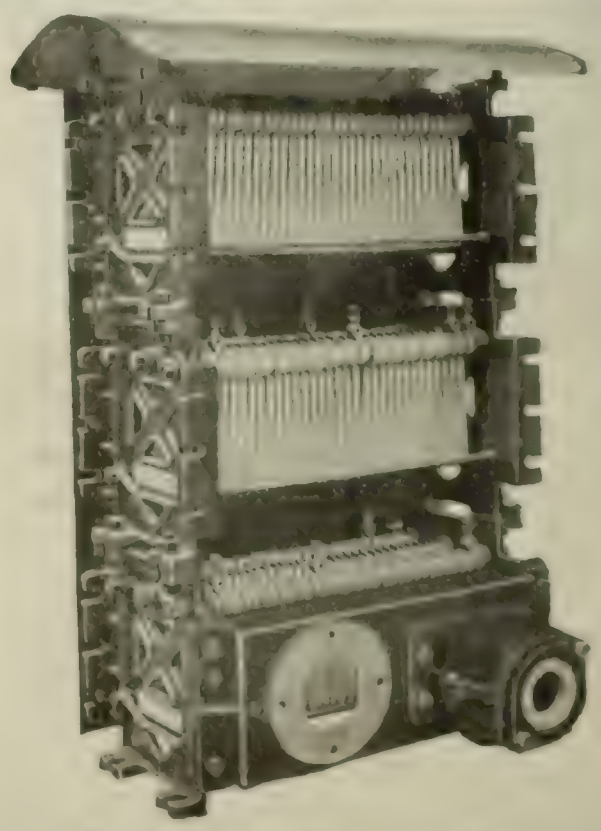


Fig. 3.—Typical Resistance Units.

(*e*) There is no risk of the lowering, however quickly the control lever is operated.

(*f*) There is no cooling pipe system to be kept clean and in order.

(*g*) The rate of accelerating the speed of the motor is automatically controlled by a relay system, so that, although the control lever may be put right over at the start, no succeeding switch closes until the current

which has increased on the closing of the preceding switch, has fallen to a predetermined and adjustable amount.

For alternating-current slip-ring motors one set of contactors is provided for opening and reversing the stator connections, and another set for short-circuiting the resistance divisions in the rotor circuit. Air-break contactors are recommended for this service, even for line voltages up to 3,300, as the wear on these is less than that on contactors breaking under oil. Typical contactor equipments for reversing stator circuits are shown in Fig. 1.

The contactor panel shown in Fig. 2 is a typical panel for use in the rotor circuit for cutting out the controlling resistances. For line voltages of 650 and less the contactors for controlling the stator circuit are mounted on the same panel as the rotor contactors and are of the same general type as the rotor contactors. For direct-current motors the contactor panels consists of four contactors used for reversing the armature connections, and a number of other contactors for short-circuiting the divisions of the starting resistance. Expanded metal protecting screens can be supplied with the panels.

The resistances used for this service consist of iron grids mounted on mica insulated rods which are fixed to the main resistance frame. Pure mica washers are used for insulating the grids from each other and from the frame. Application should be made to the British Thomson-Houston Co., Rugby, for a copy of this list.

CATALOGUES, NOVELTIES, &c.

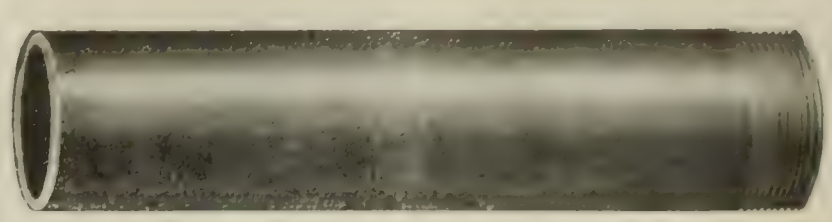
An extremely neat limp-leather folding treasury note wallet is being sent out by Messrs. Henry Wiggin & Co., of Birmingham. The case is lined watered silk, and pockets are also provided for business cards and stamps. The case itself contains no advertising matter beyond the name of the firm, but we doubt not that it will be successful in attracting favourable attention to the company's manufactures. A four-page folder has, however, been placed in the note pocket, and this contains useful tables of the properties of the firm's nickel chrome, Ferrozoid and Ferry resistance wires. Presumably, the inference is that users of these wires will find them so economical that they will need a wallet for their savings. At any rate, the tables referred to are, we think, fully worth their weight in—treasury notes.

New Ediswan Showcard.—We have received a specimen of the new Royal Ediswan lamp showcard which is now available for trade distribution. It is made up of a royal blue background containing the name of the lamp; thrust through the lower corner of the background is an arm, the hand of which holds out an Ediswan lamp. The arm is held to the card only at the shoulder, and is intended to be pulled slightly forward from the card, in which position it is retained by an invisible distance-piece. The effect produced is certainly novel and attractive. Presumably the company also has the opposite hand in these cards, so that two can be used in opposite corners of a window or showcase. We have not seen this fellow to the right-hand card, but if it does exist it will doubtless be *de rigueur* by having an armlet.



The Siemens Cup Won by the Ediswan Football Club, 3 goals to 1.

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ELECTRIC HEATING & COOKING APPARATUS.
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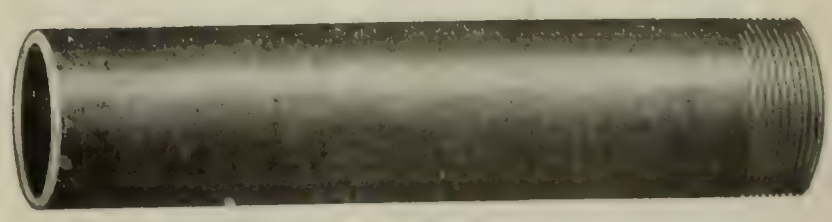


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THE LIGHTING OF A LARGE CO-OPERATIVE STORES.

The growth of the co-operative movement during the last few years has been a striking feature of British industrial life, and the prosperity of the many co-operative societies throughout the country may be judged by the freedom with which money has been forth-



coming to erect palatial buildings for office and retail department stores. One of the largest stores in the north has lately been completed for the West Hartlepool Co-operative Society. It is an imposing structure surmounted by a tower, and occupying a prominent corner site. Its lighting equipment has been carried out on modern lines, and the British Thomson-Houston Company's "Eye-rest"

system has been adopted practically throughout the building. The lighting points number 530, and the wiring work was entrusted to Mr. Edgar Phillips, of West Hartlepool. Much thought has been given to the illumination of the offices and of the large number of departments in order that the most efficient and attractive results might be secured. The lighting of offices, for example, calls for



An Example of Lighting in a Fitting Room.

treatment quite different from that in showrooms or shops, while the illumination of goods in the show windows and in show cases affords scope for a great deal of ingenuity and the application of scientific principles. The photographs here shown are only a small proportion of those available, but they are characteristic, and indicate the care



A Good Example of Window Lighting.

that has been taken to obtain the most suitable illumination under the widely differing conditions prevailing.

A fine effect is produced in the wide expanse of show windows which form so prominent a feature of this building. These windows are lighted by standard Mazda lamps in connection with X-ray

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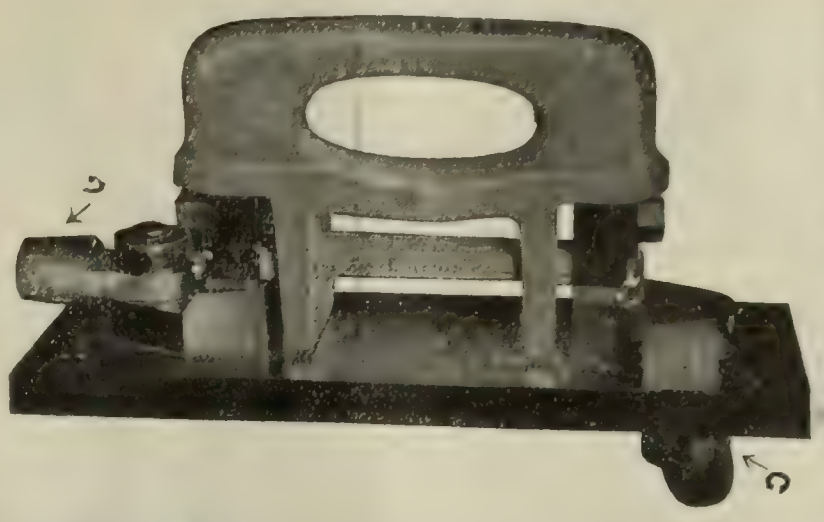
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helmet-type reflectors. The reflectors are spaced at approximately 3 ft. centres, and produce a soft and uniform light that brings out every detail in the window display. There is no glare, the light sources being concealed. Although there is ample illumination upon the goods displayed, no direct light is thrown either upwards or on to the pavement. With such a system there is no need for outside lamps. For the lighting of the haberdashery and other departments, where a counter trade is conducted with articles of small size and various colours, "Eye-rest" brass bowl fittings are employed, each containing six standard 60-watt "Mazda" lamps. These produce a well-diffused illumination of ample intensity and agreeable quality for the transaction of business in comfort.



Mantle Department - Note Reflectors in the Ceiling of Show Cases.

A novel feature is the lighting scheme in the mantle department. This has a floor space measuring 70 ft. by 50 ft., and is equipped with 14 "Eye-rest" fittings with 24 in. brass bowls. These fittings supply the general lighting, which has an average value of about 4 ft.-candles. The novel feature is in connection with the show cases, all of which are lighted independently by "X-ray" reflectors countersunk in the top of the case, each reflector containing one 60-watt standard lamp. The articles of clothing exhibited are brought into prominence, all disagreeable shadow and glare being eliminated. The number of units vary with the size of the show cases.

In the offices, which are of large size and handsomely fitted, the lighting is carried out with "Eye-rest" bowl fittings, each fitted with one 200-watt lamp. The illumination is evenly distributed, enabling clerical work, typing and cash transactions to be executed promptly and effectively. The board room, measuring 25 ft. by 35 ft., is a handsome apartment panelled in dark oak, which presents some difficulty for satisfactory lighting. In this case excellent results have been secured by the use of "Eye-rest" fittings, an average of 4 ft.-candles being secured.

Similar but smaller fittings are used in the café which is provided for customers. This department measures 40 ft. by 38 ft., and is lighted by four "Eye-rest" brass bowls, each equipped with six 60-watt Mazda lamps. The average requirements for restaurant lighting is 2·5 ft.-candles, and here, as in most of the departments, the estimated illumination has either been reached or exceeded.

Fitting rooms in tailors' or dressmakers' shops are always difficult to light successfully. They are usually of small size with mirrors on all sides, and they call for lighting that will be uniform, free from shadow and glare. Pendant fittings would be unsuitable unless ample head room were available, for they would be liable to mechanical damage and might cause undesirable reflection in the mirrors. At the West Hartlepool Society's fitting rooms satisfactory lighting has been secured by the use of a pair of two light flambeaux "Eye-rest" wall brackets placed on opposite sides of room, each fitted with two standard 40-watt lamps. The average illumination obtained is no less than 6 ft.-candles, a high value, but not excessive for the special work of fitting clothing.'

The installation may be taken as typical of the results that can be secured in practice with scientifically designed material and sound engineering knowledge and xperience.



View in the Drapery Department.

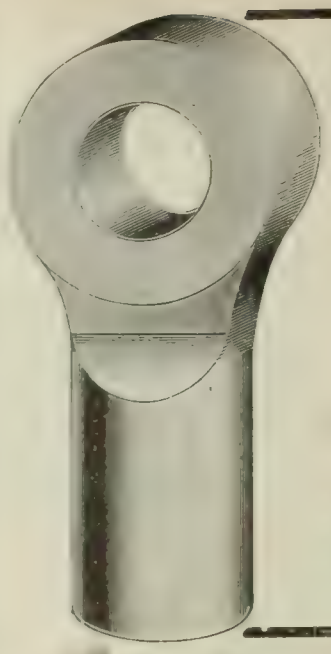
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"LEKTRIK" SWITCHES.

Everyone should know that the facility and quickness with which a tumbler switch can be operated is one of its advantages over movements of the turn or thumb-key class. As regards this point, the double-push switch comes midway between the above two classes.

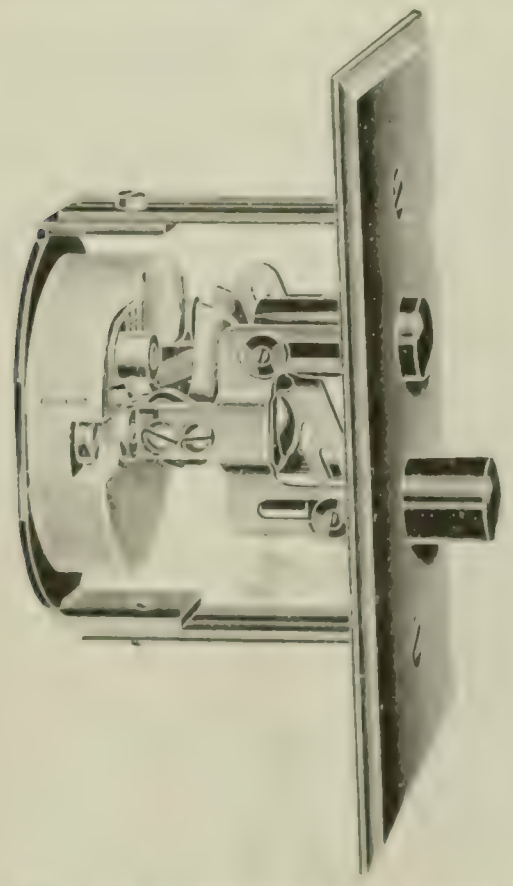


Fig. 1.—Double-pole Push Switch.

Fig. 1 shows how a Lundberg "Pivot" single-way switch is adapted for the above-mentioned method of operation, the arrangement being for flush work, and the switch being generally mounted

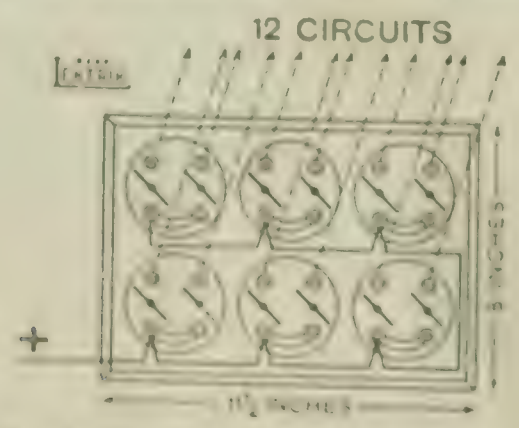


Fig. 2.—Double-pole Switch.

switch, and the number of circuits provided for in the space of 11½ in. by 8 in. should be noted.

A small section in List I is devoted to the "Lettering of Covers," and Fig. 3 gives one example applied to a "Twinob" switch. Lettered covers, by the way, are usually locked on, to secure accurate alignment of the lettering with the knob.

Lundberg switches are largely used in heating work, and the diagram in Fig. 4 shows the control for which the switch shown in Fig. 3 is marked. The "Twinob" switch is also useful for small motor controls.

Two single-way switches which are worthy of mention are the "Bi-path" and the "Quadbreak." If your voltage does not ex-

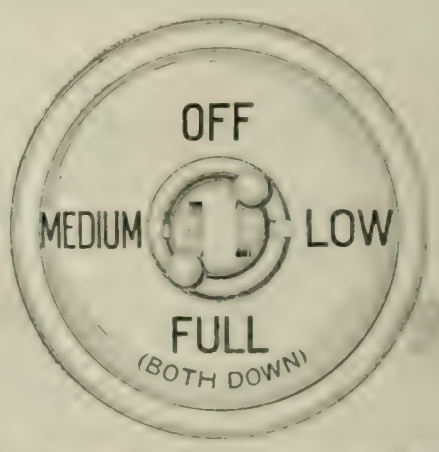


Fig. 3.—Example of Switch Cover Marking.

ceed 100, and there is not appreciable inductance about, the "Bi-path" switch will tackle twice as much current as most other switches of the same size. Thus, the two sizes corresponding to ordinary 5 ampere and 10 ampere dimensions will really carry 10 amperes and 20 amperes respectively. Suppose, on the other hand, the voltage is anything up to 250, the "Quadbreak" will deal with this quite easily, and will also cope with inductive circuits with a minimum of sparkwear. This shows the effectiveness of the quadruple break as compared with the usual double-break.

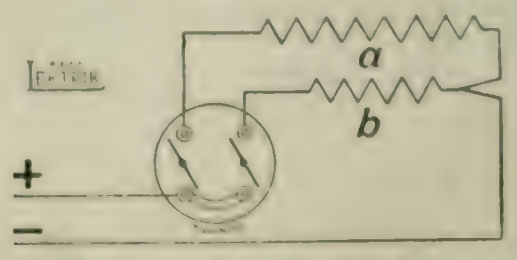


Fig. 4.—"Twinob" Heating Control.

It is easy to find one's way about Messrs. Lundberg's List I, for there is a main index in front and a general index at the back. Further, should one forget what particular article a given catalogue number stands for, the catalogue number index will help one out of the difficulty right away, for it gives the page on which the article is listed. A separate catalogue number index includes all current items in all the Lundberg lists, copies of which are obtainable at Liverpool road, London, N.

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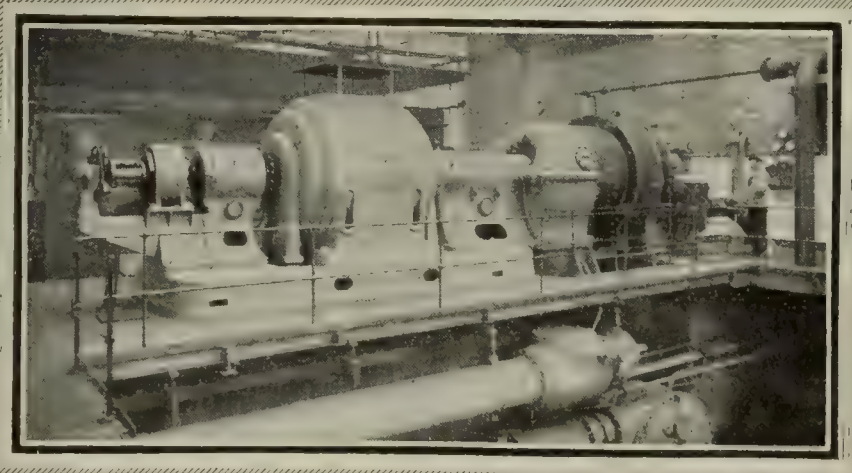
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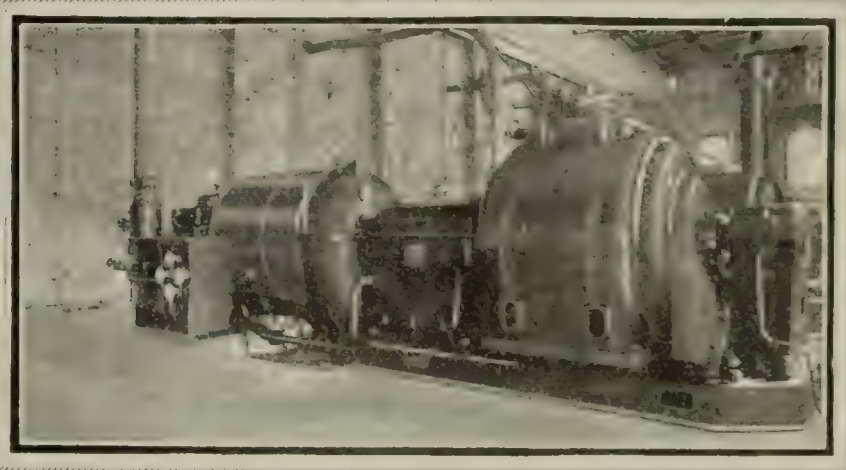
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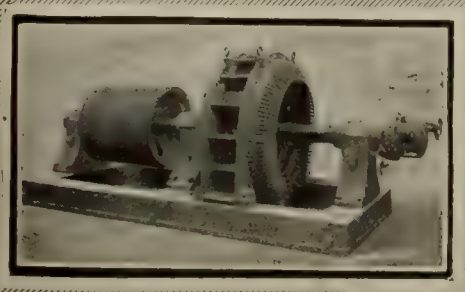


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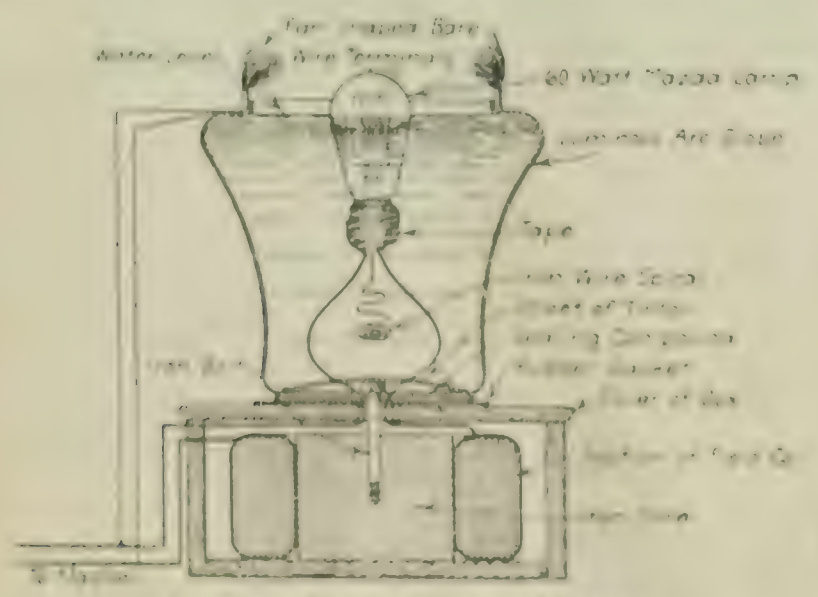
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Section of Wire or Window Novelties

trusted on for the proper execution of the ordinary as well as the more unusual electrical contracting jobs. It inspires confidence, a most valuable business asset.

A merchant dealer that has been carrying out some ideas with much success is the Freeman Sweet Co., 118, south Dearborn-street, Chicago. One of the clever window display "stunts" recently put on by this firm was described in our issue of Feb. 5, 1916. During last week another unique effect was produced which drew large crowds of interested spectators. This consisted of an opal arc lamp globe practically full of water in which an incandescent lamp floated tip up. At short intervals the lamp would light up brilliantly and at the same time submerge itself in a very mysterious way. After a few seconds it would again bob up and its light practically fade out. This cycle was continued indefinitely. The only apparent (although really misleading) explanation seemed to be in some wires with bared ends projecting over the edge of the globe, thus giving the idea that the peculiar action of the lamp was due to wireless, or inductive influence.

For the benefit of those readers interested the true explanation is shown in the accompanying diagram. A field coil from an old dismantled motor was placed in a box and within was put an iron core; a small iron pulley that just happened to fit the coil was actually used for this. An iron bolt was put through the box cover into the centre of the core and the wires for feeding the lamp run through the cover alongside the bolt. The lamp was connected in series with the coil; the wires were soldered to the lamp base and well protected by rubber tape. To seal the bottom of the globe it was put on a rubber sheet and a layer of sealing compound filled in; an electric soldering iron was used to work the compound well around the edge and about the bolt head to make a water-tight seal. Fastened to the lamp base by a loop over the tape was an iron wire with the lower part arranged in spiral form; this was of just the right weight to keep the lamp about half submerged when the current was off. Connected into the circuit was a Thermoblink flasher which periodically cut the current in the lamp and coil circuit down to a low value. As the current was restored to full value, the coil was energised and the iron spiral with the lamp was pulled down toward the bolt head, a sheet of tinfoil over the latter preventing actual magnetic contact and sticking due to residual magnetism when the current was again cut down to its low value.

The box on which the globe was placed and the wires leading to the coil and lamp were covered by a cloth, leaving very conspicuous however, the wires on the outside of the globe to the antenna like ends. This little display aroused no end of inquiries and incidentally stimulated the sales of all kinds of electrical goods, which was its primary object.—"Elec. Rev.," Chicago.

THE ROUND TABLE.

By "KVA."

A man in the trenches in Flanders sends a note to one of our staff asking him kindly to integrate $f\theta.\text{Sin } 2\theta.d\theta$, as it bothers him I presume he wants to keep amused between the intervals of dodging bullets and bombs.

* * * *

The London General Omnibus Co. will not have 'bus-women, lady conductors, conductresses, or any such names. They are to be "conductorettes," which is, of course, quite wrong, meaning a little conductor. I have seen at least two with whom I certainly should not stop to argue if a dispute arose about my fare. What will the lady drivers be —chauffettes—otherwise little hot stuffs!

* * * *

The complexities of discounts have been greatly increased with the formation of associations of manufacturers, traders and others. When accounts have to be made up discounts of 25, 15 and 10 per cent. must be deducted, and finally a further 5, $2\frac{1}{2}$ or $1\frac{1}{4}$ according to the time of settlement. Even a ball-bearing slide-rule bucks at this sort of thing. Then think of the labour and what sort of brain cells must clerks have; they must be shaped % I should imagine.

* * * *

Henley's, I find, have taken the discount problem by both noughts and made up price lists which are calculated on the basis of one or other of their many discounts. They evidently agree that life during war time contains quite enough things to swear at without including a whole lot of strafed discounts. Most electrical men have too good a flow of language to be put on calculating discounts. I don't wonder that ladies have to do it!

* * * *

The following are a few of the chestnuts pulled out of the fire by one of the artists at last Friday's Electro-Harmonic :—

A Lancashireman was explaining that in the North "The Messiah" was always given by even quite small choirs at Christmastide. "I wur at a country chapel when 't' Messiah' wur being given and a lot of scraggy old maids on't platform were singing: 'For unto us a child is born,' and then tenors started 'Wonderful, wonderful, wonderful,' and that's just wat I wur thinking misel!"

Another Lancashireman had been taken to hear the oratorio "Samson," and a friend asked him how he liked it. "Oh, it wur good tha' knows, that is, t' singin' and t' playin', but t' strong man never cum on at all!"

An old lady was told that the latest news from the Front was that we were driving the Germans back. "Driving 'em back," she cried, indignantly. "Why, I'd make 'em walk back every inch of the way, the dirty swine!"

* * * *

THE MATHEMATICIAN IN LOVE.

The lady loved dancing, he therefore applied
To the polka and waltz an equation;
But when to rotate on his axis he tried,
His centre of gravity swayed to one side,
And he fell by the earth's gravitation.

* * * *

I hear that a certain individual has changed his name from Grünbaum to Leyton. In order that there may be no misunderstanding his friends emphatically refer to him as Late Hun!

How strange it is that the enthusiasts in the gas industry are so squeamish about the Board of Trade report on the use of gas on trains. They attempt to draw across the track the red herring of the supposed risk of electricity in mines, therefore, we beg leave to ask why they are not afraid to use electric power in gas works.

* * * *

The Batti-Wallahs have decided to arrange that every Friday, the Holborn Restaurant, at the top of Kingsway, London, W.C., shall be a rendezvous at which members can be certain of meeting one or other of their friends. To help recognition the badge of the society should be worn. One member of the committee will be there about 12.30 p.m.

* * * *

The illustration is an exterior view of The Grange Convalescent Home, Worthing, about which I have written in the



past two issues. Subscriptions to the electric light fund will be welcomed, and the smallest sums can be sent in without fear of refusal. The amount required is about £60.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 22 1879.]

"USEFUL INFORMATION ON PRACTICAL ELECTRIC LIGHTING."—A second edition of this useful little work by Mr. Killingworth Hedges has been called for, and some slight addition made to its contents. The information is by no means original, but it is in a compendious form, and so arranged that a general idea of the subject may easily be obtained by anyone who has no time to dig deeply into the scientific question.

AN EXPERIMENT OF SIR H. DAVY'S WITH THE ELECTRIC LIGHT.—"Mr. Pepys having had the goodness to charge the great battery of the London Institution, consisting of 2,000 double plates of zinc and copper, with a mixture of 1,168 parts of water, 108 parts of nitrous acid, and 25 parts of sulphuric acid, so as to make an arc, or column of electrical light, varying in length from 1 in. to 4 in., according to the state of rarifaction of the atmosphere in which it was produced, and a powerful magnet being presented to this arc or column, having its pole at a very acute angle to it, the arc or column was attracted or repelled with a rotary motion, or made to revolve, by placing the pole in different positions, being repelled when the pole was on the right hand by the north pole of the magnet, and attracted by the south pole, and vice versa."

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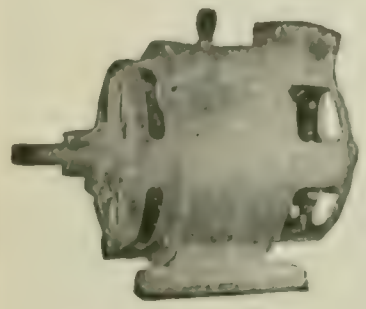
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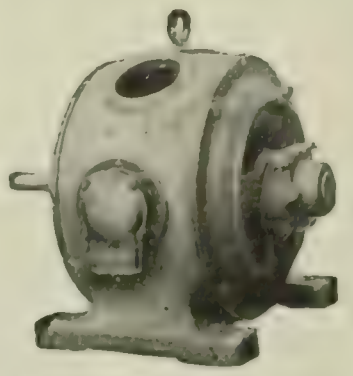
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In a new pamphlet the Sun Electrical Co. illustrates scientifically-



Sun Industrial Fitting.

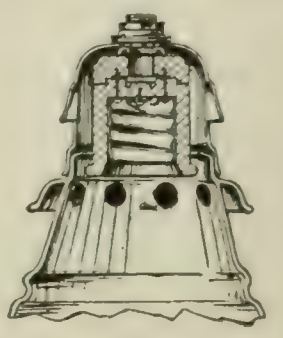
designed reflectors now on the market for both interior and exterior use. Suitable [illegible] reflectors consist of a steel reflector with detachable [illegible] to facilitate wiring and erection. Adequate ventilation [illegible] protected by louvres, are provided in both reflector and [illegible]. The inside of the reflector is finished hard vitreous porcelain enamel, sterk glass outside. Dead white inside. This finish retains its reflecting power and appearance indefinitely under all conditions, and any dirt or dust collecting is easily wiped off.

Suitable half-watt lantern fittings are available for either interior or exterior use; in every case [illegible] taken to include in the design all features necessary for the efficient use of half-watt lamps.

Ample ventilation is provided for in both the indoor and outdoor fittings, and in the latter case this is obtained without any sacrifice of weather-resisting properties. The glassware used is sufficiently obscure to counteract objectionable glare, without wasteful diminution of light. The reflectors give correct distribution of light, and are specially designed with regard to the position and high intrinsic brilliancy of the filaments.

For special cases, such as when lamps are erected at a high level, clear glass globes can be supplied to order. The company's experience and advice are at the service of clients at any time in the solution of lighting problems.

The No. P.E. 5063 15 in. diameter reflectors have detachable ventilated enamelled steel canopies. The 10 in. and 11 in. have a rolled copper liner, with a screwed thread, and other sizes are fitted with three bolts and nuts with asbestos washers. They are supplied



Section through Holder of Sun Industrial Fittings.

complete with lampholder. The reflector with support is set so that with the lamp hanging perpendicular the skirt of the reflector is tilted at the required angle to project the light over a plane that cannot be adequately illuminated by a lamp hung directly above it. The wattage of the half-watt lamp with which each reflector will give the characteristic curve is indicated in the list, but others may be used.

This unit is recommended for rolling-mills, foundries, erecting-shops (with high ceilings and moving cranes), set on brackets on the side walls; for spot or side lighting on stages and for photographic studio work.

The No. P.E. 5120 fitting is provided with 20 in. top reflector and 10 in. bowl. The fitting consists of a spun-steel reflector, finished dead white vitreous enamel, and an alabaster type bowl as bottom



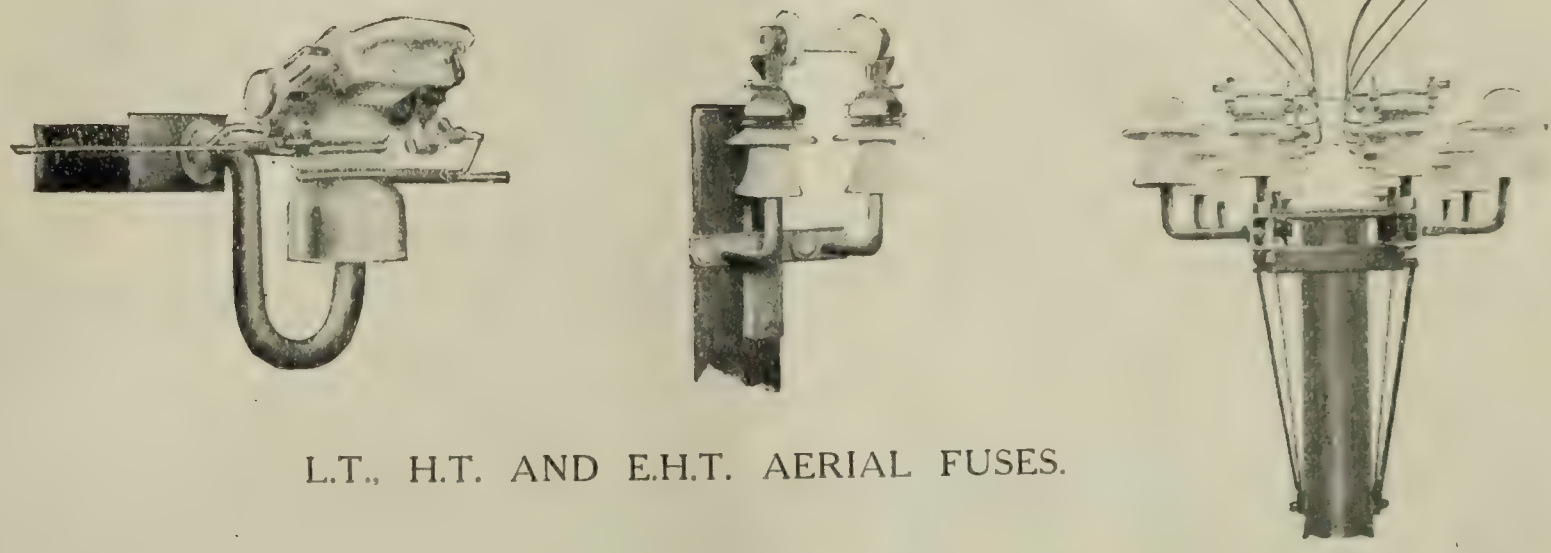
Sun Industrial Fitting with Hoop Reflector.

reflector. The bottom reflector is suspended by chains on to studs and there is no metal ring to cast shadows. Chains can be supplied dead white, polished brass or any other desired finish. The alabaster bowl gives a beautifully diffused light, without glare. The unit is efficient and retains its high reflecting power indefinitely with a little cleaning. For lofty situations top chains for suspension can be supplied in any desired finish. The standard fitting is screwed ¾ in. gas thread, and can be screwed direct on to the outlet box. The top reflector is provided with a dust proof cover.

Many other designs are shown in the list, a copy of which should be obtained by interested installation engineers.

The Electric & General Works, Ltd.,

15, Victoria Street, London, S.W.



L.T., H.T. AND E.H.T. AERIAL FUSES.

ELECTRICAL APPARATUS

up to 80,000 volts.

Telephone: 5223 VICTORIA. **Telegrams: "GABIONAGE VIC. LONDON."**

JACKSON HEATING UTENSILS.

The Jackson hot water urns, of which particulars are given in card No. 18, are made of stout copper sheet heavily tinned inside. Three-heat control is provided (full, half and quarter), and all sizes are arranged to boil in about three-quarters of an hour and to keep boiling on low heat. Heat-insulated lifting handles and brass draw-off tap are fitted. Urns can be close riveted as well as soldered. This prevents any permanent leak resulting from allowing an urn to boil dry.

Owing to the great improvements that have been made in the design of the elements, we gather that it is now quite safe to fit switches on the urns. Where this is done special precautions are taken to protect the switches from heat and from water boiling over. Nos. 240/3 require one series parallel switch; Nos. 244/5 require, in addition, one "on and off" switch. Gauge glasses to show height of water can also be fitted to the urns. The table below gives details of the sizes made :—

Catalogue No.	Approximate Capacity.		Height.		Diameter.		Weight.		Max. loading.
	Gals.	Litres.	In.	Cms.	In.	Cms.	Lb.	Kgs.	Watts.
240	1	4·5	18½	47·0	7	18·0	9	4·1	1,000
241	2	9·0	22	56·0	10½	27·0	15½	7·0	1,500
242	3	13·5	23¾	60·0	11	28·0	18	8·2	2,250
243	4	18·0	27	68·5	13	33·0	23	10·5	3,000
244	6	27·0	28	71·0	14	35·5	29	13·2	4,500
245	8	36·0	30	76·0	15½	39·5	37	17·0	6,000

The Jackson coffee percolator, referred to in card No. 17, is the result of long experience, and makes excellent coffee. The principle on which it acts is as follows: The coffee is placed in strainer at top; the water, when it boils, is forced up a tube in the centre and strikes against a "button" at the top, and so sprays down on to the coffee. In this way it gradually percolates through the coffee, the action being continued until the coffee is of the desired strength.

The percolator can be supplied in polished copper or nickel plated, and forms a handsome piece of table apparatus. It is loaded to 190 watts, has a capacity of six breakfast cups, and is 13 in. high, 9 in. wide over tap, and weighs 3¼ lb.

Prices of both these utensils from the Jackson Stove Co., 38, Blandford-street, London, W.]

FITTINGS FOR HOLOPHANE ELECTRIC GLASSWARE.

Efficient illumination is more highly esteemed than before by all sections of the public, and is now not merely a matter for the expert. The general public, as well as official, municipal and medical authorities, appreciate the difference between a well-designed system of illumination and an imperfect one. The Holophane system of illumination is the embodiment of the accurate application of the scientific principles under which light is controlled, plus the accumulated knowledge obtained as the result of exhaustive experimental work carried out during the past 20 years by the staffs of illuminating engineers maintained in several countries by Holophane (Ltd.).

On this account, as well as for the economies it is known to achieve, Holophane glassware is often specified by architects and others. Its claims to employment in the lighting of fine interiors, where it is necessary to use fittings and glassware which harmonise with the general scheme of decoration or architectural features, have to a large extent escaped attention. This result has, in part, been due

Manufacturers of
PHOSPHOR BRONZE,
GUN METAL, MANGANESE BRONZE,
Brass & Copper
Tubes, Sheets,
Rods, Wire, and
CASTINGS.
PHOSPHOR TIN.
PHOSPHOR COPPER.
CHARLES CLIFFORD & SON, Ltd.
BIRMINGHAM.

to the rich of a correct presentation of the æsthetic merits of Holophane.

The object of a new catalogue issued by the company is to suggest to those interested in the subject of illumination the adaptability of the Holophane system to varying period designs and architectural features. A scientifically planned lighting scheme is capable of artistic or architectural treatment as is one of which the only merit is elegance in design. To serve this purpose the fittings must present a pleasing variety in styles and design. Inasmuch as appearance is largely a matter of personal preference, it is difficult to embody within the limits of a catalogue such an infinite variety in design as to meet each and every fancy. The designs shown in the list, therefore, are those which have been selected from the best sources at disposal, and, as such, form the basis of what is hoped may be a progressive policy of combining a scientific system of illumination, such as Holophane, with a class of fitting as will meet with approval from an artistic point of view.

So many types and designs of Holophane glassware are now sold that to illustrate each one in combination with lighting fixtures



[illegible]

would require a volume several times the size of the catalogue to accord it, and would add but little to its value as a work of reference. In the catalogue is a representative selection of the combination of glassware and fittings as at the moment will best show the artistic possibilities which may be obtained. In the illustrations included in the catalogue the glassware appears in some cases unduly prominent. This has been done purposely to give a clearer idea of the construction of the glass used.

The many practical advantages to be derived from the adoption of the Holophane system of illumination are described in the special pamphlet. To obtain the maximum benefit from these advantages, however, it is necessary that the glassware should be installed in the positions for which they were designed.

It may be as well to enumerate here the following essentials for correct lighting:—

(*a*) There must be sufficient generated light so that objects are easily seen by means of the light which they reflect; therefore, more light must be thrown on dark objects than on light.

(*b*) There must not be too much illumination, or the brightness of objects will tire the eye.

(*c*) Exceedingly bright lights in the field of vision should be avoided—that is, the intrinsic brilliancy of the light-sources should be low, or the units placed out of the direct field of view.

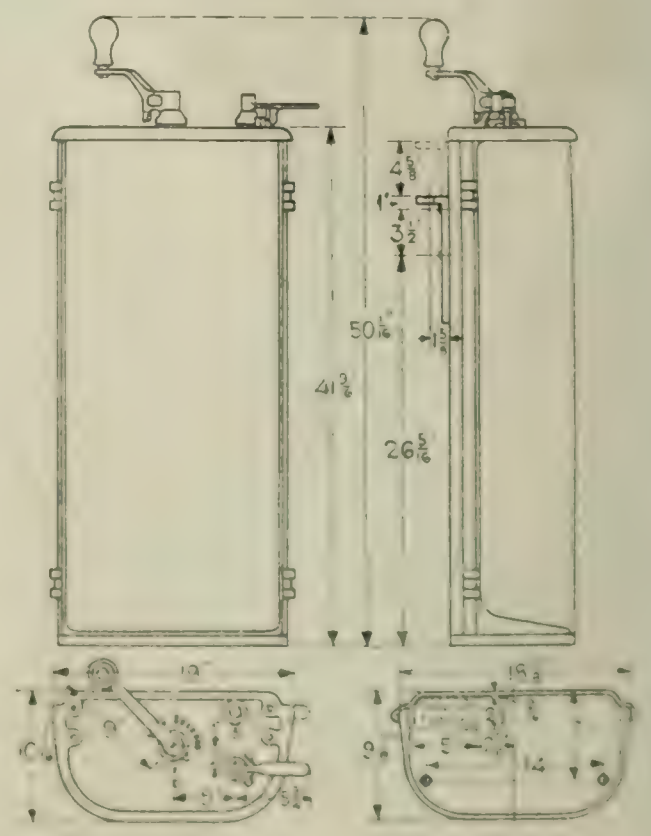
(*d*) Streaks or striations in the resulting illumination are undesirable owing to the attempt of the eye muscles to adapt themselves to the varying illumination. Highly polished reflectors which give definite images of the light sources are, therefore, to be avoided or used only with lamps provided with diffusing and enclosing globes.

(*e*) Light-sources should be properly placed so that the light is not regularly reflected into the eye. This is particularly applicable to desk lighting and similar employments, and in conjunction with the striation effects mentioned above, this has been the cause probably of more eye trouble than any other one thing with the exception of unshaded lamps of high intrinsic brilliancy in the field of vision.

The above notes are taken from List No. 102, which has just been completed by Holophane (Ltd.), Carteret-street, London, S.W., and which is an artistic catalogue of some 100 pages illustrating and pricing a large selection of Holophane fittings for use with electric light.

"RUN-BACK PREVENTER" TRAMWAY CONTROLLER.

For tramway service a simple form of control apparatus is essential, so that a driver, in cases of emergency, may instinctively do the correct thing to avoid accident. Reliable and simple forms of controllers have been in use for many years, but in one respect—viz., that relating to rheostatic braking in the event of a car running away backwards—considerable improvements remained possible. Controllers of the braking type now in use are so placed that if the car is running in a forward direction, on moving the handle to the brake notches, currents are generated in the motors, producing a retarding



Dimension Diagram of Controller.

torque, the direction of the currents in the motors being such as to strengthen the magnetism of the fields. If, however, the car is running backwards, and the controller handle be moved to the brake notches, the direction of currents generated in the motors is such as to demagnetise the fields, so that no braking effect is produced.

To obtain a braking action when the car is running backwards,

INSULATION BEADS
The only satisfactory substitute for Asbestos Wire; also for flexible leads, etc. AMPLE STOCKS.
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Extracts from an "ELASTA" agent's letter:

"We have just heard from a customer of ours regarding the life of one of your 100 c.p. lamps . . . The gentleman in question . . . purchased the lamp from us well over two years ago, and fixed it in the bar. . . . The lamp is burning all day and every day, that is for 17 hours daily; so that if you only take the life as two years . . . you will see that it has had an extraordinarily long life."

The Lamp with a Living in it.

POPE'S ELECTRIC LAMP Co LTD
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CARRON

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Carron Company control all operations in the manufacture of their Electrical Appliances.

Skilled mechanics, unique manufacturing resources and ample testing facilities complete an organisation capable of meeting the requirements of those Electrical Contractors and Engineers who insist on having the best Appliances, and will be satisfied with nothing less.

No. 327 Range illustrated is of first-class finish throughout, and comprises two 20 in. ovens, and a 10 in. hot chamber, double cased, packed with heat-insulating material, and fitted with loose porcelain enamelled linings. A continuous cast-iron hot-plate along top carries boiling plates, simmering plate, and bain marie. Grill, 18 ins. wide, is fitted above hot chamber. Ovens have double doors, inner being of transparent glass to show progress of cooking without loss of heat, and both doors have cool grip wood knobs. Crownplate and grill interiors are porcelain enamelled. Bain Marie has copper body, tinned inside. Heating elements are standardised and interchangeable, and, with the exception of grill, are arranged for three-heat regulation. Three-heat rotary indicating switches, "Zed" fuses and pilot light are mounted on separate switchboard, leads being carried in armoured flexible tube.

Write for their 22c free catalogue now and see what a variety of appliances are offered for your selection.

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INCORPORATED BY ROYAL CHARTER 1773

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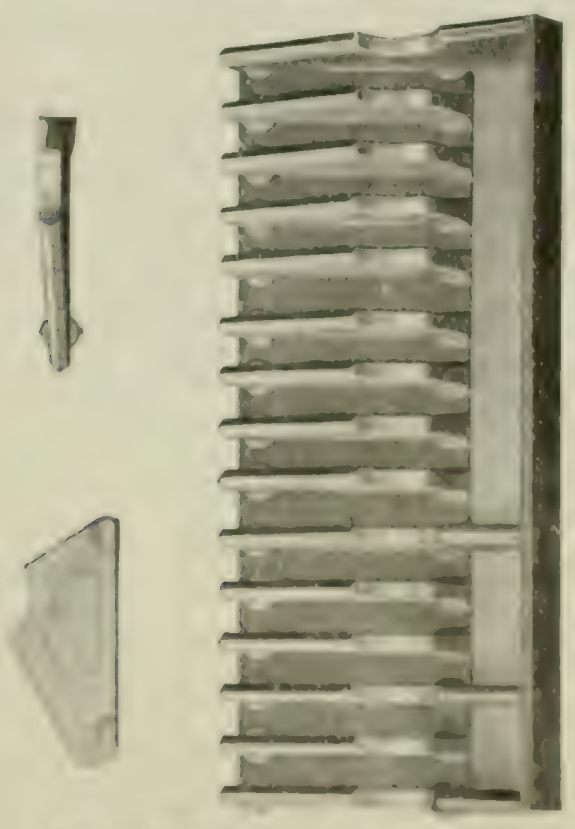
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Telephone: LONDON WALL 3151.

the British Thomson-Houston Co., Rugby, have designed and manufactured controllers in which, when the controller handle is moved to the "off" position, connections are made which cause one or more of the motors to act as generators, producing the desired



[illegible] View of Arc [illegible]

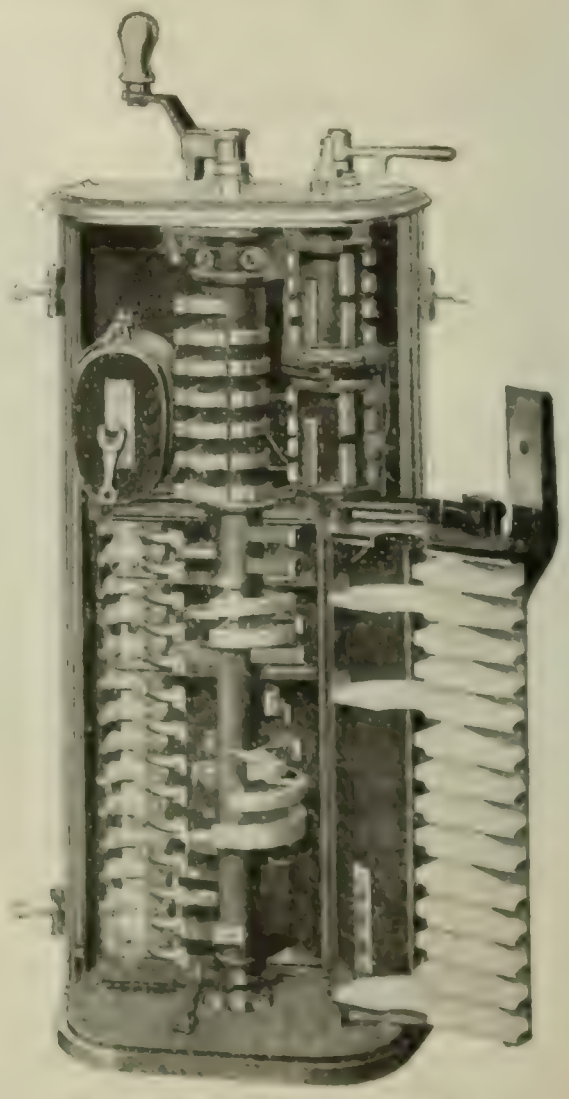
[illegible] connections are such that no braking action is obtained during forward running of the car if the handle is in the "off" position. An arrangement preferable to this, however, is one in which the motion of the control handle which produces braking for forward running will also produce braking for backward running. The B 49 controller shown in the illustration will give this result. The reverse switch handle can be removed for forward or reverse position when, by moving the main control handle to the braking notches a rheostatic braking effect will be obtained for either forward or backward motion of the car. This controller is suitable for use with two 40 H.P. 500-600-volt series motors, and has four series, four parallel and seven brake controlling points.

Another important new feature of the B 49 controller is the mechanism by which a defective motor may be cut out of service



TOP VIEW OF CONTROLLER SHOWING MAIN AND FORWARD AND REVERSE HANDLES.

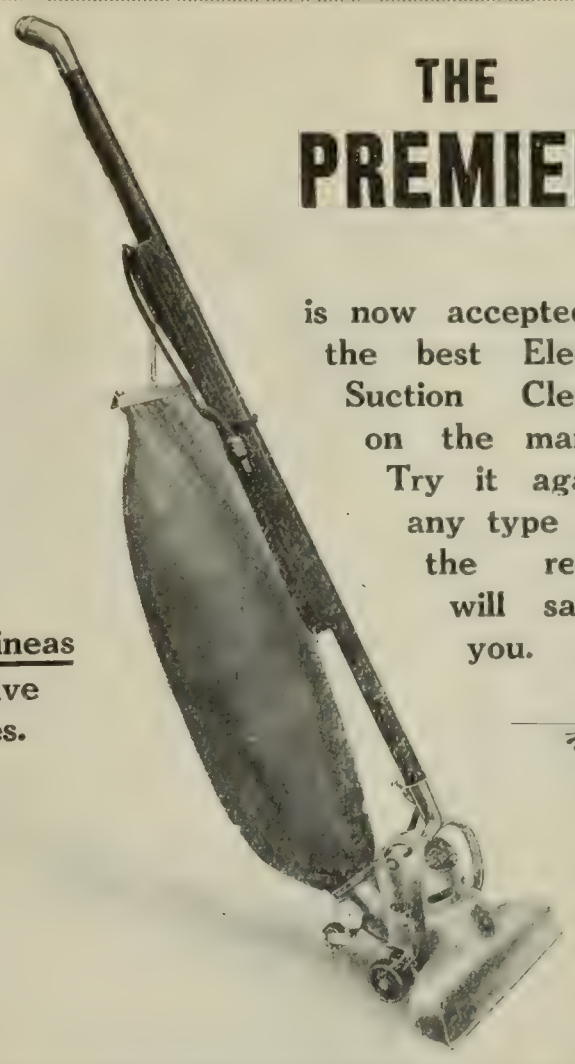
without removing the cover of the controller. This is a great safeguard in preventing delay in traffic, and avoids the necessity for the driver at any time to touch the internal mechanism. To cut out a motor it is only necessary to remove the reverse switch handle from its spindle and apply it to the cut-out spindle, which projects through the cap plate, shown in the illustration near the back edge of the cap-plate. This cut-out spindle has three running positions: a central position for which both motors are in circuit, and a position on each side to cut out either motor. An interlocking mechanism prevents the reverse switch being moved unless the cut-out switch spindle is in one of its three running positions. The usual interlocking mechanism is provided to prevent the reverse switch being moved unless the main cylinder is in the "off" position.



FRONT VIEW OF CONTROLLER OPEN.

The arc deflector of the B 49 controller, consisting of fireproof barriers, is of strong mechanical construction, the large deflector plates being supported at both ends, and the small plates moulded with large lugs for the fixing screws, thus providing rigid fixing for the plates.

A strong magnetic blow-out is provided for all fingers of the main cylinder on which strong takes place, and an insulating trough sur-



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FULLY LICENSED UNDER BRITISH PATENTS Nos 21513/06 - 27712/03 AND OTHERS

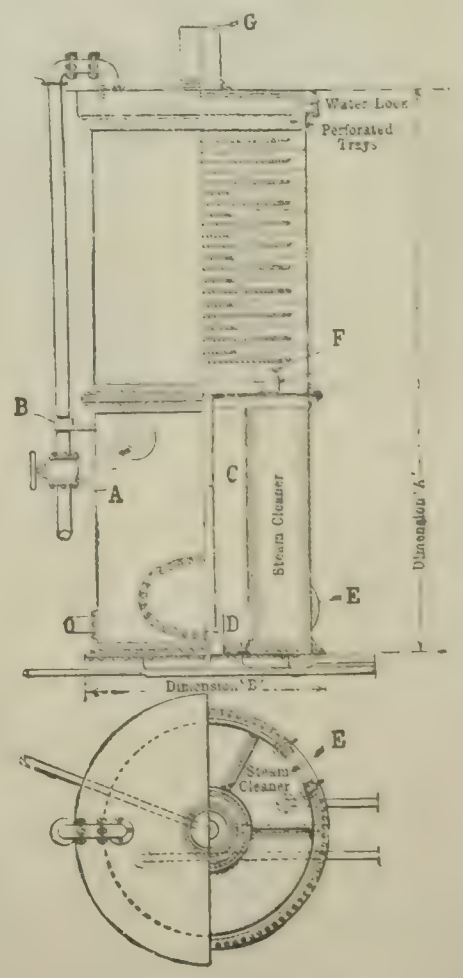
rounds the back half of the main cylinder protecting the frame from the influence of the arc or live parts. The trough is divided into sections by barriers; these, with the arc deflector which covers the front half of the main cylinder, form separate chambers for enclosing the various sections of the cylinder which may be at different potentials. The brake cylinder is mounted on the main cylinder spindle in accordance with long-established standard British Thomson-Houston practice, thus preventing any possibility of change in the relative positions of brake cylinder and handle, which may occur due to wear on the gears or cams when the brake cylinder is mounted on a separate spindle. One feature of this controller, not to be found on most tramway controllers, is the provision of ample space for the incoming cables, and the arrangement of the various parts to enable wiring to be easily and quickly effected.

THE LAWRENCE WATER SOFTENER AND HEATER.

This water softener combines in one simple plant the process of both softening and heating water. We understand that it requires no lime, that the result is certain, and that it involves practically no working expenses, as waste exhaust steam can be used. Thus, apart from the fuel and maintenance saving effected by the reduction of scale formation, there is a further saving by the utilisation of waste steam in the heating of the water, and also a saving in water by condensing the exhaust steam.

The Lawrence Co.'s apparatus removes the carbonate hardness from the water, and at the same time heats the water to about 210°F. As the carbonate salts are deposited in solid form on removable "locator" plates, without the necessity of any lime, no lime sludge has to be dealt with. When used for softening and heating the feed water for boilers there is the additional advantage of increased steaming capacity of the boilers. When an economiser is used with a boiler plant the water should also be passed through one of these heater-softeners to collect the carbonate hardness and to obtain better results and increased temperature. If exhaust steam is not available, steam direct from the boiler may be used with advantage in a heater-softener of a slightly different pattern.

The action of the heater-softener is as follows: The untreated water enters through the top cover of the plant and fa s upon perforated trays. Passing through these in divided streams it falls



next upon groups of specially formed plates or "locators." These continue to divide the water up into streams (by means of their serrated edges) as it falls from plate to plate. Exhaust steam is

IRONCASED SOCKETS & PLUGS
FOR HARD SERVICE.
Sizes up to 200 amps.
D.P. and T.P. 500 volts;
with "earthing" connection.
Also Combined Switch and Plug Boxes.



DORMAN & SMITH, Ltd.,
Ordsal Electrical Works,
SALFORD,
MANCHESTER.

admitted at the base of the plant, traversing first a steam cleaner. It then passes through a series of distributing nozzles and meets the descending streams of divided water just referred to.

A thorough mixture of the rising steam and descending water is thus obtained, and the temporary hardness of the water is removed to within about 4 deg. by the carbonate salts being deposited on these "locator" plates. The hot softened water passes down into a chamber in the base of the plant, and from there to the outlet. The "locator" plates may be easily removed from the plant in a few minutes, and the deposit, which will usually be found to be in a friable condition, can be tapped off.

The heater-softener is made in sizes from 100 gallons per hour capacity and upwards. A special form of apparatus is made for use with the exhaust of gas and oil engines, the heat from which can be profitably used. Details and estimates may be obtained from the Lawrence Water Softener Co., Parliament Mansions, Victoria-street, London, S.W.

VENTILATING AND HEATING FACTORIES.

Although it is not yet commercially possible to heat factories directly by electrical means, electrical energy plays an important part in large ventilating and heating schemes. Most of these are planned upon an ambitious scale, and involve considerable capital outlay. Some idea of the amount of engineering work in these

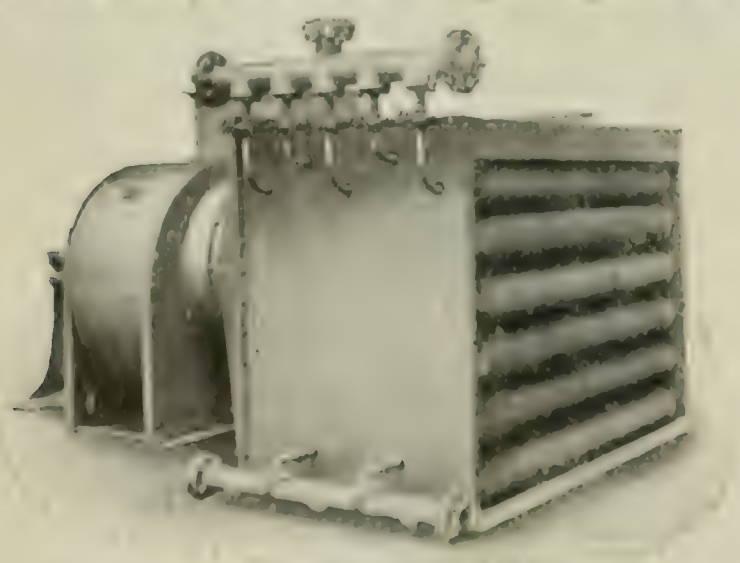


Fig. 1.—Low-pressure Horizontal Heater Unit.

installations may be gathered from a booklet published by Davidson & Co., Belfast (Publication No. 1,012). In addition to undertaking the construction of tubular heaters, the company also builds the well-known "Sirocco" fan, which can be direct coupled to electric motors and applied for the delivery of warmed or washed air for the heating of large buildings in the winter months, and by shutting down the heater for the supplying of cool air in the summer months. The heaters are made for both high and low pressure steam, also in multitubular form for heating the air by direct firing. Fig. 1 shows a low pressure steam heater comprising five heater sections of the cast-iron gilled type, designed for pressures up to 30 lb. per square inch, live or exhaust steam.

In Fig. 2 is shown a view of another form of low-pressure steam unit, designed for the warming of air and its discharge from the heater at floor level. The battery of steam pipes is enclosed in a sheet-steel casing, at the top of which a propeller fan is mounted. The low-pressure unit is fitted with gilled pipes, and when supplied with live steam at 15 lb. per square inch is capable of delivering 2,600 cubic fts of air per minute raised through 60°F. The equipment measures approximately 3 ft. 10 in. by 2 ft. 2 in. by 5 ft. 7 in. high. The unit



Fig. 2.—Low-pressure Vertical Heater Unit.

to utilise exhaust steam is identical with the above, but is 4 in. higher. The fan may be driven by either alternating or direct-current motor, according to the character of the local supply, or if more convenient the drive may be made by belt.

In the booklet referred to are interesting descriptions of many installations of heating and ventilating plant. A good example is that of the Central London Railway repair shops at Shepherd's Bush, where the heating plant is arranged on the plenum system, and serves the machine and car repair shops. A copy of the publication may be obtained on application to the company at Belfast.

FERRANTI LTD
Central House, Kingsway, London, W.C
SWITCHGEAR, TRANSFORMERS, METERS,
ELECTRIC HEATING & COOKING APPARATUS.
Write for Binder "N."

TINNING FURNACE
For COATING WIRES with Tin, Lead, etc. For use as a BATH.
WITHOUT OXIDATION. AUTOMATIC HEAT CONTROL.
The only Tinning Plant on the World's Market with Automatic Heat Control.
MONOMETER MANUFACTURING CO., Ltd., 14, Whitehouse St., Aston, Birmingham

THE ROUND TABLE.

By "KVA."

EVENT OF THE WEEK. The Melbourne City Council ask for tenders for half-a-million yellow flame carbons. Who says the arc lamp is dead ?

* * * *

William Day struck a match at midnight "somewhere in England" at a critical moment and was fined 10s. 6d. Electric heating at 8d. a unit is a heap side cheaper than this !

* * * *

In "The Times" Russian supplement a correspondent states that "in order to install a 450 kw. *American* generator at Nikolaievsk in 1910 special permission was necessary from a firm of *German* manufacturers." To all of which the Russians simply say, "Never again !"

* * * *

Ripon, that delightful, if sleeping, city of the North Riding of Yorkshire, has tried hard to get a supply of electricity from Middlesbrough, Harrogate, and the War Office via the local camp. In all three cases it has failed, so it will remain patriotic for the period of the war and use gas.

* * * *

In a review of Mr. J. E. Kingsbury's telephone book of "more than 500 closely-written pages," the "Illustrated London News" says, among other things :—

Mr. Kingsbury, in a very readable chapter for all who do not shrink from figures, tells how the telephone *travelled across Europe.*

* * * *

"Damage amounting to many thousands of pounds was caused by a fire, the result of electric wire fusing, at the Coal Bank Mills of Richard Ball & Co. (Ltd.), Norden, near Heywood."

So says the daily press. I have not seen our old friend "the fusing of an electric wire" since the war broke out. Can it be that peace is now really in sight ?

* * * *

The North of Scotland College of Agriculture recently discussed the use of Craibstone House for training disabled soldiers in agriculture, forestry, &c. Among its recommendations for the refitting of the building are new drains, new water supply and *electric light*. Here is a splendid opportunity for the local gas manager to protest, on patriotic grounds, against the last item, à la "S.O.S.," of Worthing.

* * * *

Gramophone records of morse signals are now available for the use of students of wireless. There would be a big demand for "language" records for the use of cable-laying engineers, clerks of works and others who are liable in emergency to run short of words fitting the occasion.

* * * *

When the "Belfast Northern Whig" reports anything electrical it believes in attractive headlines. Its title to a two-column report of the cross-examination in the Farrell *v.* Bloxam slander action reads : "Iliad of the Power House."

The Vice Consul of Seydisfjord, Iceland, reports that "the electric station is working well : it supplies electric light to the town and many persons now cook by electricity." I wonder if the ovens are black or polished, what the price of juice is, *and* whether the Icelanders really care how long the war lasts.

* * * *

The "Birmingham Mail," reporting the discussion of the operation of the coal clause in the agreements with high-tension consumers by the Electric Supply Committee, says "this clause provides that *the force of the current* shall vary according to the tonnage price to be paid for coal." This is a new interpretation which central station engineers will welcome. They have some control over the current if they have none over the price of coal.

* * * *

The new wiring rules of the Inst.E.E. are, quite naturally, prepared without regard to trade names or trade initials. The solid rubber covering known in one familiar instance as "cab-tyre sheathing," otherwise C.T.S., now assumes the dignity of "tough rubber compound protection !" I understand that my old friend J. H. C. B., to whom I have always referred as "C.T.S." Brooking, positively refuses to be dubbed anything else. I don't mind calling him T.R.C.P. Brooking when I can find a suitable sobriquet to correspond with the initials. To any reader of the Round Table who offers an appropriate suggestion I will award a Hot Plate, with a T.R.C.P. flex attached to it.

* * * *

The arrangements making the Holborn Restaurant, Kingsway, London, W.C., a rendezvous for Batti-Wallahs and their friends are now in force. The Committee have decided that Friday of each week (excepting Good Friday, of course) is the day on which Batti-Wallahs at home and abroad may be sure of meeting members of the Society, from 12:30 till about—well, 2:30 p.m. is the latest time to order a liqueur. If you do not lunch at the Restaurant you can still blow into the coffee room, and any Batti-Wallah present will wave his badge at you, if you are a bit short-sighted.

* * * *

THIRTY-SEVEN YEARS AGO.

[From THE ELECTRICIAN (Second Series), March 29, 1879.]

ELECTRIC LIGHT.—The Select Committee of the House of Commons appointed to inquire into the subject of the lighting of towns by means of electricity, and to which the Liverpool Lighting Bill was referred, has determined to go into the general question, settle the principle, and then leave the 34 private bills which ask for powers to light by electricity to be dealt with by the regular committees of the House of Commons. The inquiry will commence on the 31st inst. As the evidence will be lengthy, and the Committee will probably report late in the Session, it is expected that no powers will be granted this Session for lighting by electricity.

A NEW CONDUCTOR.—Mr. Alberger has presented in America a novel kind of conductor, consisting preferably of a decarbonised steel wire, surrounded by a vitreous substance, over which is placed a metallic tube. To manufacture this conductor the inventor produces a glass bulb at the end of a glass blower's tube, and passes a wire into the bulb, then drawing wire and bulb forward he obtains a conducting thread covered with glass. The wire with its casing is put into a wrought-iron tube, and the whole heated to a welding heat, and reduced in size by rolling. Joints are made by an ordinary screw coupling, the ends being first rounded off by an emery wheel, to render a contact of the conducting wire certain. This way of making a joint may seem pretty, but we very much doubt its practical success. A conductor thus made is, according to the inventor, protected from oxidation and is completely insulated. The weak point in the whole seems to be the "joint."



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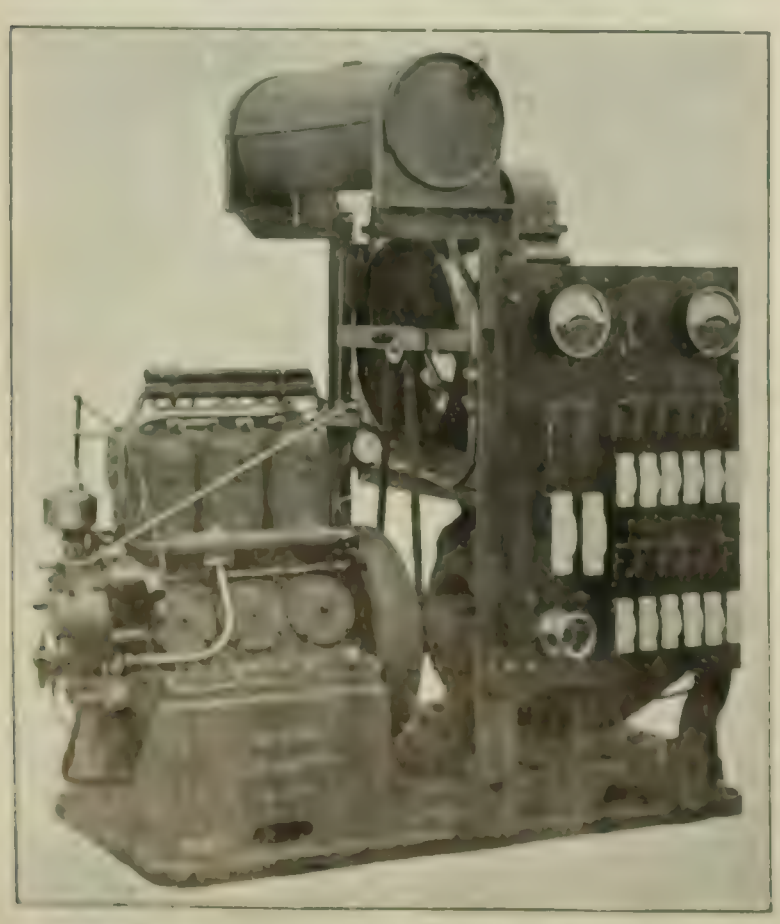
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SELF-CONTAINED PARAFFIN ELECTRIC GENERATING SET.

Generating sets of moderate output comprised of internal combustion engine and dynamo on one bedplate are now not uncommon forms of plant, but the illustration herewith shows that the convenience of such plant can be greatly extended by a careful design incorporating all the accessories of such a set, making the whole unit, therefore, self-contained and portable. We are not permitted to refer to the particular uses for which the Parsons Motor Co., Ltd., Southampton, have recently been supplying a large number of plants, both of this and also much larger sizes.

The plant illustrated is of 12-kw. output, and the paraffin engine is of the company's standard type, with all the well-known features of pump lubrication and oil cooler, high-speed sensitive governor, variable timed magneto ignition, forced water circulation, oil-pressure gauge, and oil-level gauge. We may also mention that pistons and connecting rods are removable through the crank chamber doors, without disconnecting any of the cylinders or pipes. The dynamo in this case is somewhat hidden by the instrument board. The latter comprises ammeter and voltmeter, D.P. main switch, two single-pole main cut-outs, voltmeter switch, six D.P. distributing switches, 12 single-pole cut-outs, and shunt regulator. The superstructure formed of channel iron is quite rigid, and is attached to proper facings provided on the baseplate. The radiator has removable top and bottom headers of cast aluminium, so that all tubes can be got at if necessary. The air blast through the radiator is supplied by a suitable fan, the efficiency of which is greatly increased by its operating in a casing as shown. The fan is driven by a flat belt over pulleys of large diameter. The speed of the engine and dynamo is quite moderate, viz., 900 revs. per min.

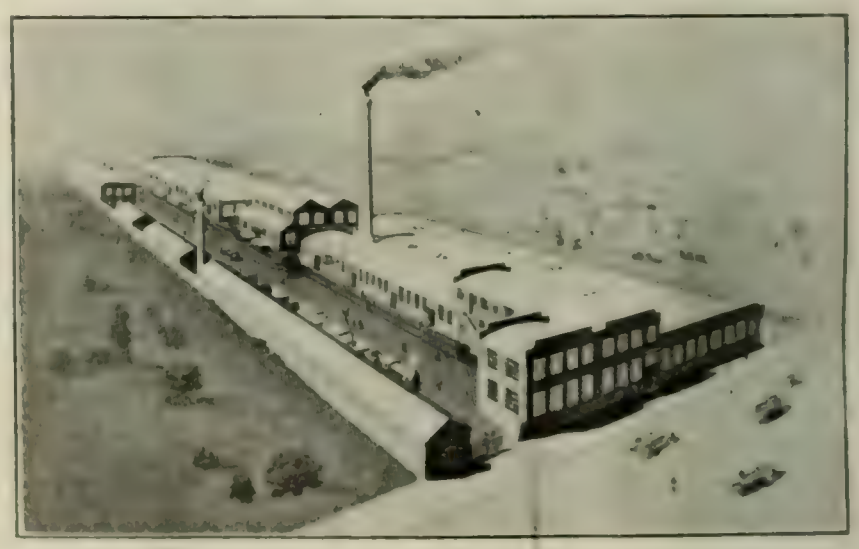
The fuel tank will be seen mounted at the top of the frame, above the fan casing, and in some recent plants has been placed a little lower. The risk of any overflow from the radiator reaching the dynamo has not been overlooked, and not only is the overflow pipe carried well clear, but a tray is fitted beneath in order to catch any slight leakage that may occur at any time. As a matter of fact, the radiator is not actually over the dynamo at all, but between it and the engine. The engine itself is fitted with a large and heavy flywheel, and the governing is, we understand, exceedingly good, usually within 2 per cent. either way. One can hardly conceive the number of uses to which such a plant as this can be put, but many will, no doubt, present themselves to our readers.



[illegible] View of Combined Dynamo and Switchboard Unit

STORAGE BATTERY CATALOGUE.

Considerable interest attaches to a new catalogue file which is now being issued to the trade by Pritchett & Gold & E.P.S. Company. In the file are six pamphlets which deal respectively with batteries



A Bird's-eye View of Works at Dagenham Dock, Essex.

and boosters in central stations and factories, notes on capacity and voltage of cells, general specification of batteries, accessories, glass box cells, and wood box cells. The pamphlets are clearly printed, and are of uniform size and style as to printing and grouping of data. This feature will doubtless be welcomed by users.

In the first pamphlet the scope of power batteries is pointed out. Not only do they now do the same kind of work as dynamos, but

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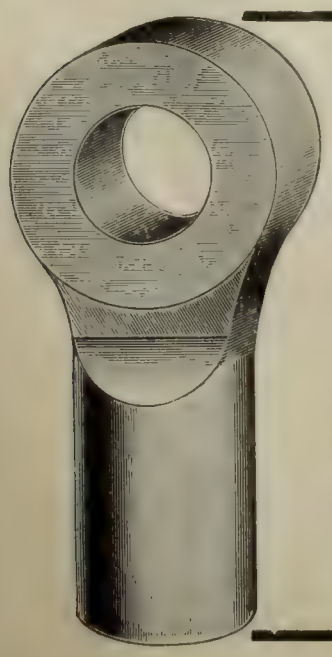
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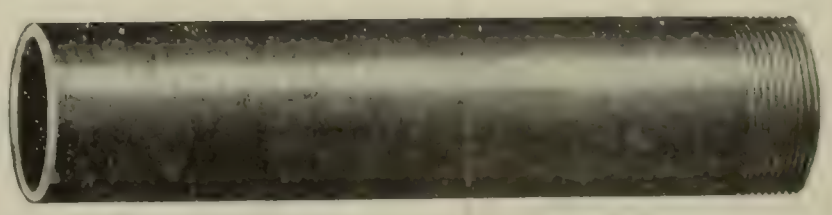
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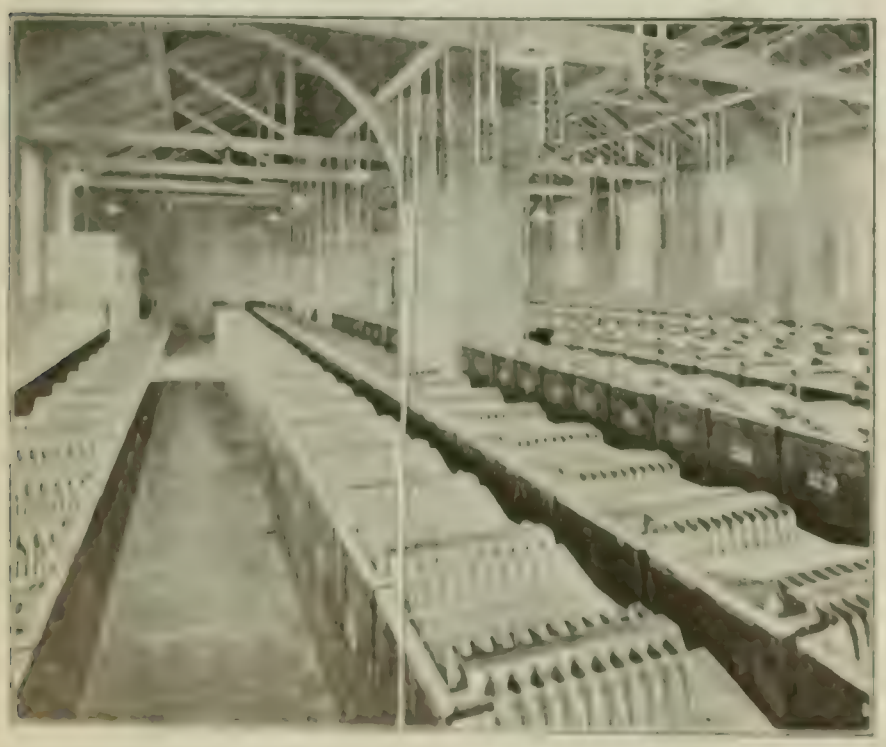
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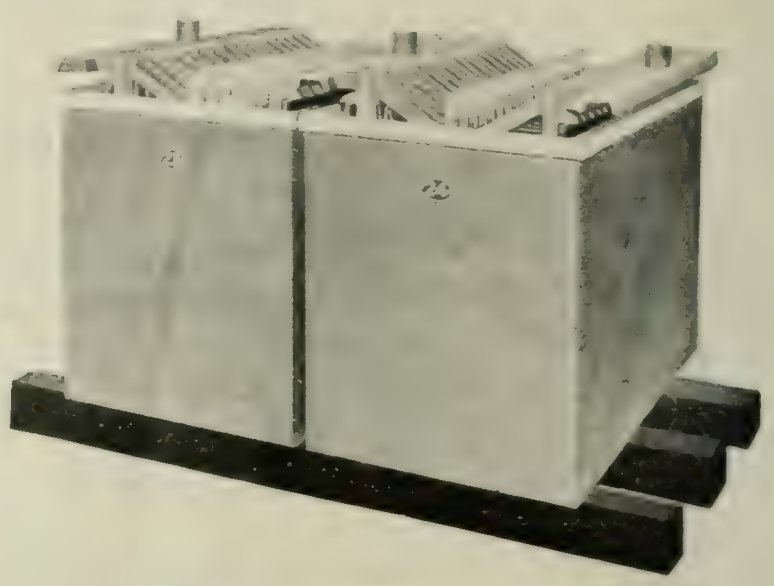
are entrusted with the heavy end of the work, and actually protect the dynamo, a condition of things which would have struck the storage battery engineer of a few years ago with wonder. It is possible to demonstrate that benefits can be derived from the employment of electric storage, whether the power load be that of a



[illegible] Factory at Burnley.

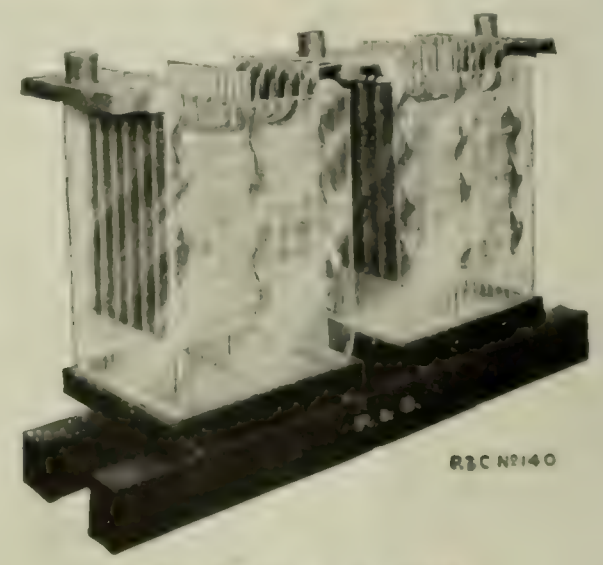
[illegible] supply [illegible] a single factory. In regard to the latter, there have been cases in which the fluctuations of lighting due to the voltage disturbances put up by heavy duty motors have given rise to the discontinuance of the electric lighting for other less satisfactory illuminants. The power that a powerful case can be made out for the use of batteries in connection with industrial electric power supply.

Where the energy is generated practically on the works, the employment of a battery will admit a considerable reduction in the generating plant. It is stated that in the case of one works where a close test was taken, the saving in fuel amounted to practically 30 per cent. It is, of course, possible for any engineer to obtain an estimate of the cost of an equalising plant to verify by calculation the economic results which can be obtained. Some interesting notes are given on the use of end-cell switches versus hand reversible boosters. It is pointed out that the method of using the battery to give the best and most economical results can only be decided by a close con-



Batteries in Wood Boxes.

sideration of each individual case. Considerable difference of opinion appears still to exist upon the method to be employed with different types of load. On grounds of efficiency the charging booster has advantages over a reversible booster, because with the latter operating on discharge as much as 15 per cent. of the battery current on occasion is required to drive the booster motor. It is pointed out in the notes under this heading that both battery and booster and switchgear must be large enough to carry a greater current than would be the case if regulating switches were employed.



Plates in Glass Boxes.
Burnt to a common Connecting Bar at the time of erection.

Under the heading of automatic reversible boosters, the merits of this particular form of unit are detailed. At the present time when expenses must be reduced, the advantages of a battery booster plant confer steady engine load, steady voltage, good load factor, reduced wear and tear, freedom from breakdown, and certain stand-by in case of emergency. On one of the pages of the first pamphlet are given interesting notes upon the calculation of battery and booster plants, both with end-cell and reversible booster systems. Two tables are given which show respectively the voltages, number of

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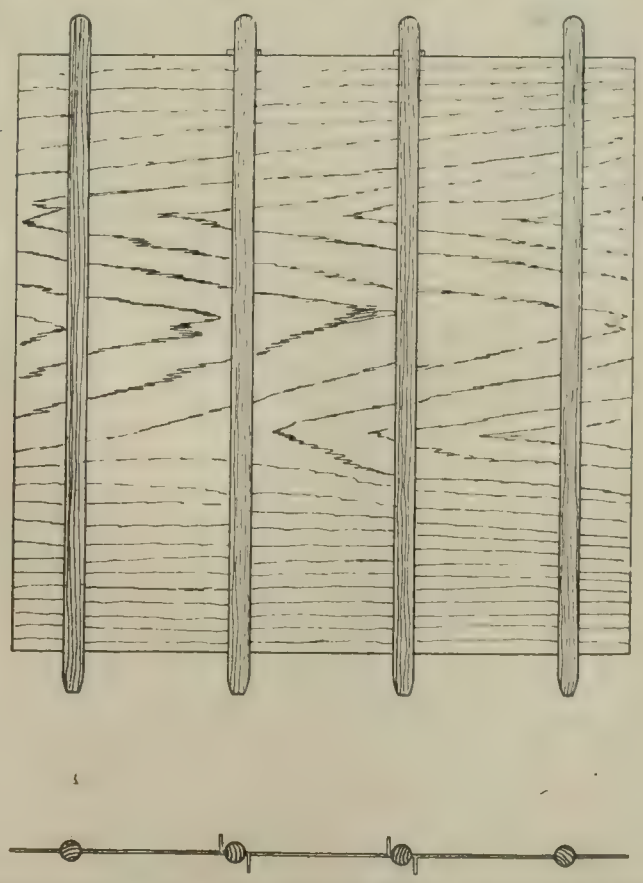
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cells, &c., for various methods of battery control, and the capacity and voltages of cells on discharge.

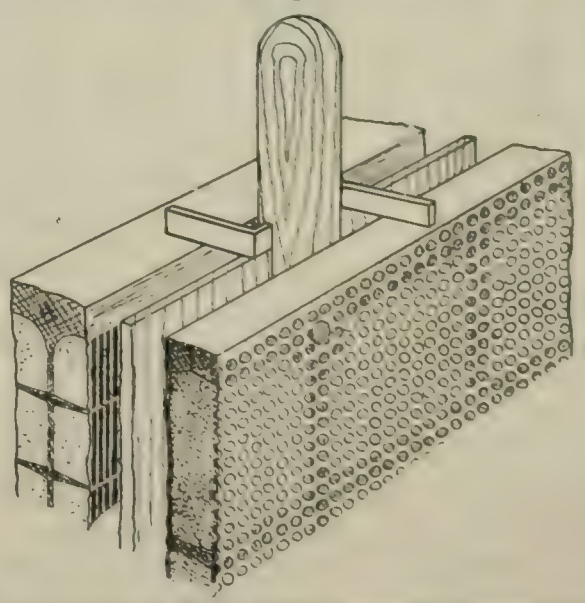
In the second pamphlet a complete specification of cells, stands and fittings for batteries for lighting and power installations is given.



Wood Sheet Separator fitted with Spacing Rods and Suspension Pieces.

This is accompanied by detailed illustrations which clearly show the method of supporting the plates in their boxes, and the arrangement of the wood separators between the plates. The detail of the latter is shown in one of the adjoining illustrations. These wood separators are employed in the larger sizes of cells made by the company. They consist of thin veneers about $\frac{1}{16}$ in., which have been treated by a process which removes impurities, but leaves the wood highly porous. They are suspended in the cell between each pair of plates by threading them through split sticks known as dowells, these having at their upper ends what are known as knee pieces threaded through the top of the slot and resting on the top edges of the two adjacent plates. In this pamphlet are reproductions of several excellent photographs of large battery installations.

The pamphlet on the capacity and efficiency of storage batteries will be followed with considerable interest by battery users. Curves are given which show the variations of time of discharge with rate of discharge, variation of capacity with time of discharge, the fall of voltage on discharge, and rise of voltage on charge. In the pamphlet on accumulator accessories are given details of acid testing sets,



Method of suspending Wood Separators by means of Insulating "Knee Pieces."

mixing tanks, hydrometers, glass-oil insulators, bridging cables, voltmeters, cell inspection lamps, sediment pumps, lead burning apparatus, and water distilling plant.

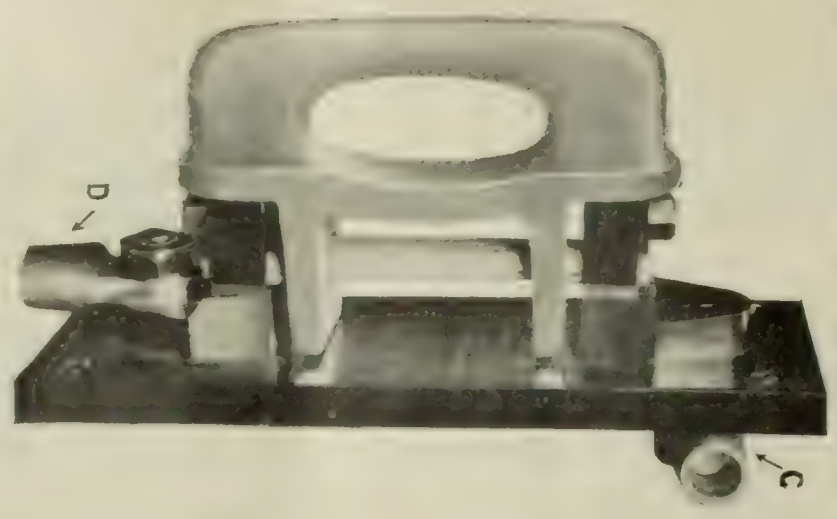
We are asked to state that copies of this file, complete with pamphlets, will be supplied to interested inquirers at the company's address, 82, Victoria-street, London, S.W.

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A CASE OF EVOLUTION.

The large express railway engine of to-day is much the same as Stephenson's "Rocket" of 1829. The latter had a coal fired boiler generating steam that drove a piston forward within a cylinder, the movement of the piston being communicated by a connecting rod and crank to the flanged driving wheels running on rails. The difference between the engine of to-day that draws at high speed a train weighing 300 tons or more and its original, that now is a mere exhibit at South Kensington, lies in the improvement of detail. Higher steam pressures are possible by the use of more suitable material for the boiler; steam can be raised more quickly and the pressure maintained more easily by the addition of boiler tubes and the use of forced draught. The slide valve did away with the oscillating cylinder, the double-acting cylinder gave an impulse to the piston at both ends of its stroke, and scores of minor improvements added to the efficiency of the machine, which even Stephenson himself would scarcely recognise as a development of his pioneer work.

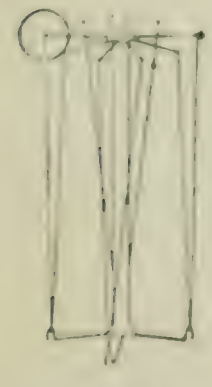


Fig. 1.

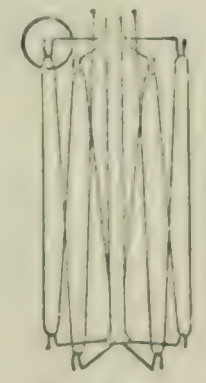


Fig. 2.

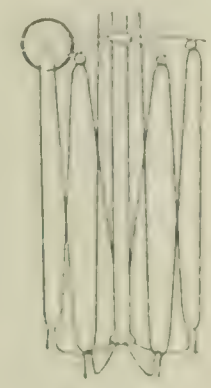


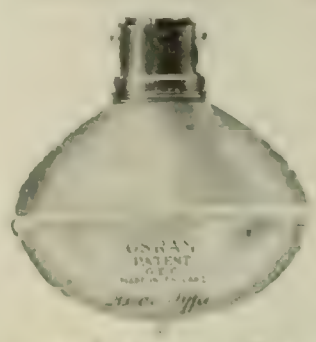
Fig. 3.

With electrical devices the same principle holds good. The glow lamp of to-day is quite a different thing from that type of 36 years ago, yet its light is produced in the same way—within an exhausted bulb, by a filament raised to incandescence through the passage of current. Improvements are concerned with the type of filament used and method of support, with the kind of vacuum secured, with the use of special methods of counteracting blackening, and with scores of minor details that by themselves seem perhaps of small moment, but in combination make up the difference in efficiency, life and strength that exists between the lamp of to-day and that of 1879.

In the Mazda lamp, for example, one of the many details in construction that have made for mechanical strength is the method of support for the filament loops. When filaments of squirted tungsten were used, consisting of a number of short hairpin-shaped pieces, the ends had to be supported or welded to stiff supports reaching from the central glass stem (Fig. 1). This construction was weak mechanically, hence the frequent fracture of the filament at or near the ends, which was not always. With the introduction by the British Thomson-Houston Co. of a filament formed from one continuous length of drawn wire these intermediate joints were no longer needed, the filament loops being supported by a "spider" consisting of hooked wires over which the wire was wound (Fig. 2). This removed the great source of trouble, and by the absence of joints and the freedom at the supports fewer filament breakages occurred, but it was possible for the filament to become dislodged by vibration. Finally, however, the hooked wire support was superseded by what is known as the "pig-tail" loop (Fig. 3), a feature incorporated in Mazda lamps. The filament loops are passed into the "pig tails," which by their form prevent the filament becoming detached, however violent may be the vibration to which the lamps may be subjected. Moreover, it provides a spring support that allows for expansion and contraction of the filament and for a limited freedom of movement within the coil of the "pig tail." It is only a detail, nevertheless its introduction and the perfecting of the machinery to make it cost many hunreds of pounds. But it had a material bearing upon the life and strength of Mazda lamps, so it was added without extra cost to the user.

THE USE OF "AXIAL" LAMPS.

In places in which a concentrated light is required over, say, writing desks, billiard tables, machine tools, fitting benches in munition works and other engineering factories, typewriting offices, drawing offices, shop windows, showcases, staircases, passages, as well as for such delicate work as is undertaken by the optician, jeweller, watch and clock maker, &c., a special lamp has been developed at the Osram-Robertson Lamp Works (Hammersmith), and is known as the Osram "Axial" type lamp. In appearance it differs from the standard Osram in that it has a bulb of larger diameter, and rather more squat. The filament, consisting of pure drawn tungsten wire, is wound into a helix of small diameter, in a comparatively small space so that the light is thrown downwards instead of sideways as is the case with the ordinary tungsten lamp.



OSRAM "AXIAL" TYPE LAMP FOR DOWNWARD ILLUMINATION.

It will, of course, be understood that the Osram "Axial" type lamp is not meant to replace the standard Osram lamp, although there are many positions where its use would be distinctly advantageous. By means of a conical opal reflector which is made to fit closely to the upper half of the bulb, any rays of light which would otherwise be lost in the upward direction, are reflected downwards, thereby increasing the candle power in the direction required.

Full particulars and any information respecting lighting problems will be given by The General Electric Co., Ltd. (Illuminating Engineering Dept.), to those desirous of obtaining the utmost commercial efficiency from their illumination.

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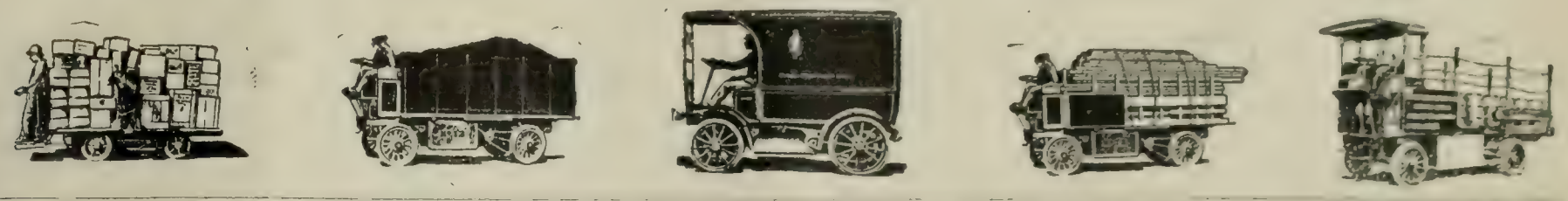
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ELECTRIC VEHICLE PROGRESS



THE LIGHT ELECTRIC DELIVERY VAN.

While excellent progress is being made in the heavy patterns of electric delivery vehicles such as those employed in industrial and commercial work, and also for municipal service, and it may be noted that the demand for such vehicles is on the increase, there undoubtedly exists an exceptionally wide field for the exploitation of the light pattern of vehicle which will compete more particularly with the three-wheel petrol driven cars which at present enjoy a considerable vogue. We think we are right in stating that the widespread employment of these small petrol vehicles is attributable to the facilities which are given small tradesmen to hire them out on somewhat favourable terms. The hiring arrangement relieves the vehicle user of responsibility for repairs and maintenance, and virtually enables him to drive the machine in such way as he thinks fit and at such a speed as will enable him to carry out his transport work in the minimum amount of time. These facilities give in some measure a deceptive idea of the merits, both technical and transport, of these vehicles for light delivery work. It is true the hirer covers himself with the charges which he makes for the use of the vehicle, and he is also in a position to centralise or to organise the work of repair and maintenance. It is such centralisation which regulates the price at which the vehicle is hired.

From the point of view of the electric vehicle, the existence of a type of motor-car user who has been able to dispense with the trouble of garaging, repairing and maintaining his trade vehicle is extremely opportune. There can be no better prospective user of the electric vehicle than a tradesman who has been operating one or several petrol-driven machines under a hiring scheme. His drivers are not mechanics, he has no workshop facilities, and his premises are, in fact, as innocent of the engineering paraphanalia which go towards the maintenance of special cars as they very well could be. He should, therefore, be an excellent prospective user of the light electric delivery van.

On the other hand, there are many tradesmen who have, during the past two years, been tempted to buy the more inexpensive forms of American petrol-driven cars which present such rosy prospects for dealing with transport problems when they are first purchased, but which subsequently prove themselves rather more costly in service than they were expected to do. This type of light delivery vehicle user is probably in possession of facts and figures regarding the operation of his car, and to him it will be possible in presenting the case for the electric vehicle, to offer a machine which will have a low maintenance factor, be capable of operation by unskilled labour, and also be able to maintain a good average mileage for the class of service in which it will be used ; in addition it will be able to show an annual saving which will justify the increased capital outlay which it is at present necessary to expend in its purchase. There is another feature of the light electric delivery van which will appeal to the tradesman who finds mechanical transport necessary to the conduct of his business. If he is a baker or confectioner, a laundryman, a grocer, an ironmonger or butcher, or a general provision merchant, he will as likely as not, be a consumer of the local electricity department, and in all probability he will also be something more than a mere light user. He will have on his premises a few motors for turning some form of machinery necessary to the carrying on of his trade. In these circumstances the installation of the necessary plant for the charging of his battery during the night time will be a comparatively simple matter. It is true it will add to the initial cost of the installation, but will not be greatly in excess of the amount required for a petrol storage pit or a small workshop.



"Ward Special" Light Electric Delivery Van.
(Krieger Electric Carriage Syndicate.)

In the light of the foregoing facts interest attaches to the Ward Special light delivery van, which is being put on the British market by the Krieger Electric Carriage Synd., Gillingham-street, London, S.W. The adjoining illustration shows this vehicle with a typical light delivery body. The chassis is built up of channel steel sections, suitably cross-braced and stiffened. The front axle is of drop forged steel with Timken bearings, and the rear axle is built up in a standard Timken pressed steel housing with helical gears and Timken bearing. The wheels are of the artillery type with 12 wooden spokes.

Osram
DRAWN WIRE
Lamps
for Motor Car Lighting. Made at the Osram-Robertson Lamp Works, Hammersmith, London, W.



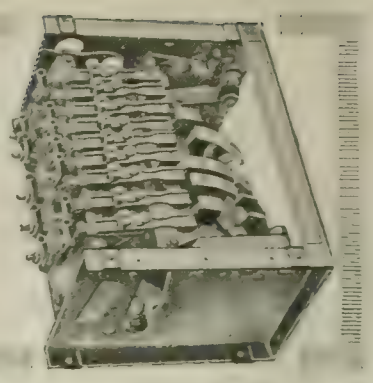
The Controller on your Electric Vehicle

The man who buys an Electric Vehicle, wants economical working, and for a personal car expects comfort. If the control system is

'IGRANIC'

he'll get both, to the point of real refinement. There's real genius in these Controllers, manifest in their way of economising power and the silky way the car responds to the driver's touch. Have us send you particulars.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.



The springs, front and rear, are of the semi-elliptical pattern, and the tyres are known as the "Firestone Electric," 32 in. by 2½ in., on side wire rims. The steering is of the wheel pattern, with minimum lost motion gear, and the controller, operated by a lever immediately below the steering wheel, is of the continuous torque pattern with four speeds ahead and two reverse, the control being of the ordinary rheostat type. A battery of 42 nine-plate lead cells is mounted on top of the chassis in a box which forms part of the driver's seat. The motor is mounted on a sub-frame amidships on the chassis, and is of the Westinghouse series heavy vehicle type. It drives the rear axle through propeller shaft. The normal speed of the vehicle on the level is 10 miles per hour, and the battery is capable of giving a radius of 35 to 45 miles on one charge, according to the nature of the road. The loading capacity of the vehicle is 750 lb. Two pedal-operated brakes are fitted, one of the expanding pattern on each of the rear wheels and another of the contracting type on the propeller shaft immediately ahead of the differential gear box. This vehicle is being offered at the extremely moderate price of £260, complete with lead battery. We were recently given an opportunity of inspecting one of these interesting vehicles at the Krieger Co.'s garage, and we were much impressed with the simplicity of the design and the practical character of the construction. We are informed that trial runs of the vehicle can now be arranged on application to the company.

"WOLSEY" ELECTRIC VEHICLE.

The adjoining illustration is of considerable interest, because it shows a pattern of electric vehicle which has recently been put into operation by the manufacturers of the famous "Wolsey" underwear.



Side View of "Wolsey" Battery Vehicle.

This company has a number of woollen mills in the Leicester district, and these mills are so situated that an electric vehicle is the ideal method of transport for giving the desired delivery service between them. The machine was put into operation shortly after the outbreak of war and its purchase enabled the company to release several petrol vehicles for the use of the conveyancers.

The chassis is of the Edison-Co.'s standard D type, and is fitted with single seater driving and cab seats for goods, and thence to the back wheels by side chains. The machine has a carrying capacity of 1 ton, and has a mileage range of about 40 on one charge of the battery. We understand that the daily round of the various mills is accomplished without the need for boosting, and the energy for the charging of the battery is supplied from the company's own plants.

Considerable attention has been paid to the design of the body, and we feel sure that if the vehicle were to appear on the London streets it would constitute a magnificent advertisement, and would create considerable public interest. The panels are of light bird's-eye maple, and are all carefully French polished. This latter fact will serve to explain the care taken with the design of the body. In the centre of the side panels is a large medallion bearing the company's trade mark, a bust of the famous cardinal with his red cap and robe. The colour is brilliantly brought out in enamel. The photograph of the car was taken at Leicester Abbey, to which place it will be remembered Wolsey journeyed after his final interview with the King, and when he came, to use his own words, "To lay his bones among his own people."

ELECTRIC DUST VANS.

Considerable progress is being made in a number of districts in various parts of the country with electrically-operated vans for the collection of the town's refuse. Among the recent converts to this admirable and efficient system are the Corporations of Sheffield, Nottingham and Dover. The illustrations show the tipping-body type of Edison vehicle adopted by the Nottingham Corporation. This vehicle was supplied to the order of Mr. J. Terry, M.Inst.C.E.,



Nottingham Corporation Dust Van. Body Raised.

Superintendent of the Cleansing Department. The capacity of the vehicle is 2 tons. The Sheffield van is of almost identical design, but has a capacity of 3 tons. These cars are fitted with a neat form of electric tipping gear which is operated by an independent motor which is connected to the main driving battery.

The extended employment of vehicles of this class will afford the municipalities throughout the country an opportunity of proving their undoubted economies over horse-drawn or petrol or steam-

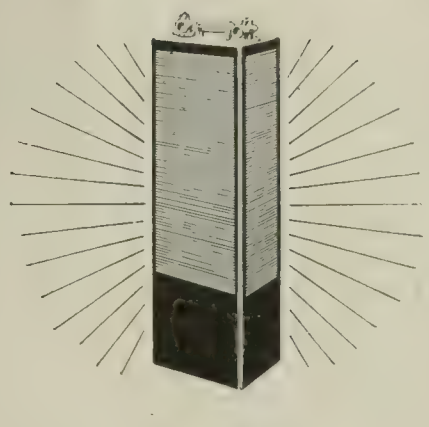


Nottingham Corporation Dust Van. Body Tipped.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON, S.W.

driven vehicles. The case of the electric battery dust van has hitherto rested almost entirely upon the evidence of figures. The fact that a number of these vehicles are now in service should furnish operating data which ought to bring into line the many municipalities who have adopted mechanical propulsion, either by steam or petrol, or who, as in the case of the majority of them, still rely upon horses. The war has in some measure forced the hands of many of the municipal undertakings in this matter. Their horses have been commandeered, and even the petrol vehicles which have a type of body to be of use to the Government have been taken from them. In these circumstances they have been unable to resist the attentions of the various firms who specialise in battery-propelled vehicles and who have recently laid themselves out to supply the right type of vehicle for this work. In particular Messrs. Edison Accumulators have an excellent record of sales of dust collecting vans.

Quite apart from the operating economies which the electrically-propelled dust van introduces, the cleansing authorities are attracted to the use of these vehicles by the excellent facilities which exist in the majority of towns for recharging the propelling batteries. The necessary electrical energy can be obtained either from the mains of the local authority (company or municipal), or where small steam plants are in operation in connection with dust destructors, these are of sufficient capacity and usually operate at the correct voltage for battery charging purposes. It is encouraging to note that in this particular field at any rate the battery-propelled vehicle is being given a real chance to prove its merits, and the immediate outlook is one which may certainly give the petrol and steam car makers something to think about.



SIDE VIEW OF MIDLAND RAILWAY BATTERY VAN.

TWO LONDON ELECTRIC VEHICLES.

Nothing tells the story of the progress of the electric battery vehicle than pictures of their use under service conditions. It is gratifying to note that the railway companies are awakening to the genuine merits of electric delivery vans for town and suburban service. The Midland, in particular, have shown a keen interest on the subject and are probably well ahead in the matter of the use of these vehicles, especially in the London area. There is no doubt that the vehicles create considerable public interest. A van will come steadily and almost noiselessly along the street, and its moderate speed and quiet running are at once noticed by the pedestrians who invariably look round and are evidently a little mystified. Should the vehicle pull up at the curb it will be the object of several admirers, and not in-



TYPICAL 2-TON BATTERY VAN WELL LOADED.

Particulars and Catalogues from

SIEMENS BROTHERS & CO., Ltd.

WOOLWICH.

Telegrams: "Siemens Woolwich."

Telephone: City 6400 (7 lines).

CABLES & WIRES,

MOTOR-CAR LEADS

(Weatherproof, Strong, Flexible and Durable),

BATTERIES

&c., &c.

frequently the driver or the van boy will be questioned by some practically-minded inquirer; perhaps a repentant user of petrol or steam vehicles on town service.

The wholesale as well as the retail trader is also coming to use the battery van, as the illustration of one of Peter Keevil's 2-tonners shows. This vehicle, a standard Edison G.M. type, is in daily service under the arduous loading conditions which now obtain in these warlike times. Deprived of their horses as well as of petrol vehicles there are many traders only too glad to turn to the electric to help them out of their troubles. Initially they enter upon the experiment with some misgiving, but before many weeks are over they find the step fully justified by economic and efficient running.

FROM BUFFALO TO NEW YORK IN AN ELECTRIC VEHICLE.

Considerable interest has been evinced in the cross-country trip made recently by Mr. Chas. S. Chamberlain, of Buffalo, N.Y., in a Waverley electric. Mr. Chamberlain's original plans indicated that he would make the entire trip, 504 miles, in three days. However, due to the exceedingly poor charging service facilities in Albany and Poughkeepsie, he was forced to remain in Poughkeepsie over night, thus requiring a day to complete the trip. For the most part Mr. Chamberlain said he found excellent charging facilities in the upstate towns where he obtained service immediately, enabling him to keep up to his schedule. There were many rough roads and several very bad hills, which, however, were negotiated without trouble. At one particularly difficult grade Mr. Chamberlain related a rather amusing incident. It was a steep hill filled with deep, fresh earth which more than one petrol car had failed to take. Several onlookers congregated to watch the performance of the smart-looking luxurious electric and a touring car stopped also, evidently waiting to see it get stuck. But nothing of the kind! The electric sturdily ploughed its way right to the top of the hill without any apparent effort, leaving the doubtful onlookers in a state of surprised admiration. 94 kw.-hours were consumed in covering the 504 miles, or an average of 0·16 kw.-hours per mile. This represents less than 1 cent. per mile for the distance covered. Mr. Chamberlain feels that his trip was a great success. That he did not make it in the three days originally planned was due primarily to the inadequate charging facilities referred to, and partially to extensive detours made necessary on account of road repairs. With anything like good charging service in the afore-mentioned cities, Mr. Chamberlain would easily have negotiated the trip in schedule time. This tour caused considerable comment and interest and is one more instance to prove the power and capacity for endurance which are the inherent qualities of an electric vehicle.

"HITCH YOUR WAGGON TO THE SNOW."

The following letter was recently received by the secretary of the Electric Vehicle Association, N.Y.

Gentlemen: Santa Cruz, Cal., February 24, 1914.

Yours of February 11th to hand. I am interested in what you say as to the future of electric waggons and trucks. Petroleum, with all its by-products, will be exhausted some day, but electricity will last. Here in California we have a big high ridge, the Sierra Nevada Range, where the Creator has His reservoir of snow; as the warm season advances the snow melts and streams rush to keep down, making possible relay after relay of electric generating plants. Electricity will be more and more abundant. Our cities are filling up with people. The era of steam farming on large areas is passing. Those large farms are being subdivided, and great numbers of small farms, better tilled, are coming. Now you men who look into the future, can't you make us a commercial motor waggon, an electric vehicle, say, one half ton to a ton capacity, or so, to be used mostly for light loads, and for handling things. The cities are carrying people. We could have a fine thing if we had a waggon to run on the level and put the other on, thus changing our waggons from one set to another in a few minutes. Such a waggon would meet the wants of a large number of middle-class people and able to own a waggon and an automobile, both. Do you know of any firm that makes such a waggon? If so, put me in correspondence. I am now living in Santa Cruz, but own an orchard of 15 acres in the Santa Cruz Valley, where I am thinking of going to live. I would like to have such a waggon, so I could handle my fruit, and with the same waggon take my family to church. The cost may be in our way, for we haven't got piles of money to spend on racing autos. A waggon that would go 10 miles an hour would be fast enough for the class I speak of. If there is no such electric waggon now manufactured, *make one.* I put it up to you Yankees to fill this long felt want.—Fraternally, J. H. M.

PARKING SERVICE FOR ELECTRIC VEHICLES.

There is need for a system for parking waiting automobiles in large cities, and as evidence of this need annoyance is caused the owners of private houses in certain residential streets by stationing automobiles for hours at a time in front of their homes while the car-owner is in some other locality where laws prohibit vehicles from standing in one place for more than a specified time. Nearly all of the large cities of the United States have enacted legislation which allows a vehicle to stand in the business district for but 30 minutes. Anticipating the inconvenience that such regulations would cause car owners who do not employ chauffeurs, the Electric Vehicle Association of America has introduced a system for parking electrics which has succeeded so well in Chicago that practically all electric garages there have entered the service. The vigorous enforcement of the thirty-minute law compelled many women who were accustomed to driving their own electrics to abandon their cars for use while shopping. While a portion of one of the parks in Chicago was thrown open to the public for use as a parking space, it was too remote from the shopping district to be of any great service. Therefore, the down-town electric parking service idea had its first conception as a remedy for the existing conditions, and at the same time to give to the passenger electric vehicle the distinction of possessing a service which is not available to any other type of car.

The matter of expense being prohibitive for each electric garage alone to maintain a parking station, three of the largest co-operated, and through the efforts of the Chicago Section of the Electric Vehicle Association a station was started with headquarters at the electric shop of the Commonwealth Edison Co. Patrons leave their cars at the station designated, and receive a key tag, which states plainly that the service is accepted on condition that same is entirely at owner's risk. The car is then parked by a competent chauffeur, and returned at the time specified by patron. There is no charge to the customer for this service. The licensed chauffeur is maintained at 50s. a week, each garage paying 16s. per week. The idea became so popular that three more garages applied for the service, and a second station was started. Here the expense was 50s. also, each entering garage paying 16s. a week.

ELECTRIC VEHICLE RECOMMENDED FOR USE IN FILM PRODUCTION.

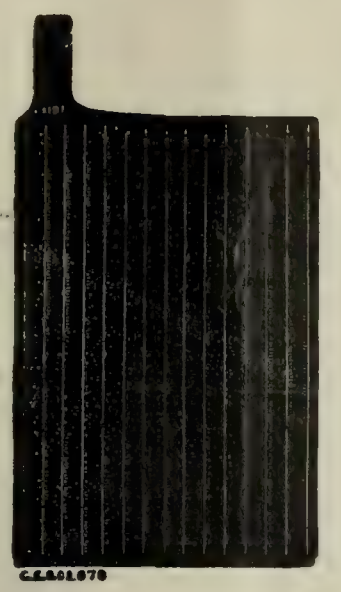
The motor car has now definitely entered another field and has allied itself with another industry which is at present in a flourishing condition. The motion picture business, which is now classed among the seven greatest world industries, has acquired the motor car as a necessary asset. The film-producing concerns use a lot of cars and use them very roughly, too. It is stated that £500,000 worth of motor trucks and passenger carriers are used in one district in California. One concern and its actors are represented by 300 machines, and scores of used cars are bought for wrecking purposes.

As a result of using petrol cars so extensively among people who are frequently not familiar with the complicated mechanism, many serious accidents have occurred to actors and thousands of feet of film have often been needlessly wasted. The electric vehicle with its simple mechanism and positiveness of control must ultimately be recognised as the safest vehicle, and the one best adapted to furthering the dramatic interest of the picture when the action of the plot is dependent on a quick get away or an immediate stop. To further emphasise the danger of using petrol cars in taking pictures of scenes where they must be operated by actors who are not skilled drivers, a number of instances have been collected where actors have either been seriously hurt or have barely escaped real injury. As evidence of the danger and difficulty experienced in using a petrol car in film production, a disastrous accident happened some time ago.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



No better testimony can be found of the satisfaction which the Battery is giving in actual service than the number of repeat orders which we are receiving. We can substantiate every claim made for it by the experience of users over considerable periods, and are able to clearly demonstrate that its life is between two and three times that of an ordinary flat plate. While its reliability day in and day out has been proved beyond cavil.

WILL STAND HEAVY BOOSTING CHARGES.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

While taking a picture of a sensational "act," a car containing three passengers was to be driven directly to the edge of a precipice and stopped. The passengers were to leave the car and dummies were to take their place, being thrown over the precipice in the car, thus portraying a thrilling and realistic wreck on the screen. The actor driving the car had had practically no experience in driving, and when he got to the edge of the cliff he became panic-stricken. In his excitement and confusion, instead of throwing on the brakes he opened the throttle, accelerated the car and plunged it over the precipice with the passengers. While no one was killed or seriously hurt, all suffered painful injuries.

Accidents of this kind would be practically impossible with an electric. When a person in the position of a driver sees danger imminent and becomes fear-stricken, the natural impulse is to throw the body back, thrusting the feet against the floor of the car. In an electric, the brake pedal not only throws on the brakes but automatically cuts off the current. There is no accelerator to confuse him. In traffic, its ease of operation, positiveness of control and immediate response to the driver's touch recommend it especially as the vehicle par excellence for traffic-congested streets where frequent stops are necessary. Because of its few parts there is nothing about an electric to get out of order and, with the proper care and attention to charging and batteries, it gives practically uninterrupted service at all times.

ELECTRIC VEHICLES IN INDIA.

The whole question of electric vehicles is receiving a great deal of attention in England at the present time, and some of the same enterprise might also be shown in India. It is generally the borough electrical engineers who have taken the initiative in the matter so far, and, says "Indian Engineering," this should be a stimulus to municipal and other engineers who are in charge of electric installations in India to follow their excellent example.

There seems again no reason why small electric vehicles should not displace the rickshaw in hill stations where these are in general use. Take Simla, for example, where the rickshaw is used universally, and is, with its four refractory coolies, a source of perpetual annoyance. Electric vehicles are now in the market that will take most of the gradients found in and about Simla. An automatic governor arranged on the shaft and operating brakes could keep the speed limit down to any desired figure; this would, of course, be necessary in order to prevent accidents by people coasting down hill at abnormal speeds. Zig-zags could be manœuvred by having a revolving driving seat with a set of operating gear on both the front and back of it, so that the driver could reverse the direction of the car and at the same time be always facing the direction in which the car is travelling. The overall dimensions of the car need not exceed about 11 ft by 5 ft., which would be inappreciably larger than the present single-seated rickshaw. The conditions in a hill station are ideal for regenerative control, and advantage would naturally be taken of this fact. The electric braking properties of the motor greatly facilitate matters for hill station use.

BATTERY EXCHANGE SYSTEM APPLIED TO ELECTRIC PASSENGER VEHICLES.

Ranking with the tremendous interest manifested in the recent large price reductions of several makers of electric passenger vehicles in the United States is the important development of the battery rental and exchange systems, which many authorities seem to feel are destined to exert a far-reaching influence on the automobile industry in general. Some predictions are to the effect that within a comparatively short time the demand for electric vehicles will become so great that it will not only tax the capacity of existing electric vehicle manufacturers, but will, furthermore, compel petrol car manufacturers to enter the electric vehicle field extensively. This would mean that the electric vehicle is to acquire the supremacy now enjoyed by the petrol motor, especially for city and suburban work.

There are a number of battery rental and exchange systems now available for electric commercial vehicles, and it is interesting to note that recently a large manufacturer of passenger electrics in Chicago (Walker Vehicle Co.) announced great price reductions, the vehicles now being put out without batteries, enabling purchasers to use the battery exchange and rental systems. However, it is stated that the

TUDOR Accumulators

FOR ELECTRIC VEHICLES.



ELECTRIC OMNIBUS—BRIGHTON AND HOVE.

About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

purchaser of this particular make of car has the option of buying it with or without batteries. To those who desire to buy without batteries a large deduction is made. They can procure rental batteries from a local battery company or through an electric garage.

The customer has the privilege of laying the car off for two months during the year's contract, for which time there is no charge for the battery after the customer has given the specified number of days' notice. The capacity of the battery in ampere-hours is guaranteed to be kept up at all times when fully charged in such a shape as to deliver 80 per cent. of its rated capacity. The Battery Rental Co. will make repairs of all broken jars, terminals or such minor repairs as are necessary from time to time to keep the battery in good operating condition. In other words, the amount paid per month to the battery company will cover all expenses and will provide the customer with a battery in good condition at all times. Whenever the battery, through use, fails to give the required mileage, a new battery is put in. The customer agrees to accept the responsibility for the loss of the battery in case of fire, theft or collision. The Battery Rental Co. agrees also that a deduction may be made from the rental if the battery is out of commission for more than 24 hours after notification by the owners of the car that it is in need of attention. The customer agrees to have the battery charged regularly, and to give it reasonable care as to flushing and charging. The rental battery company has the right to inspect the battery at the customer's garage at a reasonable time, and further, has a right to remove the battery from the car without notice at any time upon failure of the customer to pay the regular rent.

It is claimed by the manufacturer that there are many excellent arguments in favour of this rental battery proposition. In the first place the exact maintenance cost of batteries will be known definitely to the customer. They will be no higher than the stipulated amount to pay per month for the full service. The customer, under this system, saves the cost of a battery, which is sufficient to pay for nearly two years' rental service. In addition to this, the customer who employs battery rental service has no extras for the washing of batteries and renewals. It is argued that it is by far the more economical method.

Other considerations regardless of difference in cost must not be forgotten. After a battery has covered three-quarters or four-fifths of its total life, and would still be able to give considerable service, it sometimes happens that its mileage capacity has materially decreased, and that before the full life of the battery has been consumed it is necessary to purchase a renewal in order to get the required mileage. It is further maintained that with a rental battery, capacity is guaranteed. When it has reached a point that sufficient mileage is put in, the user is assured of a rental battery at continued high efficiency at all times. Most owners of electric cars spend from one to two months out of town per year, at which time their car is taken out of service. In the case of a rental battery during this time a deduction is made, and for the time this car is out of use their battery cost stops.

The vehicle manufacturer responsible for this particular system further states that the customer is also assured against any mishaps in regard to treatment and care of his battery, the Rental Battery Co. being responsible for keeping the battery in prime condition. When the customer owns his battery, and through mistreatment or inattention its life is impaired or depreciation sets in, he alone is responsible. It is pointed out that the general introduction of battery rental systems will greatly change the complexion of the entire automobile industry, with greatly increased popularity for the electric.

THE WORNOUT "PLUG."

As I go drilling through the town I see old horses, broken down,
Poor, friendless and abandoned plugs, still straining feebly in their tugs
To haul big loads beyond their strength and hoping death will come at length.
Ah, what's more pitiful than these, the worn-out nags with broken knees—
And broken hearts as well, no doubt—their ribs, all fleshless, sticking out,
With shoulders sore and tortured eyes, where gather fifty million flies.
When they were young and fat and strong they laboured blithely all day long,
Or on the pike like Maud S. raced—they did their best wherever placed.
Then there were hands to stroke the necks of these poor man-forgotten wrecks,
And they were groomed and manicured, and lives of comfort seemed assured.
But when the vim of youth was o'er, and they could caracole no more,
Like outcasts they were chased to die at least six deaths a day.

No kindly rifle ends life's storm; no friendly dose of chloroform.
They'll bring a few dishonoured yen, so send them to the dinky men!
Whene'er I see a poor old steed, sad eyed, despairing, broken kneed
I think: "The man who wore him down should haul his burden through the town!" *Walt Mason.*

[The moral to be drawn from these doleful verses is buy an electric vehicle and stick to it.]

MAIL HANDLING BY ELECTRIC TRUCKS.

Electric storage-battery trucks, replacing trolley mail cars, have been adopted by the United States Government for the handling of mail in the postal district of Boston, Mass. The new vehicles began service August 15, 1915.

The Boston Mail Delivery Co., with a capital of £10,000, has been organised, and there will be 13 mail trucks of General Vehicle Co. manufacture, each of 1·5 ton rating. Ten trucks are for delivery only, and two for collecting the sacks from postal stations and delivering them to the general post office. The former will be manned by a chauffeur only, and the latter will have a mail clerk in addition to the chauffeur.

The sacks had to be taken from the loading platforms in the post office basement in horse-drawn wagons, which entered the building by a ramp from the street at either side, and then transferred to the cars, which stood in the centre of the street. This double handling of the sacks is now obviated, the electric trucks entering the building and loading and discharging at the basement platforms.

The longest run to be made on any route is 23·5 miles; the next longest 18·5 miles. These runs cover a circuit of the suburbs and include stops at several sub-post offices. The cars will be run during the day and well into the night, and some extra trips will be made on Sundays.

Garaging and care of the trucks will be carried out at the Boston Edison Co.'s Atlantic-avenue electric garage, where interchangeable storage batteries will be kept charged, to be immediately substituted for spent batteries when the trucks come in from their runs.

The battery equipment consists of 44 cells, 15 plate Ironclad Exide, and there will be 15 batteries for use of the cars.

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ELECTRIC VEHICLE PROGRESS



BATTERY VEHICLES WITH SEARCHLIGHTS.

Considerable interest attaches to the work which the Birmingham Electrical Engineers (Volunteers) have been doing in the metropolis of the Midlands. At the outbreak of war a regiment of electrical engineers was formed, and it has been kept constantly active by various operations such as laying signal lines, establishing lighting plants, operating telephone and telegraph lines, &c. The adjoining illustrations show how Edison battery vehicles, which seem to be booming at present in the Brimingham district, were temporarily pressed into service for some recent operations in the Warley district. These operations were arranged on the instructions of the regimental commandant, Col. Lewis. One of the vehicles carries a complete petrol dynamo set with controlling switchgear, and the other is fitted with a 60-ampere regulation searchlight. During the course of the operations it was demonstrated that the vehicle could be run over give-and-take roads and the searchlight could be used at the same time from the battery with which the vehicle was propelled. An instructive feature of the demonstration was the almost complete silence of the battery propelled car in travelling along the road with the searchlight in operation. This feature admitted of the car being kept moving while the beam of the searchlight was directed upon a fixed point. There was no need to stop the vehicle in order to listen for "enemy aircraft." It was demonstrated that this movement on the part of the searchlight would be distinctly baffling to the enemy.



Battery Vehicle with Search Light.

The vehicles employed are of the Edison G.M.C. type, with single motor drive and large battery mounted on the top of the chassis frame and not underslung. The controller and instructions are mounted on the forward side of the dashboard and enclosed by a short weatherproof hood. This design is identical with that which is in use for 'buses, dust-vans, delivery lorries, and a number of other uses. The operations were closely followed by Mr. R. A. Chattock,



Battery Vehicles with Search Light and Petrol Dynamo Set.

Honorary Colonel of the Birmingham Electrical Engineer's Volunteers, also by D. Shanks, Esq., J.P., the Commandant of the Corps. The vehicles have recently been supplied by Mr. J. P. Kemp to Messrs. Hopes Ltd. and Mr. W. D. Richards, who kindly placed them at the disposal of the electrical engineers.

INDUSTRIAL TRUCKS IN OPERATION.

For a period of about 18 months the Bullock Electric Co., Ohio, has had in use a 2-ton electric industrial truck. Formerly the company found it necessary to use two railroad industrial trucks and six hand trucks to serve its factory departments. These trucks in all required 10 men, while the one electric truck superseding them requires only two men. The following figures show the relative costs of the different systems for one year: Former Transporters: Two industrial railroad trucks at £18. 15s. each, £37. 10s.; six hand trucks at £3. 2s. 6d. each, £18. 15s.; cost of industrial track in factory, £104; interest for one year at 6 per cent., £9. 13s.; total,

Osram
DRAWN WIRE
Lamps
for Motor Car Lighting. Made at the Osram-Robertson Lamp Works, Hammersmith, London, W.



CHARGING BATTERY VEHICLES.

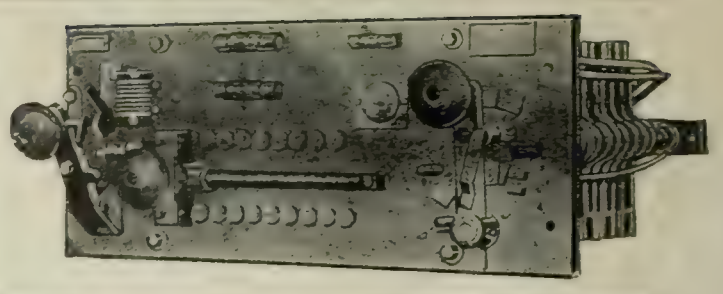
IGRANIC

UNIT TYPE BATTERY CHARGING PANELS

are the most convenient and thoroughly developed Charging Rheostats yet available. The compactness of each unit without omission of any essential feature and the easy expansion of plant are worth consideration.

IGRANIC ELECTRIC Co LTD

147, Queen Victoria Street, London.



about £170. Present Transporter: One electric industrial truck, £250; interest at 6 per cent., £15; total, £265. The difference in the initial cost of the two outfits is thus £95 in favour of the hand and industrial trucks. The following covers the comparative costs: Former trucking force, 10 men at 8s. 4d. per day, £4. 3s. 4d.; present trucking force, two men, 16s. 8d.; saving per day, £3. 6s. 8d. From this it is calculated that the difference in the cost of the two systems is wiped out in the labour saving in six weeks' time. Operating on a basis of 50 weeks a year, which was the case of the Bullock plant for the past 12 months, the saving in labour approximates £916, as against the use of hand trucks. The question of depreciation is figured at 20 per cent. for both systems. No trouble has been experienced in carrying a full load of 4,000 lb. over rough runways and down narrow aisles; loads are also carried to and from the building across the street. In serving the upper floors the truck is simply run on one of the many elevators in the different buildings and conveyed to the floor desired. Another use to which it is put is in delivering material from one shop department to another, where the overhead cranes cannot be used. The maintenance expense, exclusive of current, is put at less than £10 for the entire 18 months that the truck has been in use. The company has its own power plant, but had it been necessary to buy current from public service power plant the current cost would have averaged approximately 1s. a day.—"Iron Age."

A "CO-OPERATIVE" MOTOR LORRY.

The Blackpool Industrial Co-operative Society has recently taken delivery of an electric lorry supplied by Messrs. Drake & Gorham (Ltd.), 47, Spring-gardens, Manchester. This vehicle, as will be



located in a compartment on the front of the chassis, partly under the driver's seat, and extending slightly beyond this to the point where the loading platform commences.

Current is taken from the battery, through a controller underneath the front bonnet, to the motor, which is suspended from the rear end of the chassis frame and drives on to the worm differential gear through a flexible shaft of special design giving a "cushioned" drive, free from shocks, even on uneven roads. The differential gear is mounted on a countershaft which carries a chain sprocket at each extremity, and these sprockets drive direct on to the rear wheels by standard roller chains. The controller handle is mounted above, and concentric with, the steering wheel, so that the handling of the vehicle is a simple matter. Two foot-brakes are provided, one pedal operating an internal expanding drum brake on each of the rear wheels, while the second (emergency) pedal actuates a similar drum on the differential shaft.

A Klaxon horn, operated by a contact switch under the driver's heel, heralds the approach of the car when necessary to clear the road, and the equipment is completed by two electric head-lamps and an electric tail-lamp, all of which are controlled by a switch on the dashboard, so that the driver can light them without leaving his seat. The vehicle is rated to travel fully loaded at 11 miles per hour, but in the trips that have been made the average running speed has been found to be well up to the legal limit of 12 miles per hour.

As the society possesses its own suction gas and electricity plants in Charnley-road, the battery is charged and the lorry driven at the very minimum of cost. The driver of the new lorry is to be congratulated on having an easier job than his petrol car confrères, as he has no laborious cranking to do before starting, no gear changing to perform when starting and stopping and negotiating hills, no carburetter to worry about and to keep clear of grit, and no oily engine to make his hands dirty. Further, there is no possibility of his being confronted on a dark rainy evening with the problem of having to light three acetylene or oil lamps in a high wind and discovering that he has only one match to do it with! He retains his seat beneath the shelter of his canopy, and merely turns on the lighting switch.

The members of the society are also to be congratulated on being part owners of a smart-looking car that bids fair to save them money.

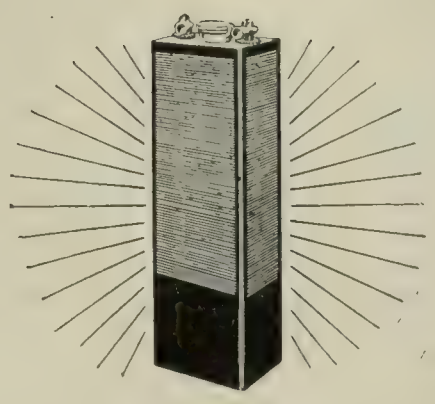
NEW BATTERY CHARGING RATES IN BIRMINGHAM.

In order to encourage electric vehicle users in the Birmingham area of supply, Mr. R. A. Chattock, the city electrical engineer, and the chairman of the Electric Vehicle Committee, has recently put into force a revised scale of rates for battery vehicle charging. In accordance with the scale of rates arranged by the Electric Vehicle Committee, in consultation with a large number of electricity undertakings in various parts of the country, a minimum charge has been fixed, which the vehicle user must pay whenever he brings in a car to be charged. Any electrical energy used over and above this minimum charge was to be paid for at 1d. a unit. In the Birmingham district the minimum charge was fixed at 2s—that is to say, 24 units of electrical energy at 1d. a unit. Vehicles of the smaller type which do not require 24 units at a charge had, however, to be paid for on the minimum charge basis. If only 12 units were taken this meant that the vehicle user was paying at the rate of 2d. per unit. Probably at the time the vehicle was sold to him it was pointed out that the rates for electrical energy for charging battery vehicles in Birmingham district was 1d. per unit. The minimum charge of 2s. would, therefore, operate to this particular type of vehicle users'

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON. S.W.

AGENTS:—

Birmingham:— J. P. KEMP, Grand Hotel, Birmingham.

Lancashire and Cheshire:— DRAKE & GORHAM, Ltd., 47, Spring Gardens, Manchester.

Glasgow:— J. HALLY CRAIG, 45, Hope Street, Glasgow.

detriment, and also give him the impression that he had been deceived. Assuming the vehicle to be in daily use, the weekly cost to the small vehicle user on the minimum charge basis would be 12s.

Since a number of electrics have been put into service in the Birmingham district by tradesmen who, not having their own plant, purchase energy from the Corporation, this anomalous state of affairs has been brought to light. A ½-ton vehicle under normal working conditions will not consume more than 8s. worth of electrical energy per week—that is to say, about 96 units. With the minimum charge of 2s. in operation this type of vehicle user in paying 12s. was obviously not given an opportunity to run his vehicle under the most economical conditions. If during the day a boost of only short duration was required, the minimum charge was again 2s.

It will readily be understood that this scheme of charging could not remain in operation without occasioning adverse criticism and giving rise to dissatisfaction amongst small vehicle users. Mr. Chattock therefore recommended his committee to put the matter upon a more equitable basis. He suggested that the minimum charge should be reduced to a figure of 6s. per week, with a minimum charge of 1s. for any boosting charges required at any period in the day, any excess of energy taken to be charged at the rate of 1d. per unit. This new scale has been in force for about a month, and is giving general satisfaction. Mr. J. P. Kemp, who is at present very active in propagating the sale of Edison electric vehicles in the Birmingham area, states that a ½-ton vehicle doing about 200 miles a week will require approximately 96 units. It is very largely due to his activities in putting vehicles into operation that this new method of charging has been instituted.

AN ELECTRIC MILK FLOAT.

The delivery of milk either in bulk or retail is a class of transport for which the electric battery vehicle is pre-eminently suited. Already there is a considerable number of vehicles of the electric battery type on milk rounds in London and they are giving the users every satisfaction.

The illustrations shows an Edison 30 cwt. milk float which has been in the service of the Leicester Co-operative Society for the past 12 months and is employed by their model dairy department for the collection of milk from farms in the environs of Leicester. After collection the milk is distributed by the same vehicle to the Society's branches in various parts of the city. The float body is mounted on an Edison accumulator G. M. chassis, the 60-cell battery having a capacity of 225 ampere-hours. On one charge of the battery a run of 40 to 45 miles can be made at a maximum speed on the level of 12 miles per hour.

The Society recently secured a fine advertisement for the vehicle in being "hauled before the beak" for furious driving. The evidence



Edison 30-cwt. Milk Float.

as is usually the case was all against the defendants, but the plaintiffs were unable to establish their facts because it was demonstrated to the magistrates that the vehicle could not exceed 12 miles per hour on a level road. As it was contended that the offence "took place" on a thoroughfare without the suspicion of a gradient the difficulty of proving that it was exceeding the speed limit was insurmountable. On the ground that the evidence was inconclusive the case was dismissed!

OPERATING COST DATA OF ELECTRICS v. HORSES

One of Chicago's largest manufacturers, in the fall of 1913, made the statement that "There isn't a motor truck, of any description, that can be a paying proposition where deliveries are made in a territory from one-half to two miles from the plant. This work is most economically performed with horse and wagon."

Some time after, this same manufacturer, when confronted with the above statement, frankly admitted that he, like many other manufacturers and team owners, had been most mistaken in the economy and efficiency of the electric truck; that he was just beginning to realise that the electric truck was not so much a competitor of the petrol propelled machine, but that its most profitable field of operation lay in the work that was now being done by the horse.

Many motor truck operators still labour under the misapprehension, that because of the slower speed and limited radius of operation, they feel the electric cannot do the work for which the petrol truck is sold, and owing to its first cost, the electric cannot possibly be cheaper than horse-drawn equipment for close-in work.

Perhaps it would be well to consider the experience of the brewers. It goes without saying that they own the best that money can buy in the way of horses and wagons. They spare no effort in keeping this equipment in first-class condition. Further, they were the first to try motor delivery as far back as 1900 and to-day there are practically 900 electric trucks in this particular line of service, of which 561 are 5-ton machines.

Everything in the brewery business is figured on a cost per barrel basis, that is cost per barrel of overhead expense, cost per barrel of manufacture, cost per barrel of selling expense and cost per barrel of delivery. The first item is fixed and cannot easily be lowered. The second, cost of manufacture, fluctuates with market and labour conditions; the third is practically a fixed cost. On the question of delivery the brewers are obliged to pay particular attention to this, owing to the strong organisation of the drivers, whose wages are based on the number of barrels delivered. Therefore, if there is any saving to be made, it must be made on cost of operating the conveyance used for delivery purposes.

Inasmuch as everything is figured on a cost per barrel basis, it is quite apparent that in this line of business it is an easy matter to tell the difference in the cost when deliveries are made with different types of vehicles. What conclusions the brewers arrived at, after determining all their costs of deliveries with various types of vehicles, is self evident in the fact that 121 brewers are using 892 General Vehicle electric trucks.

Brewers are credited with maintaining cost departments which determine every item of expense incident to the carrying on of their business, and the following data presents authentic operating costs obtained from vehicles in daily delivery service.

After determining what the cost of operating an electric truck will be, the mileage question may be considered. The average 5-ton truck in any ordinary line of business is required to make from 24 to 28 miles per day. The 5½-ton truck is usually called on for from 25 to 30 miles and so on down to the 1 ton model which is seldom called upon for more than 40 miles.

Manufacturers' estimates on mileage exceed the above named figures from 25 to 50 per cent. and there are many instances in Chicago where 5 ton trucks are doing as high as 55 miles on a single charge of the battery. The field of operation of the electric is not as limited as many would believe, and it is a fact that the electric truck is fit for the most economical and reliable motive of transportation for 85 per cent. of the city hauling. The fact that it is noiseless, odourless, easy to operate and that its wearing parts are few, in fact may be summed up in the following: three chains and about four sprocket, account for its long life and a maintenance cost which in pounds, shillings and pence amounts to less than horse feed. There are a number of trucks in service in Chicago which were delivered from the factory to the General Vehicle Company in 1903.

[*Electric Vehicles.*



A TYPICAL 5 TON ELECTRIC LORRY FOR THE DELIVERY OF CASES OF BEER.

COST OF OPERATING AND MAINTAINING HORSE DRAWN EQUIPMENT.

Investment.			
95 Horses at £47. 18s. 4d.	£4,552	1	8
Harness	347	18	10
Wagon	2,725	12	5
	£7,625	12	11
Fixed Charges.			
Depreciation, Horses	£941	17	6
" Wagons	151	5	0
" Harness	70	2	9
Insurance	38	5	10
Taxes	194	15	10
	£1,396	6	11
Operating Expense.			
Feed	£2,681	5	0
Shoeing and Veterinary	1,050	5	5
Wagon repairs	701	0	5
Harness supplies	119	3	4
Harness maker	178	15	0
Barn wages	1,773	5	10
Barn supplies and expense	435	8	4
	£6,939	3	4
Investment per Horse.			
Horse	£47	18	4
Harness	3	13	3
Wagon	28	13	9
	£80	5	4

Operating Expense per Horse.

	Per Year.			Per Day.		
Feed	£28	4	6	£0	1	9¾
Shoeing and veterinary	11	1	1¼	0	0	8½
Wagon repairs	7	7	7	0	0	5¾
Harness supplies	1	5	1	0	0	1
Harness maker	1	17	7½	0	0	1½
Barn wages	18	13	3¼	0	1	2
Barn supplies and expense	4	11	8	0	0	3½
	£73	0	10	£0	4	8

Total Expense.

	Per Year.			Per Month.			Per Day.		
95 Horses	£8,335	10	3	£694	12	6	£26	14	4
1 Horse	87	14	10	7	6	3	0	5	7½

[*Figures converted on basis of value of dollar as 4s. 2d.*]

WARD ELECTRIC VEHICLES.

Interesting particulars are now available of the Ward electric battery vehicles, which are now being put on the English market by the Ward Electric Vehicle Co. In our last issue we described the light delivery van of 750 lb. loading capacity, of which this company have a demonstration available in London for trial trips. The Ward vehicle is also made in larger sizes as the adjoining outline in Fig. 1

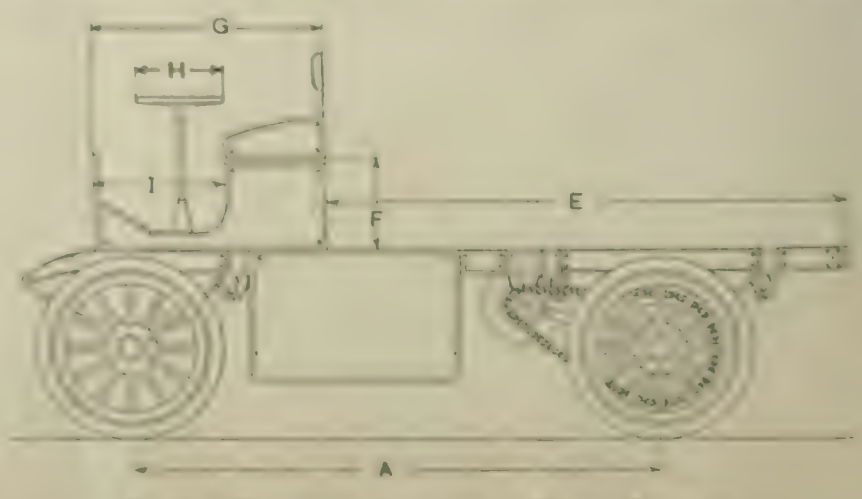


FIG. 1.—DIMENSION OUTLINE OF WARD VEHICLES.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



No better testimony can be found of the satisfaction which the Battery is giving in actual service than the number of repeat orders which we are receiving. We can substantiate every claim made for it by the experience of users over considerable periods, and are able to clearly demonstrate that its life is between two and three times that of an ordinary flat plate, while its reliability day in and day out has been proved beyond cavil.

WILL STAND HEAVY BOOSTING CHARGES.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

and the table of dimensions shows. In Fig. 2 is illustrated a Ward "EA" van of 18 cwt. capacity which has a mileage radius of 40 to 45 on one charge of the battery over give-and-take roads. The chassis is of standard channel steel construction with semi-elliptical springs to the front and rear wheels. The axles are rectangular section front and rear and the wheels are of the artillery type with hickory spokes and Timken roller bearings; they are shod with special electric cushion tyres.

The battery is underslung in the frame between the front and rear

Type.	A.		Track	E.		F.	G.	H.	I.	Capacity.
	Ft.	in.	In.	Ft.	in.	In.	In.	In.	In.	
"EO"	7	6	52	7	0	16	42	14	24	9 cwt.
"EA"	8	3	54	8	0	18	43	15	25	18 cwt.
"EB"	9	3	57	9	6	18	44	16	26	36 cwt.
"EC"	11	0	60	12	0	18	46	17	28	3 tons.
"ED"	13	3	63	14	6	18	48	18	30	4½ tons.



FIG. 2.—WARD 18 CWT. VAN.

foot-board, where it is readily accessible. A shaft concentric with the steering column terminates in the controller handle, which is placed immediately below the steering wheel, and by this means the controller is actuated. Four speeds forward and two reverse are provided on the controller. The speed is 8½ to 10 miles per hour.

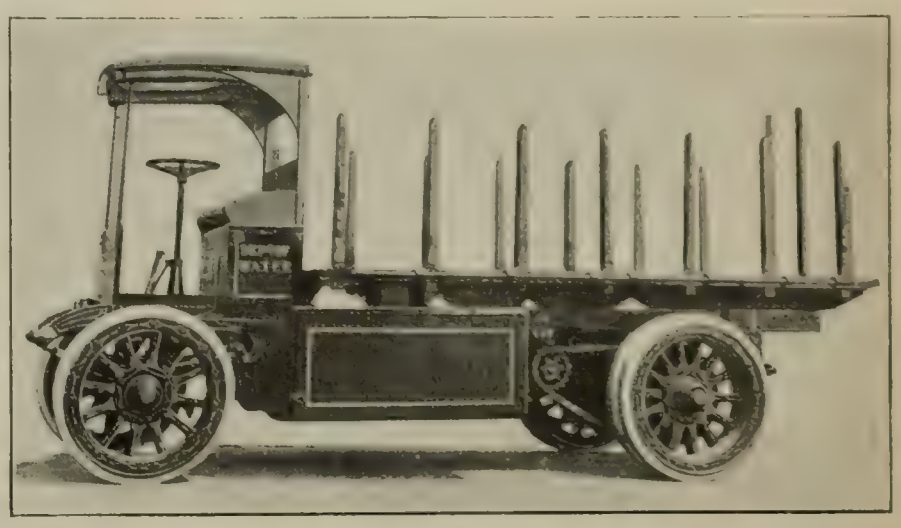


FIG. 3.—WARD 4½-TON LORRY.

wheels and comprises 42 Ward lead cells. A single motor mounted in the centre of the chassis drives a countershaft by silent chain, and the drive from the countershaft to the road wheels is by side roller chains. The controller, of the horizontal pattern, is fixed under the

The vehicle is fitted with two brakes of the band contracting type, one pair on the rear wheels and the other on the countershaft; these brakes are pedal operated.

Any design of body can be fitted to this vehicle, and it is supplied

TUDOR
Accumulators
FOR ELECTRIC VEHICLES.



ELECTRIC OMNIBUS—BRIGHTON AND HOVE.

About 16 Electric Omnibuses have been in regular service for the past six years, and TUDOR Accumulators have been employed exclusively.

THE TUDOR ACCUMULATOR CO., LTD.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER

complete with storm curtain, lamps, bell, hub-odometer, and hydrometer, also a set of tools and lifting jack.

In Fig. 3 a somewhat heavier pattern of the same class of vehicle is illustrated. The loading is ½ ton, and the mileage range on one charge of battery is 25 to 30, the speed being 5 to 6 miles per hour. The descriptive details are identical with those of the 18 cwt. vehicle. A full catalogue and price list of these vehicles can be obtained from the Ward Vehicle Co., Gillingham-street, London, S.W.

A MAZDA LAMP VEHICLE.

It would seem appropriate that the local transport of electric lamps—and other electrical material, for that matter—should always be entrusted to electric battery vehicles. In London and the great provincial centres there is a considerable amount of local delivery

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Can be supplied to Central Station Engineers for distribution. Annual Subscription Rates on application to

"THE ELECTRICIAN" PRINTING & PUBLISHING COMPANY,
1, 2 & 3, Salisbury Court, Fleet Street, London, E.C.

work in connection with electrical supplies and material, and at the present time, when motors are used, they are of the petrol type. By degrees this somewhat anomalous state of affairs will be altered, and we shall see every electrical undertaking "all electric" in its operations.

One of the first of the large manufacturing firms to set an example in this direction is the British Thomson-Houston Co., who make Mazda lamps at their large factory in Rugby. In the same town is a large warehouse, converted from an old skating rink, in which these lamps are stored after manufacture, and this store is some distance from the factory. The lamps are, therefore, electrically transferred from the factory to the store by the agency of a G.V. 2-ton lorry.

The illustration shows this vehicle standing with its load at the door of the warehouse. It has a maximum speed on the level of 12 miles per hour, and is a standard pattern machine made by the General Vehicle Co. The drive is from a single motor by silent enclosed chain to a countershaft, and thence to the rear wheels by side roller chains. The wheels are shod with heavy solid rubber tyres.

The battery, made up of 44 Ironclad Exide cells, is enclosed in a crate slung under the chassis frame between the front and rear wheels. This battery has a capacity of 230 ampere-hours, and will drive the vehicle loaded over average roads a distance of 45 miles on one charge. The energy for re-charging is obtained from the company's works, where there is, of course, a large power plant which supplies the town of Rugby, the Mazda lamp factory and the B.T.-H. engineering works.

We understand that this vehicle has been in service just over a year, and has given no trouble electrically or mechanically. In addition to doing the journey between the works and the stores, it also travels to Coventry to the B.T.-H meter and instrument works in that famous city.

ELECTRIC VAN'S RECORD RUN.

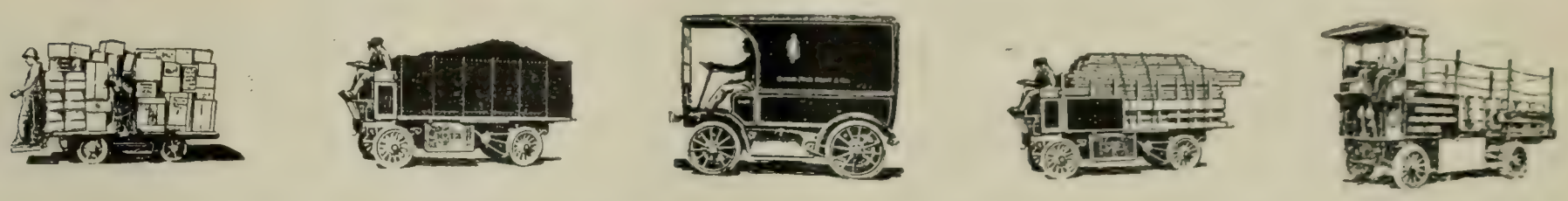
The longest cross-country run ever made by an electric commercial motor car, says the "New York World," has been completed by a Ward stock delivery car between New York City and Cleveland, O., a distance of 733·7 miles. This test run was made under the auspices of the New York Electric Vehicle Association. The latest type of Edison storage battery was used. According to John F. Delahant, of the New York Electric Vehicle Association, who accompanied the car as official observer, the run was made without a single mishap, or without an adjustment being made on the car. The total running time was 84 hours and 43 minutes; the average running time was 8½ miles per hour. One of the features revealed by the run is that only 25 charges of battery were necessary for the entire 733·7 miles, the total current consumption being 1,564 ampere hours.



[illegible] with its load of Mazda Lamps at the B.T.-H. Rugby Stores.

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ELECTRIC VEHICLE PROGRESS



THE ELECTRIC VEHICLE IN GREAT BRITAIN.

It is gratifying to note that during the past year the electric vehicle has made steady progress in almost every field of suburban road traction. The war has been mainly responsible for the brisk demand for motor vehicles to take the place of horse-drawn vehicles for town service. In particular this demand has been principally noticeable among municipal service. Special steps have been taken in certain cases to enable municipalities to obtain the money for the purchase of these vehicles, and one of the principal incentives to their purchase is undoubtedly the economy which they introduce over horse-drawn cars. Their purchase represents a sound commercial investment, and one which ensures the recovery of the capital expenditure in a short period.

The railway companies, according to the above-mentioned record, have been particularly active, and have acquired no



Fleet of Edison Battery 'Buses at York.

cleansing departments. There can be no doubt that the electric vehicle has come to stay in this important field of motor traction. The initial apathy to a battery-propelled vehicle for this class of work has been broken down, and an opportunity has now been afforded to vehicle makers to demonstrate in practice the claims which they so persistently urged, but could only put forward on paper, that the battery-propelled vehicle is the only economical vehicle for refuse collection, street watering, cleaning, &c. According to the returns made by the official organ of the Electric Vehicle Committee, there are 10 municipal authorities which have 21 of these vehicles in less than 38 battery-propelled trucks for the transport of baggage and other goods on railway termini and in and about warehouses, wharves, &c. Similarly, they have acquired 15 delivery vans ranging in capacity from 1 to 3½ tons, and these are employed on parcel and other delivery work, principally in the London area.

The co-operative societies have also awakened to the value of the electric battery vehicle, both for the delivery of provisions, bread, &c., and also for the hauling of raw material, &c. With characteristic enterprise, the Co-operative Societies of Stratford (London, E.), Glasgow, Leicester, Ipswich and

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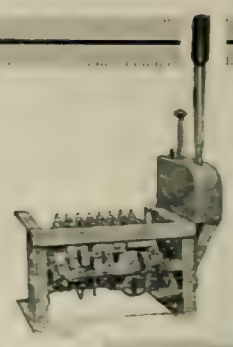
Development Work need not be hampered for want of Control Gear

'IGRANIC'

ELECTRIC VEHICLE CONTROLLERS

are available for all types of Battery Vehicles; are proved and standardised, ready for service. In design and construction they show intimate acquaintance with the best international practice.

WRITE US FOR LEAFLETS.



IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

Blackpool have acquired battery vehicles, the total number in use in this direction being 11.

The departmental stores in the London area are easily headed by Messrs. Harrods (Ltd.), who have an exceptionally fine fleet of 73 vehicles, ranging from ½ ton upwards. They also can boast of six industrial trucks. The adjoining illustrations, taken recently, show a portion of this fine fleet.

The dairy companies in London have also got busy with electrics, there being eight companies who employ 23 battery vehicles, both for the transport of milk from the main termini to their creameries and also for its delivery in bulk to sub-dealers.

electric lorry can satisfactorily displace petrol or horse traction, as is shown by a list of 10 vehicles which are employed in service both in London and the provinces.

We must not forget that the electric 'bus has also been making good progress during the year. While the 16 battery 'buses of the Brighton, Hove & Preston United Omnibus Co. still represent the largest fleet, 'buses of a more modern type have been put into service by the Loughborough 'Bus Co., the York Corporation, South Shields Corporation, West Bromwich Corporation and the Southend Corporation. These vehicles are proving their capacity to handle passenger traffic both for the feeding of existing tramway lines and also for service on





Two Views of a portion of Harrods' Fleet of Edison Battery Vehicles.

The electrical manufacturers who are concerned with the transport of comparatively light material, such as electric lighting supplies, and also those firms who have a certain class of haulage work to do from goods yard to warehouse or works, are coming into line with electrics. The published records show that there are 17 vehicles in use by nine separate firms in London and the provinces.

The mechanical lift of vehicle trade is steadily growing, and at the present time it shows 41 commercial vehicles, which are well distributed in various parts of the country.

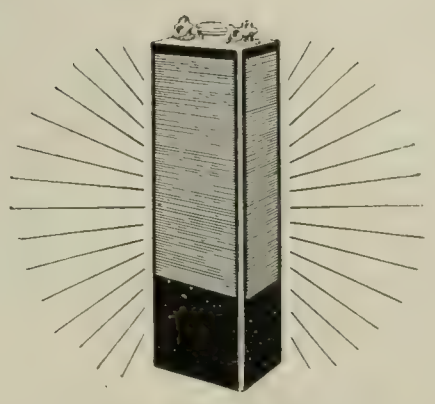
The motor-car factories have learned to appreciate that the routes between the suburbs and the centre of the towns, upon which it would not pay to instal electric tramways and upon which petrol 'buses have shown up to considerable disadvantage.

The total number of electric vehicles in use or on order at the present date reaches the imposing total of 660. This is a most gratifying advance upon the figure of 150 vehicles in service 12 months ago. The coming year will assuredly witness a further substantial increase in these figures, and we think that the outlook for the commercial electric battery vehicle is a most promising one.

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON. S.W.

AGENTS:—

Birmingham:—
J. P. KEMP,
Grand Hotel, Birmingham.

Lancashire and Cheshire:—
DRAKE & GORHAM, Ltd.,
47, Spring Gardens, Manchester.

Glasgow:—
J. HALLY CRAIG,
45, Hope Street, Glasgow.

DUST TRUCK WITH TIPPING BODY.

Municipal authorities are awakening to the fact that the electric battery truck can be of immense value to them, particularly for refuse disposal.

An Edison accumulator tipping truck of a special design is of considerable interest.

The frame is made of two steel channel sections extending the entire length of the platform, converging at the end into a solid cast-



Tipping Body Truck supplied to Dover Corporation.

ing. The frame is supported by four spiral springs, each of which is encased within a malleable-iron box and transfers the weight direct to the axles. The transmission is by morse silent chain from a pinion on the electric motor to the sprocket wheel placed on a jack shaft supported under the two frame members; thence by two side roller chains from the jack shaft to the driving wheels, giving a total gear ratio of 12 to 1. The jack shaft contains a substantial and compact differential. The axles are rigid under the frame, and by their outer extremities run in a double set of standard annular roller bearings mounted in solid ribbed cast wheels, round which are secured solid rubber band tyres of 16 in. diameter.

The steering is effected by means of lever conveniently arranged at the front of the vehicle, which moves in a vertical plane and operates the wheels as in all standard makes of automobiles. The power for operating the truck is derived from an Edison battery of 20 cells type A-4, 150 ampere-hours capacity, located in a steel compartment on the driving end of the truck. The motor is specially designed, having high starting torque and high efficiency; it is series wound for 24 volts. The armature is carried on annular ball bearings, and has a capacity sufficient to propel a loaded truck up a 15 per cent. to 25 per cent. grade.

The controller is of the drum type, specially designed for these trucks, eliminating all arcing in operation. The current cannot be applied to the controller without first releasing the brake, which automatically closes the circuit switch. The moment the current is cut off, the brakes will set automatically, and remain set until the circuit breaker is again closed, at which time the band brake is automatically released. The controller is operated by a lever in a vertical plane giving three speeds forward and three reverse.

The body consists of a galvanised steel tank, strengthened with angle iron and suitable plating, and the tipping is operated by hand, one of the sides being hinged at the top and operated by hand lever. The capacity of the hopper is 35 cubic ft. The truck is, of course, complete with all wiring for Edison battery, and necessary charging plug.

An ampere-hour meter is supplied when desired at an extra cost. The nstrument is of the Sangamo differentially shunted type, which measures true output of battery on discharge, and effective input on subsequent charge. It serves as a warning clock against accidental shortage of power, and checks service performances.

The weight of the complete truck is 2,000 lb., and the chief dimensions are: Length overall, 7 ft. 7 in.; width of track, 2 ft. 7 in.; height from ground to top of body, 4 ft. 2 in.; wheel base, 3 ft. 1 in.; extreme outside dimensions, 3 ft. 9 in. by 4 ft. 8 in. by 7 ft. 7 in.

Edison Accumulators inform us that they have several of these vehicles on order for house refuse collection in narrow streets.

Particulars and Catalogues from

SIEMENS BROTHERS & CO., LTD.

WOOLWICH.

Telegrams: "Siemens Woolwich." OVER 4,000 EMPLOYEES. Telephone: City 6400 (7 lines).

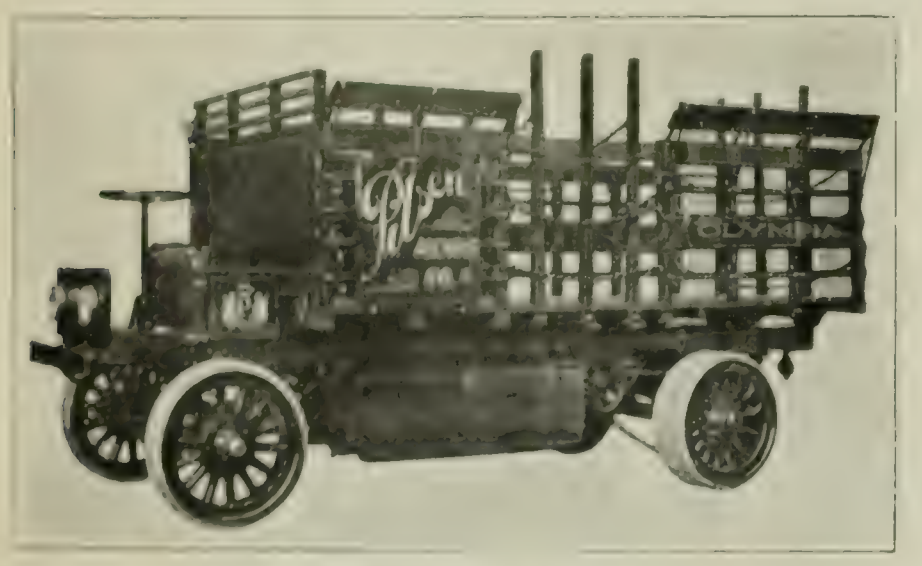
CABLES & WIRES,
MOTOR-CAR LEADS
(Weatherproof, Strong, Flexible and Durable),
BATTERIES
&c., &c.

BREWERS AND ELECTRIC TRUCKS.

It has been stated that the brewing industry in the U.S.A. has invested over £200,000 in electric trucks during the past 10 years. Next to the express companies, the brewery interests have made the largest expenditure for electric commercial machines. Most of the purchases have been made by the brewers of New York, but of late Chicago is beginning to take notice.

The Pilsen Brewing Co. was one of the first Chicago breweries to adopt electric delivery service. They installed Waverly machines and a recent test proved to their satisfaction that the electric commercial truck is ideally suited to their particular work. Recently, records were kept on one of their 5-ton trucks and it performed as follows:

The truck on June 9 left the brewery at 5:15 a.m., carrying 31 half-barrels of beer weighing 380 lb. each—11,970 lb.—made 10 deliveries and returned to the brewery at 10:40 a.m., covering 15·4 miles. The trip usually takes a team of horses all day. The afternoon trip was one planned to feed the wagons in the congested section, leaving the brewery at 12:45 p.m., carrying 31 half-barrels of beer; the truck made eight deliveries and arrived at the brewery at 3:40 p.m., covering 11·7 miles. The afternoon trip usually takes a team of horses all afternoon. On June 10 the truck left the brewery at 5 a.m., carrying 31 barrels of beer and distributed to eight different customers in the outlying districts, returning to the brewery at 2·30 p.m., having covered 43·5 miles. To do this day's work usually required three double teams.



A typical Brewers' Electric Truck.

"CEDES" VEHICLE FOR BOOTS (LTD.)

The adjoining illustration shows the first of what we hope will prove to be a large fleet of battery vehicles for Messrs. Boots, the [illegible] chemists. The machine is being put into service at the company's headquarters at Nottingham, and is a standard Cedes vehicle having a loading capacity of 4 tons. The chief feature of the Cedes vehicle is the employment of a motor wheel for driving purposes. A single motor is built up in the hub of the wheel, and current is supplied to it through the rubber rim [illegible]. This arrangement dispenses with all gear of every description. The transmission of the motor, which is of the [illegible] type, is controlled automatically by the current supply, which is the equivalent of the hand operation of an ordinary vehicle. Two of these motor wheels are fitted at the rear portion of the chassis. The energy for propulsion is obtained by 44 [illegible] cells having a capacity of 160 ampere hours. The maximum speed on the level with the vehicle fully loaded is 10 miles per hour. The [illegible] cooling, which is placed under the footboard, is actuated by a [illegible] pedal, and is of the rotary drum type, and provides five speeds forward and reverse. The same lever which operates the controller is also employed for applying the brake, the pedal being pushed down to its full extent, and at the limit of its travel the current is cut off and the brakes applied.

It is interesting to note that Messrs. Boots, Ltd., are more than usually interested in the subject of battery vehicles, and are taking steps to put a number of these into service. The Electromobile Co., Leeds, have supplied them with a delivery van, which is being employed for parcels service between the company's branches in the Leeds district. We understand that a number of second-hand battery vehicles have been acquired, and that these are being modernised and fitted with commercial bodies to convert them into light delivery vans for use in the Nottingham area. The Ward light delivery van is also on trial, and a standard pattern of industrial battery truck for warehouse service is being delivered by the General Vehicle Co. This use of the battery vehicle by so important a commercial house as Messrs. Boots will doubtless be followed with considerable interest. It is clearly indicative of the tendency of large firms to inquire more closely into the economical operation of their about-town transport service.



Boots, Ltd., 4-ton "Cedes" Lorry.

WARD VAN MAKES 733·7 Miles on 1,564 Ampere Hours.

The longest cross-country run ever made by an electric commercial automobile has just been completed by a Ward stock delivery car between New York City and Cleveland, O. This test run was made under the auspices of the New York Electric Vehicle Association, and the latest type of Edison storage battery was used.

The car was started from New York on the afternoon of



Ward Van on Cross-country Run.

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



No better testimony can be found of the satisfaction which the Battery is giving in actual service than the number of repeat orders which we are receiving. We can substantiate every claim made for it by the experience of users over considerable periods, and are able to clearly demonstrate that its life is between two and three times that of an ordinary flat plate, while its reliability day in and day out has been proved beyond cavil.

WILL STAND HEAVY BOOSTING CHARGES.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

October 6th in connection with the opening ceremonies of the Electrical Exposition and Motor Show, the driver bearing a letter from Arthur Williams, president of the exposition, to Cleveland's mayor. During the exposition, which lasted 10 days, crowds awaited bulletins which told of the successful progress of the car. On Wednesday, October 13th, it passed through Buffalo, and on Saturday evening, October 16th, the closing night of the exposition, a telegram came which stated the electric would arrive in Cleveland the following morning. The message was greeted with enthusiasm by a record crowd at the exposition. On Sunday, October 17th, just 11 days after the start, the little covered electric delivery waggon noiselessly entered Cleveland, having covered a distance of 733·7 miles.

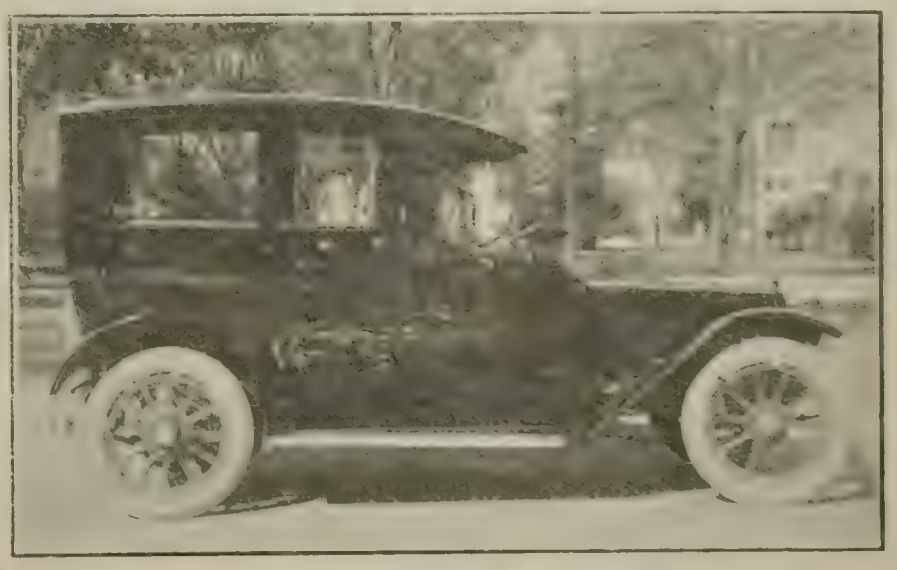
According to John F. Delehant, of the New York Electric Vehicle Association, who accompanied the car as official observer, the run was made without a mishap or without an adjustment being made on the car. The total running time was 84 hours and 43 minutes; the average running time was 8½ miles per hour. One of the features revealed by the run was that only 25 charges of battery were necessary for the entire 733·7 miles, the total current consumption being 1·164 ampere-hours. Much valuable data was secured on the run, which has demonstrated without a doubt that the modern electric vehicle is master of all conditions. It is no longer a delicate mechanism, but a hardy and powerful machine, capable of fighting its own way over the roughest roads and through mud and rain.—"Electric Vehicles."



Heavy-going along Swampy Roads.

THE ELECTRIC TAXICAB.

A determined effort is evidently being made in that city of the electric vehicle, Detroit, to permanently establish a service of electric taxicabs. The adjoining illustration shows the latest design of cab, of which a number have been in service for some months past. It will be noticed that the vehicle has a long wheel base, while the body is designed with a view to the reduction of windage, and that the compartment for the passengers is roomy and well lighted. Ample



Detroit's Latest Electric Taxi.

TUDOR
ACCUMULATORS
FOR ELECTRIC VEHICLES.



AMBULANCE WITH TUDOR BATTERY.
Port of London Authority—4 Vehicles. City of London Corporation—2 Vehicles.

BATTERIES FOR COMMERCIAL VEHICLES,
PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST IN WEIGHT—HIGHEST IN EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., Ltd.,
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.
Works: DUKINFIELD, near MANCHESTER.

protection is also afforded the driver, who sits immediately behind the extended hood which carries the battery. Technical particulars of the vehicle are not yet available, except that the wheel base is 121 in., and that the interior of the cab body has a space 68 in. long and about 50 in. wide, providing comfortable accommodation for four or five passengers. The Limousine type of body has been selected in preference to the Landaulette type, because it can be operated upon at a lower cost. It is stated that the vehicles can be run at a cost not exceeding 20 cents (10d.) per mile, this cost including driver's wages, overload charges, tyres, garaging, depreciation and maintenance. The first of the cars was put into service in June, 1914, and has been in continuous service since. It was introduced in a quiet manner, that is without any advertising or preliminary announcements, and took its place on the rank with petrol vehicles. The result was sufficiently gratifying to justify the placing of a further 11 cabs in service in December, 1914, and January, 1915. By the beginning of 1916, 47 of these cabs will be in service. According to published figures, petrol cabs in the United States cost between 30 and 40 cents per mile. In the case of Detroit, the revenue obtained is about 33 cents a mile, and that fact calls attention to the direction to the employment of the electric cab. In the foregoing figure of 20 cents per mile operating cost for the battery cab, there is a more than satisfactory margin for profit. We anticipate that more complete details of these vehicles will be available, and we await these with considerable interest.

ELECTRIC VEHICLES IN SWEDEN.

We are coming to regard Norway, Sweden and similar countries as promising prospective centres of world activity, mainly on account of their abundant sources of water power. Coal, and, indeed, fuel generally, is most costly in such countries, and by how far such methods as hydro-electric supplies of power are being developed will matter. In a land in which there are bright prospects for the generation and distribution of electrical energy on the grand scale and where electric railways are probably destined to displace steam it is not surprising that electric battery vehicles for industrial and commercial purposes are being put into operation. The illustration shows an Edison G.M. vehicle of 2 tons capacity, which has recently been put into service by a firm in Christiania



SIDE VIEW OF EDISON G.M. VEHICLE.

The vehicle is fitted with Edison battery, which is mounted above the chassis frame in a case which at its front edge forms the driver's seat. The drive to the rear wheels is from a single motor mounted on a



FRONT VIEW OF EDISON G.M. VEHICLE.

sub-frame just forward of the back axle. The motor drives a jack shaft placed near the centre of the chassis, and from the ends of this shaft the drive to the rear wheels is by roller chains. The whole of the control gear, instruments, &c., is mounted under a short bonnet at the front of the vehicle.

ELECTRIC VEHICLES IN USE IN GREAT BRITAIN.

Following is a summary of the table given in the last issue of the "Electric Vehicle" of all classes of battery vehicles in use or on order in Great Britain:

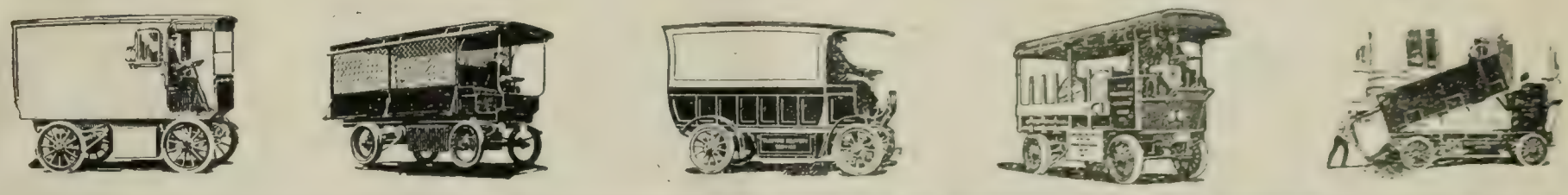
	No. of vehicles.
Artistic fabrics and furniture	3
Breweries and distilleries	3
Departmental stores	79
Dyeworks	4
Co-operative societies	11
Dairies	23
Railway companies	55
Cab companies	187
County Councils	15
Cinder and contractors	7
Public authorities	13
Tramway authorities	15
Hotels	1
Electric omnibuses	55
Food manufacturers and contractors	13
Municipal authorities	29
Unclassified	**41**
Electrical manufacturers	**17**
Electric supply authorities	35
Omnibus proprietors	21
Flour millers and bakers	5
Steel and metal works	**17**
Munition factories	10
Mineral water manufacturers	1
Cloth manufacturers	1
Total	661

Batteries supplied for above vehicles:—

Edison	297	Hart	7
E.P.S.	162	Unclassified	1
Tudor	107		
Lead	48	Total	661
Exide	39		

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ELECTRIC VEHICLE PROGRESS



DANGERS OF THE STREETS—THE CRAZE FOR SPEED.

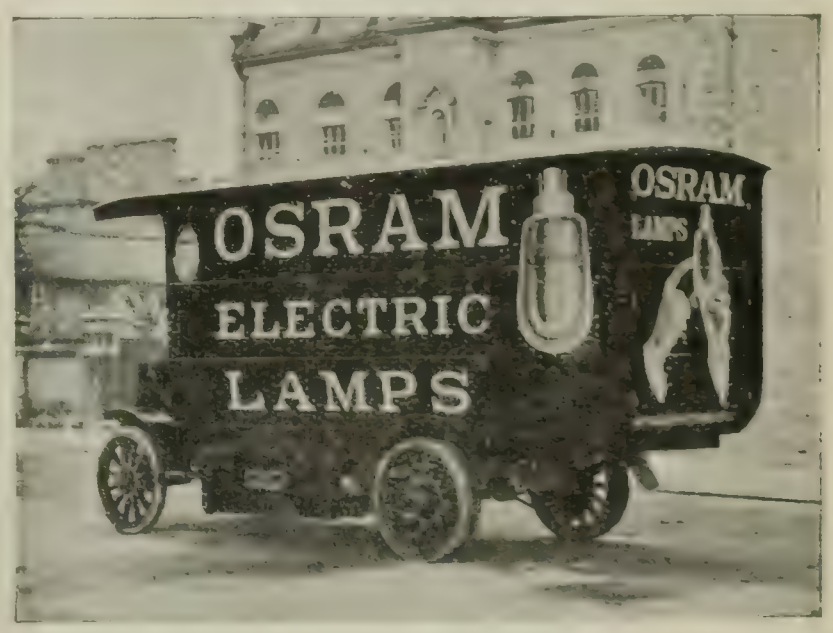
The following article, abstracted from the "Daily Telegraph," may be said to reflect public opinion upon the matter of high-speed traffic in the streets of the metropolis and provincial cities. It is virtually an appeal for a vehicle which is incapable, even in the hands of a young and spirited driver, of reaching a speed on the level which will be dangerous to the other traffic and to pedestrians. Needless to say, that vehicle is the electric :—

Those of us who see much of London traffic in these days and nights have good reason to believe that it is not every accident which finds its way into print. For one which kills there are a score which merely wound, and in these strenuous times a street accident which adds nothing to the death-rate is no more accounted of than silver in the days of King Solomon. Londoners born and bred, who used to think that no traffic conditions would ever disturb their experienced nerves, begin to go delicately when they step off the kerb, and sit in a motor-car a prey to horrid apprehension. The authorities continually do cry that the volume of London traffic has diminished. Yet the streets are by far more perilous than of old. Nor is this a consequence of the restrictions of lighting. At night, or in the dim twilight, the dangers are greatest, for the speed of traffic has not been checked adequately to the new conditions, and drivers in general give one another and the foot passenger no more consideration than was needed when we could all see each other. In daylight the perils of reckless driving and inordinate speed have increased, are increasing, and ought to be abolished.

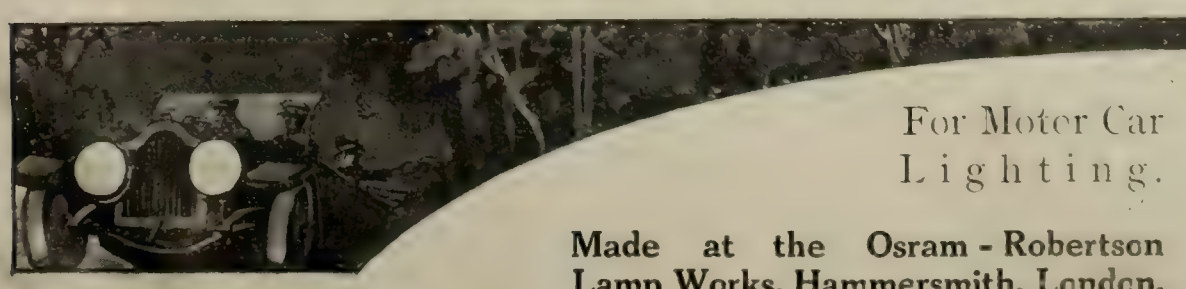
The most perilous highways are those which, while carrying a considerable traffic, are wide enough to give opportunities for high speed. Try to cross one of these, drive along one of them with the most cautious hand at the steering wheel, and you will hardly avoid a thrilling moment, a hairbreadth escape from the imminent deadly smash.

It is the offside traffic which is the enemy, the driver who must always be sweeping past something in front of him or cutting round a corner upon his wrong side. That is, the root of the trouble is the craze for speed. The streets are full of chauffeurs who would rather run any risk than check their pace for an instant. Everyone of them seems to carry a message upon which the fate of the Empire depends. Any foot passenger, any vehicle which is slower than their own, must get out of their way. Theirs not to reason why, theirs but to do, and anyone who chooses may die. This school of chauffeurs was not unknown before the war. No one with experience of London traffic will contest that it has become much more noxious since the war conditions have affected traffic.

It is equally true that all chauffeurs are not to blame. Many drive with consideration for their fellows and a due appreciation of the new conditions of traffic ; but that is no reason for mercy to the offenders. The reckless may plead some excuses. Slow-horsed traffic will persist in taking the middle of the road. The scarcity of qualified chauffeurs has imposed an extra burden of work upon those who are left, and the temptation to save time by running at high speed is great ; but no plea can justify driving to the general danger, and of late that offence has become so common as to demand stringent action. The driver who expects that everything should give way to his desire for speed should be taught a stern lesson. The great need of the moment is drastic penalties for those, whoever they are, who will risk anything rather than check their vehicles. A few cases sternly dealt with would work a wonderful reform in London streets, a wonderful diminution of the casualty list. It is not a question of a speed limit. What is absolutely harmless at one moment and in one place and upon one road surface may be murderous under different conditions. But the long and growing roll of disastrous "accidents" makes it imperative that the authorities should give their attention to the craze for speed, and enforce upon every driver, whether he is steering his own six-cylinder car or a steam lorry full of rags and bones, that the safety of the public is the supreme law.



A New Battery Vehicle now running on the London Streets : an "Electric" delivering Electric Lamps.



For Motor Car Lighting.

Made at the Osram - Robertson Lamp Works, Hammersmith, London.

Osram
DRAWN WIRE
Lamps

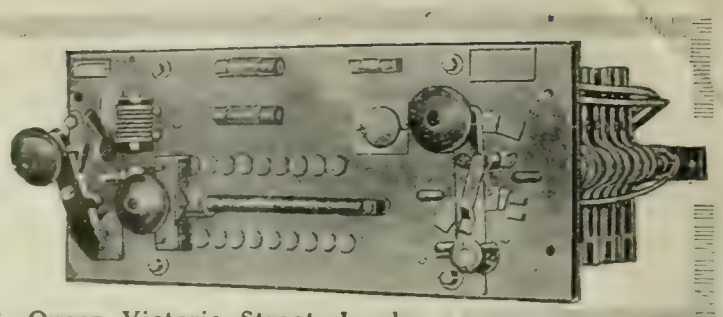
BATTERY CHARGING EQUIPMENT.

It doesn't need an Expert to operate

IGRANIC

Unit Type Battery Charging Panels.

Besides being uniquely designed for convenience in erection and expansion, these Panels are extremely simple to operate and fully protected by safety devices. If this subject is of interest write.



IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London.

PERFORMANCE OF PETROL AND ELECTRIC VEHICLES IN SIMILAR SERVICE.*

One of the many favourable arguments advanced by the electric vehicle salesmen in his efforts to combat the more popular petrol machine has been that in its field of application this type of vehicle can accomplish practically as much in a day as can the higher speed petrol machine, and do so at a less cost. Several factors must first be ascertained, and their relation to the subject as a whole weighed to determine all the contributory causes for the existence of this belief.

1. The speed of acceleration and of retardation of the petrol machine.

2. The speed of acceleration and of retardation of the electric machine.

3. The probable frequency of stops expressed in stops per mile.

4. The effect of other traffic on the highway as it relates to stops and speeds.

5. The total time available for running the vehicle.

The last is so important that it might be the determining factor in deciding whether to use power wagons at all, because with a relatively high standing time the advantages of power wagon

Elapsed time in seconds.	Speed, miles per hour		Total distance travelled (ft.)	
	Petrol.	Electric.	Petrol.	Electric.
1	1·5	2·5	1·10	1·84
2	2·0	4·2	4·40	6·98
3	4·4	5·4	10·03	14·33
4	4·4	6·0	16·79	22·78
5	5·0	6·6	23·84	32·04
6	5·6	7·2	31·63	42·33
7	6·8	7·6	40·59	53·35
8	8·4	8·0	51·61	64·81
9	9·0	...	64·39	...
10	8·8	...	77·43	...
11	8·5	...	90·10	...
12	9·6	...	103·51	...
13	10·6	...	118·79	...
14	11·2	...	134·96	...
15	11·5	...	151·79	...
16	11·8	...	168·91	...
16 2-5	12·0	...	186·50	...

which are usually overlooked in the ordinary course of power wagon application; and because they are overlooked the popularity of the petrol machine sways the buyer toward it regardless of the practicability of its application.



Three of the Large Fleet of Edison Electrics used by the Stratford Co-operative Society.

operation over those of horse-drawn vehicles entirely disappear, as the proportion of the day when the machine is running is insufficient to make an appreciable reduction in the total running time; hence the machine can do no more work.

Now, turning to the speed of acceleration and retardation of the petrol and electric machine, a series of observations on petrol and electric trucks of equal load capacity and quality made under identical operating conditions, the petrol vehicle, however, having a speed capacity of 20 per cent. in excess of that of the electric, have shown that for the first eight seconds of acceleration the speed of the electric machine exceeds that of the petrol, at which time it has reached its maximum, but that the acceleration of the petrol machine at a speed 20 per cent. higher than that attained at this point requires practically the same time to exceed the elapsed time, speed in miles per hour and distance travelled for each type of machine being given in the following table.

A fleet of [illegible] delivery service in a city of [illegible] and the surrounding towns, operating within a radius of 16 miles of the business centre, made [illegible] stops

These important contributory factors establish the following time elements in proportion to the total time consumed:—

Time running on route	29·80 per cent.
Time running off route	17·76 per cent.
Time delivering	28·18 per cent.
Time loading	24·20 per cent.

Also that the relative values of the "miles off route" and the "miles on route" are 36 per cent. and 64 per cent. respectively. If all these factors are resolved to a comparative basis for equal work performance the petrol vehicle will but slightly excel the electric, which difference is of little consequence when the time-saving effected is properly segregated into the different time elements of a nine hour day. For example, the time elements in a nine hour day would be as follows:—

Time running on route	2 hours 41 minutes
Time running off route	1 hour 36 minutes
Time delivering	2 hours 32 minutes
Time loading	2 hours 11 minutes

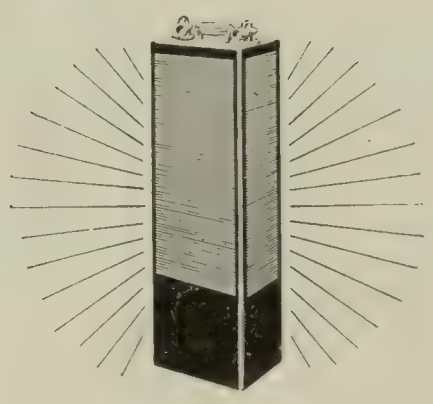
Of these only the first two are affected by the relative speeds of the machines, the first being partially governed by the frequency of stops and the second by the speed capacity of the machine.

* Enclosed by William J. Miller and Stephen O. Dessaint at a Dispatch before the Electric Vehicle Association, U.S.A.

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Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

EDISON ACCUMULATORS, Ltd., 2 & 3, DUKE STREET, ST. JAMES, LONDON. S.W.

AGENTS:—

Birmingham:—
J. P. KEMP,
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DRAKE & GORHAM, Ltd.,
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J. HALLY CRAIG,
45, Hope Street, Glasgow.

On an average basis of six stops per mile and a daily work performance equal to that possible with the electric vehicle the daily saving of the petrol machine over electric would be 73 minutes, which for increased performance must be segregated into the time elements as follows:—

Time running on route	21·80 minutes
Time running off route	12·96 minutes
Time delivering	20·57 minutes
Time loading	17·67 minutes

All the foregoing deductions are based upon unimpeded traffic when the machines are able to reach their maximum speed between stops and when running off route. Now if the figures are made to include a consideration of the effect of traffic stops and slow-moving traffic, this apparently increased efficiency of the petrol machine will almost entirely disappear. For proof of this there is the record of 100 days' observation of two petrol and two electric trucks of equal capacity operating in the service of the Central Stamping Co. between Newark, N.J., and New York City. Here it was found that the petrol machines could attain an average of only 58 per cent. of its maximum speed, while the electric maintained 72 per cent. of its maximum possible speed. Expressed in miles per hour, this amounted to 6·1 miles for the petrol machine and 5·8 miles for the electric.

The value of this increased speed, or, for that matter, the increased efficiency, is rather questionable when the cost of obtaining it is considered. What this means is well illustrated in the statement of the Central Stamping Co., who declare that when properly applied they have found that it is possible to operate a 3½-ton electric truck 25 to 40 per cent. a day cheaper than a 3-ton petrol truck on the same work.

ECONOMY ON SHORT HAULS.

Motor trucks can be made to work cheaper than horses on one-mile hauls. Short hauls have always been the bane of successful truck operation, according to many users, but the greater truck efficiency as compared to horses may be secured irrespective of the length of haul. The belief that motor trucks are only efficient on long hauls is wrong. Although one often hears that trucks are not as efficient as horses except on long hauls, this is not the fault of the trucks, but of the manner in which they are applied. The length of haul has nothing to do with it. In speaking with motor truck salesmen one often finds them loud in their claims for economy of trucks when the haul is long, but they begin to hedge when one starts to talk of one-mile runs. This is wrong.

Time is the all-important essential of modern business. It is especially so in all forms of vehicular transportation. The motor truck is a time-saver. Its existence to-day among the movers of the world's goods is due to the fact that it is a time-saver as compared with the horse. It will carry the same or a greater amount of goods much more quickly than horses require to haul the load. The saving of time is the most important of the assets of the motor truck, although economical and sanitary considerations also are of prime moment. The motor truck is a time-saver—when moving. Unfortunately many hundreds of trucks are not moving for as great a proportion of their possible working time as they should, and for this reason do not save as much time as they should and are not as economical as they might be. The great proportion of idle truck time is not spent generally in the delivery of the goods carried, but in their loading, and also in their unloading, when they are hauled intact from point to point, rather than delivered at various stops along the way. Idle truck loading and unloading time is responsible in almost all cases for truck inefficiency and for the fact that in some instances the cost per unit delivered by the truck is greater than with horses.

Hundreds of thousands of pounds are being wasted annually because motor truck owners have not installed modern time-saving devices in connection with their motor equipment. This condition does not apply only to certain business, but unfortunately is general, many instances being found in practically every class of work in which trucks are used. As more goods are delivered, piece by piece or package by package, than are hauled intact from the point of loading to the destination, the loading time is of the most importance in the great majority of cases. In nine cases out of ten dissatisfied users of motor trucks can trace the reasons for their dissatisfication to the methods of loading, whereas those loudest in praise of the motor truck as compared with the horse will be found among those who banished horse-pace methods of loading when they banished the horse. It is impossible to operate motor trucks successfully on

horse-pace methods. One of the most flagrant of horse-pace abuses to which motor trucks are subjected is to load them in the same manner as the horse wagons which they replaced were loaded. Whereas an idle loading time of one or two hours per day did not materially diminish the work capacity of a horse during the day, and in some cases was necessary in order to give the beast a rest, the same percentage of idle time in the operation of a motor vehicle plays an important part in the latter's cost of operation per unit of work done, because of the truck's greater cost of maintenance and its unrealised ground-covering ability.

Cases of improper operation, however, are becoming less and less numerous because of the greater dissemination of motor-truck operating knowledge and linking up with this the realisation of the fact that time is money and that a motor truck only makes money when it is saving time. This result is being accomplished in many various ways, according to the different conditions under which the trucks are working. The means used to accomplish the end desired may be roughly divided into three general classes, as follows :—

1. Mechanical loading and unloading devices on the truck or at the point of loading and unloading.
2. The use of demountable or nest bodies, or bodies with side doors.
3. The use of trailers of the four-wheeled semi-trailer or two-wheeled types.

The methods to be pursued in each case in order to keep the truck moving naturally vary a great deal, due to the kind of goods hauled and the peculiar conditions under which each different installation has to work. No matter what these restricting conditions are, there are bound to be one or more places where some sort of mechanical time-saving devices, either on the truck or on the loading platform, may be used to increase the truck's moving time.—"Electric Vehicles."

NO ELECTRIC KNACKERS.

Some of the General Vehicle trucks purchased between 1901 and 1905 have had chequered careers. Instances have been shown where a brewer bought two such trucks, became disgusted with them and sold them for the proverbial song. They went to a contractor who had better success with them, though no doubt his vocabulary was considerably increased before the end of the first year. In the meantime a competitor of this brewer had gotten the knack of successful operation of electric trucks, and began buying up the bargains made possible by dissatisfied users. The first brewer who sold the two trucks to the contractor is reported to have bought them back at a considerable premium, and he used them for seven years, or until the machines were nine years old, when they were taken as part payment for new trucks.

According to "Electric Vehicles," another brewer got along very well with his 1903 models until he came to getting spare parts for them. This was in 1909, and he found that the manufacturer had since amplified and standardised his design and could only supply 1903 parts at a steep price, as they had to be specially made up, almost by hand. The brewer was a shrewd buyer, and this is how he solved the problem. He bought two second-hand electrics of the same make and capacity, paying $150 and $225 respectively, and took from them the parts he needed for those in service. This scheme was so practicable that when two of the grocer's trucks had not more spare parts he sacrificed one of his own three to keep the other two running, and when they needed further help he bought some new standardised machines. Two other brewers studied battery problems in 1904, and, after getting their own machines on a paying basis, bought up all the 3-ton electrics they could find at low prices. One of them still operates 19 old cars and two new ones, the other 14 being of the oldest brewery type now in service.

A famous New York jewellery house sold all horse seven years ago as a result of what their 1902 electrics accomplished in the way of economy. To-day 17 of their 19 electrics are over 10 years old, and, notwithstanding the fact that their 1-ton panel wagons weigh 1,000 lb more than the 1-ton wagon built by the same manufacturer to-day, they have no trouble getting all the mileage they need at a cost very satisfactory to them.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

THE POPULAR ELECTRIC STEVEDORE.

Among the many new and successful applications of electricity, the electric commercial vehicle is holding its own with other "current-consuming devices." It has been recognised for some time that the chief competitor of the city horse is the electric truck, and now the vehicle manufacturer has brought out a competitor for the hand truck, which is to be seen about the freight sheds and factories. When the electric industrial truck, or "electric stevedore," as it is sometimes called, was first brought out it was anticipated that labour unions would oppose them, but this has seldom been the case. In fact, when one steamship company started to transfer a number of these trucks to another seaport the drivers went on strike, and practically obliged the company to retain them. There is a lot of difference between pushing a hand truck with a cask of oil on it, part of the great weight of which falls on the labourer's shoulders, and in riding on and guiding a powerful little electric, which can move five casks at once. Hundreds of these electric freight trucks are used by railroad and steamship companies, manufacturing plants, &c., and indications point to the use of thousands in a few years. Most of them are of 1-ton capacity, with a speed of from 7 to 12 miles per hour, and they cost about one cent per mile for current, even when worked hard. They can climb grades of from 20 to 30 per cent. and go through narrow aisles and around sharp corners. As they carry five times as much freight as the average hand truck, and go over the ground in one-third time, each truck naturally does the work of about 15 freight handlers.

Down on the lumber tramways of Lousiana the electric "mule" has made its appearance. The "mule" is nothing but an electric tractor, sufficiently powerful and elastic to take the place of the real mule at one end of a lumber dolly, which moves thousands of feet of green lumber. The long tramways cost thousands of dollars in repairs each year, due to the shoes of the mules cutting into the planks. This set a big lumber man thinking about motor trucks and the electric "mule" was the result, preference being given it owing to lower fire risk, greater elasticity and the fact that electricity was already available as a by-product. Tractors of this kind are rapidly spreading through the South and North-West.

G.V. ELECTRICS PROGRESS.

A company which records considerable progress in the sale of battery-driven trucks and wagons is the General Vehicle Co., Imperial House, Kingsway, London, W.C. The Midland Railway Co. has had several in service for some time past engaged upon about town and suburban delivery work. The G.V. machines are of a standard design, and have single motor drive through double reduction gearing. The main features of the vehicle are set out in the following specification, which relates to a 3½-ton chassis. Two of the vehicles are illustrated on the opposite page

Frame.—5 in. rolled steel channel.

Springs.—Semi elliptical front and rear, fitted with grease cups on all link bolts.

Axles.—Both front and rear axles round section of alloy steel: alloy steel steering knuckles.

Wheelbase.—10 ft. 8 in. Gauge 5 ft. 5 in.

Width.—Total overall width, approximate 6 ft. 7 in. Over side members of frame, approximate 45 in.

Length.—Total overall length of chasses, 15 ft. 3 in.

Wheels.—Artillery type on Timken roller bearings.

Tyres.—Front 900 mm. 140mm. single. Rear 900 mm. 100mm. twin.

Brakes.—Service brake, internal expanding on each rear wheel, controlled by foot pedal with ratchet. Emergency brake, external contracting on each end of countershaft controlled by foot pedal.

Steering Gear.—Pinion and sector type with vertical steering column having large hand wheel.

Transmission.—Single motor, double reduction, with chains. First reduction: Morse silent chain enclosed from motor to countershaft. Second reduction: Roller chains from countershaft to each rear wheel.

Countershaft.—Housed type on Timken roller bearings with spur gear differential.

Motor.—G.E. (U.S.A.) totally enclosed series automobile type with ball bearings.

Battery.—Edison A 10 (60 cells) carried in cradle under chassis.

Controller.—G.E. (U.S.A.) continuous torque, placed under driver's seat in sheet steel box, operated by lever by driver's side. Four speeds forward, two reverse, regulation by field coils.

Running Switch.—Three way type (running-neutral-charging), fixed in sheet steel box adjacent to controller. Handle can be removed only when in neutral position. This constitutes a safety factor, and the vehicle can be left when the handle has been removed.

Circuit Breaker.—Fitted in sheet steel box near running switch in charging circuit, with ampere hour meter.

Meter.—Ampere hour meter fitted in steel box under driver's seat,

"Ironclad Exide"

(Registered)

THE BATTERY FOR COMMERCIAL ELECTRIC VEHICLES.



No better testimony can be found of the satisfaction which the Battery is giving in actual service than the number of repeat orders which we are receiving. We can substantiate every claim made for it by the experience of users over considerable periods, and are able to clearly demonstrate that its life is between two and three times that of an ordinary flat plate, while its reliability day in and day out has been proved beyond cavil.

WILL STAND HEAVY BOOSTING CHARGES.

THE Chloride ELECTRICAL STORAGE CO. LIMITED

CLIFTON JUNCTION, MANCHESTER.

LONDON OFFICE: 39, VICTORIA STREET.

having contacts which automatically trip circuit breaker when battery is fully charged.

Lamps.—Two electric lamps mounted in dashboard and electric tail lamp are provided, with cartridge fuses and switch.

Equipment.—A mechanical horn, kit of tools and charging plug and receptacle with 12 ft. of cable supplied with each chassis.

Toolbox.—A sheet-steel toolbox is provided and fixed under rear of chassis.



G.V. Lorries used by Midland Railway Co.

Portable Lamp.—A socket is fitted beneath the driver's seat and 12 ft. of cable provided with plug and lampholder, with each chassis.

Wiring.—All wires, including lamp circuits are run in screwed metal barrel.

Mileage Recorder.—A Hub-Odometer is fitted on the front wheel.

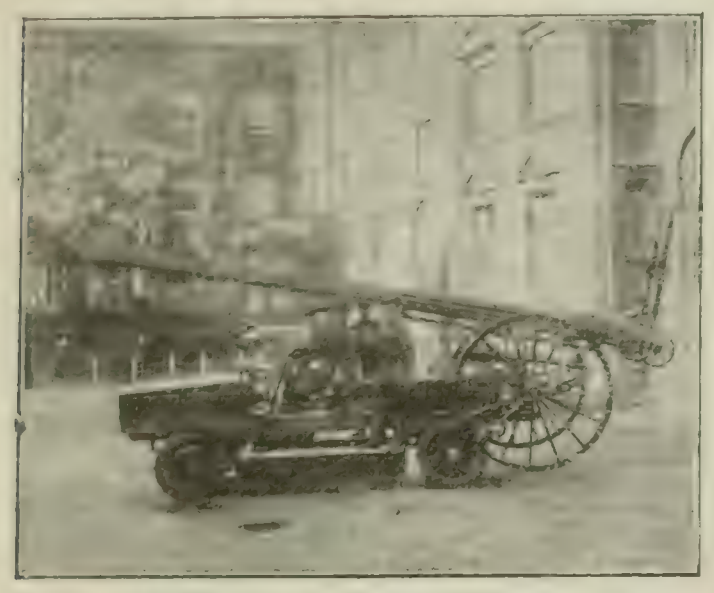
Speed.—Over hard level asphalt roads 10 miles per hour.

Mileage.—Over hard level roads, loaded to rated capacity half distance, per battery charge: 35 miles.

Weight of Battery.—2,300 lb.

Weight of Chassis with Battery.—8,260 lb.

TUDOR
Accumulators
FOR ELECTRIC VEHICLES.



FIRE BRIGADE VEHICLES WITH TUDOR BATTERIES.

London Fire Brigade—11 Vehicles. Liverpool Fire Brigade—4 Vehicles.
Rathmines (Dublin) Fire Brigade—1 Vehicle.

BATTERIES FOR COMMERCIAL VEHICLES, PLEASURE CARS, OMNIBUSES, &c.

LIGHTEST in WEIGHT—HIGHEST in EFFICIENCY.

Maintenance undertaken at Moderate Mileage Rates.

THE TUDOR ACCUMULATOR CO., LTD.,

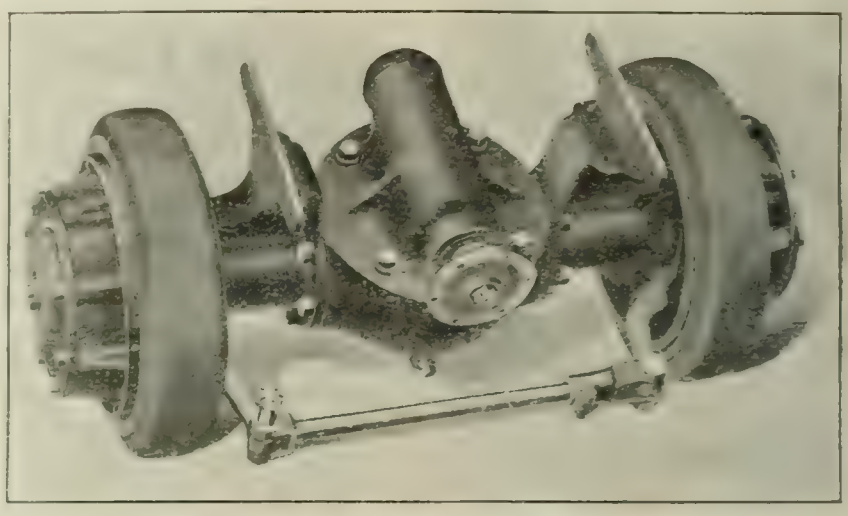
3, CENTRAL BUILDINGS, WESTMINSTER, LONDON, S.W.

Works: DUKINFIELD, near MANCHESTER.

ELWELL-PARKER RAILWAY AND INDUSTRIAL BATTERY TRUCKS.

The adjoining illustrations depict an extremely interesting type of battery propelled platform truck which has already been put into service in considerable numbers in this country. The compact manner in which the motor is arranged in a cradle supported on the front axle is shown in one of the views. It will be seen that the ends of the cradle are fitted with steel bearings, which support the truck frame and constitute a three-point flexible suspension with it. The rear axle, which is also shown, is provided on the centre line with a worm gear which is totally enclosed in an oil-tight case which also contains the differential. The method of effecting the steering will be clearly shown in the illustrations. Both ends of the front and rear wheels serve to explain that they are fast on unusually large double row ball bearings. The drive from the motor cradle on the front axle to the gearbox on the back axle is by cardan shaft. The double reduction gear is totally enclosed with the wormgear and differential in the back axle housing. The motor pinion engages the differential on a countershaft which is fitted with forged universal pinions, one at each end. These engage internal cast-steel spur gears, which are rivetted to each of the driving wheels. The motor is specially built for this class of service, and is a high efficiency machine giving a high starting torque; it is series-wound, 24 volt, and is totally enclosed. It is capable of propelling a fully-loaded truck up a 10 per cent. grade. It is stated that at starting the current consumption is very low.

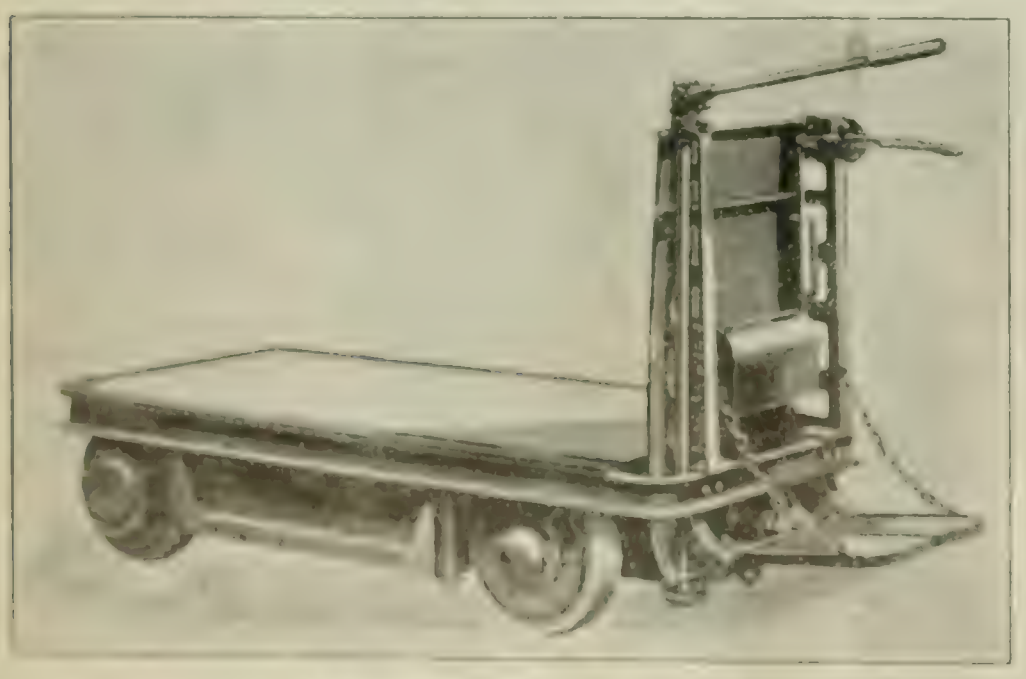
The control gear is placed at one end of the truck, and the steering and controller handles are fixed at a convenient operating level on a rectangular frame mounted at right angles to the platform. To operate the truck the driver stands upon two hinged flaps, which are spring controlled, and which assume a vertical position when the driver leaves the truck. The act of pressing these flaps down releases the brake and closes the main circuit breaker; the current to the motor is, however, not turned on until the operating handle is either pressed down or pulled up, according to the direction of travel desired. Should the driver attempt to leave the truck while it is in motion the main circuit will be broken, and the brakes will be applied, bringing the vehicle at once to a standstill.



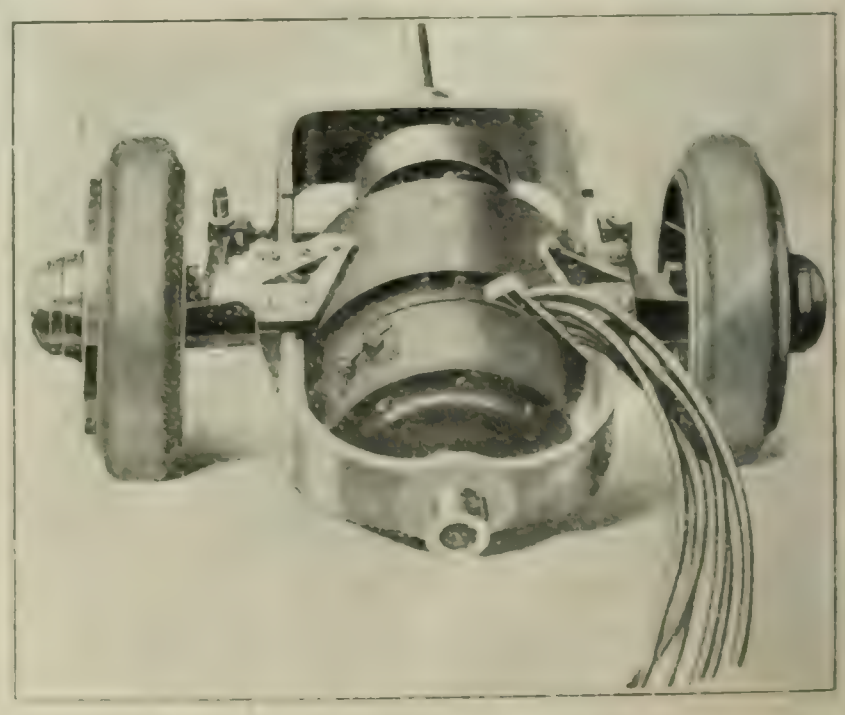
Driving Axle of Industrial Truck.

The wheels are shod with solid rubber tyres of special section, the rubber being vulcanised on to a separate metal base ring; this latter is then hydraulically applied to the rim of the truck wheel with a pressure of from 6 to 8 tons.

The type of truck illustrated has a loading capacity of 3 tons, and the tare weight with battery is about 17 cwt. The Edison battery comprises 42 P6 cells in two trays, representing a capacity of 240 ampere-hours. A trading load of 2 tons can be satisfactorily drawn with a truck fitted with this pattern of battery. The daily cost for electrical energy is 1*d.* per truck, and a saving of 40 per cent. has been effected over hand haulage. The trucks are supplied by Railway Truck Supply Co., Greenhurst Street, E.C. The illustrations are reproduced by kind permission of the "Railway Gazette."



Elwell-Parker Industrial Truck.



Front Axle and Driving Motor.

ELECTRIC VEHICLE PROGRESS



AN ELECTRIC BATTERY LOCOMOTIVE.

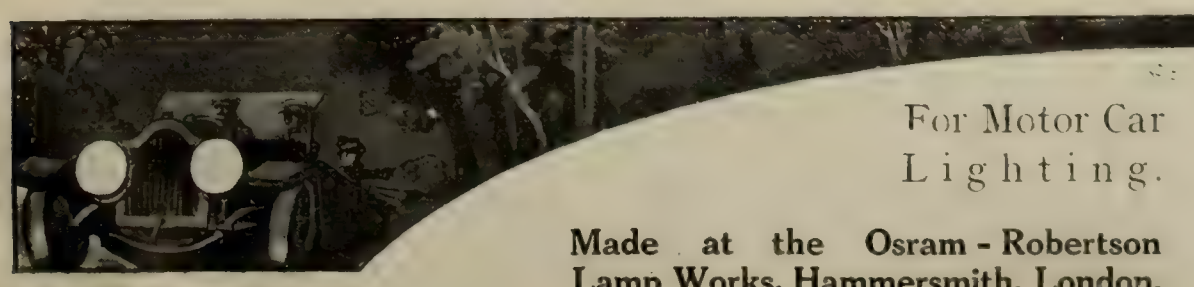
Some eighteen months ago the Midland Railway Co. placed in service a battery operated electric locomotive for shunting and sorting the coal traffic in the West India Dock Depot, London. Previously this work was performed by horses in connection with a number of turntables situated in each road, and investigation showed that the shunting could be done more satisfactorily and economically by an electric locomotive than by horses, hydraulic or electric capstans and snatch-heads.

A locomotive is considerably more flexible in operation than any of the alternative arrangements, and as the ordinary steam locomotive cannot enter the yard, the only access from the railway being by means of an hydraulic wagon lift, the whole of the work had to be undertaken by the electric locomotive.

High speeds are unnecessary in working a yard of this type, and the maximum speed attained with full load is only about 7 miles per hour, speeds up to 12 miles per hour being attained with light loads. The rated capacity of the locomotive is six loaded wagons weighing 15 tons each, and 12 light wagons of approximately 6 tons each. The weight of the locomotive complete with battery is 17·5 tons, and the wheel base, which is rigid, is 8 ft. 6 in. The general



Midland Railway Electric Shunting Locomotive.



For Motor Car Lighting.

Made at the Osram-Robertson Lamp Works, Hammersmith, London.

Osram DRAWN WIRE Lamps

Remember what an important part the Controller has to play

and see to it that your Electrics have 'IGRANIC'

VEHICLE CONTROLLERS.

There is no other that will give the same safety, ease, economy and reliability.

IGRANIC ELECTRIC Co LTD 147, Queen Victoria Street, London. Works: BEDFORD.



appearance and method of construction of the locomotive is well shown in the illustration. There are two motors (one per axle) of 22 h.p. each, supplied by Dick, Kerr & Co.

The battery, which is situated in the two end compartments, was provided by the "D.P." Battery Co. (Ltd.). It consists of 108 cells, 21 plate H.L. type, and has a capacity of 300 ampere-hours. The cells are of the standard train-lighting pattern in lead-lined teak boxes, and are fitted with "block" type lids.

The locomotive has not been out of service at any time on account of the failure of the battery, and no single cell has failed since work commenced about 18 months ago. The battery has been in daily use (Sundays excepted), the discharge rate varying from 40 to 90 amperes, with occasional discharges up to 150 amperes.

The battery is charged every day from about 12:30 p.m. for one to two hours, and a "refreshing" charge is given in the early morning. Cleaning of the battery is done without interruption of work, and although subjected to severe handling in shunting operations, repairs are a small item.

Control is by the ordinary series parallel method, providing two economical running speeds, and breaking is of the rheostatic type operated by the main controller, this method being very useful for shunting operations. A band brake with hand operation is also fitted to each axle, being equivalent to the tender brake on steam locomotives.

The mechanical portions of the locomotive are largely constructed of standard wagon parts—*e.g.*, the wheels, axles and draw-gear. The body and cab are of wood, suitably braced with iron work. The covers over the battery compartments are arranged to drain off all rain water, while both sections are so ventilated that gases given off during charging or working the battery are carried away.

Charging is performed by a motor generator, the supply voltage of 460 volts being too high to offer any advantages for the use of a reverse booster. The generator is differentially compounded, so that after current is switched on further attention is unnecessary, except in the case of a "guessing" charge.

THE COMING OF THE ELECTRIC VEHICLE—A REVIEW OF THE AMERICAN SITUATION.

The past year has seen many changes and improvements in the electric vehicle industry, all of which point to a bright future both in the commercial field and with passenger cars. There have been no sudden spurts of popularity in the recent progress of the electric vehicle, rather it has been a gradual steady growth, forming a foundation upon which to build up increasing business. Since the transportation world recognised the value of the motor truck for merchandise it has invariably been admitted in the larger cities where there are opportunities of testing the various forms of trucks that the electric is the economical vehicle for city and suburban work.

The best authorities upon transportation problems bear out this statement of the electric's adaptability to city traffic after four years of observation and statistical study. Large fleets of electrics have been adopted by the largest and most conservative business houses. The American Express Company has now about 300 electrics in use, and the additions to its fleets during the autumn and winter of 1914-15 are practically all of the electric type. The Adams Express Company operates 276 electrics, and has just received the final shipment of an increase to one fleet of 42 electrics. The Ward Baking Company is now using 640 electric delivery wagons. The Anheuser Busch Brewing Company has 142 electrics, many of which are 6 ton capacity units. The Gunther Wheat Brewery 126, the New York Edison Company 120. A number of large fleets of electric coal trucks varying from the light 2 ton capacity to 5 and 6 ton trucks, are used in and around them, where they are operated 18 hours a day, hauling coal to the business houses and office buildings at night, thus avoiding the difficulty and delay of operating in the sections where traffic is most congested during the day. In the lighter, less

of delivery wagons the department stores have shown a strong preference for the electric. In Chicago the Marshall Field Company operates no less than 230. In nearly every case where a concern has adopted the electric large repeat orders have been the result, evincing a marked confidence in the electric vehicle for city and suburban transportation service. [This is also noticeable in this country now that the commercial vehicle is becoming better known.—ED.]

While nearly all of the largest fleets of electric vehicles have been installed primarily through the efforts of the vehicle manufacturers, the central stations have exercised considerable influence in their promotion. In New York there is a minimum of something over $10,000,000 annually to be derived from the sale of current for electric vehicles in place of horses. Of 10,000,000 horses that are in use in U.S.A. probably all could be successfully displaced by electric vehicles. This would mean an additional income to some 6,000 electricty supply companies of about one billion dollars. This is all the more significant when we consider that the combined income of all these central stations from all sources last year was approximately $450,000,000, of which but a very small percentage was derived from the sale of current for electric vehicle charging. Even if only a small fraction of the business in sight were obtained it would represent a tremendous increase in the total incomes to the electricity supply undertakings.



THREE-TON EDISON G.M. LORRY.

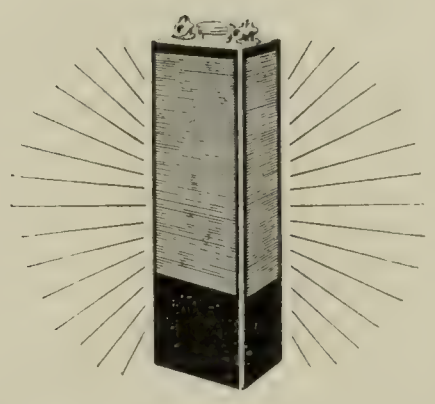
The horse and cart is gradually being displaced by the light electric delivery wagon. Within its capacity rating, the small ¼750 lb electric costs less to operate than a single horse wagon, and can do far more work. Where conditions are such as to demand mileage ranges of 30, 40 or 50 miles per day the saving obtained by the use of this car may actually cover its cost in less than two years after all other running expenses have been paid for. It costs less to keep this car in tyres than it does to keep a single horse in shoes for the same work done. For equal service the cost of electrical energy per kilowatt-hour amounts to but about half the cost of hay and oats. In New York more than 50 livery stables have expressed a willingness to store and wash this car for £2 per month. These same stables get from £5 to £6 per month for stabling and caring for a single horse and wagon, and there is profit in the former and, as a rule, loss in the latter.

Another important development of the electric vehicle during the past year in a special field is its adoption for municipal service by many progressive cities in one form or another. Philadelphia has a liquid electrically propelled fire apparatus, and high commendation has been given it by the fire chiefs of the following cities, all of which have adopted the electric vehicle: Springfield, Mass.; Baltimore, Md.; Boston, Mass.; Akron, Ohio; Worcester, Mass.; Uniontown, Pa.; Camden, N.J.; Paterson, N.J.; Hartford, Conn.; and several others. A recent demonstration of electrically-driven fire

EDISON

ACCUMULATOR ELECTRICS are LEADING!!

Some of the Reasons:



Because they are equipped exclusively with the Edison Accumulator, which, now in its eighth year of service, is proving more durable, more reliable and simpler to operate than any other type of storage cell.

Because the Edison Accumulator is made of Steel throughout, including the container; uses a **steel preserving electrolyte;** and cannot buckle its plates, sulphate, corrode, lose its charge, nor suffer from the effects of overcharging, high rate boosting nor being discharged to zero when necessary.

Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

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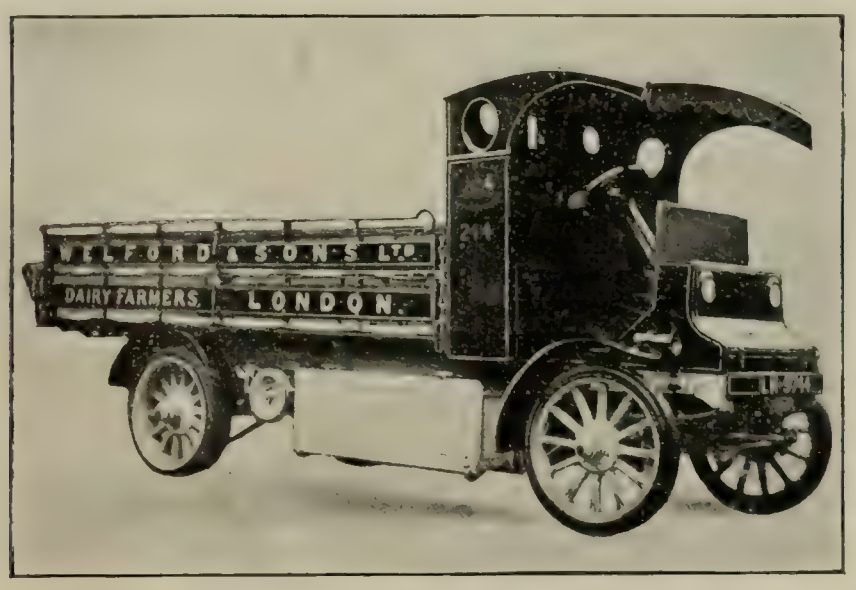
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Grand Hotel, Birmingham.

Lancashire and Cheshire:—
DRAKE & GORHAM, Ltd.,
47, Spring Gardens, Manchester.

Glasgow:—
J. HALLY CRAIG.
45, Hope Street, Glasgow.

apparatus was held on the steep grades in and around Paterson, N.J., during November, at the time of its initial installation in that city. The tests showed the remarkable power of a combined chemical engine and hose wagon fully equipped with 20 lengths of hose and a crew of 14 men, weighing in all 18,320 lb., and a second piece of apparatus consisting of 65 ft. aerial ladder carrying a crew of 22 men, with total weight of 20,000 lb. These two pieces negotiated an 18·23 per cent. grade, having an uneven cobble stone paving in 1 minute 13 seconds, starting at the foot of the hill from a dead stop. This hill had always been used as a test hill for every piece of apparatus used by the Paterson fire department, and the previous fastest time had been 1 minute 40 seconds, made by a petrol-driven combination. These pieces of electrically-driven apparatus made the run from Philadelphia to Paterson, approximating 125 miles, in 14 hours elapsed time, including stops at Trenton, New Brunswick and Newark.



TWO-TON EDISON ANDERSON LORRY.



ONE OF "LYONS" LARGE FLEET OF EDISON G.M. ELECTRICS NOW RUNNING IN LONDON.

Electrics are now being used in large numbers for the collection of refuse, two of the most recent installations being in Boston, where two 5-ton trucks have been purchased by the city, and in New York, where two gas-electric tractors are being used for the same purpose. Several cities of the south have adopted electrics for refuse collection, notably Miami, Fla., which has operated electric refuse vans for some time. Electric street sprinklers, snow ploughs, rollers, police patrol wagons and ambulances are all being gradually adopted by progressive municipalities, which recognise the economy of operating cost and efficiency of the modern electric commercial vehicle.

The latest development, and one which will play an important part in further popularising the passenger electric, is the electrically-driver taxicab. The present petrol taxicab service in many cities, and especially in New York, is inefficient, in many instance unsafe and costly to operate. An electric taxicab has been developed by a company in Detroit, where there is now a fleet of 47 in operation.

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The cab has all the exclusive refinement of a privately-owned limousine in appearance, and is operated with far greater ease and safety than the best of the petrol taxicabs. Plans are now under way whereby a company will be formed to introduce electric taxicab service in New York and other large cities in this country.

The battery rental and exchange system is also being developed successfully for passenger cars. Coupled with this project will be a substantial reduction in the price of electric vehicles. Already one large manufacturer of passenger electrics in Chicago is selling a vehicle minus batteries for nearly $1,000 less than last year, the purchaser renting the batteries from the various service stations in the city. In this way the user can estimate his maintenance costs without difficulty, and he will know beforehand exactly what his operating expenses will be. In some figures recently compiled it is shown that in the comparative costs of operating an electric and a petrol car of the same valuation the difference in upkeep expenses is as high as 185 per cent. in favour of the electric in cases where the owner employs a chauffeur to run his petrol car. In instances where no chauffeur is employed the electric shows a saving of from 36 to 55 per cent. in operating costs over the petrol type. Other price reductions in electric passenger vehicles have been due to quantity production and an unprecedented increase in sales. A decrease of $875 was announced by one company which has been carrying on an extensive sales campaign, and other manufacturers have offered reductions of



A Loop-to-20 Electric Exacts of an Electric Lorry.

from $300 to $800. All of this augurs well for future popularity of the electric, and already its recognition as the most satisfactory car for city and suburban use is evidenced in the increased numbers which are to be seen daily in the streets.

The past year has been marked by a number of successful long runs organised by several of the leading manufacturers. Fifteen hundred miles in 14 days, using but a single charge of the batteries per day, was the record made by the Beardsley Electric Company, of Los Angeles, Cal. Recently a Detroit electric made a run of 180 miles in less than 10 hours, and the same make of car also accomplished a 350-mile run from Hartford to Washington in an actual running time of 12½ hours. The topmost 85.65, or less than 11 cents per mile. A Waverley electric made the trip from Buffalo to New York in three days, and at the time of the Convention of the Electric Vehicle Association of America, at Cleveland, a Chicago electric made a record run of 424 miles between Chicago and Cleveland, in a running time of 28 hours. The Milburn light electric has been making some long-distance runs on the Pacific coast, and has shown excellent hill-climbing ability and mileage radius in the hilly sections around Portland, Oregon. One hundred and forty, and even 160 miles on a single charge of the batteries have been accomplished by several different makes of electrics, showing that batteries are constantly being improved and their mileage capacity increased.

Manufacturers of electrics have begun to realise during the past year that there is a growing demand for electrics built along more masculine lines. This type of automobile has so long been recognised as the ideal car for a woman that they have lost sight of the fact that certain features of the electric have an especial appeal to business and professional men, with whom destination on time is of vital importance. An electric is absolutely dependable, and in traffic congested streets it winds its way in and out more easily than any other type of car, saving time by stopping and starting in immediate response to the driver's touch. Sturdy appearing roadsters, built on more masculine lines, have therefore been developed to meet popular demand, and the electric is fast establishing itself as a favourite with men for city and suburban use.

During the summer the new co-operative electric garage of the New York Electric Vehicle Association, located at Central Park West and 62nd-street, was thrown open to the public, and is housing its full quota of 100 electric passenger cars. The charging equipment of this electric garage, which is the largest in New York, is unusually complete, having facilities to charge from 100 to 200 cars per day and to care for the various sizes of batteries fully equipped electric garages are springing up all over the country, offering excellent facilities, and in some instances giving a parking service free of charge. The electric garages of Chicago offer a parking service in the Loop district, which has proved a boon to shoppers and theatre patrons. Owing to the strict enforcement of the "half-hour law" for motor vehicles, which prohibits a car standing in any one place for more than a half hour, the owners of electrics who rarely employ a chauffeur were especially inconvenienced. Recognising this, the electric garages organised the free parking service, and the cars are brought to a centrally located garage by the owner and parked by a reliable and competent chaffeur, who returns the car when needed again. This is but one instance of the excellent service offered to users of electric vehicles, both commercial and passenger. Manufacturers, electricity supply companies and electric garages are all co-operating to further electric vehicle development and to give the best service under all conditions.

WARD LIGHT DELIVERY VAN MILEAGE RECORD.

Official recognition has been given to a new mileage record just established by a Ward special delivery wagon, which covered 98 miles on a single charge of its battery while operating under regular service conditions through the streets of New York, carrying its capacity load and making the average number of stops. The route followed was from Mount Vernon, through the Bronx and Manhattan to the Battery, then north to Kingsbridge, back to 40th-street, and back and forth between 40th and 160th-streets, the Hudson and East Rivers, until the battery was discharged. The distance covered was 98 miles, the total time 16 hours 7 minutes, actual running time 12 hours 2½ minutes, average speed 8·1 miles per hour, number of stops 35, and the current consumed was equivalent to 164·5 ampere-hours. This figures out 1·68 ampere-hours per mile.

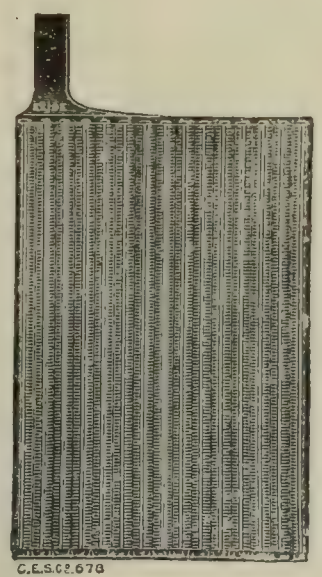
This remarkable record was not made under favourable conditions. A drizzling rain with slippery pavements prevailed throughout most of the test. No repairs nor adjustments were made. The vehicle used is the Ward special, which is being marketed through a unique campaign in which all the central stations in that vicinity are co-operating.

Why not a space like this under reading matter? The cost is purely nominal. Let us quote you.

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PETROL v. ELECTRICITY.

The following symposium, taken from our contemporary "Electric Vehicles," of Chicago, will be read with interest in this country, where the prices of petrol and electrical energy are respectively lower and lighter than they are in the United States. The original is so breezy in its phrasing that we reproduce it as published, substituting only the word "petrol" for "gasoline," that being the American term of the magic spirit.

Petrol! Spirit of progress and essence of joy! In the span of a few short years how has thy planet risen—and also thy price! More precious than jewels thy scintillating dew drops, evaporating and stealing away like a ghost of a Wall-street banker. In sordid gallons thy measure is taken in thy zinc-lined cell, but thou fleetest hence with every sob of thy engine, and presently thou art gone, together with four dollars and 20 cents.

And now they talk of substituting benzol—not that its price is less but that its pep is more. Twenty-five cents a gallon: four gallons for a dollar. Add lubricating oil quantum suff., a dash of anti-freeze mixture, and some new dry cells. Oh, leave the blame thing in the garage; maybe some sucker will come along and buy it.

Get an electric; it's the only reasonable answer, so quit arguing. You know it looks better and runs better and makes you feel better. Electricity is 10 cents a kilowatt-hour—lots of places less. It used to be 12. Picture that it used to be 15. Petrol keep it will probably be seven. Some day it will be four.

They can't ship the supply of electricity to England or Germany. Nobody can corner it. It can't run short. You can buy it every where, and there's only one quality!

Electricity is the natural motive power; petrol the unnatural. You doubt that? Talk to [illegible] automobiles is driven by petrol power? A [illegible] small washing charge and a million farmers' people, choked and [illegible] possible. Nothing more of consequence, sadly. But electricity drives everything—even those deadly Prussian submarines. It drives the world.

Keep up your enthusiasm, you fellows whose ambitions for big business are always postponed for one year. The day will come—and remember that we said it—when ALL the cars on the street will be electrics.

A STAKE BODY INDUSTRIAL TRUCK.

Three G.V. industrial battery-driven trucks have been put into service by the Associated Equipment Co., Walthamstow. It is noteworthy that each of these machines is in charge of a boy, a fact which demonstrates the ease of control and general simplicity of the vehicle. The company referred to is engaged in the production of motor 'buses, and also undertakes repair work in connection with them. The operation of the factory naturally calls for a means of inter-departmental transport, and after due consideration of the methods available the battery truck was decided upon as being economical, both from the energy and labour points of view. The three little vehicles will carry a load of 1 ton, and they will also pull trailers. Two trucks have a 10-ft. platform, and the third a 6-ft. platform. The driving power is furnished by a battery of 42 five-plate Ironclad Exide cells, spring supported in a crate which is underslung between the front and rear pairs of wheels. A single motor drives the rear wheels through spur gearing of the single reduction type, and the speed on the level, with full load, is about seven miles an hour. The mileage range allowing for this speed is about 25, on one charge of battery.

The G.V. truck illustrated is of interest to transport users on account of its simple construction. Both battery and driving mechanism are mounted below the platform, which accordingly is free and clear to carry not only a compact load, but iron pipe and similar material. The platform with its rounded corners is extended so as to protect the mechanism and running gear in every direction.



G.V. Battery Truck with Stake Body

The speed on hard, level surfaces is about 7 miles per hour, and the average radius is 25 miles per single charge of the battery. The current consumption on a full charge of the battery is 6-8 kw.-hours. All mechanical parts of the truck are accessible, the weight is 2,150 lb. and the turning radius is 7 ft.

This truck has single reduction gearing, and in the case of two motors each rear wheel is driven by an individual motor geared to a housed spur gear fastened to the wheel. One motor is standard for grades up to 10 per cent. Two motors are best for grades above this and up to 30 per cent. Each wheel has two complete self-lubricating Timken roller bearings. The controller is enclosed and an automatic cut-off switch minimizes accidents. One handle is used as controller lever, and the other handle for steering. The controller returns to neutral as the hand is removed from the lever. The cut-off switch cuts off the power when the foot is removed from the brake pedal. In other words, the driver applies the brake simply by releasing the pedal with his foot, and as he releases the pedal the power is cut off automatically.

The driver standing erect on the end of the truck with hands on controller and steering lever respectively, and foot on the brake pedal, is in the best possible position to guide and control this load. The simplicity of operation does away with the necessity for hiring expensive operators. The average unskilled labourer can be taught to successfully operate a truck of this type, even in congested plants or terminals, in about 48 hours.

A feature of the truck illustrated is that it is very useful where it is desired to operate between floors: it is sufficiently handy to use in elevators.

A complete specification of this truck can be obtained of the General Vehicle Co., Imperial House, Kingsway, London, W.C.

Printed and Published by [illegible] at the Office of "The Electrician" Printing and Publishing Offices, Bouverie House, 154, Fleet Street, E.C.4. LONDON, FRIDAY, FEBRUARY 25, 1916.

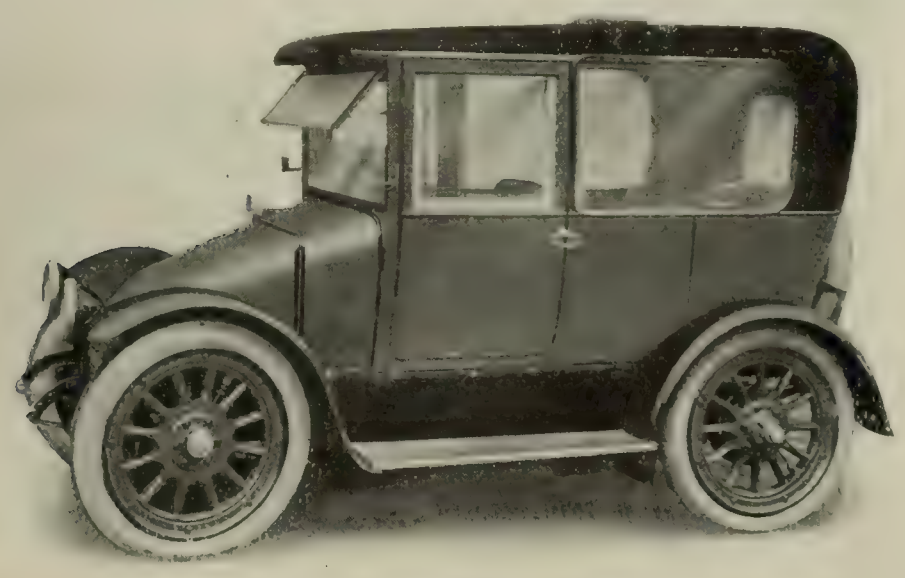
ELECTRIC VEHICLE PROGRESS



AN ATTRACTIVE PASSENGER ELECTRIC.

A very attractive private battery car has just been built by Messrs. Electromobile (Leeds) Ltd., to the special requirements and order of their Swansea representatives, Messrs. Johnson & Burgess, Ltd. Every refinement of a modern car has been incorporated. The vehicle is a considerable advance on American electric car design, both in technical features and in comfortable appurtenances. The difficulty of the design of the forward end has been ingeniously overcome without the use of a dummy radiator.

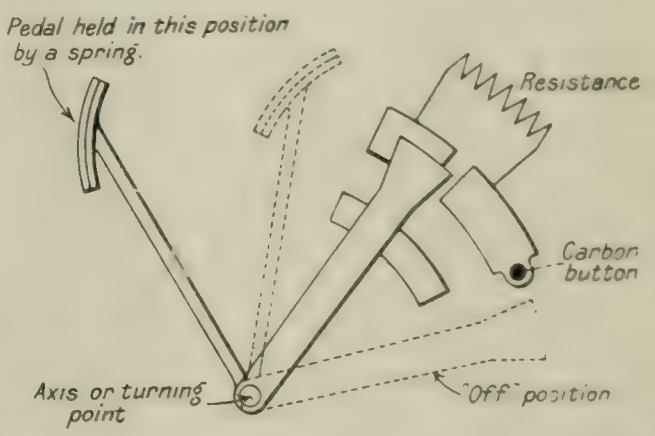
The energy consumption is 3 to 4 ampere-hours per mile, according to surface of road, and at 88 volts this is 264 to 352 watt-hours per mile, or approximately $\frac{1}{4}$ to $\frac{1}{3}$ unit per mile. At 1d. per unit this i equivalent to 3 to 4 miles for 1d.



General View of Saloon Body Electric.

The body provides inside drive saloon for four persons, with two swivelling and collapsible seats for driver and his companion. It is painted in Vauxhall brown and black, and the upholstery is in fine beige Bedford cloth. A ventilator is fitted in the roof, and door windows and screen are arranged to open. The upper half of the screen overlaps the lower portion, when closed, to prevent ingress of rain. A small glass trap-door is provided in the screen to give the driver a clear view when the screen is down and the trap open. All windows are bevelled plate-glass, and the bonnet and body made of beaten aluminium sheet with invisible joints. All the mudguards are domed. One holophane roof light, and one cast aluminium rear light attached directly to number plate, also two head and two side lights are fitted and controlled by switches on the instrument dash board. The latter is of polished mahogany, and in addition to the lamp switches, carries flush Stewart speedometer; flush Stewart rim-winding clock; latest Weston combined volt-ammeter with miniature electric lamp; and Sangamo ampere-hour meter

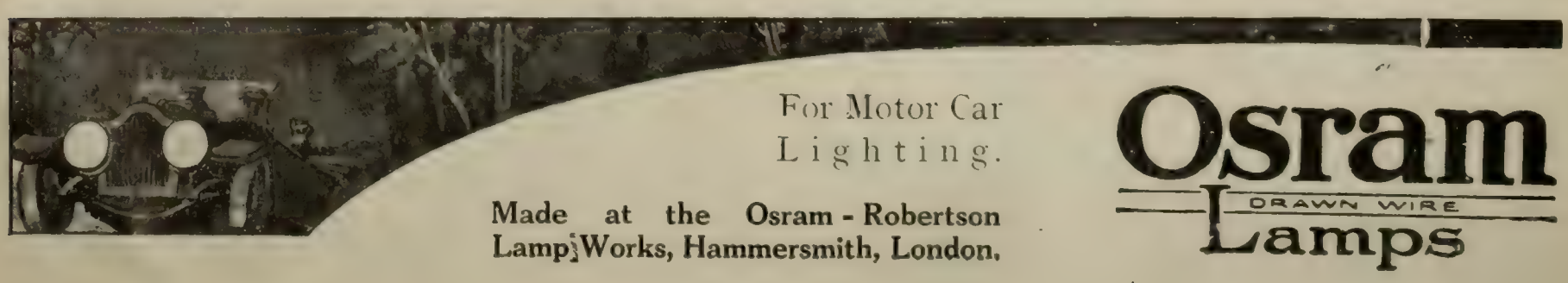
The frame is of pressed steel, and the front is in-swept in order to give a wide lock. The front and rear axles are suspended on semi-elliptical springs. The transmission is direct from the motor in the frame to differential on the rear axle by double helical machine-cut gears; ball bearings are fitted throughout. The motor develops 3 H.P., and is of the double commutator series type being totally enclosed. Its normal speed is 1,600 revs. per min. at 76 amperes, 96 volts. The wheel-base is 7 ft. 6 in., and the tread 4 ft. 6 in. The rims are of the Warland divisible and demountable type, with spare rim and tyre carried behind the body, as shown in the illustration. Avon tyres are used, 820 × 120 mm.



Detail of Pedal "Clutch" or Controller.

In a large box slung under the chassis is the Chloride-Exide thin plate battery of 44 cells. It has a capacity of 165 ampere-hours, and weighs 32½ lb. per cell; between the bottom of the cell and the bottom of the plates is a sediment space 3¾ in. deep. The battery will give a range over average roads of 50 miles on one charge.

The control of the motor is by a foot-pedal combined with a main switch (with magnetic blow-out) and starting resistance (*see* sketch). Different speeds are selected by a handle-placed below, but concentric with the steering wheel. The use of the pedal control



CHARGING VEHICLE BATTERIES

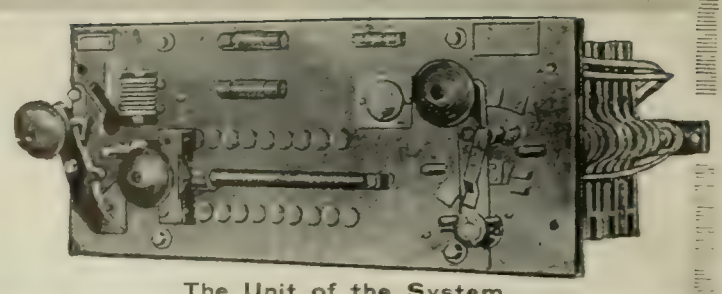
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admits of a lady or any inexperienced person driving the car. Three patterns of brakes are fitted, foot, hand and automatic electric, the latter short-circuiting the motor with a resistance, and employing it as a dynamo.

An electric horn switch of the "Seng" type, one of the first of this pattern in this country, is fitted to the car. It consists of a metal ring mounted underneath and concentric with the steering wheel. When the ring is touched by the fingers at any point of its circumference, the horn is immediately sounded. This is most convenient, for without looking or releasing the steering wheel, the driver can readily give a loud warning with either hand. Further, the wiring for the horn is fixed in a stationary position, and does not twist round the steering pillar as is the case with a switch mounted in the usual way on one of the arms of the steering wheel. A Sangamo ampere-hour meter is a useful part of the equipment. As it incorporates a differential shunt, the readings are automatically corrected, and when the battery is put on charge and is fully charged the pointer makes contact with a small switch which trips the main circuit-breaker, thus disconnecting the source of supply, without the necessity of an attendant standing by to switch off.

CONGESTION AT RAILWAY AND MARINE TERMINI.

BY A. JACKSON MARSHALL.

While the shortage of ocean carriers is the major reason for the present condition of things in docks and wharves, the congestion would be considerably relieved if goods were handled in an efficient manner at the termini. Because of old-fashioned methods, antiquated handling facilities and confused schedules steamers are delayed for long periods. Vessels can be rapidly loaded if cargoes are delivered properly and if they can pass through the termini with a minimum amount of delay. With the present lack of system and inefficient handling of goods this is utterly impossible. Mr. C. H. Bertz, manager of the Australian department of French, Eddye & Co., regards the shortage of pier facilities and the poor methods of moving goods in termini as the most serious problem in connection with present day commerce.

Not only export trade has been affected by the congested condition of termini, but domestic transportation suffers as well. Shortage of ocean tonnage is not responsible for the fact that local merchants are unable to get their goods through. It is estimated that there is a total of 720,000,000 tons of goods every year that passes through the railway goods and transfer stations of the U.S.A. and 600,000,000 tons handled at marine termini, making a grand total of 1,320,000,000 tons handled annually in the United States, or 4,400,000 tons every working day in the year. The present lack of system in handling and the tremendous amount of lost time involved represents a yearly loss of more than £16,000,000 at railway terminal alone.

All of the railways agree that the great obstacle to movement is the deficiency of terminal accommodations and poor facilities. No railway can be more efficient than the terminal facilities permit it to be. Railway engineers have conducted and solved the problem of the line haul, and by their skill the speed of line haulage has been increased many fold. Goods haulage by rail has reached a high point of perfection, embodying both efficiency and economy. But it is only lately that we find the application of the engineer's skill to an improvement of goods termini. With a few exceptions, these and their arrangements remain substantially the same as they were 25 years ago. With an eye to the speeding up of line haulage conditions, transportation experts have made the line itself the scene of perfection, but they have left the goods terminal, with its gross inefficiency, entirely alone. William C. Redfield, Secretary of Commerce, against accepting Railway tracks, coal hoist bridges, motive power, cars, signals, and in fact all the mechanical and engineering side of the railway proper, show the impress of the line haul of mechanical correctness. It is only when we go into the railway warehouse that we go back into the dark ages of industry. There the human worker still wages unequal rolling up an annual pay roll of millions and congesting traffic by his cumbersome motions. Here goods are moved by the crudest kind of labour, and with an apparent absence of any attempt at scientific handling. I am absolutely sure that mechanical appliances can be employed for the greater part of the work. Where are the moving platforms, the mechanical carriers and the motor trucks? We have almost wholly failed to apply to the handling of goods the principles of mechanical transferring with which we are quite familiar in other lines. We complain about our goods rates, but nobody seems to worry much about terminal charges, and yet the terminal charge is as inevitable as the carrying charge, and is by far the largest part of the entire rate. We are to-day paying goods bills without giving a thought to the fact that a part of the work for which we pay is being done in a highly scientific way, while a still larger part of it is being done by methods which it would be complimentary to call mediæval."

In comparing the cost of handling goods at railway termini with the cost of hauling by rail the following tables, developed by the Electric Vehicle Association of America, are based on figures given by Mr. W. J. Wilgus, late vice-president of the New York Central Railroad. As a concrete example, we will suppose that a manufacturer in Philadelphia sends 1 ton of goods to a merchant in New York City. From the time the goods leaves the manufacturer the Philadelphia charges are as follows:

Labour cost of loading on a wagon	$0.25
Unloading at goods station	0.50
Costs to railway in billing and other clerical work	0.40
Actual operating expense of loading and switching goods car, &c.	0.25
	$1.40

The cost of handling in New York is as follows:—

Terminal costs on New Jersey side of North River (average of all railroads)	$1.15
Lighterage	0.80
Terminal cost on water front of Manhattan Island	0.50
Cartage expenses in New York City	0.80
	$2.25

The cost of getting a ton of goods started on its journey at one end and handling it from the Jersey City terminal to the consignee's store at the other end is nearly 14 times as much as the cost to haul the goods all the way from Philadelphia to New York. To haul a ton of goods 1,000 miles from New York to Chicago costs $3, or



The Electric Stevedore.

1-Ton "G. V." Industrial Truck with dumping body supplied to A. Kenrick & Sons, West Bromwich (General Vehicle Co.).

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Because the **Edison Four-Year Guarantee** is unique and warrants the user that his accumulator shall give full rated capacity at the end of this time.

Because the Edison Accumulator is the lightest and strongest storage cell and **may be charged in less time** than any other type.

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Glasgow:— J. HALLY CRAIG, 45, Hope Street, Glasgow.

65 per cent. less than the terminal charges at both ends. In other words, it costs more to load a barrel into a car at Chicago and to unload it at New York than it does to move the same barrel between the two cities on the railroad.

The fact that drayage and terminal expenses of goods transportation is 22 per cent. more than the line haulage over 1,000 miles of rail is a condition which every effort should be exerted to remedy. No one thing alone can solve the problem. In the first place, co-operation between railways, steamship companies, trucking concerns, manufacturers and the public itself is vital.

As the connecting link between the goods terminal and the merchant, the battery-driven truck must assume the first position. One case where great improvement has recently been made in the methods of handling freight through the application of this truck is at the piers of the Chicago and South Haven Steamship Company, where the Fruit Belt Auto-Truck Express has been inaugurated. A fleet of motor trucks collect shipments of fruit direct from the farmers within a radius of 15 miles around, delivering to the steamship pier, where shipments are sorted on the docks according to the consignees, and a bulk receipt taken for all the fruit destined for each consignee, greatly facilitating delivery at the other end. By this method the farmer is saved the inconvenience of hauling to a terminal, and in addition has his fruit transferred in the cool of night, so that the produce reaches the market early in the morning in good condition. From the point of view of the steamship company this system has two very decided advantages. It opens up new business that they previously were unable to get, and it reduces the overhead expenses of handling business, as the consignments come to them in bulk instead of in smaller quantities from each individual shipper.

In places where some modern equipment has been installed, such as the electric industrial truck, a more systematic condition has resulted and a considerable economy been effected. In the railway terminals, where the electrically-propelled baggage truck has supplanted the hand truck, it is estimated that there is a total saving of 66 per cent. A report of the operation of an electric industrial truck at the Cunard pier, New York City, showed that in handling macaroni in boxes six "electric stevedores" did the work in nine hours that would have required 24 hand trucks. The cost of labour with electric vehicles was £4, while at current longshoremen's rates it would have cost for labour £18 if hand trucks had been relied upon. In handling grapes in barrels at the same dock, two industrial trucks did the work of 21 hand trucks. In handling mackerel in barrels, two electric trucks did the work of 19 hand trucks. In handling casks of wine, seven electrics with 13 men did the work of 36 men rolling the casks from one man to another. Under the method of hand-truck operation, the cost per ton of handling goods at railway terminals and steamship piers is 2s., while the cost per ton for performing the same work with electric industrial trucks is but 5d.

As the use of the "electric stevedore" increases and other modern methods and appliances are installed, it is to be hoped that this will influence a further systematised manner of delivery. As this work becomes more thoroughly unified, freight sheds and docks may find it desirable to operate on a full or partial 24-hour schedule. In cases where the limited ground space available in cities prevents the installation of mechanical carriers that would bring about economy and efficiency, the remedy which appears most feasible to the writer is the establishing of large outer platforms or warehouses where all outbound package freight could be assembled and consolidated, and where the floor movement would be performed by the electric industrial trucks. If the co-ordination of the railway and highway movement of merchandise and a collaboration of the railways and carting interests could be effected, there is every reason to believe that a powerful and efficient trucking organisation could be formed which would effect not only an enormous saving over present cost, but render greatly improved service through the employment of scientific and efficient methods of operation, and a truck-despatching system worked out along the same lines as is passenger-train despatching.

ELECTRIC BATH CHAIRS.

The prospect of quite considerable numbers of crippled and maimed men in our midst for many years to come, as one of the heritages of this terrible war, will doubtless occasion something of a boom in mechanical appliances which will contribute to their comfort and enable them to get about in the world. The electric bath chair is not unknown as a practical mechanism, and it was utilised

in considerable numbers and quite practical form at the recently held Panama Exhibition, San Francisco. In this latter case it served the purpose of pleasure rather than convalescence, and in this respect it is not improbable that there may be something of a boom in bath chairs at seaside places and health resorts.

The Elieson Electric Traction Co., Ltd., of 85, Newman-street, Oxford-street, London, W., have developed a form of bath chair in which a single ¼ H.P. motor is suitably mounted at the front of the machine, and drives on to a pair of 14 in. wheels through a 20 to 1 worm gearing. The space beneath the seat, which is readily available for the purpose, is occupied by a battery of 20 Elieson cells which weigh 78 lb., and have a capacity of 30 ampere-hours. The vehicle is suitably geared to give a maximum speed of 5 miles per hour on the level, and has a range of about 20 miles on one charge of the battery. The controller is placed at the right-hand side of the occupant of the chair, and is actuated by a minimum of effort. It is pushed forward to give a forward direction to the chair, and pulled back for reverse. It is provided with a zero position, movement beyond which applies the brake to the rear wheels.

Another battery-driven bath chair is being offered on the English market by Messrs. A. W. Gamage, Holborn, London, E.C. This machine is also fitted with a ¼ H.P. motor, but the motor is mounted below the seat of the chair and drives, through single reduction spur gearing, the offside wheel on which a spur ring is attached to the spokes of the wheel. The battery is also placed below the seat of the chair, and has a capacity of 50 ampere-hours, giving a range of 30 to 40 miles on one charge at a speed of about 5 miles per hour. The controller in this case is attached to the end of the steering pillar, which serves to move from side to side the small leading wheel of the chair. To go forward the controller is pushed to the left; the chair is also fitted with a brake which is operated by a side lever at the left hand of the occupant of the chair. This machine is manufactured by the Société Anonyme A. Tribelhorn & Cie., Feldbach, Zurich.

AN ALL-BRITISH COMMERCIAL BATTERY VEHICLE.

We have frequently suggested that excellent openings are presented to British engineers to design and manufacture in this country electric battery vehicles, both for pleasure and commercial purposes. We referred some time ago to the fact that Messrs. Ransomes, Sims & Jefferies, Ltd., of Ipswich, had undertaken the construction of the "Orwell" electric vehicles, the general design of which has been developed by Mr. P. A. Mossay. We understand that a considerable number of vehicles are now going through the company's works at Ipswich, and that orders are steadily coming in.

The vehicle is designed for front wheel drive, with two motors suitably suspended, and carried on specially designed stub axles from ½ to 4 tons. Fig. 1 is a side view of a 30-cwt. lorry which has been in the service of the Midland Railway Co. for some time past.

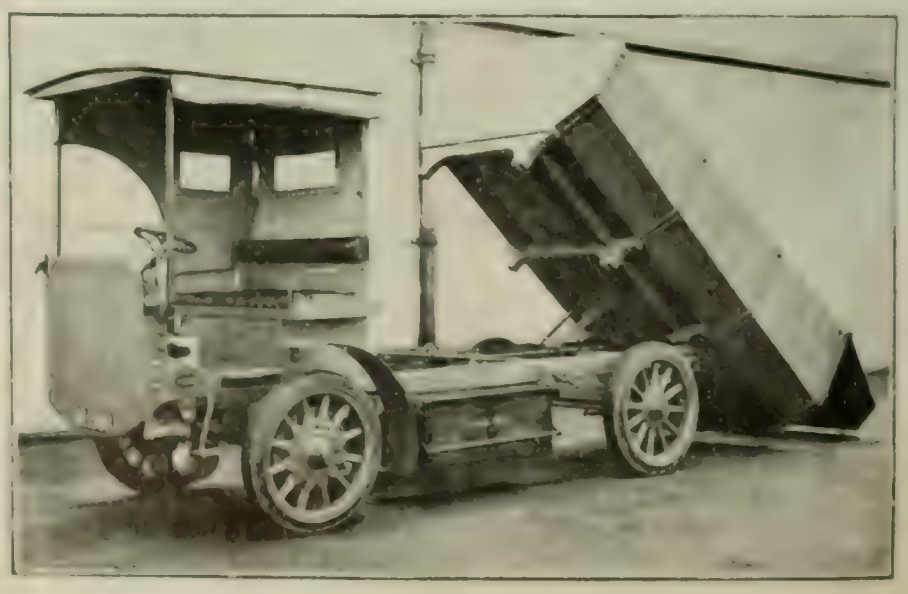
Figs. 2 and 3 show a 2½-ton tipping wagon which has recently been supplied to Wolverhampton Corporation. This vehicle is provided with a standard Orwell chassis, being driven by two 2¾-H.P. compound-wound motors, driving on the two front wheels through single reduction totally enclosed skew gearing. At a motor speed of 1,300 revs. per min. the vehicle will travel at the rate of 11 miles per hour on the level. The battery, which is divided into two parts and is underslung amidships, is made up of 40 Ironclad Exide cells giving a range of 35 miles on one charge. The controller, which forms a portion of the dashboard, is made by George Ellison, and is fitted with magnetic blow-outs. It provides five speeds forward and one reverse. The resistance grids are of the cast-iron type, and are mounted immediately below the body of the controller. The controller itself is actuated by combined foot pedal on the floorboard and radial lever mounted above the steering wheel.



Fig. 1.—30 cwt. Lorry in service of Midland Railway Co.

The design of the tipping gear is of more than ordinary interest. In the vehicle shown it is arranged for hand operation, but a small motor can be fitted for carrying out this work with energy from the propelling battery. Where such a motor is fitted the gear can alternatively be actuated by hand. For hand operation, the long transverse shaft is placed in bearings attached to the upper side of the main chassis girders, and this shaft has square ends for the receipt of the driving handles. About the centre of the shaft is a pinion which engages with a spur wheel attached to a long spindle carried from the spur wheel towards the rear of the vehicle. This shaft is furnished with two square threads, each of different pitch, that at the forward





Figs. 2 and 3.—2½-ton Tipping Wagon.

which they grip the sleeving. With this arrangement of driving differential gear is done away with, and the body of the chassis is left free for the accommodation of the battery. In the Orwell vehicles practically the whole of the electrical gear is at the front of the chassis.

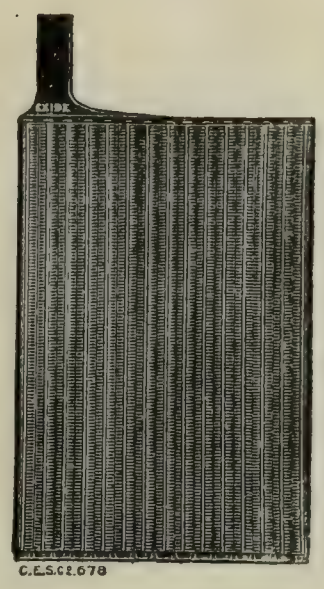
The vehicle is substantially constructed and is designed for hard-

end having three threads to the inch and that at the backward end five threads to the inch. Travelling along each thread are blocks, to each of which are attached two levers which terminate in a knuckle fixed on the underside of the wood body. These levers and the threaded shaft form a triangle which can be made flat or steep according to the position of the blocks on each of the square threads.

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illustrations is shown the method of suspending the battery from the side members of the chassis, also the ingenious arrangement introduced for the drawing out of the battery so as to give easy access to the cell connections, and also to admit of the removal of the top board during charging operations. The movement of the battery is facilitated by horizontal rollers, and by means of side levers coupled with a long tubular bar at the front of the battery box, the accumulators and their case are racked outwards from the centre to the side of the vehicle (Fig. 5).

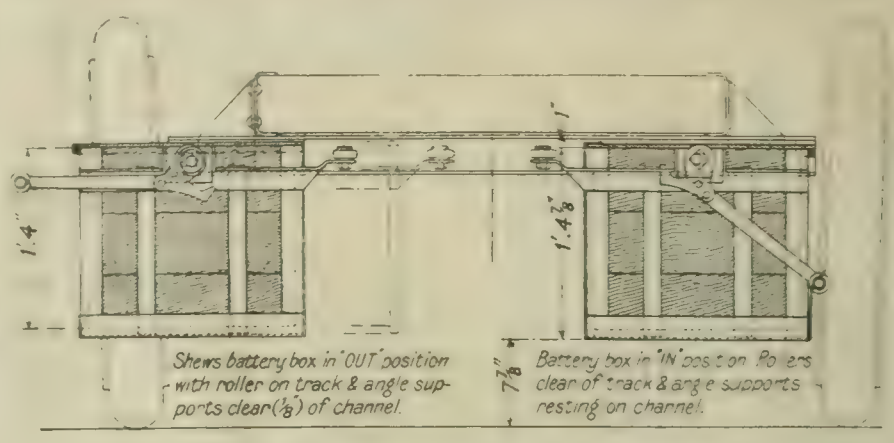


FIG. 5.—DETAIL OF BATTERY SUSPENSION.

Fuller details of these interesting vehicles, together with complete specification and prices, can be obtained from the selling agents in Great Britain and Ireland, Messrs. Mossay & Co., Queen Anne's Chambers, Westminster, London, S.W.

TIPPING DUST VAN AT SOUTH SHIELDS.

The South Shields Corporation, who were the pioneer users of electric battery 'buses in this country, have recently ordered a 2-ton Edison van with tipping body for dust collection in the district. Mr. L. Roseveare, the borough engineer, has advised the Corporation to purchase this vehicle on the score of general reliability and efficiency. He estimates that the vehicle will do the work of three horses at about the same cost per ton. The vehicle, which has recently been delivered, is found to be practically noiseless on night work, even though frequent starting and stopping are necessary. The chassis is standard Edison C.M., with battery mounted on the frame and single motor drive through flexible cardan shaft to counter shaft, and side chains to the rear wheels.

The net effect of the traverse of the threads by these blocks is to thrust upwards the body of the vehicle, and also to travel backwards the point at which the levers are attached. Suitable side rollers and guides are also fitted to the body to take up the rolling friction. This is an extremely simple and easily maintained form of tipping gear (Fig. 4).

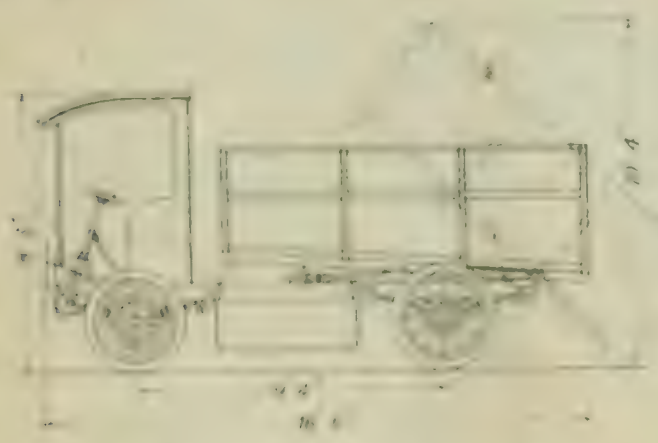


FIG. 4.—SIDE VIEW OF TIPPING BODY.



SOUTH SHIELDS DUST VAN SHEWN TIPPED.

The body fitted to the vehicle possesses a number of interesting features. It is wider at the back than at the front, and is also tapered from back to front. The bottom is set on a 5 per cent. grade, so that refuse and other material thrown into the body tends to move towards the back. This movement is accelerated by the jolting of the vehicle when in motion. Water, which also forms a not inconsiderable portion of town refuse, flows towards the rear of the body, and can drip out at the back quite clear of the chassis and frame. By this simple means the chassis is protected against rust, which is usually set up when moisture can drip through on to the metal parts. In the standard tipping vehicle the back of the body is no higher than 6 ft. 3 in. from the ground, and this height is sufficient to admit of loading operations without the use of a ladder. In the Wolverhampton vehicle the sides are hinged so that they can be raised and made extra high to accommodate ashes, for the sorting of which the vehicle is also employed. In one of the

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